JCAB Activities and Considerations

On RNAV Flight Inspection

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ABSTRACT

Many aviation users have equipped their aircraft with RNAV systems including FMS as primary navigation, resulting in the increased demand for the introduction of RNAV routes. Under such circumstances, ICAO published PBN manual (ICAO Doc. 9613 Performance Based Navigation Manual), and the some countries have been introducing RNAV flight procedures into their airspace.

Japan Civil Aviation Bureau (JCAB) also has introduced RNAV routes into Japanese airspace according to the PBN manual and PANS-OPS (ICAO Doc.8168 Procedures for Air Navigation Services - Aircraft Operations). At the same time, JCAB Flight Inspection established Flight Inspection criteria to check RNAV routes and introduced special inspection software to deal with new technology. Then JCAB started Flight Inspection on RNAV routes, especially DME/DME route, from spring in 2007.

When Flight Inspectors conduct RNAV Flight Inspection, it is possible that they may encounter many difficult aspects as compared to conventional Flight Inspection. So they might need to change their mind against new flight procedure.

In our presentation, we will show our activities on RNAV routes and we would like to suggest some issues based on our experiences of RNAV Flight Inspection, and then seek many opinions from audiences. We hope that our presentation can be useful information for many countries that are planning to start Flight Inspection on RNAV routes, and it is our great pleasure if our presentation can be useful thing to the related documents, such as each country's manual or ICAO documents.

INTRODUCTION

In Japanese domestic airspace, three RNAV routes were published for en-route use in 1992, and where authorized for trial operation. In 1995, provisional working standards for RNAV operation were established and this trial operation was shifted to operational use for evaluation by aircraft which conformed to these standards.

The number of these routes was gradually increased, and finally formal operations were authorized in 2002.

Meanwhile in terminal airspace, FMS Arrival Route using FMS was published for arrival aircraft to Tokyo International Airport during the middle of the night and provisional operation was started in 1999. Furthermore RNAV STAR (Standard Terminal Arrival Route) were increased to support an additional 5 domestic airports in 2004.

The RNAV routes published as en-route portion were set within the range where 2 or more DME stations could be received, and its position was determined within an error of ± 4NM for the aircraft which could fly between

waypoints only under the RADAR monitor environment. Also FMS Arrival routes were set within the range which the aircraft equipped with FMS could make RNAV flight by DME/DME.

Concerning these RNAV routes, JCAB Flight Inspection had verified DME reception, ground obstruction, and fly-ability etc. However at that time, concerning DME reception we only verified whether the number of DMEs was more than 2, and we had not taken into account the inclusion angle between DMEs which affect position accuracy.

Similarly RNAV Arrival/Departure route had been set in some other States and/or region, however these procedures required each operational approval standards by each States and/or region. It was not harmonized internationally.

Accordingly, the RNP Special Operational Requirements Study Group (RNPSORSG) was organized by ICAO in order to unify terms and definition on RNAV, to promote RNAV implementation which is harmonized internationally and also to show the directivity of future RNAV operation. The RNPSORSG was working to revise the previous RNP Manual (ICAO Doc.9613) from 2004. Then at length PBN Manual was published in 2007 as a result of their activities. Director for International Policy Coordination of JCAB participated in RNPSORSG as one of the core members, and it goes without saying that he actively worked for the development of the PBN Manual.

RNAV INTRODUCTION PROCESS IN JAPAN

In parallel with the activities for the development of PBN Manual in RNPSORSG, JCAB was developing RNAV Roadmap to show RNAV implementation plan of Japan. Also using PBN Manual for reference, the preparation work to work out the national regulations concerning RNAV (e.g. Operational Approval Standards etc.) was forwarded in JCAB. Simultaneously the preparation work to obtain RNAV operational approval for aircraft was forwarded in Airline Company in Japan. Based on the issue of the PBN Manual from ICAO in 2007, RNAV operation in accordance with ICAO guidance was begun in Japan. The reason why JCAB waited for the issue of the PBN Manual was that we should introduce RNAV which was harmonized internationally into our country.

On the other hand, concerning establishment of RNAV route/procedure, basically existing Japanese original RNAV route/procedure where navigation accuracy had not been specified was shifted to the RNAV route/procedure based on the ICAO PBN Manual. Furthermore, JCAB Flight Procedure Design office designed new RNAV route/procedure based on JCAB flight procedure design criteria which had been in conformity with the ICAO PANS-OPS by using a Flight Procedure Design tool which had been newly introduced into the airport/airspace where operational efficiency will be improved and the rate of aircraft having appropriate RNAV performance is higher.

