Agenda Item 4:   **Assessment of operational requirements to determine the implementation of improvements in communication, navigation and surveillance (CNS) capabilities for operations in route and terminal area**

EXPANSION OF SELCAL CODE (SELCAL 32)

(Presented by the Secretariat)

SUMMARY
This working paper presents information on the expansion of SELCAL code.
References
• Second Meeting of the Data Communication Infrastructure Task Force (DCIWG/2), Montreal-Canada, 22 to 26 October 2018.

ICAO strategic objectives:	*A – Safety* *B – Air navigation capacity and efficiency*

1.   **Background**

1.1   During the Second Meeting of the Data Communication Infrastructure Task Force (DCIWG) of the Communication Panel (CP), working paper N°15 was submitted related to the expansion of the code used in the selective calling system (SELCAL), in order to increase the number of current 10,920 codes to a possible maximum of 215,760 permissible codes. Appendix to this working paper shows the mentioned working paper DCIWG/2-WP/15.

2.   **Discussion**

2.1   The need for expansion is due the increased demand for SELCAL codes, which causes the reuse of the same 4-letter code for more than one aircraft. The number of registered SELCAL codes has increased by more than 37,000 assignments, more than triple the number of available codes.

2.2   To avoid potential operational errors, it is necessary that the proposed new scheme be approved and operationally applied. In this sense, users of HF and VHF equipment that uses this functionality, need to adapt them to operate with the new SELCAL code scheme (SELCAL 32).

2.3   By request of the Communication Panel Secretariat, the SAM Regional Office has sent a letter to all South American States asking for information of which Air Navigation Centres would be using selective calling, the type of service provided (ACC, APP, RCC, VOLMET, etc.) and when they would be adapted to the new system SELCAL 32.

2.4   At present time, only Chile and France (French Guiana) have provided information. Chile has informed to employ SELCAL for Air Traffic Services in oceanic areas, and will adapt its system to the SELCAL 32 scheme by 2020. France (French Guiana) is already using SELCAL 32 for Air Traffic Services in oceanic areas.

2.5   It is expected, for the present Meeting, that the participants will present information related the situation in each State and discuss the subject.

3   **Suggested action**

3.1   The Meeting is invited to:

a) take note of the information provided herein;

b) provide the necessary information; and

c) discuss any other matter it may deem appropriate.

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International Civil Aviation
Organization

WORKING PAPER

SECOND MEETING
OF THE

DATA COMMUNICATION INFRASTRUCTURE WORKING GROUP
(DCIWG)

Montreal, Canada, 22 to 26 October 2018

Agenda Item 7: Selective Calling (SELCAL) Code Pool Expansion

SELECTIVE CALLING (SELCAL) CODE POOL EXPANSION

(Presented by Aviation Spectrum Resources Incorporated)

SUMMARY
This Working Paper provides an update on the progress of expanding the Selective Calling system code pool, known as SELCAL32.
SELCAL is a commonly used signaling method transmitted over HF or VHF that meets ICAO Annex 2 requirements, relieving flight crews from maintaining a continuous listening watch on assigned frequencies. Due to the continued demand for SELCAL codes and the limited number of unique 12 tone codes, it has become necessary to issue duplicate codes. It is urgent that the SELCAL 32 code pool expansion be approved in order to avoid operational errors potentially affecting aviation safety.
A technical solution to expand the number of possible codes was developed by ICAO and has now been standardized in both Radio Technical Commission for Aeronautics (RTCA) and Airlines Electronic Engineering Committee (AEEC) publications. Since the standards were published, it has been confirmed that new aircraft are already capable of supporting the expanded SELCAL32 code pool.
The previous CP meeting has approved this amendment subject to confirmation with ANSPs of the implementation date in Annex 10.
ACTION
CP members are asked to consider the updates in this working paper and to finalize the approval of the SELCAL Code Pool Expansion as agreed at the previous meeting.

