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| **Radiocommunication Study Groups** |  |
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| **3 April 2017** |
| **English only**  **SPECTRUM ASPECTS** |
| Working Parties 3J, 3K and 3M | |
| Liaison Statement to Task Group 5/1  (Copy for information to working parties 4A, 4B, 4C,  5A, 5B, 5C, 5D, 6A, 7B, 7C and 7D) | |
| Guidance on the use of ITU-R P-Series Recommendations for interference prediction and sharing studies  under WRC-19 agenda item 1.13 | |

# 1 Introduction

ITU-R Working Parties 3J, 3K and 3M (WPs 3J, 3K and 3M) have been identified as concerned groups with respect to WRC-19 agenda item 1.13. The results of CPM 19-1(CA/226), Annex 9, *decides* 4 states, “that the Working Parties of Study Group 3 are to provide the relevant propagation models for sharing studies for the frequency bands listed in resolves to invite ITU-R 2 of Resolution **238 (WRC-15)** to TG 5/1 by 31 March 2017, at the latest”.

This liaison statement addresses the application of propagation models for sharing and compatibility studies relevant to Resolution **238 (WRC-15)** between IMT systems operating in the frequency range 24.25 to 86 GHz and other systems in the same or adjacent frequency bands. The Working Parties of Study Group 3 note that information provided by WP 5D (Document [3J/60 – 3K/69 – 3M/107](https://www.itu.int/md/R15-WP3J-C-0060/en)) has been considered in providing this guidance to TG 5/1. The Working Parties of Study Group 3 did not make any further assumptions about the parameters or the modelling of IMT systems.

The ITU-R P-Series Recommendations were reviewed for applicability to interference prediction and sharing studies for the specific frequency bands indicated in WRC‑19 agenda item 1.13. Applicable Recommendations are described for three interference scenarios: 1) between stations on the Earth’s surface and stations in space, 2) between stations on the Earth’s surface and airborne platforms, and 3) among stations on the Earth’s surface. In addition, Recommendations of general use for all these scenarios are described.

Unless otherwise stated below, the most recent approved version of the Recommendation should be used.

This document addresses only propagation prediction for interference – that is, the calculation of the unwanted signal, including enhancements that may decrease the path loss and thereby increase the interfering signal. Other P-Series Recommendations, not described here, would be useful for the prediction of the wanted signal or simulation of an operating system and could be used in evaluating the viability of systems.

# 2 Recommendations applicable for all sharing geometries

For an overall reference, Recommendation ITU-R P.1144 (see Document [3/53](https://www.itu.int/md/R15-SG03-C-0053/en)) provides a summary of the P-Series Recommendations containing prediction methods, along with relevant frequency range, inputs and outputs.

TG 5/1 may also find the “Handbook on ITU-R Propagation Prediction Methods for Interference and Sharing Studies” of use, noting that it was published in 2012 and does not reflect the most recent versions of all Recommendations discussed here.

Draft new Recommendation ITU-R P.[Clutter], Prediction of Clutter Loss

This draft new Recommendation (see Document [3/51](https://www.itu.int/md/R15-SG03-C-0051/en)(Rev.1) provides a method for calculating additional loss due to one or both of the radio terminals being embedded in local clutter (e.g., buildings) in an urban or suburban environment. For interfering paths at the frequencies of interest to TG 5/1, two statistical models are provided to estimate clutter loss as a function of probability. One model (in section 3.2) addresses terrestrial paths, while the other model (in section 3.3) is for an inclined path where the terrestrial end of the path is within the clutter. Practical situations where clutter loss is negligible have also been accounted for. These models have been developed using measurement results as well as analytical models over the range of frequencies described in WRC‑19 agenda item 1.13, particularly in urban environments. It should be noted that the model in section 3.3 of the Recommendation is not applicable to base stations in the suburban open-space hotspot environment as defined in Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en) Attachment 2 section 4, because clutter loss is expected to be insignificant.

While this Recommendation is suitable for the work of TG 5/1 in its current form, the Working Parties of Study Group 3 would welcome additional measurements and/or analysis for relevant environments and frequencies to assist Study Group 3 in refining the models.

An associated draft new Report ITU-R P.[CLUTTER\_REP] (see Document [3/52](https://www.itu.int/md/R15-SG03-C-0052/en)(Rev.1)) describes the development of the inclined path model in this Recommendation.

This Recommendation should be used in addition to one of the Recommendations described below for specific geometries. Please refer to comments below as to when and how this should be included.

Draft new Recommendation ITU-R P.[BEL] Prediction of Building Entry Loss

This draft new Recommendation (see Document [3/57](https://www.itu.int/md/R15-SG03-C-0057/en)(Rev.1.)) provides a method for calculating additional loss due to one of the radio terminals being inside a building while the other is outside. It has been developed using measurement results over the range of frequencies described in WRC‑19 agenda item 1.13. While this Recommendation is suitable for the work of TG 5/1 in its current form, the Working Parties of Study Group 3 would welcome additional measurements and/or analysis to assist in refining the method.