Also JCAB Flight Inspection established RNAV Fight Inspection criteria based on the ICAO PBN Manual and the ICAO PANS-OPS. Then in order to make it meet a requirement of ICAO PBN Manual, we re-verified the inclusion angle of receivable DMEs on all of existing Japanese original RNAV route/procedure for which navigation accuracy had not assigned.

At the same time, we verified the receivable condition of each DMEs on new RNAV route/procedures proposed by JCAB Flight Procedure Design office as considering the Inclusion Angle between DMEs of (30~150).

(1) Establishment of RNAV Roadmap

JCAB RNAV Roadmap was published in April 2006 in order to show introduction and development plan for middle/long term into Japanese domestic airspace. To establish this Roadmap, much discussion was made by all interested aeronautical parties in Japan including Airline Company, Pilot association, Electronic Navigation Research Institute and so on.

This Roadmap was described in order to accomplish following goal taking account of operator's demand, Airline's aircraft performance, traffic density around airport/airspace and working process for establishing ICAO guidance etc. This Roadmap was described dividing into 3 phase of Short-term (FY2005~FY2007), Medium-term (FY2008~FY2012) and Long-term (FY2013~), also dividing into 2 part of en-route portion and terminal portion.

- ✓ Short-term: Introduction and development of RNAV route for the purpose to improve operational efficiency mainly.
- ✓ Medium-term: Expansion of airspace capacity corresponding to the Phase 2 Project at Kansai International Airport and the Further Expansion Project at Tokyo International Airport.
- ✓ Long-term: Direction for future RNAV operations which Japan should aim at.

Afterward, this RNAV Roadmap was revised based on the ICAO PBN Manual, then re-issued as Version 2 in April 2007. The purpose of its new RNAV Roadmap is following.

- ✓ Short-term: Early achievement of improvements in operational efficiency by

introducing RNAV that meets globally harmonized standards.

- ✓ Medium-term: Improvements in operational efficiency by increasing the airspace capacity step by step in response to the Phase 2 Project at Kansai International Airport and the Further Expansion Project at Tokyo International Airport.

- ✓ Long-term: Direction for future RNAV and RNP operations for Japan.

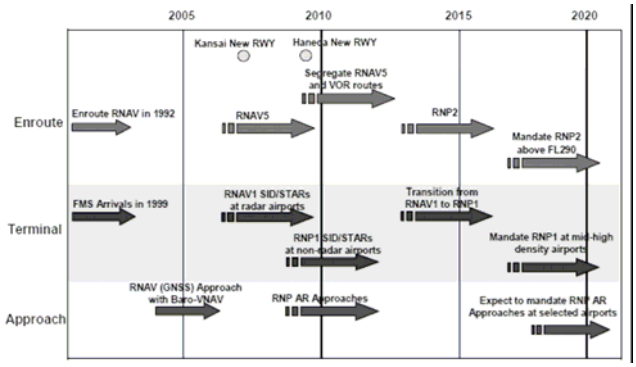

Figure 1: RNAV Implementation Plan

This version of JCAB RNAV Roadmap is available at "http://www.mlit.go.jp/koku/english/06_airtraffic/img/rnav_roadmap_2007.pdf"

Figure 2: Cover page of JCAB RNAV Roadmap Ver.2

(2) Foundation of RNAV Implementation Team

For the realization of an RNAV Roadmap that had been already published, "RNAV Implementation Team", which aimed for the making of basic guideline harmonized with the people concerned, the making of the implementation plan and the development of standard and/or criteria, was founded in October 2005 in JCAB headquarters.

"Director for International Policy Coordination" was assigned as a team leader for this Team, and also this Team consisted of "Air Traffic Controller", "Flight Procedure Designer", "ATS Engineer", "Airline representative", "Flight Standards" and "Flight Inspection". The intensive activity was carried out in this Team for one year.

The environment where the person having different viewpoint sat side by side in the same room made it possible to discuss at all times. That atmosphere was considered most suitable for the pace and complexity of this work.

Figure 3: Lineup of RNAV Implementation Team

(3) Introduction of Flight Procedure Design Tool

JACB Flight Procedure Design office had designed flight procedures/ATS routes based on JCAB flight procedure design criteria referring to ICAO PANS-OPS amendment 2 as adopting FAA TERPS (FAA 8260.3 United States Standard for Terminal Instrument Procedures) for about 30 years.

However, in order to introduce new RNAV route/procedure which is harmonized internationally in ICAO, JCAB Flight Procedure Design office decided to re-enact their Flight procedure design criteria according to the latest ICAO PANS-OPS. At this moment new RNAV route/procedure is designed according to these new criteria.

