This paper presents report on Agenda Item 5 from the sixteenth meeting of the All Weather Operations Panel (AWOP/16) with includes the results of the discussions on the future utilization of the band 108-117.975 MHz by the various elements of the Aeronautical Radionavigation Service. The information herein has been reviewed by the Air Navigation Commission.

WG B/D are invited to consider this information as required.


Agenda Item 5: Miscellaneous topics

5.1 INTRODUCTION

5.1.1 Under this agenda item, the meeting addressed the following topics:

a) co-ordination between microwave landing system (MLS) and non-geostationary (NGSO) fixed-satellite system (FSS) feeder links in the 5 GHz band;

b) draft amendments to MLS Standards and Recommended Practices (SARPs) and guidance material in Annex 10;

c) new definition for classification of approach and landing operations;

d) future utilization of the 108 - 118 MHz aeronautical radio navigation band;

e) modelling of navigation systems; and

f) future work considerations.

5.2 CO-ORDINATION BETWEEN MLS AND NGSO FSS FEEDER LINKS IN THE 5 GHz BAND

5.2.1 The meeting reviewed the draft new recommendation 4A/XM, which was referred to ICAO by the International Telecommunication Union (ITU) for comments. The recommendation addressed co-ordination distances between microwave landing system (MLS) stations and NGSO MSS feeder link stations of the fixed-satellite service operating in the Earth-to-space direction.

5.2.2 The meeting noted that the recommendation needed to be amended in the following areas:

a) unnecessary sections were to be deleted;

b) factually incorrect material needed to be amended;

c) the text needed to be perfected in order to clearly and unambiguously define the conditions and methods for determining the co-ordination distance; and

d) the recommendation needed to identify that co-frequency band sharing was not addressed and that the terms "in-band" and "out-of-band" interference referred only to interference from stations in the fixed-satellite service operating in frequency bands above 5 091 MHz and MLS operating in the band 5 030 - 5 091 MHz.
In-band interference was referred to as any unwanted emission from FSS stations into the band 5 030 - 5 091 MHz and out-of-band emissions were referred to as emissions outside this band.

5.2.3 The following major issues with respect to the ICAO agreed protection requirements concerning the technical and regulatory aspects of the recommendation were identified:

a) the maximum permissible interference level at the MLS receiver input;
b) the bandwidth within which this interference level is to be measured;
c) the bandwidth consideration determining the permissible out-of-band interference;
d) the maximum level of permissible out-of-band interference;
e) the need to include NGSO MSS feeder link stations operating in the band 5 150 - 5 250 MHz in the co-ordination process;
f) the methodology to calculate the required separation distance, including the effect of path-losses beyond the radio horizon; and
g) the need to protect all frequencies in the MLS band from 5 030 - 5 091 MHz from interference from NGSO MSS feeder link stations.

5.2.4 The meeting noted that various amendments were necessary in order to incorporate ICAO's concerns. It was agreed that general material, as provided below, was required to explain the rationale for these amendments.

5.2.4.1 The maximum permissible interference level at the MLS receiver input. The meeting confirmed that the maximum permissible level of in-band interference into the MLS receiver was -130 dBm in the reference bandwidth. This value was based upon several considerations, for example, a receiver sensitivity of -120 dBm and a margin of 10 dB.

5.2.4.2 The bandwidth within which this interference level is to be measured. The meeting agreed that the bandwidth within which the interference level as in a) above needed to be measured was 150 kHz. The ITU observer could not agree to this value and preferred to refer the interference to a 26 kHz bandwidth. It was pointed out to the meeting that the need to measure the in-band interference in a 150 kHz bandwidth was repeatedly stated by ICAO at several ITU meetings and that ITU WP 8C concurred with this requirement in their liaison statement to WP 4A (Report of the fourth meeting of Working Party 8C (November (1995) refers). The requirement to refer interference to a 150 kHz bandwidth was already confirmed by ICAO in the early nineties when developing criteria for the development of MLS frequency assignment plans. Having noted the reservations expressed by the ITU observer, the meeting concluded that no reasons were presented to depart from the ICAO requirement.

5.2.4.3 The bandwidth consideration determining the permissible out-of-band interference. It was unanimously agreed that the total transmitted power from the FSS stations should be used to determine the
out-of-band interference.

5.2.4.4 **The maximum level of permissible out-of-band interference.** The meeting agreed that the value of -61 dBm provided adequate protection to MLS against out-of-band interference.