This Recommendation should be used in addition to one of the Recommendations described below for specific geometries. Please refer to comments below as to when and how this should be included.

# 3 Recommendation applicable for sharing between stations in space and stations on the Earth’s surface

[P.619](http://www.itu.int/rec/R-REC-P.619-1-199203-I/en) Propagation data required for the evaluation of interference between stations in space and those on the surface of the Earth

This Recommendation was revised at the March 2017 meeting of Working Party 3M (see Document [3/49](https://www.itu.int/md/R15-SG03-C-0049/en)(Rev.1)). The draft revised Recommendation provides methodologies to calculate individual propagation effects (for example, tropospheric refraction or beam spreading loss) as well as methods to combine the individual calculations for single-entry or multiple-entry interference analysis. The frequency range for each effect is given in the Recommendation and in general, is valid up to 100 GHz. Note that some of the effects described in this Recommendation, for example, depolarization by Faraday rotation, and effects due to the ionosphere, will not be relevant to the frequencies of interest to TG 5/1.

As described in this Recommendation, additional loss due to local clutter on an inclined path and/or building entry loss should be calculated using the Recommendations described in section 2 above, depending on the environment of the terrestrial terminal.

# 4 Recommendations applicable for sharing between airborne stations and stations on the Earth’s surface

[P.2041](https://www.itu.int/rec/R-REC-P.2041-0-201309-I/en) Prediction of path attenuation on links between an airborne platform and space and between an airborne platform and the surface of the Earth

This Recommendation provides, in Section 6, a method for predicting loss on a path between an airborne platform and a station on the surface of the Earth. As it assumes a direct unobstructed path, the mechanisms are rain attenuation, cloud attenuation, gaseous attenuation and tropospheric fading. Of these, only gaseous attenuation will be relevant at the time percentages used for interference analysis. Therefore, a more direct approach would be to calculate the gaseous attenuation as described in section 6.2 of the Recommendation (using Recommendation ITU-R [P.676](https://www.itu.int/rec/R-REC-P.676-11-201609-I/en) for the specific attenuation). This should then be added to free space loss and, as appropriate, to additional loss due to clutter on an inclined path and/or building entry loss as described in Section 2 above. This approach is relevant for all frequencies of interest to TG 5/1 provided that the gaseous attenuation is calculated with Recommendation ITU-R P.676.

[P.1409](https://www.itu.int/rec/R-REC-P.1409-1-201202-I/en) Propagation data and prediction methods for systems using high altitude platform stations and other elevated stations in the stratosphere at frequencies greater than about 1 GHz

This Recommendation provides advice on interference between, *inter alia*, high altitude platform stations (HAPS) and terrestrial systems. In the case of the ground stations for HAPS, it recommends the use of Recommendation ITU-R P.452 (described in section 5 below). In the case of elevated HAPS platforms, it recommends the use of Recommendation ITU-R P.619 (described in section 3 above). Although not explicitly described in Recommendation ITU-R P.1409, additional loss due to local clutter on an inclined path and/or building entry loss should be calculated using the Recommendations described in section 2 above, depending on the environment of the terrestrial terminal.

# 5 Recommendations applicable for sharing between stations on the surface of the Earth

[P.452](https://www.itu.int/rec/R-REC-P.452-16-201507-I/en) Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz

This Recommendation is explicitly intended for calculation of interference between terrestrial stations. While the models have been tested up to 50 GHz as described in the introduction of the Recommendation, WPs 3J, 3K and 3M consider that it can be used for frequencies up to 100 GHz with the following caveats.

The free space loss component is applicable for all frequencies without limit.

The gaseous attenuation component, based on Recommendation ITU-R P.676, is applicable to 1 000 GHz.

The prediction method for diffraction loss is applicable for frequencies to at least 100 GHz although the input data required, such as terrain profiles, may not be detailed enough at the higher frequencies. However, the loss due to diffraction at these frequencies is quite large, so once a path is fully trans-horizon, the only significant propagation mechanism is troposcatter. The diffraction calculation requires a specific terrain profile but may be suitable for Monte Carlo simulations by extracting random but real terrain profiles and running the model repeatedly. It should be noted that calculating diffraction using only a flat (smooth earth) profile is not necessarily the lowest loss case and should not be used as a simplified model.

While the troposcatter and anomalous propagation methods have been based on measurements up to 50 GHz and have not been tested at higher frequencies, there is nothing intrinsic in the methods that would prevent their use up to 86 GHz for the purposes of TG 5/1.

The clutter correction in section 4.5 of Recommendation ITU-R P.452 should not be used for the TG 5/1 interference analyses, as it assumes specific knowledge of the location of the transmitter, receiver and nearby obstacles. Instead, the method of the draft new Recommendation ITU‑R P.[CLUTTER] should be used to calculate additional loss due to clutter. (In a future revision of Recommendation ITU-R P.452, Working Party 3M will clarify the relationship between the specific-path clutter calculations needed in P.452 and the statistical model for clutter loss in draft new Recommendation ITU-R P.[CLUTTER].)