In addition, JCAB Flight Procedure Design office introduced a new Flight Procedure Design tool to cope with re-enactment of the above-mentioned flight procedure design criteria and to deal with huge workload for designing the new RNAV routes/procedures which are anticipated to rapidly increasing in the future.

To conduct RNAV Flight Inspection mission, Flight Inspection office also introduced the same Flight Procedure Design tool and connected it on line with Flight Procedure Design office due to following reason.

- ✓ To share information with Flight Procedure Design office, for example, facility information, obstruction

information, geography information, simulation of DME pair information, result of re-analysis of the DME reception information and so on.

- ✓ To minimize the error of the data which are required for Flight Inspection.

(4) Work Process for Transaction of RNAV Flight Procedure

Although as of today application software to analyze DME/DME surroundings on RNAV route has not introduced yet, from now on we will intend to exchange data electrically on line between Flight Procedure Design office and Flight Inspection office by making the best use of above mentioned "Flight Procedure Design tool" in accordance with the following Steps.

- ➢ Step 1: Proposal of RNAV Route or Procedure including candidate DMEs proposed from Procedure Designer to Flight Inspection
- ➢ Step 2: Check DME/DME surroundings by Flight Inspection aircraft
- ➢ Step 3: Result of confirmed DME/DME reception from Flight Inspection to Procedure Designer
- ➢ Step 4: Screening DME/DME surroundings considering mutual angle（30 ° ～150 °） between DMEs by procedure design tool
- ➢ Step 5: Depending on Step 4, back to Step 1 or Publication of AIP

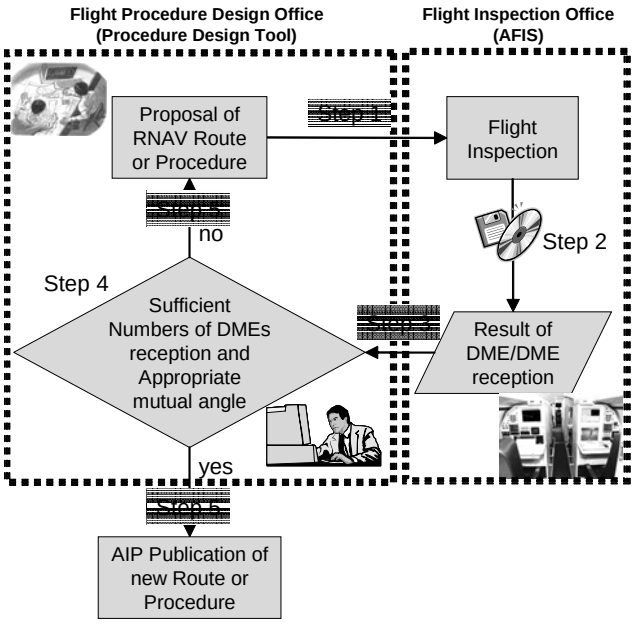

Figure 4: Work Process

FILGHT INSPECTION ON RNAV ROUTE

Generally, RNAV system on an aircraft is using IRS, GNSS, DME/DME and VOR/DME as a navigation sensor. Among those sensors, the main subjects for RNAV Flight Inspection might be GNSS RNAV and DME/DME RNAV routes. In advance of checking them, it needs establishment of Flight Inspection criteria and making of Flight Inspection system. Therefore, JCAB established the Flight Inspection standard for RNAV inspection procedure before starting its inspection flight, as considering consistency related documents which were developed by RNAV Implementation Team in JCAB. At the same time, JCAB examined the countries conducting Flight Inspection on RNAV route already to get knowledge and discussed technical matter about our Inspection system with the manufacturer.

Hereinafter, we focus on the DME/DME RNAV route which may be specifically complicated task in the above mentioned two RNAV routes and we want to show our Flight Inspection method which was started from April in last year.

(1) Different points between conventional Flight Inspection and RNAV Flight Inspection

Compared to the conventional jobs of simple substance such as NDB, VOR/DME, ILS inspection, etc, we had thought “what we should consider for DME/DME Flight Inspection”. Those are as follows;

a. Need to check many DMEs simultaneously if possible (otherwise, Flight Inspectors are obliged to fly on the same route over and over again!)

b. Need to confirm whether DME/DME pair can be made according to international standard, even if the signal itself was good (confirmation of DMEs surroundings which would be the base of navigation solution in air)

c. Need to confirm whether there occurs Critical DME on the route, as well as the confirmation of a good DME/DME pair. If such case happened, it is needed to specify the name of Critical DME and determine its range.

d. Need to confirm whether there occurs DME gap on the route. If such case happened, it is needed to determine its range, because DME gap can be allowed on RNAV route depending on a type of RNAV route.

e. It is crucial to assess DME surroundings with Flight Procedure Design tool or simulator before and after actual inspection flight (DMEs checked by Flight Inspection should be the identical DMEs assumed by the tool or simulator).