1.   SELECTIVE CALLING (SELCAL) INTRODUCTION

Selective Calling (SELCAL) is an International Civil Aviation Organization (ICAO) managed communications method used to notify aircraft that a ground radio station wishes to communicate. The current rules for SELCAL code assignment, with sixteen available letters, limit the number of possible allowable codes worldwide to 10,920. Given the ICAO SELCAL Registrar's database is currently recording over 37,000 separate assignments, duplicate codes have been identified as a potential safety issue. The expansion to SELCAL 32 with thirty-two available letters/numbers mitigates this over the long term by expanding the maximum number of possible allowable codes to 215,760.

Previous Communications Panel meetings have approved the proposal subject to physical testing of compatibility with existing avionics and verifying ANSP implementation timelines. Both of these requirements have now been completed. The testing by avionics manufacturers confirmed the new system can operate alongside existing aircraft without modification, and a survey of ANSPs concluded that a 1 January 2021 worldwide implementation is feasible. Given that the approval of new RTCA and AEEC standards has been completed, new aircraft can support the new SELCAL32 standard and are ready to implement the new standard pending formal approval of the SARPS and incorporation into Annex 10.

1.1.   Aviation Spectrum Resources (ASRI)

SELCAL began use in civil aviation in 1957 under the direction of ICAO. Shortly after the introduction of SELCAL Operations, ICAO formally transferred the SELCAL registration and management functions to Aeronautical Radio Incorporated (ARINC). From that point, ARINC became the official registrar of SELCAL codes, accepting all SELCAL applications directly, as well as providing an annual report to ICAO with a summary of SELCAL usage.

In 2006, the ARINC section responsible for SELCAL was re-structured into a separate company called Aviation Spectrum Resources, Inc. (ASRI). ASRI is now the official ICAO SELCAL Registrar for all SELCAL codes worldwide.

1.2.   SELCAL Code Duplication Issue

Given the growth in the demand for SELCAL codes, there is a shortage of available 4-letter codes. This shortage has required re-use of the same code by more than one aircraft. The number of SELCAL codes registered has now increased to over 37,000 SELCAL code assignments, over three times the number of available unique SELCAL code combinations.

Where possible duplicate codes are assigned to aircraft operated in widely separated areas of the world, and usually do not have the same HF radio frequency assignment. However, there are numerous examples of multiple aircraft have responded to the same SELCAL code when operating in the same control area. Therefore, SELCAL should not be used as a substitute for proper voice identification procedures as aircraft could assume that they are the intended aircraft, thus increasing pilot workload and the potential for errors.

2.   How SELCAL Works

Almost every aircraft operating over the ocean or in remote areas has a SELCAL code registered with ASRI. The SELCAL code is entered into field 18 of the aircraft's flight plan that is filed with the relevant aviation authorities.   When a ground station wishes to communicate with an aircraft, the radio operator enters the required SELCAL code into the radio system which then transmits the SELCAL tones. All aircraft monitoring the assigned radio channel will receive the SELCAL broadcast, but only those that

have been programmed with the specific 4-alphabetic code will be alerted. The crew will then respond to the ground station operator using ICAO recommended voice radio procedures before confirming the message and the necessary actions.

SELCAL codes are made up of the various combinations of alphabetic characters represented as two pairs (for example AC-BD), with each character representing a unique audio frequency (see table at the bottom of this page). To transmit a SELCAL code, these audio frequencies are modulated onto the selected voice channel at the ground station transmitter. This can be for either long range High Frequency (HF) communications, or more localized Very High Frequency (VHF) voice channels. SELCAL codes are transmitted as two consecutive pulses, with the first pulse consisting of the first pair of audio tones (from our example, the AC part), and the second pulse the last pair of audio tones (the BD). The pulses are approximately 1 second in duration, separated by an interval of approximately 0.2 seconds.