Additional loss due to building entry loss should also be calculated as described in section 2 above.

[P.2001](https://www.itu.int/rec/R-REC-P.2001-2-201507-I/en) A general purpose wide-range terrestrial propagation model in the frequency range 30 MHz to 50 GHz

This Recommendation provides a calculation for path loss across the full distribution of time percentages, defined as the percentage (*Tpc*) of an average year for which a given loss value is not exceeded. For interference analysis, this Recommendation should be used by choosing small values for *Tpc*.

The propagation mechanisms (including free space loss, diffraction and troposcatter) in Recommendation ITU-R P.2001 are similar or identical to those in Recommendation ITU-R P.452 and the comments given above in relation to Recommendation ITU-R P.452 about frequency applicability apply to Recommendation ITU-R P.2001 as well. The gaseous attenuation component in Recommendation ITU‑R P.2001 is an approximate method which is applicable up to 54 GHz. Above 54 GHz, the Recommendation ITU-R P.676 should be used instead of the Recommendation ITU-R P.2001 calculation.

As with Recommendation ITU-R P.452, diffraction using only a flat (smooth earth) profile should not be used as a simplified model.

It is not appropriate to include rain attenuation in this (or any) calculation, as it does not create an enhancement of the interfering signal but only a short-term degradation.

Although not explicitly described in Recommendation ITU-R P.2001, additional loss due to local clutter on a terrestrial path and/or building entry loss should be calculated using the Recommendations described in section 2 above, depending on the environment of the terrestrial terminals.

[P.1411](http://www.itu.int/rec/R-REC-P.1411-8-201507-I/en) Propagation data and prediction methods for the planning of short-range outdoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz

This Recommendation was revised at the March 2017 meeting of Working Party 3K (see Document [3/54](https://www.itu.int/md/R15-SG03-C-0054/en)(Rev.1)). This draft revised Recommendation provides methods for predicting loss on outdoor short-range (typically less than 1 km) paths. The prediction includes line of sight (LOS) and non-line of sight (NLOS) environments, multipath models, polarization characteristics and fading conditions. The physical environments discussed in this Recommendation include: urban very high rise, urban high rise, urban low-rise/suburban, residential, and rural.

All of the path loss models of this recommendation require measured empirical constants to compete the calculations. Many of the prediction methods are based on measurements at specific frequencies within the range of interest. However, in general prediction methods in the Recommendation applicable to sharing studies in TG 5/1 are valid up to 73 GHz.

It must be emphasised that the measurements and modelling in this Recommendation intrinsically include the effect of clutter over the full length of the path, so it would be inappropriate to add a calculation of clutter separately. Section 4.5.2 of the Recommendation notes the requirement to consider building entry loss separately, and this can be done by using the draft new Recommendation ITU-R P.[BEL] described in section 2 above.

[P.1238](http://www.itu.int/rec/R-REC-P.1238-8-201507-I/en) Propagation data and prediction methods for the planning of indoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz

This Recommendation was revised at the March 2017 meeting of Working Party 3K (see Document [3/55](https://www.itu.int/md/R15-SG03-C-0055/en)). This draft revised Recommendation provides prediction methods for paths contained entirely within a single building, at frequencies up to 73 GHz. It would be of use to TG 5/1 for interference scenarios where the dominant paths between the interfering and interfered-with systems remain inside the same building. For obvious reasons, the addition of clutter loss or building entry loss would not be appropriate in this case.

# 6 Summary of applicable Recommendations

Table 1 is a summary of the Recommendations described above for easy reference.

Table 1

Summary Guidance for AI 1.13 Sharing Studies

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| Sharing scenarios | ITU-R reference | 24.25-27.5 GHz | 31.8-33.4 GHz | 37-52.6 GHz | 66-76 GHz | 81-86 GHz |
| General | Handbook on interference | Gives general advice | | | | |
| P.1144 | Provides overview of Recommendations | | | | |
| P.[BEL] | YES | YES | YES | YES | YES |
| P.[Clutter\_Loss] | YES | YES | YES | YES | YES |
| Between space stations and stations on the Earth’s surface | P.619 | YES | YES | YES | YES | YES |
| Between airborne stations and stations on the Earth’s surface | P.2041 | YES | YES | YES | YES | YES |
| P.1409 | YES | YES | YES | YES | YES |
| Between stations on the Earth’s surface | P.452 | YES | YES | YES | YES | YES |
| P.2001 | YES | YES | YES | YES | YES |
| P.1411 | YES | YES | YES | YES | NO |
| P.1238 | YES | NO | YES | YES | NO |

# 7 Conclusions

Working Parties 3J, 3K and 3M hope that the information in this document, and the associated Recommendations, is of use to Task Group 5/1 in undertaking the sharing studies under WRC-19 agenda item 1.13. These Working Parties will meet again in August 2017 and can provide further advice as necessary. In the interim, the Chairmen of the Working Parties, and the Chairman of the Study Group, are available for further advice by correspondence.

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| **Status:** For action to TG 5/1 |  |
| For information to concerned groups |  |
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