The above contents are very important not only to make an Inspection System but also to think about link with Flight Procedure Design tool. Especially, the above item b is a point of vital importance. The reason is that DME/DME pair can not be made on the route in the case of unsuitable for those related angle, even if each DME signal conforms to ICAO ANNEX10. In the wake of that, the strange case, "DME/DME RNAV route is unsatisfactory though each DME signal is satisfactory", may happen possibly. Therefore, although it is right for Flight Inspector to check the signal of DME itself, the more important task for us is to confirm existence of the right DME/DME pair on RNAV route. In conventional Flight Inspection, there had not been such additional job. In other words, we can say its task, as "With procedure design tool, Flight Procedure Designer predicts and assesses airspace surroundings where RNAV system is supposed to work properly and then Flight Inspector verifies the environment by Flight Inspection aircraft".

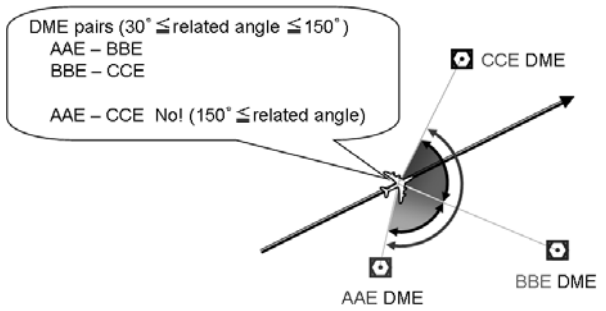

Figure 5: Example of DME/DME pair

However, Flight Inspection executes the mission only to check DME signal and collect DME data, then the duties can entrust overall judgment to Flight Procedure Design tool depending on the positioning of its tool. Although it is important for countries to have sound policy on the role of the simulation tool and Flight Inspection, it is essential that both of them always carry out the complicated works together in RNAV world. JCAB has organizational structure to assess and inspect in the same environment even if it is conducted under the simulation tool or Flight Inspection system. Especially, JCAB Flight Inspection is executing inspection flight as focusing on "the number of suitable DME/DME pair, extraction of Critical DME from good DMEs, DME Gap, etc."

(2) Flight Inspection system for RNAV route

On upgrading our Flight Inspection system to cope with RNAV route, we studied about several things based on the above contents. Those are as follows;

a. What equipment is needed for RNAV Flight Inspection? Can we use our equipments we are using now? Do we need to install new equipment into our Inspection System?

b. How should we determine the specification of software for RNAV Flight Inspection?

c. How should we link the Inspection System with Flight Procedure Design tool?

We studied technical matter based on the above things. Consequently, we found that we can use current equipments as installed and cope with RNAV Flight Inspection only by upgrading of the Inspection software. One of the key points to make a compact hardware is how many DME facilities we can tune to simultaneously, with one Inspection DME TRX. Our DME TRX, scanning-DME, was capable of tuning up to five DME facilities, so we could configure our Inspection system as follows. However, we might think about modification of our system depending on the movement of future international standards.

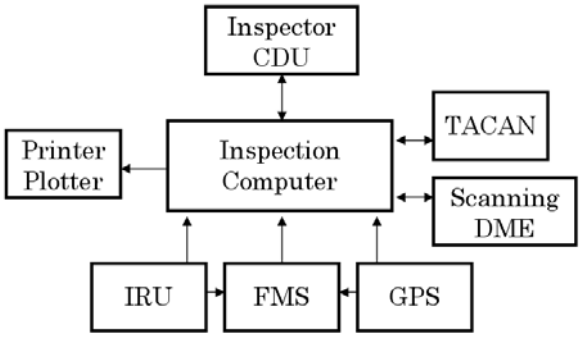

Figure 6: Schematic diagram of the DME/DME RNAV Inspection system

(3) JCAB regime for introducing RNAV route

The figure shows basic regime in JCAB from planning to publication of RNAV route. Basically, it may be similar to JCAB regime, even if a country has introduced RNAV route already or a country is planning RNAV route in future.

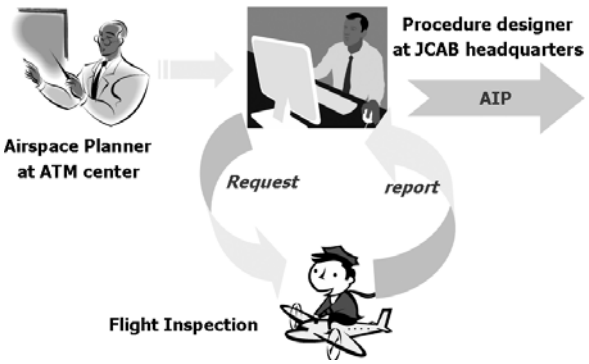

Figure 7: RNAV organization in JCAB

It is possible that RNAV route would be set efficiently without dependent upon constellation of ground facilities.

