COMMUNICATIONS PANEL MEETING 2 (CP/2)

WORKING GROUP - MAINTENANCE

Montreal, Canada 28 September – 2 October 2015

Selective Calling (SELCAL) Code Pool Expansion
Avionics Testing

(Presented by V. Nagowski, ASRI)

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<th>SUMMARY</th>
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<tr>
<td>This Working Paper provides the results of backwards compatibility testing of existing avionics when using the expanded Selective Calling (SELCAL) system code pool.</td>
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<td>There was concern expressed at the CP/1 meeting that it was difficult to adopt the changes without knowing the outcome of the validation activities.</td>
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<th>ACTION</th>
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<td>CP/2 members are asked to review the positive results of the testing in this working paper and to continue to support the SELCAL Code Pool Expansion solution.</td>
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1. Introduction

An Aviation Spectrum Resources, Inc (ASRI) working paper was provided to the Working Group of the Whole (WG-W) meeting in September 2011 as background on the Selective Calling (SELCAL) system. The paper described the SELCAL system, the SELCAL code pool shortage problem and provided some alternatives to be considered by WG-W. There is a concern that the continued duplication of the SELCAL codes may lead to operational errors potentially impacting aviation safety.

The SELCAL working paper called for an expansion of the SELCAL address pool to deal with the problem of multiple aircraft being issued with the same SELCAL code. Namely, that duplicate SELCAL notifications can be received by multiple aircraft in oceanic control regions, thus causing confusion and possible miscommunication of ATC instructions. The possibility of an impact on safety was raised, with different views of the magnitude of such an incident.

There was a general agreement at the CP/1 meeting in the benefits of expanding the available SELCAL code pool. However, as the backwards compatibility of existing avionics had yet to be fully confirmed by the avionics vendors by the time of the meeting, there was a general agreement that the expanded SELCAL address pool should be tested with legacy avionics.

This paper provides the status of the standardization process of the proposed SELCAL code pool expansion for both the Airline Electronic Engineering Committee (AEEC) avionics specification and the RTCA Minimum Operational Performance Standard (MOPS). This paper also provides the initial results of backward compatibility testing completed by the SELCAL avionics vendors and aircraft manufacturers.

2. SELCAL Code Pool Expansion Standardization

ASRI is responsible for administering SELCAL codes on behalf of ICAO, maintaining the database of codes and providing periodic reports on the system status to ICAO. ASRI formally requested that the AEEC and RTCA both update their corresponding SELCAL standards to include the proposed SELCAL code pool expansion. The AEEC formed a SELCAL Working Group (WG) to update the ARINC Characteristic 714 (Mark 3 Airborne SELCAL System) and RTCA formed Special Committee (SC) 232 to develop a MOPS replacing the existing DO-93, Minimum Performance Standards – Airborne Selective Calling Equipment.

The AEEC SELCAL WG held four meetings and developed draft 5 of ARINC Project Paper 714A Mark 4 Airbourne Selective Calling (SELCAL). The Mark 4 SELCAL system, when fully deployed, will be capable of uniquely calling each user aircraft that is equipped with a compatible Mark 4 SELCAL decoder. The Project Paper 714A represents a step-wise evolution of the older Mark 3 SELCAL system deployed in the 1970’s defined by ARINC Characteristic 714-6. The Mark 4 SELCAL system is capable of decoding up to 215,760 unique SELCAL code identifiers by using a set of 32 audible tones. For the purpose of comparison, the Mark 3 SELCAL system uses a set of 16 audible tones and provides 10,920 unique SELCAL codes.

The Mark 4 SELCAL document was approved by the AEEC Executive Committee at the Mid-Term meeting held on September 23-24, 2015.

RTCA SC-232 held four meetings responsible for developing a Minimum Operational Performance Standard (MOPS) for the Airborne Selective Calling (SELCAL) Equipment. The MOPS document
will reflect the current 16 tone system being used today\(^1\) and add the proposed solution of expanding the system by an additional 16 tones. The system design and system operational functionality were not modified.

RTCA management provided the SC-232 leadership with specific guidance to define interoperability requirements of legacy airborne ARINC 714-6 systems (16 tone) with the new ARINC 714A (32 tone) avionics systems and define interoperability requirements between the upgraded ground systems and the ARINC 714-6 and the ARINC 714A airborne systems. Testing of the upgraded systems is required to ensure no false annunciations for legacy equipment.