The below figure gives shows how the example AC-BD code would be sent.
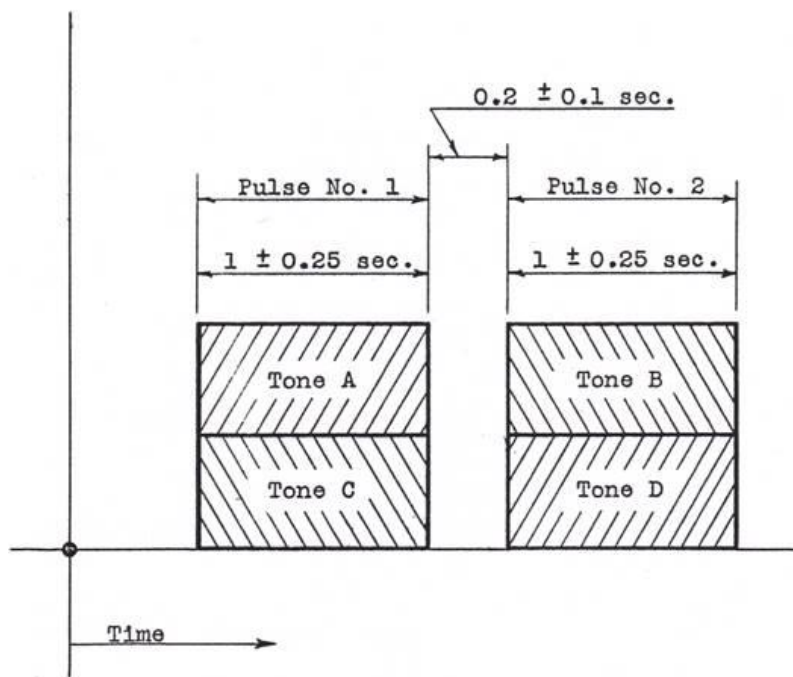
A special decoder on the aircraft's radio is programmed to recognize only the audio frequencies of the SELCAL code assigned to the aircraft. When the decoder receives the correct aircraft SELCAL code, the decoder sends an alert message to the crew, so they can turn the radio audio volume back up to talk with the ground station radio operator.

SELCAL code assignments have a few rules that are followed to make sure the radio systems are consistent in their usage. Firstly, a character may never be repeated, i.e. a code cannot use the 'A' twice. Secondly, the first character of each pair must be shown with the lowest alphanumeric character first, i.e. 'A' must be before 'F' or 'D' must be before '3' or '5' must be before '8'.

The following table contains the original 16 SELCAL designators (A - S) and corresponding frequencies and the new additional 16 SELCAL designators (T - 9) and corresponding frequencies. The Air Navigation Service Providers (ANSPs) are currently using the original 16 SELCAL designators operationally and will have to upgrade their ground systems to support the new SELCAL designators.

Code Designator	Audio Frequency (Hz)	Code Designator	Audio Frequency (Hz)
A	312.6	T	329.2
B	346.7	U	365.2
C	384.6	V	405.0
D	426.6	W	449.3
E	473.2	X	498.3
F	524.8	Y	552.7
G	582.1	Z	613.1
H	645.7	1	680.0
J	716.1	2	754.2
K	794.3	3	836.6
L	881.0	4	927.9
M	977.2	5	1029.2
P	1083.9	6	1141.6
Q	1202.3	7	1266.2
R	1333.5	8	1404.4
S	1479.1	9	1557.8

3.   SELCAL 32 Expansion Program

3.1.   Growth of SELCAL

While SELCAL is an older technology by aviation standards, demand for SELCAL codes continues to increase by approximately 4% annually. This demand is being driven by the expanding civil aviation market and the requirement for almost all aircraft flying in remote regions to have HF communications. The resulting growth in the last decade has now oversubscribed the ICAO SELCAL register maintained by ASRI. The current database totals over 37,000 individual SELCAL code assignments while still increasing at rate of nearly 3000 registrations a year. Given the 16 tone SELCAL system is limited to only 10,920 unique codes, this means multiple duplicate codes have been issued to different aircraft for what is supposed to be a unique identifier. While the ICAO Registrar (ASRI) attempts to mitigate the issue of duplicate SELCAL codes, the situation is expected to deteriorate with the growing number of airframes worldwide.