Although RNAV route can have flexibly such as avoiding obstacles or dense resident area, possibly, that could not guarantee good DME surroundings. In that case, Flight Procedure Designer may modify the route or abandon the establishment of the route itself. So it is essential that the relationship between ATM center, Flight Procedure Designer and Flight Inspector must be taken closely.

(4) Preparation before conducting RNAV Flight Inspection

Once Flight Procedure Designer designed RNAV routes, those are passed to Flight Inspector with the details for the database. The database, content for inspection flight include such things as route information, waypoints list, obstacles information, altitude on RNAV routes, rate of climbing or descending, airspeed, and so on. Unfortunately, JCAB is now upgrading software of the new Flight Procedure Design tools introduced into ATM center, Flight Procedure Design office and Flight Inspection office to a special version, so JCAB Flight Inspectors are making the candidate DME lists by map tool which is being used for Flight Inspection mission. Although this map tool was made originally, with the ability for data entry and were input into the tool such as facility data, topography data, aircraft performance data and logic software to select the right DMEs over RNAV routes. The data being used by the tool is updated constantly to contain the latest available data.. And the logic to select the candidate DMEs and DME/DME pair is based on the descriptions of ICAO PBN manual, etc. However, the method of selecting DMEs in this tool can not generate all candidate DMEs assumed to be used in all types of FMS all over the world. If DMEs were selected based on each type of FMS logic, we can not deny that a variety of DME list may be output from the tool or simulator. But, as a minimum, the important thing to service providers is that DME list should be generated based on the description of ICAO PBN manual. And it means “confirmation of airspace environment where RNAV system may work properly”, provided that the inspection flight is done based on the DME list.

When we create candidate DME list with the map tool, if needed, we can specify not only route information but also climb rate, descent rate, speed, and aircraft weight as requirements. Once requirements were entered into map tool, the tool generates candidate DME list and the best combination of DME/DME pair automatically. Needless to say, the candidate DME list and DME/DME pair is being changed depending on the position of airplane on routes, so the DME list is made based on its position on RNAV route. The following is a sample of candidate DME list which map tool assumed based on the airplane position.

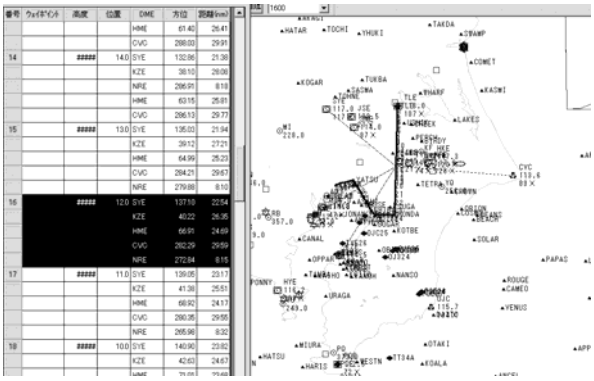

Figure 8: Sample of DME list generated by JCAB Flight Inspection map tool

The route section shown with blue line on the above sample means there are DME/DME pairs properly, and there is no critical DME and no DME Gap. If critical DME or DME Gap happened, the section indicating critical DME is shown with orange line, and the section indicating DME Gap is shown with red line. At this point in time, there may be the case that Flight Inspector needs to talk about changes of route structures or altitudes with Flight Procedure Designer depending on the demonstration by simulator before actual inspection flights. Of course, the color of the route section could change in the re-assessment with the tool after the actual inspection flight, in the case of admitted bad DME condition. We would like to mention those tasks in the following section, (7) Re-assessment after RNAV Flight Inspection. And the map tool can convert the original DME list generated by the tool into special format which can be read by Flight Inspection system.

(5) Actual Flight Inspection on RNAV route

Once the DME list file was prepared, we can conduct the actual Flight Inspection. But, be sure to confirm NOTAM. The reason is that Flight Inspector might confuse why the DME TRX could not detect the targeted DME facility, for instance, it was not in service due to maintenance? or it was outside of the coverage really? After the above confirmation, then Flight Inspector can start the actual inspection flight.

First, Flight Inspection System operator downloads the DME list file into the Inspection system when he or she boards the Flight Inspection aircraft. In addition, the Flight Inspection pilots enter the detail of RNAV routes into FMS, for example, coordinates of WPs, altitude, speed, etc. then they confirm whether the values calculated in the FMS are identical with the contents designed by Flight Procedure Designer. If there is no doubt, finally, on Flight Inspection Display, Flight Inspection System operator makes sure of whether the flight plan based on the DME list is same as the flight plan made in FMS.