The SC-232 committee has developed a mature draft of the MOPS that is expected to be reviewed and updated one more time in November 2015. The MOPS will then go through a formal RTCA review and comment period following the November meeting. All comments received will be dispositioned at the final meeting of SC-232 scheduled for late January 2016. The MOPS will be forwarded to the RTCA Program Management Committee for final approval in March 2016.

3. SELCAL Avionics Backward Compatibility Testing

The avionics backward compatibility testing consisted of theoretical analysis, bench testing, and flight testing. In support of testing, the SC-232 committee developed a bench test procedure to support the backward compatibility testing of legacy avionics with the proposed 32 tone system. The test procedure was provided to SELCAL avionics vendors for comment, updated based on comments received and was approved as the standard to be used by all avionics vendors when testing.

Avionics testing was conducted by AvtechTyee and Cobham.

Bench testing conducted by AvtechTyee, the primary manufacturer of SELCAL avionics equipment both federated and integrated architectures for Boeing aircraft, was completed on all operational SELCAL avionics for the Boeing fleets (e.g. B737, B747, B757, B767, B777, and B787). The majority of testing was very positive showing little or no susceptibilities to false detection of the new tones on legacy systems. Testing of avionics associated with these fleets indicates that the legacy avionics are backward compatible with the new 32 tone system. A few susceptibilities that were detected during testing were focused on some combinations of the lowest frequency tones A, B, C, and D and also some tone combinations when a tone imbalance of 12 dB was inserted between tone pairs.

Bench testing conducted by Cobham, the primary manufacturers of SELCAL avionics equipment for Airbus, was completed on all operational SELCAL avionics for the Airbus fleets (e.g. A319, A320, A330, and A340). Testing of avionics associated with these fleets indicates that the legacy avionics are backward compatible with the new 32 tone system. The Airbus Audio Management Unit (AMU) on the A350 and the A380 which support the SELCAL functionality are similar. Testing has been conducted on the A350 AMU and the test results were positive. Cobham and Airbus are confident the A380 AMU will provide similar results of A350 AMU. A modified A380 AMU with Mark 4 SELCAL functionality is scheduled to be tested in the laboratory environment by the end of the year.

Airbus will be conducting a flight test campaign to verify backward compatibility with A320 aircraft.

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\(^1\) The existing RTCA Minimum Performance Standards – Airborne Selective Calling Equipment (DO-93) was not updated from the original 12-tone system in 1969, and therefore the new MOPS standard will reflect both the existing 16 tone system, and also the new 32 tone SELCAL system.
in October. These A320 ferry flight aircraft will operate a couple times a day between Toulouse and Hamburg testing with the existing SELCAL Mark 3 avionics. Airbus will be using an upgraded SELCAL ground station in Toulouse sending SELCAL Mark 4 signals to the aircraft, monitoring for false detections. The results of the testing are expected in early November 2015.

Additional SELCAL OEMs including Rockwell Collins, Free Flight Systems, and Honeywell Avionics are still in discussions about possible testing plans.

3. Intermodulation Assessment

The SC-232 committee reviewed a theoretical analysis of intermodulation (IM) products when the new 16 tones are incorporated into the existing SELCAL system. The analysis provided the IM products and the probability of false detection associated with each tone pair. There are a number of tone pairs that produce no IM products that fall in the band of legacy tone pairs. The results indicated that there are 14 tone pairs that affect 14 other tone pairs. By excluding use of approximate 5000 tone pairs of the “suspect” codes, the odds of false trigger are very low and it should have little effect on code assignments due to the large number of codes (215,760) that will be available. ASRI has agreed to exclude the suspected tone pairs that were identified as a result of the IM assessment.

4. Conclusions

The bench testing conducted to date indicates that all the tested legacy avionics are fully backwards compatible with the proposed SELCAL code pool expansion.

The IM assessment raised some concern with a small set of tone pairs which could result in false triggering. The committee concluded that by ASRI excluding the issuing of the suspected tone pairs, it would eliminate the probability of false triggering, and there would still be over 210,000 unique tone pairs available for assignment.

Additional bench and flight testing are scheduled to be completed by the end of 2015.

4. Recommendation

The CP/2 is invited to:

- Note the successful SELCAL avionics backward compatibility testing and analysis conducted to date as outlined in this paper.
- To continue to support the proposed SELCAL code pool expansion, with an expected approval for incorporation into the ICAO SARPS at CP/3 in 2016.