SELCAL Codes Issued Per Annum
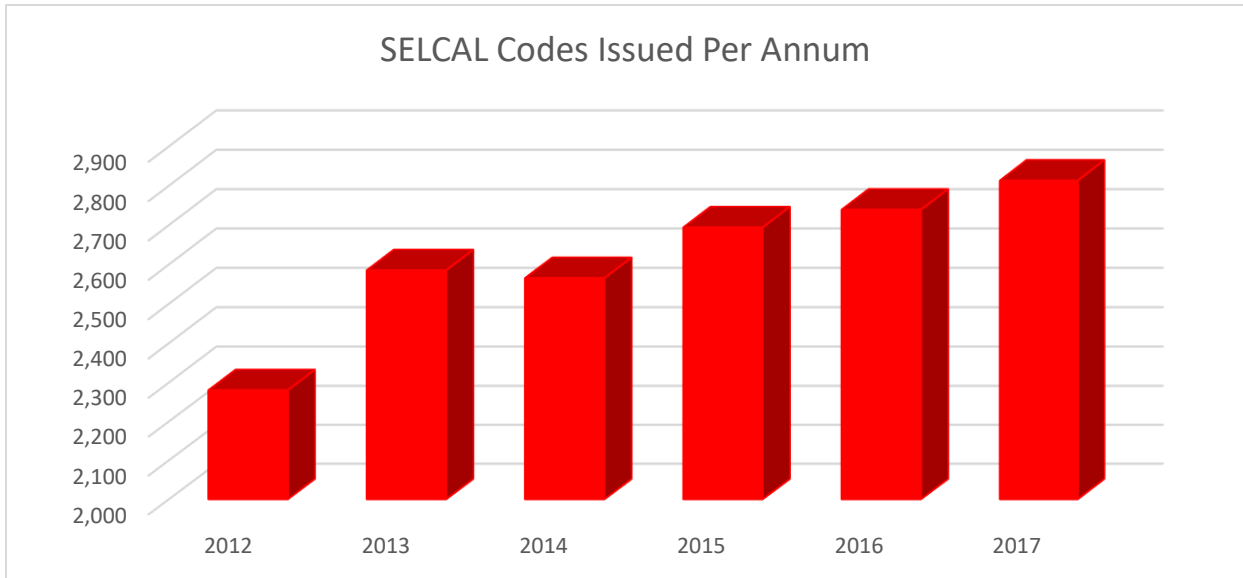
In one study by ASRI in 2012, a single ANSP ground station reported 266 occurrences of multiple aircraft responding to the same transmitted SELCAL code. Furthermore, several incidents have been reported with up to 6 different aircraft answering to a single transmission for what is supposed to be a unique assignment.

A second ANSP with a Flight Information Region (FIR) covering the NAT recorded duplicate SELCAL events listed below over the last five years.

DATE	2012	2013	2014	2015	2016
TOTAL Flights	400,480	404,787	420,423	442,645	470,000
Recorded Duplicate SELCAL Events	90	100	181	250	280

As the ICAO nominated registrar, ASRI is concerned that the duplication of codes is creating some potential human factors risk for aircrews and additional workload on service providers.

Aviation HF and VHF voice continues to be used extensively world-wide and will be a backup communications media for the foreseeable future. The ICAO Global Air Navigation Plan (GANP) 5th edition has planned that HF systems will be operational beyond 2030.
Expected HF usage has already been extended several times over the years due to existing equipage and demand for use from aircraft operators and ANSPs.

