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| **Radiocommunication Study Groups** |  |
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| Source: Document 5A/TEMP/89 | **Annex 12 to Document 5A/198-E** |
| **20 November 2012** |
| **English only** |
| Annex 12 to Working Party 5A Chairman’s Report | |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M.[HF-SPECTRAL OCCUPANCY] | |
| Spectral occupancy within the band 5 250-5 450 kHz as observed near Ottawa, Ontario, Canada | |

*[Editor’s Note: This document is carried forward for information and future consideration. The workplan for Agenda item 1.4 as adopted during the May 2012 meeting of Working Party 5A calls for the preparation of two relevant Reports, one for characteristics of amateur stations, and one documenting compatibility studies with existing services.]*

*[Some administrations have pointed out that the measurements described in this document, taken prior to WRC-12, cannot accurately represent fixed and mobile service occupancy in the band 5 250-5 450 kHz for the purposes of Agenda item 1.4 and Resolution* ***649****. For example:*

*• The measurements only recognize received emissions ten dB or more above the measured noise floor, while amateur service operators in the band would recognize use of a frequency at power levels much closer to the noise floor. Thus, the "listening" represented in the measurements may find far less activity in the band than would that of amateur service operators.*

*• The algorithm for the noise measurement should be clarified, with consideration that the noise level may not be constant across the measurement window of 180 kHz.*

*• Further information on the measurements, expected at the next meeting, may clarify whether other aspects of the procedure, such as the resolution bandwidth, were appropriate to justify the conclusions.]*

Scope

This Report describes ITU-R studies undertaken to determine the spectral occupancy of channels within the frequency band 5 250-5 450 kHz.

Vocabulary

The following definitions apply for the purpose of this study

Busy hour: the hour of the day when a frequency band is most congested.

Congestion: the likelihood that the measured signal power in a selected channel sampled within a frequency band will exceed a specified power threshold.

Occupancy: the percentage of time that the measured signal power exceeds a specified threshold.

Abbreviations[[1]](#footnote-1)

HF high frequency

VOACAP Voice of America Coverage Analysis Program[[2]](#footnote-2)

SSN Sunspot Number

SFI Solar Flux Index

A Solar “A” Index

K Solar “K” Index

References

[1] TCI International, Inc, TCI Model 613-N Broadband Dipole Antenna, Data Sheet.

<http://www.spx.com/en/assets/pdf/TCI%20613.pdf> (Online)

[2] D.I. Warner, S. Bantseev, and N. Serinken. “Spectral occupancy of fixed and mobile allocations within the high frequency band,” *Ionospheric radio systems and techniques Conference York UK*, May 15-17, 2012.

<http://scpro.streamuk.com/uk/player/Default.aspx?wid=13437&ptid=26&t=0> (Online)

[3] Industry Canada – Spectrum Management and Telecommunications. (2009, December) Industry Canada.

<http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/cane2009edition-eng.pdf/$FILE/cane2009edition-eng.pdf> (Online)

[4] (2012, Feb) Solar Influences Data Analysis Centre.

<http://sidc.oma.be/sunspot-data/>(Online)

[5] N.F. Wong, G.F. Gott, and L.W. Barclay, “HF Spectral occupancy and frequency planning,” *IEE Proceedings – Communications, radar and signal processing*, vol. 132 Part F, no. 7,   
pp. 548-557, December 1985.

[6] Roy H. Stehle and George H. Hagn, “HF Channel occupancy and band congestion: The other-user interference problem,” *Radio Science*, vol. 26, no. 4, pp. 959-970,   
July-August 1991.

ITU-R Recommendations

TBD

# 1 Introduction

The high frequency (HF) band is the highest frequency band that supports propagation of radio signals via a reflected path incident on the ionosphere. This is called ionospheric or sky-wave propagation. Because of this unique characteristic, an important feature of the HF spectrum is its ability to support long range communications via sky-wave propagation. However, one disadvantage of long range propagation is the likelihood that noise and interference from distant sources may affect a desired communication. Therefore, the usability of HF sky-wave communication channels depends on both signal propagation and the absence of excess noise and interference. While propagation conditions have been studied extensively over several decades, there are relatively few published measurement studies that have looked at noise and interference in the HF band 5 250-5 450 kHz.