During inspection flight, AFIS automatically analyzes signals in space for each DME facilities based on the DME list file, and also calculates PEE, Position Estimate Error, according to the optimum DME/DME pair. The following figure shows the sample of inspection screen on our AFIS of SAAB2000 aircraft.

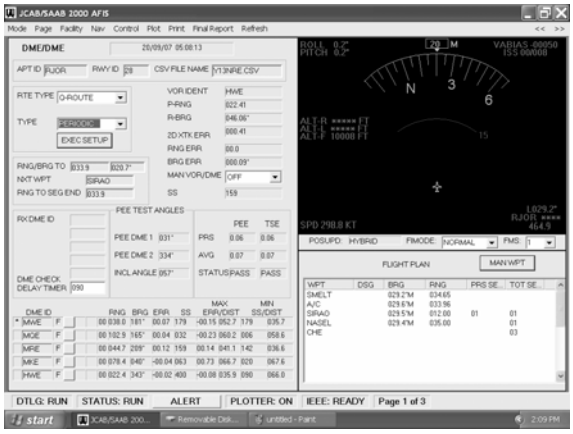

Figure 9: Sample of Inspection Display

As for Flight Inspection procedure to collect DME data, basically, we are collecting those data on the center course. However, in addition, we are also checking the data on both of edge of primary area, in the case of terminal RNAV route "RNAV1 type". The reason is in order to confirm DME coverage for the whole route. Concerning whether Flight Inspector should check the DME coverage on the edge of primary area or not, we understand its flight causes us to bring up a variety of arguments. And if Flight Inspection aircraft flies on the edge, as everyone knows, its flight needs close attention. Because, the off course flight could carry many risks, compared to center course flight. About this matter, we state the detail in the section of "Issue and Consideration for RNAV Flight Inspection". Do not make a mistake, while we are flying on the edge is not only for confirmation of DME coverage but also verification of obstacles clearance around the RNAV route.

Once we finished the inspection of DME signal and DME/DME pair, synthetically, we are also flying its RNAV route by autopilot, as flyability check. Needless to say, it is impossible to judge "flyable or not" with only one type of Flight Inspection aircraft. However, our pilots possibly verify the flyability check as setting air speed, climb/descend rate, turning radius, and so on. The above numerical values set during flyability check are the values calculated by Flight Procedure Design tool. Of course, if there is no special instruction on the chart, our pilots use the maximum value allowed in the terminal area. These values are very important to verify the clearance against obstacles existing under the RNAV route. Depending on the results of this flyability check, sometime we might find new circumstance which was not predicted in the simulation. In that case, we are again discussing the route design carefully with Flight Procedure Designer.

About RNAV route in terminal area, RADAR service and air-to-ground communication are essential under JCAB rule, so we are checking the coverage on RNAV route. Therefore, there could be a rare case that the altitude of RNAV route is raised depending on the condition of coverage.

(6) JCAB criteria on RNAV route

The following table shows JCAB criteria about main Items and Tolerances for DME/DME RNAV route.

Table 1: Inspection Items and Tolerance

Item	Tolerance
Data Base Integrity	Distance: within0.1NM Bearing: within 0.1 degree ※between WPs
DME error	Within 0.2NM for locked DME
DME pair	More than 1 pair. 30 degree ≦related angle≦150 degree
Critical DME	If yes, report the facility name & range to Flight Procedure Designer.
DME Gap	If yes, report the range to Flight Procedure Designer.
Specific DME	Report the DME to Flight Procedure Designer. ※Specific DME; Have a deterious effect on navigation solution
Communication and RADAR	Within coverage ※RADAR; if RADAR service required
Flyability	Flyable
Other	DME signal strength PEE & TSE VOR signal, if needed GPS signal

In the above table, the DME error "within 0.2NM" is not coincide with the criteria in ANNEX 10, Doc 8071 and EUROCONTROL documents. Why JCAB is adopting

this value is that we are considering the raw DME distance output from Flight Inspection system. That means the raw DME distance includes distance error of DME signal and internal error of Inspection System such as error of DME TRX itself. If we can remove the internal system error from the raw distance, we might change this tolerance to a decreased value. However, we are thinking that it is not easy to remove the system error like DME TRX error itself compared to VOR Bearing error, because the DME error may fluctuate depending on a distance between DME facility and airborne DME TRX. Now ICASC is also discussing this issue, so we might change the tolerance according to International movement.

