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| **World Radiocommunication Conference (WRC-15)Geneva, 2–27 November 2015** |  |
| **INTERNATIONAL TELECOMMUNICATION UNION** |  |
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| PLENARY MEETING | **Document 94-E** |
|  | **16 October 2015** |
|  | **Original: English** |
|  |
| Australia and New Zealand |
| Proposals for the work of the conference |
|  |
| Agenda item 1.5 |

1.5 to consider the use of frequency bands allocated to the fixed-satellite service not subject to Appendices **30**, **30A** and **30B** for the control and non-payload communications of unmanned aircraft systems (UAS) in non-segregated airspaces, in accordance with Resolution **153 (WRC‑12)**;

Introduction

Australia and New Zealand support measures to allow use of frequency bands allocated to the fixed-satellite service (FSS) not subject to Appendices 30, 30A and 30B for the control and non-payload communications (CNPC) of unmanned aircraft systems (UAS) in non-segregated airspaces. With that in mind, Australia and New Zealand support Method A Option 1.

However, noting the difficulties encountered in achieving agreement on this Method, Australia and New Zealand are proposing a variation on Method A as a potential means of enabling bands allocated to the FSS to be used for UAS CNPC.

This proposal specifically identifies the use of aeronautical mobile (R) service allocations in the FSS bands under consideration. Importantly however, use of this allocation would be limited to aircraft earth stations communicating with space stations in the fixed-satellite service. Australia and New Zealand propose two separate Radio Regulations Table of Frequency Allocations’ footnotes and an associated Resolution to address the conditions identified by ICAO that call for clear identification of all frequency bands which carry aeronautical safety communications. These measures will ensure that assignments and use of these bands for UAS CNPC links can be consistent with Article 4.10.

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. 2.1)

MOD AUS/NZL/94/1

10-11.7 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 10.7-11.7FIXEDFIXED-SATELLITE(space-to-Earth) 5.441 5.484A(Earth-to-space) 5.484MOBILE except aeronauticalmobileADD 5.AUS5A | 10.7-11.7 FIXED FIXED-SATELLITE (space-to-Earth) 5.441 5.484A MOBILE except aeronautical mobileADD 5.AUS5A |

**Reasons:** To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service in the band 10.7-11.7 GHz.

MOD AUS/NZL/94/2

11.7-14 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 11.7-12.5FIXEDMOBILE except aeronautical mobileBROADCASTINGBROADCASTING-SATELLITE   5.492 | 11.7-12.1FIXED 5.486FIXED-SATELLITE(space-to-Earth) 5.484A 5.488Mobile except aeronautical mobile5.485 ADD 5.AUS5A | 11.7-12.2FIXEDMOBILE except aeronautical mobileBROADCASTINGBROADCASTING-SATELLITE   5.492 |
| 12.1-12.2FIXED-SATELLITE (space-to-Earth) 5.484A 5.488 |
|  | 5.485 5.489 ADD 5.AUS5A | 5.487 5.487A |
|  | 12.2-12.7FIXEDMOBILE except aeronauticalmobileBROADCASTINGBROADCASTING-SATELLITE   5.492 | 12.2-12.5FIXEDFIXED-SATELLITE(space-to-Earth) 5.484AMOBILE except aeronauticalmobileBROADCASTING |
| 5.487 5.487A |  | 5.487 ADD 5.AUS5A |
| 12.5-12.75 | 5.487A 5.488 5.490  | 12.5-12.75 |
| FIXED-SATELLITE(space-to-Earth) 5.484A(Earth-to-space)5.494 5.495 5.496 ADD 5.AUS5A | 12.7-12.75FIXEDFIXED-SATELLITE(Earth-to-space)MOBILE except aeronauticalmobile | FIXEDFIXED-SATELLITE(space-to-Earth) 5.484AMOBILE except aeronauticalmobileBROADCASTING-SATELLITE 5.493 ADD 5.AUS5A |

**Reasons:** To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service in the band 11.7-12.75 GHz.

MOD AUS/NZL/94/3

14-15.4 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 14-14.25 FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A    5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.504C 5.506A Space research 5.504A 5.505 ADD 5.AUS5A |
| 14.25-14.3FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A   5.506 5.506B RADIONAVIGATION 5.504 Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.508A Space research 5.504A 5.505 5.508 ADD 5.AUS5A |
| 14.3-14.4FIXEDFIXED-SATELLITE(Earth-to-space) 5.457A5.457B 5.484A 5.506 5.506BMOBILE except aeronauticalmobileMobile-satellite (Earth-to-space) 5.504B 5.506A 5.509ARadionavigation-satellite5.504A ADD 5.AUS5A | 14.3-14.4FIXED-SATELLITE(Earth-to-space) 5.457A5.484A 5.506 5.506BMobile-satellite (Earth-to-space) 5.506ARadionavigation-satellite5.504A ADD 5.AUS5A | 14.3-14.4FIXEDFIXED-SATELLITE(Earth-to-space) 5.457A5.484A 5.506 5.506BMOBILE except aeronauticalmobileMobile-satellite (Earth-to-space) 5.504B 5.506A 5.509ARadionavigation-satellite5.504A ADD 5.AUS5A |
| 14.4-14.47 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Space research (space-to-Earth) 5.504A ADD 5.AUS5A |
| 14.47-14.5 FIXED FIXED-SATELLITE (Earth-to-space) 5.457A 5.457B 5.484A 5.506 5.506B MOBILE except aeronautical mobile Mobile-satellite (Earth-to-space) 5.504B 5.506A 5.509A Radio astronomy 5.149 5.504A ADD 5.AUS5A |