This Report examines congestion and occupancy statistics in the frequency range 5 250-5 450 kHz to determine how channel availability varies with frequency, hour of the day, season of the year and channel bandwidth.

# 2 Data collection procedures

Measurements were taken near Ottawa, Canada (Lat 45.36N Long 75.88W) using a TCI-613N broadband dipole antenna [1]. The antenna was connected, via a band-pass filter, to a Rohde and Schwarz model FSP spectrum analyzer. The TCI-613N is a passive, horizontally polarized, nearly omni-directional antenna, with nulls at the horizontal elevation angle. At 3.4 MHz the maximum gain is at vertical, with the elevation angle decreasing to 30° as the frequency increases to 13.6 MHz. A band-pass filter with cut-off frequencies at 2.5 and 33 MHz and a surge protector were used to protect the input of the spectrum analyzer.

The spectrum analyzer scanned the spectrum between 3 and 30.03 MHz in approximately 2 seconds. A 180 kHz window was moved up the 3-30 MHz range to estimate the noise floor for every range. The noise after estimation from 180 kHz was converted to a density and then scaled to 1 kHz (Nk, where k is the kth range), to detect the signal power above or below the threshold in a 1 kHz segment of spectrum.

Using a sampling period of 8.533 ms for an FFT based spectrum analyzer the frequency resolution (bin size) was 122.7 Hz. The power for 1 kHz channels was calculated by combining the power observed in nine or ten contiguous bins so as to make up 1 kHz. If the combined power exceeded 10 dB above Nk, then the 1 kHz channel was considered occupied.

During the month of August 2011 measurements were taken for approximately 20 minutes each hour resulting in approximately 600 sample traces. In November 2011 measurements were collected for periods of approximately 10 minutes resulting in approximately 300 sample traces each hour. In August, between 22 and 28 days of data were collected depending on the hour, and between 25 and 27 days of data were collected in November. This measurement database is held at the Communications Research Centre Canada (CRC), in Ottawa.

*(Editors Note: Canada will provide further information on the January 2012 observations)*

# 3 Observations

Congestion rates were computed for each hour and then averaged across four hour-time blocks. Hourly figures for each month are presented in Table 1.

Hourly and seasonal trends variations are apparent in the congestion statistics, which correlate to the diurnal cycles and variation in the hours of daylight. In Ottawa, during the month of August 2011, sunrise ranges from 09:47 to 10:23 UTC and sunset from 00:31 to 23:43 UTC. Sunrise in November 2011 ranges from 11:42 to 12:21 UTC, and sunset ranges from 21:50 to   
21:22 UTC. Sunrise in January 2012 ranges from 12:43 to 12:26 UTC, and sunset ranges from 22:03 to 22:06 UTC. Observed sunspot numbers for August 2011, November 2011 and January 2012 were 42.4, 66.1 and 24.7 respectively [4]. The monthly mean Solar Flux Index (SFI)[[3]](#footnote-3) based on the Dominion Astrophysical Observatory (Penticton) observed 2800 MHz values were 101.7 for August 2011, 153.1 for November 2011 and 133.1 for January 2012. A solar event was reported for 05 August 2011; however, there was no observed impact on radio propagation.

Table 1

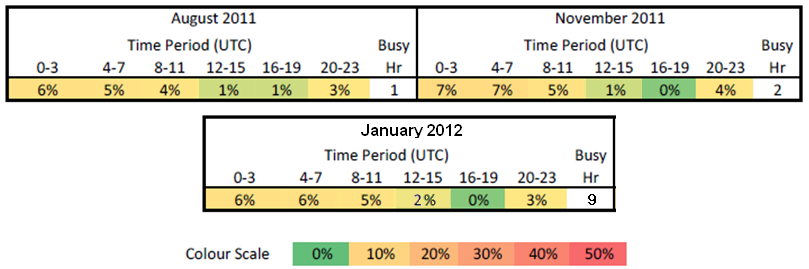
Congestion for 1 kHz channel bandwidth  
within the frequency range 5 250-5 450 MHz

Local time at Ottawa ON in August 2011 was UTC minus 4 hours (EDT) and in January 2012 was UTC minus

5 hours (EST). In November 2011 local time was UTC minus 4 hours up to and including 05 November and UTC

minus 5 hours from 6 to 30 November.