5.2.4.5 **The need to include NGSO MSS feeder link stations operating in the band 5 150 - 5 250 MHz in the co-ordination process.** The meeting noted that the out-of-band protection requirement for MLS receivers for the bands 5 000 - 5 030 MHz and 5 091 - 5 250 MHz was -61 dBm. The meeting agreed that this would require stations of the FSS operating in the bands 5 091 - 5 150 MHz and 5 150 - 5 250 MHz to co-ordinate their assignments with a view to protect MLS operations. The ITU observer could not agree with the requirement to co-ordinate out-of-band emissions in the band 5 150 - 5 250 MHz, since this band is not shared with MLS. It was agreed that further studies were required on the compatibility between FSS operating in the 5 150 - 5 250 MHz band and MLS operating in the 5 030 - 5 091 MHz band, since the current MLS receiver mask was established when the whole band 5 000 - 5 250 MHz was available for use by MLS. The meeting agreed on the need for further studies of the required interference threshold in the band 5 150 - 5 250 MHz. Furthermore, the meeting indicated the need to co-ordinate with the Aeronautical Radio, Inc. (ARINC), RTCA, the Airlines Electronic Engineering Committee (AEEC) and the European Organization for Civil Aviation Equipment (EUROCAE) with a view to review the MLS receiver specifications, in light of the actual performance of the existing receivers in the band 5 150 - 5 250 MHz. The meeting further stated that the current standards should be used until they are modified.

5.2.4.6 **The methodology to calculate the required separation distance, including path-losses beyond the radio horizon.** The meeting studied details of the calculation of the required separation distance, taking into consideration the effect of the radio horizon as well as the effect of stations, either MLS or FSS station, not operating at sea level. After lengthy discussions, the meeting could not establish one single separation distance which would protect MLS in all cases. Further work on this issue, in particular considering the appropriate propagation model, is required. The ITU observer indicated that such a single separation distance would considerably ease co-ordinating efforts.

5.2.4.7 **The need to ensure that constraints due to NGSO MSS feeder links operating in the band 5 150 - 5 250 MHz would not prevent the development of the most-efficient frequency assignment plan for MLS.** The meeting stressed that the introduction of stations of the fixed-satellite service in the band above 5 091 MHz should not constrain the full development of an MLS frequency assignment plan for MLS in the band 5 030 - 5 091 MHz. Therefore, interference considerations need to ensure that throughout the band 5 030 - 5 091 MHz the interference criteria are met at any operational or planned MLS location.

5.2.5 The meeting agreed that several mitigation techniques on the above aspects could be applied and they should be addressed in the draft recommendation.

5.2.6 On the basis of the foregoing general discussion, the following comments were made with respect to text of the original draft recommendation, and a proposed draft revision of the recommendation was developed as contained in Appendix A to the report on this agenda item. Unless specified otherwise, references hereunder are to the original draft new recommendation as developed by ITU-R Study Group 4:
It was proposed to amend the title in order to clearly indicate that the recommendation is addressing interference from stations operating in the fixed satellite-service in the band 5 091 - 5 250 MHz into MLS systems operating in the band 5 030 - 5 091 MHz only. A new title is in the draft revision of the recommendation.

considering a). No comments were made;

considering b). It was proposed to slightly modify the text of considering b) in order to keep it as close as possible to the text of the Radio Regulations. Proposed new text is in considering c) of the draft revision of the recommendation;

considering c). It was proposed to slightly modify the text of considering c) in order to keep it as close as possible to the text of the Radio Regulations. Proposed new text is in considering b) of the draft revision of the recommendation.

considering d). It was proposed to delete considering d), as reference to resolution 114 was not relevant and did not address NGSO MSS feeder links in the band 5 150 - 5 250 MHz;

considering e). It was proposed to slightly modify the text of considering e). Proposed new text is in considering h) of the draft revision of the recommendation;

it was proposed to add the following considerations to the recommendation:

1) to identify the need to apply Resolution 46 (Rev. WRC-95) when making assignments to the FSS as well as the provisions in the Radio Regulations referring to the temporary nature of the allocation to the FSS. Proposed new text is in considering d) of the draft revision of the recommendation; and