3.2.   What is SELCAL 32?

To mitigate duplicate SELCAL code concerns, ASRI has been attempting to educate users about the potential duplication issue, while radio ground station operators have been proactively managing aircraft to minimize the issue. However, these measures can only mitigate the duplication issue so far, and therefore ASRI in cooperation with the affected Civil Aviation Authorities (CAAs), ANSPs, and avionics manufacturers, has been updating the SELCAL standards to allow for aviation growth. The new SELCAL proposal uses sixteen (16) new audio tones, in addition to the existing 16 audio tones, to create SELCAL codes from a total of 32 available audio frequencies (called SELCAL 32).

The updated standard labels the new audio frequencies with letters from T to Z, and the numbers 1 to 9. Creating SELCAL codes from these 32 different audio tones will result in over 200,000 new unique SELCAL codes being available for assignment, mitigating the duplicate code issue for the foreseeable future.

The SELCAL 32 proposal will allow for new SELCAL avionics to operate without an increasing risk of SELCAL code duplication and the associated operational impacts. As this solution uses the existing 16 audio tones, it is backwards compatible with all existing aircraft avionics, while providing benefits to new aircraft with the updated SELCAL 32 standard. With growing support in the international aviation community, the new SELCAL 32 standard will eventually allow for continued operation of the SELCAL system to meet the increasing worldwide demand from aviation.

3.3. Implementation Guidance for SELCAL 32

ANSPs will need to consider the impact of the SELCAL code pool expansion on their flight planning systems and any other systems that support the SELCAL system. Several implementation options are available, including[1]:
- Contact SELCAL encoder supplier to include the extra tones in the existing encoder
- Install a new PC based encoder
- Upgrade HF transmitters to include a new encoder with the additional tones.

Airlines will need to evaluate the impact that the SELCAL code pool expansion may have on their ground systems including flight planning when new aircraft are added to their fleets that support the expanded SELCAL code pool functionality. Airbus and Boeing are expected to begin offering the SELCAL 32 functionality on new aircraft being delivered after the 2020 timeframe, with some existing aircraft being already compatible with suitable software updates.

4. Current SELCAL 32 Progress

Both the Airline Electronic Engineering Committee (AEEC), and Radio Technical Commission for Aeronautics (RTCA) standards for SELCAL avionics were completed in 2016. Technical details of SELCAL operation can be found in ICAO SARPS, Vol. V, RTCA DO-93A, and ARINC A714A.

At the last ICAO CP, the SELCAL 32 proposal was agreed at the technical level. However, a question was raised about implementation timelines and what would be appropriate for ANSPs. It was therefore agreed to postpone the adoption of the amendment subject to further consultation limited to '*…only the timing and applicability of the amendment*'.[2] Once an implementation date had been confirmed, then the panel would be able to compete the approval process.

Since the last meeting of CP, ASRI has completed a survey of the ANSPs worldwide to determine if/when they would be able to support the SELCAL 32 upgrade. The survey process was used to help educate the industry, confirm support for the SELCAL 32 upgrade, and identify an implementation schedule. The results received indicated that a majority of the ANPSs replied that they will be able to support SELCAL 32 by 2020. There was one ANSP organization that expressed concern over the implementation schedule of the upgrade to their ground system. However, on examination of their existing equipment, it was confirmed that a 1 Jan 2021 worldwide implementation update was feasible given the minimal changes needed.

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[1] More specific information is available from the ICAO SELCAL Registrar at www.asri.aero/selcal
[2] ICAO CP Minutes, CP/2-DCIWG Appendix 2, Section 2.13

6.   Conclusion

In view of the potential safety risks posed by duplicate SELCAL codes, ASRI and the affected ANSPs strongly urge acceptance and worldwide implementation of the SELCAL 32 functionality.

ASRI and other aviation organizations are encouraging ANSPs to support the proposed SELCAL 32 functionality and support the ICAO approval of the SELCAL 32 solution in the SARPS.

7.   Action Requested by the Meeting

- Note the information provided in this working paper
- Support the approval of the SELCAL 32 Code Pool Expansion