Concerning the decision about DME error during inspection flight, it is very important to judge carefully, especially in case of out of tolerance. The reason is Flight Inspector must decide whether the cause came from signal error, interference, multi-path or wrong Database. Mostly, it results from mistakes in coordinate "WGS-84 Latitude, Longitude and Height of DME station". A point of vital importance in RNAV world is to confirm the reliability of Database based on WGS-84.

(7) Re-assessment after RNAV Flight Inspection

As we mentioned before, JCAB is now upgrading the software of the new tool to a special version. So, after inspection flight, we are again evaluating the route on the map tool being used in JCAB Flight Inspection office.

First, we are revising the candidate DME list according to data of each DMEs admitted during the inspection flight, then we are re-assessing the route in the map tool with the revised DME list. With this re-assessment, we can find whether there is critical DME and DME GAP on the route. According to the result of re-assessment, we are talking about whether the route should be modified or not with Flight Procedure Designer. Of course, there is the case that we need to check the modified route again. The following figure shows a critical DME happening on a part of route at the re-assessment.

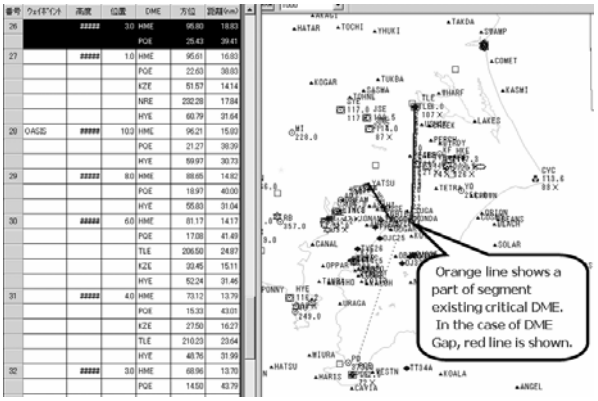

Figure 10: Re-assessment after flight

(8) Report to Flight Procedure Designer and Periodic Flight Inspection

Once we finished a series of the above task, we have to report the result including the advisability of RNAV route to our Flight Procedure Designer. The contents we are reporting to Flight Procedure Designer are as follows;

a. List of available DMEs on each segment

b. Name of critical DME and the area where it happened

c. Area where DME gap happened

d. Unsuitable DME station which may deteriorate position solution

e. Comments on Flyability

Based on this information, JCAB Flight Procedure Designer finally moves draft AIP to a public announcement process.

And, if the surroundings under RNAV route where changed, we can assume an impact on DME coverage and Flyability. For that reason, we are planning to conduct periodic Flight Inspection at least once in a year for the published RNAV routes. Sometime, the route minimum altitude might be raised due to new obstacles and so on.

ISSUES AND CONSIDERATIONS ON RNAV FLIGHT INSPECTION

Almost one year has passed since we started Flight Inspection of RNAV route based on ICAO PBN manual and PANS-OPS. However, the more we have experienced RNAV Flight Inspection, the more we have encountered a variety of issues or comments from our staff. Among them, we would like to show the main issues and considerations we are now discussing in JCAB Flight Inspection.

a. How should we deal with the case in which we found the out of tolerance on DME signal or un-locked condition in a very short period? Of course, we are performing the flight to confirm those situations two or three times.

   We are judging those unique conditions to be no problem in the case of RNAV5. In the case of RNAV1, terminal RNAV route, the judgment depends on the condition. For instance, if good DME/DME pair can be made without the bad DME, we decide its RNAV1 route is OK. However, if any DME/DME pair could not be made without the inappropriate DME, we tell those conditions to

JCAB Flight Procedure Designer and ought to ask him to modify the route structure or abandon the publication.

b. Should we check DME coverage not only on center course but also on edge of route?

Basically yes, it is not always that we, or even if it is airline aircraft, are flying on center course. In other words, everyone is not flying on the same line, in the case of RNAV route. And also, safety of flight is guaranteed as long as pilot flies his or her aircraft within protected airspace. From the point of these things and the definition of Coverage, we are thinking it is better for Flight Inspector to check DME signal as to whole route including edge of the route. However, we think Flight Inspector can check the signal on only center of the course, if the simulation tool can expect the signal coverage within the protected airspace exactly. Do not make a mistake. We want to quit checking the signal on the edge of route if we can find reasonable theory that we can omit the risky flight from RNAV Flight Inspection flight. ICASC is discussing whether Flight Inspector should check the signal not only on center but also on edge. So we want to look at the current of international opinion for a while.

c. Every type of RNAV system is supposed to select DME/DME pair from DMEs checked by Flight Inspection or simulation tool?