2) to specify the different interference scenarios (as given in considering e) of the draft revision of the recommendation);

recognizing a). No change was proposed;

recognizing b). It was proposed to slightly modify the text of recognizing b). Proposed new text is in recognizing b) of the draft revision of the recommendation;

it was proposed to add a new recognizing to indicate that the recommendation only addresses the interference scenario of MLS operating in the band
5 030 - 5 091 MHz and FSS operating in the band 5 091 - 5 250 MHz. Proposed new text is in recognizing c) of the draft revision of the recommendation;

it was proposed to add a new recognizing referring to the need for further studies on the co-ordination conditions between MLS operating in the band 5 030 - 5 091 MHz and FSS operating in the band 5 150 - 5 250 MHz. Particular attention should be given to the receiver mask in the band 5 150 - 5 250 MHz. Proposed new text is in recognizing d) of the draft revision of the recommendation;

recommends. It was proposed to slightly modify the text of recommends. Proposed new text is in recommends of the draft revision of the recommendation; and

Annex 1 of the ITU Recommendation:

1) significant modifications to the text of Annex 1 were proposed by the meeting. These modifications were considered necessary in order to clarify unambiguously the interference mechanisms, in relation to the need to prevent restriction in MLS frequency assignment planning due to the operation of FSS stations. Also, the various technical considerations, as referenced in 5.2.3 above, need to be incorporated in this Annex. The new text is incorporated in the draft revision of the recommendation; and

2) the meeting agreed that Annex 2 of the ITU recommendation should be deleted. It was further agreed that, provisionally, Annex 2 of the draft revision of the recommendation could be annexed to the recommendation. The need to retain elements of this Annex can be identified at a later stage.

5.2.7 The meeting agreed that the draft revision of the recommendation, as contained in Appendix A to this report on Agenda Item 5, and the foregoing considerations, should be communicated to the appropriate ITU body in an expeditious manner.

5.3 DRAFT AMENDMENTS TO MLS SARPs AND GUIDANCE MATERIAL IN ANNEX 10

5.3.1 The meeting recalled that, in response to States and International Organizations' comments on amendments to MLS SARPs as developed by AWOP/14, the Air Navigation Commission (141-6) referred the issue of Category I performance MLS to the AWOP. Proposals for relevant amendments to Annex 10, Volume I were developed and reviewed by the Working Group of the Whole (2 to 11 April 1997). A simplified MLS was defined and proposed for introduction in MLS SARPs presently defining the basic and expanded MLS configurations. Having noted that the proposed system characteristics for simplified MLS were equal to those defined for Category I ILS and that these characteristics were supported by test data available from mobile MLS configurations, the meeting agreed to draft amendments as shown in Appendix B to the report on this agenda item.
5.3.2 The meeting also reviewed additional proposals for amendments to MLS SARPs and guidance material. These included:

a) integrity and continuity of service SARPs which were similar to those recommended for ILS (see paragraph 4.2.4 in the report on Agenda Item 4);

b) guidance material on demonstration of mean time between failures (MTBF) and mean time between outages (MTBO) which was similar to that recommended for ILS (see paragraph 4.2.5 in the report on Agenda Item 4); and

c) clarifications/corrections of MLS SARPs.

5.3.3 The meeting agreed to the draft amendments to MLS SARPs and guidance material as consolidated in Appendix B to the report on this agenda item and recommended as follows:

**Recommendation 5/1**

**Amendment to Annex 10, Volume I**

**Updating guidance material**

That Annex 10, Volume I, Chapter 3 and Attachment G to Volume I be amended as shown in Appendix B to the report on Agenda Item 5.

5.4 **NEW DEFINITION FOR CLASSIFICATION OF APPROACH AND LANDING OPERATIONS**

5.4.1 The meeting recalled that, in the development of required navigation performance (RNP) for approach and landing operations, an additional operation which could be conducted by modern aircraft using glide path developed on board of aircraft from a navigation database was identified. This operation was associated with a procedure termed as an instrument approach procedure with vertical guidance (IPV). The RNP 0.3/125 type was developed and included in the draft Manual on Required Navigation Performance (RNP) for Approach, Landing and Departure Operations to support such an operation (Table 3-1, Appendix B to the report on Agenda Item 1 refers).

5.4.2 Similarly, this operation was introduced in the assessment of new technology systems when it was recognized that all global navigation satellite system (GNSS)-based approach and landing operations could not be accommodated within the present ICAO classification defined in Annex 6, Part I, Chapter 1 and in other ICAO documents. In the assessment report, this was referred to as instrument
approach with vertical guidance (Section 4.3, Appendix A to the report on Agenda Item 3 refers).

5.4.3 The meeting agreed that a new operation, already in use, required a revision of ICAO classification and could be introduced with minimal changes to the existing definitions in Annex 6. The meeting therefore developed a draft amendment proposal, as shown in Appendix C to the report on this agenda item, and recommended for amendment to Annex 6, with the understanding that consequential changes to other ICAO documents would be made if the amendment to Annex 6, Part I, Chapter 1 is adopted. The following recommendation was made:

RSPP

**Recommendation 5/2**

Amendment to Annex 6, Part I - Definition of each operation

That Annex 6, Part I be amended as shown in Appendix C to the report on Agenda Item 5.