Note: Time blocks cover four-hour periods, e.g., 0-3 covers 00:00 to 03:59 UTC.



There is a trend toward moderately higher congestion rates in November 2011 as compared to August 2011. The congested periods are longer in duration, which is consistent with the shorter daylight hours when D layer absorption limits propagation in these bands.

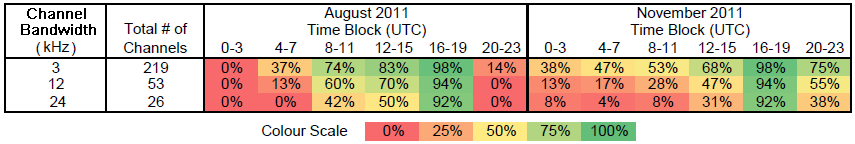
The “busy hour” was also computed and is included in Table 1. The fact that frequencies are most congested in the early evening hours may be related to time of use patterns, and/or changing propagation conditions allowing long range propagation of signals from other parts of the globe. An analysis of coverage contours using the VOACAP Propagation Prediction tool suggests that likely sources of observed signals at this frequency range are Western Europe, North and Central America.

An objective of this study is to determine the availability of a sequence of adjacent channels in the frequency band 5 250-5 450 kHz that can support available bandwidth for transmission of up to 24 kHz bandwidth. Table 2 displays percentages which represent the number of observed unoccupied channels in fixed and land mobile allocations in the 5 000-6 000 kHz frequency range, divided by the total number of channels that the frequency range could support assuming no guard

space between channels. An “unoccupied channel” is defined for this study as a 1 kHz channel where the measured occupancy rate is less than 5%, nine days out of ten. Available 3 kHz, 12 kHz, and 24 kHz channels are determined by contiguous spans of 1 kHz channels that meet this “unoccupied channel” criteria.

[Table 2

Percentage of 3, 12 and 24 kHz bandwidths channels that are unoccupied (occupancy < 5%, 9 days out of 10) in fixed and land mobile allocations for 3, 12 and 24 kHz channel bandwidths  
within the frequency range 5 000‑6 000 kHz



Note: Time blocks cover four-hour periods, e.g., 0-3 covers 00:00 to 03:59 UTC.

The results in Table 2 show that there are few if any contiguous channels available even with 3 kHz bandwidth during the first time block (0-3 UTC) however, a significant number of channels are available in time block 5 (16-19 UTC) corresponding to about noon local time. The lack of wideband (24 kHz) channels available at night is more severe in the August data. At some intervals of time and frequency where there are some smaller bandwidth channels (e.g. 3 kHz) available, but few or no wider-band channels.

# [4 Conclusions

The measurements of this study as observed near Ottawa, Ontario, Canada indicate that at most times of the daytime locally, there is adequate frequency support for usage of communication channel bandwidths up to 24 kHz in the frequency range 5 250-5 450 kHz. However, during the local late afternoon and evening hours when congestion is most severe, there are very few contiguous unoccupied channels available in this frequency range.]

1. Definitions, as they appear in this document, are specific to this document and are not intended to supplement or contradict ITU-R definitions, e.g., those in the [ITU-T/ITU-R Terms and Definitions Database](http://www.itu.int/oth/R0B0500000C/en). [↑](#footnote-ref-1)
2. <http://www.voacap.com> [↑](#footnote-ref-2)
3. <http://www.ngdc.noaa.gov/nndc/struts/results?op_0=eq&v_0=Penticton_Observed&t=102827&s=4&d=8&d=22&d=9> [↑](#footnote-ref-3)