The answer to that is NO! Basic logic in RNAV system such as FMS is similar among them. However, the detail of selection method depends on how manufacturers make the software. And also, if the aircraft has two FMS systems, the selected DME in the primary FMS might be subtly different from one selected in the second FMS or the method of selection might differ depending on direction of flight. We express it again, the important task in RNAV world is "Assessment and verification of airspace surroundings where RNAV system is supposed to work properly". To do that, Service provider needs to let the simulation tool reconcile the basic specification with International standards such as ICAO PBN manual.

d. A check on flyability of RNAV route can be judged only by Flight Inspection aircraft?

Of course, it is very difficult to check on flyability of RNAV route with one type of aircraft as considering every performance of each aircraft. However, there is a case that simulator tool can not predict without actual flight. For example, any comments from Flight Inspection pilot are very important to evaluate the relation between route and obstacles. JCAB Flight Inspection is conducting a check on flyability in consideration of design data as possible. Sometime we are checking on flyability several times as using not only one type of inspection aircraft but also other type "propeller type or jet type aircraft" depending on route design. In addition to the check on relation between obstacles and route, there are many important things. For example, whether altitude change is acceptable? whether turning angle between legs is reasonable? whether the portion of final phase connected with ILS approach course has enough length? and so on.

CONCLUSIONS

Flight Inspection on RNAV is demanding high intelligence and sophisticated knowledge for Flight Inspector to judge the route. Because, with only checks on signals of conventional navigation aids separately, it seems that Flight Inspector can not judge the route. So Flight Inspector may need to get not only knowledge of each navigation sensor but also knowledge of aircraft performance flying with RNAV route. And also, Flight Inspector needs to be familiar with the design criteria of RNAV route, because the judgment on RNAV route depends on the type of RNAV routes, such as RNAV1, RNAV2, etc.

On the other hand, when each country thinks about preparation of Flight Inspection aircraft and system for RNAV Inspection, the type of them depends on its purpose. In a word, it depends on whether it is used for only check on signal of navigation aids or whether it might be used for not only check on signal but also flyability checks. At any rate, even if Flight Inspectors want to check on only signal on RNAV route, it seems that the Flight Inspection aircraft needs to have RNAV system like FMS. The reason for that is necessary for Flight Inspection aircraft to fly RNAV routes precisely.

Figure 11: JCAB SAAB 2000 Cockpit

From now on, the more countries who gain experience with RNAV Flight Inspection, the more various opinions would be brought out. It is a good policy to continue having more discussions on this subject to decide proper policy of Flight Inspection. Especially, it is preferable to have positive mind for challenge to new technology. It is our great pleasure to have provided the content showed here and can be a useful reference to each country. However, we express it again, Flight Inspector must have knowledge about ground facility and avionics, and also be familiar with performance and operation of high technology aircraft. In other words, Flight Inspectors have to change an attitude to face RNAV world.

FUTURE WORK

As we introduced here already, we are using the map tool being used in JCAB Flight Inspection for assessment on DME coverage. In the near future, the new Flight Procedure Design takes the place of the current map tool. It means JCAB ATM center, JCAB Flight Procedure Design office and JCAB Flight Inspection are connected each other online. So each office can exchange RNAV data in the same circumstance and this new framework prevents us from making a mistake in data exchange. And also, we think we can cope with the growth of RNAV routes promptly compared with the current map tool.

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Biography of Mr. Yutaka Oikawa and Mr. Yoshiyuki Sasaki

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Mr. Yutaka Oikawa

Mr. Oikawa graduated from Aeronautical Safety College in 1984. His major was Aeronautical Electronics. After graduation from the college, he had been working as an ATS engineer for operation and maintenance of Aeronautical Radio facility on the ground for about 10 years.

In 1994, Mr. Oikawa was assigned as Flight Inspector at Japan Civil Aviation Bureau. He is conducting Flight Inspection with Gulfstream-IV and Global Express aircraft.

He has also been in charge of maintenance and improvement of Flight Inspection System on board mainly. In the meantime, he belonged to RNAV Implementation Team in JCAB as one of team members for one year from 2005.

Mr. Yoshiyuki Sasaki

Mr. Sasaki graduated from Aeronautical Safety College in 1985. His major was Aeronautical Electronics. After that, he was working at domestic airports as an ATS engineer and maintaining ILS and VOR/DME.

In 1990, Mr. Sasaki was assigned as Flight Inspector at Japan Civil Aviation Bureau. He is conducting Flight Inspection with Gulfstream-IV and SAAB 2000 aircraft.

From 1996, as an Instructor and Checker, he has taught Flight Inspection methods to trainee including foreigner from Asian countries. From 2005, he is developing Flight Inspection criteria and methods for new CNS and RNAV procedure. Since 2005, Mr. Sasaki has been ICASC member.