5.5 **FUTURE UTILIZATION OF THE 108 - 118 MHZ AERONAUTICAL NAVIGATION BAND**

5.5.1 The panel was made aware that the fourth meeting of the Aeronautical Mobile Communications Panel (AMCP) developed Recommendation 2/3 - Future use of the frequency band 108 - 137 MHz, which, inter alia, recommended that ICAO study the need to increase the spectrum allocated to the aeronautical mobile (R) service (118 - 137 MHz) taking also into consideration the introduction of data links in the VHF bands. The Air Navigation Commission (142-13) approved the recommendation and, among other things, requested the AWOP and the Global Navigation Satellite System Panel (GNSSP) to study the adequacy of present spectrum allocated to the aeronautical radio navigation service in the band 108 - 117.975 MHz and, if necessary, identify future requirements.

5.5.2 The meeting recalled that the 108 - 118 MHz band was allocated world-wide to satisfy the needs of aeronautical radio navigation service. It was noted that ITU Radio Regulation 5.197 (formerly Radio Regulation 590A) also allocates the 108 - 112 MHz band on a secondary basis for use by the mobile service in many countries in ITU Regions 1 and 3. However, a mobile service would be allowed to be introduced in the band only when it is no longer required for aeronautical radio navigation service in those States.

5.5.3 The meeting noted the work under way in the GNSSP to develop SARPs for the GNSS ground-based augmentation system (GBAS) which would make use of VHF spectrum. It was also noted
that, in the long term, at least one State plans to address the possibilities for expansion of the AM(R)S below 118 MHz. It was further noted that there may be other aeronautical radio navigation services that may be proposed for the 108 - 118 MHz band.

5.5.4 In response to the ANC request, the meeting then discussed the prospects for release of some portions of the 108 - 118 MHz band that may be expected as a result of the phase out of VHF omnidirectional radio range (VOR) and ILS.

5.5.4.1 With regard to VOR, the meeting indicated that the system would remain as a primary means of air navigation world-wide for en-route down to non-precision approach at least until 2010, considering implementation is still under way and the growing number of VOR installations and transition time required for the system phase out. Consequently, the meeting stated that general release of VOR frequencies should not be expected in the foreseeable future.

5.5.4.2 With regard to ILS, the meeting observed that the ICAO strategy for introduction and application of non-visual aids to approach and landing and ILS SARPs in Annex 10 protect ILS service for an indefinite period of time. Furthermore, the meeting believed that it was premature to suggest any dates for the withdrawal of ILS service (and for the release of ILS frequencies) in the absence of conclusive information on the availability of GNSS-based systems to support precision approach and landing.

5.5.5 The meeting also pointed out that the continuing extensive usage of the 108 - 118 MHz band for aeronautical radio navigation precludes any sharing of other-than-radio navigation services in the band. The increased congestion in the band would take place with the expected introduction of data broadcast systems of ground-based GNSS augmentation. The meeting stressed that the introduction of GBAS, while not unfeasible in the band, would require thorough capacity and transition studies and development of co-ordination criteria for GBAS co-channel and adjacent channel assignments in the frequency band presently assigned to ILS and VOR. The meeting noted that these issues were being addressed by the GNSS Panel.

5.5.6 The meeting finally suggested that consideration should be given to a removal, through ITU mechanism, of the present secondary allocation of the 108 - 112 MHz band in ITU RR 5.197 (see paragraph 5.5.2 above) in view of the expected increase in the utilization of the band for safety critical approach and landing applications. It was also noted consideration was given to these issues in the ICAO Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including Statement of Approved ICAO Policies.

5.6 MODELLING OF NAVIGATION SYSTEMS

5.6.1 The meeting observed that various States had developed computer-based mathematical models to predict and analyse the performance of the ILS, VOR and GNSS in the real environment. However, insufficient effort has been dedicated to sharing models and establishing/maintaining uniform baseline standards for the models.

5.6.2 The meeting noted that, in reviewing the ILS SARPs and guidance material in Annex 10, the status of modelling used to analyse and predict NAVAID performance was addressed. It was noted
that computer math modelling had been used extensively by some States to determine expected performance before the installation of an equipment, to evaluate the effects to performance of planned construction and to diagnose the cause of degraded performance. A model was also developed to determine the effects of radio frequency (RF) interference to localizer and subsequent aircraft control performance.

5.6.3 It was recalled that several years ago, the Microwave Landing System (MLS) Math Model Users Group was formed by participating States. This co-operative effort enhanced the ability of those States to deal with the complexity of MLS siting and installation. The meeting believed that a similar co-operative effort for current NAVAIDs would greatly enhance the ability to sustain ground-based NAVAIDs beyond the year 2000.

5.6.4 The meeting also noted that documentation on GNSS modelling had recently been presented at both AWOP and GNSSP working group meetings to aid both panels in determining if GNSS could meet availability, integrity and continuity requirements. Since these models were designed generically to simulate GNSS signals, it would be possible to modify them to aid users in predicting environmental effects and performance as these models were validated for international use.

5.6.5 The meeting recognized that the past activities were limited and not all-encompassing. The meeting believed that, through ICAO sponsorship, there could be assurance of a uniform co-operative process. In order to promote the use of mathematical modelling in sustaining and developing ground- and space-based NAVAIDs well into the future, the meeting recommended as follows:

**Recommendation 5/3**

**Modelling of radio navigation system**

That ICAO co-ordinate and encourage development of internationally accepted models for ground- and space-based NAVAIDS.

5.7 **Future work considerations**

5.7.1 It was brought to the attention of the meeting that there may be plans to discontinue the existence of the All Weather Operations Panel following the AWOP Meeting. In this connection, the meeting noted a number of tasks which were far from completion: some previously assigned to AWOP, others arising from the business of the meeting. Among the latter tasks, a potential need was discussed to develop a navigation system classification in support of RNP implementation. These tasks and the
The expertise required to complete them were formulated as follows:

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<tr>
<th>Task</th>
<th>Expertise</th>
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<tbody>
<tr>
<td>1) Completion of assessment of new technologies for application to A-SMGCS.</td>
<td>Technical equipment</td>
</tr>
<tr>
<td>2) Development of appropriate ICAO documentation on A-SMGCS, including completion of the A-SMGCS Manual</td>
<td>Technical equipment, Operational ATC, Operational pilot</td>
</tr>
<tr>
<td>3) Navaid sustainability (ILS, MLS, VOR, DME, GNSS)</td>
<td>Technical equipment, Operational ATC, Operational pilot</td>
</tr>
<tr>
<td>a) compatibility studies</td>
<td>Regulatory frequency allocation</td>
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<tr>
<td>i) spectrum issues</td>
<td>Technical software (modelling)</td>
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<td>? ILS/VOR, GBAS, MLS frequency assignments</td>
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<td>ii) RFI</td>
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<tr>
<td>b) navaid modelling (system validation, siting criteria)</td>
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<td>c) maintaining current navaid capabilities</td>
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<td>d) updating Annex 10 material for NAV AIDS</td>
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<tr>
<td>4) Completion of assessment of GNSS for Cat II/III precision approach and landing.</td>
<td>Technical equipment, Operational ATC, Operational pilot</td>
</tr>
<tr>
<td>5) Technical and operational issues associated with implementation of RNP for approach, landing and departure operations</td>
<td>Technical equipment, Technical software, Regulatory certification, Operational ATC, Operational pilot</td>
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5.7.2 It was noted that the previous work of the AWOP was a common element in a number of ICAO work areas. Thus, termination of the AWOP might leave a significant gap, and consideration should be given to continuation of those functions which had been so far performed by the AWOP. It was also noted that the tasks identified above were not the purview of any other existing group, yet which demanded attention.

5.7.3 The meeting therefore agreed that it would be appropriate to offer suggestions on the manner in which the tasks identified might be completed. The options proposed were identified as follows:

a) the continuation of the present panel; or
b) the re-assignment of the tasks identified to the existing panels and/or to a newly established group(s).

5.7.4 Having noted that the Air Navigation Commission (ANC) was currently in the process of re-assessment of the air navigation panels' structure and allocation of tasks, the meeting submitted that the Commission would be in a better position to make a choice of the best option.

5.7.5 In conclusion, the meeting discussed some general aspects of planning and co-ordination of the work of the panels in the light of experience gained from many years of work on multidisciplinary tasks assigned to the AWOP. The meeting believed that the need to co-ordinate panels' work even closer stems from the continuing integration of systems, which requires a conceptual approach rather than a topic-oriented approach. The quickly evolving new technologies and the pressure to introduce them as soon as possible make a requirement for a flexible and reactive working structure. A number of suggestions for improvements in this areas were offered, and the meeting agreed that they should be elaborated in the panel's debriefing to the ANC.