**Reasons:** To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service in the band 14-14.5 GHz.

MOD AUS/NZL/94/4

15.4-18.4 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 17.3-17.7FIXED-SATELLITE(Earth-to-space) 5.516(space-to-Earth) 5.516A 5.516BRadiolocation | 17.3-17.7FIXED-SATELLITE(Earth-to-space) 5.516BROADCASTING-SATELLITERadiolocation | 17.3-17.7FIXED-SATELLITE(Earth-to-space) 5.516Radiolocation |
| 5.514 ADD 5.AUS5A | 5.514 5.515 | 5.514 |
| 17.7-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A(Earth-to-space) 5.516MOBILE | 17.7-17.8FIXEDFIXED-SATELLITE(space-to-Earth) 5.517(Earth-to-space) 5.516BROADCASTING-SATELLITEMobile5.515 | 17.7-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A(Earth-to-space) 5.516MOBILE |
|  | 17.8-18.1FIXEDFIXED-SATELLITE(space-to-Earth) 5.484A(Earth-to-space) 5.516MOBILE5.519 |  |
| 18.1-18.4 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B   (Earth-to-space) 5.520 MOBILE 5.519 5.521 ADD 5.AUS5A |

**Reasons:** To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service in the bands 17.3-17.7 GHz and 18.1-18.4 GHz.

MOD AUS/NZL/94/5

18.4-22 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 18.4-18.6 FIXED FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B MOBILE ADD 5.AUS5A |
| 18.6-18.8EARTH EXPLORATION-SATELLITE (passive)FIXEDFIXED-SATELLITE(space-to-Earth) 5.522BMOBILE except aeronauticalmobileSpace research (passive) | 18.6-18.8EARTH EXPLORATION-SATELLITE (passive)FIXEDFIXED-SATELLITE(space-to-Earth) 5.516B 5.522BMOBILE except aeronautical mobileSPACE RESEARCH (passive) | 18.6-18.8EARTH EXPLORATION-SATELLITE (passive)FIXEDFIXED-SATELLITE(space-to-Earth) 5.522BMOBILE except aeronauticalmobileSpace research (passive) |
| 5.522A 5.522C ADD 5.AUS5A | 5.522A ADD 5.AUS5A | 5.522A ADD 5.AUS5A |
| 18.8-19.3 FIXED FIXED-SATELLITE (space-to-Earth) 5.516.B 5.523A MOBILE |
| 19.3-19.7 FIXED FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 5.523B5.523C 5.523D 5.523E MOBILE |
| 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.516BMobile-satellite (space-to-Earth) | 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.516BMOBILE-SATELLITE(space-to-Earth) | 19.7-20.1FIXED-SATELLITE(space-to-Earth) 5.484A 5.516BMobile-satellite (space-to-Earth) |
| 5.524 ADD 5.AUS5A | 5.524 5.525 5.526 5.528 5.529 ADD 5.AUS5B | 5.524 ADD 5.AUS5A |
| 20.1-20.2FIXED-SATELLITE (space-to-Earth) 5.484A 5.516B MOBILE-SATELLITE (space-to-Earth) 5.524 5.525 5.526 5.527 5.528 ADD 5.AUS5B |

**Reasons:** To provide footnotes allowing the use of UAS CNPC links in the fixed-satellite service in the bands 18.4-18.8 GHz and 19.7-20.2 GHz.

MOD AUS/NZL/94/6

24.75-29.9 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 27.5-28.5 FIXED 5.537A FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 MOBILE 5.538 5.540 ADD 5.AUS5A |
| 28.5-28.6 FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.523A 5.539 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540 ADD 5.AUS5A |
| 28.6-29.1FIXED FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.523A 5.539 MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540 |
| 29.1-29.5 FIXED FIXED-SATELLITE (Earth-to-space) 5.516B 5.523C 5.523E 5.535A5.539 5.541A MOBILE Earth exploration-satellite (Earth-to-space) 5.541 5.540 |
| 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.516B 5.539Earth exploration-satellite(Earth-to-space) 5.541Mobile-satellite (Earth-to-space) | 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.516B 5.539MOBILE-SATELLITE(Earth-to-space)Earth exploration-satellite(Earth-to-space) 5.541 | 29.5-29.9FIXED-SATELLITE(Earth-to-space) 5.484A 5.516B 5.539Earth exploration-satellite(Earth-to-space) 5.541Mobile-satellite (Earth-to-space)  |
| 5.540 5.542 ADD 5.AUS5A | 5.525 5.526 5.529 5.540 ADD 5.AUS5B | 5.540 5.542 ADD 5.AUS5A |

**Reasons:** To provide footnotes allowing the use of UAS CNPC links in the fixed-satellite service in the bands 27.5-28.6 GHz and 29.5-29.9 GHz.

MOD AUS/NZL/94/7

29.9-34.2 GHz

|  |
| --- |
| Allocation to services |
| Region 1 | Region 2 | Region 3 |
| 29.9-30 FIXED-SATELLITE (Earth-to-space) 5.484A 5.516B 5.539 MOBILE-SATELLITE (Earth-to-space) Earth exploration-satellite (Earth-to-space) 5.541 5.543 5.525 5.526 5.538 5.540 5.542 ADD 5.AUS5B |

**Reasons:** To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service in the band 29.9-30 GHz.

ADD AUS/NZL/94/8

5.AUS5A *Additional allocation:* T**he bands** 10.7-11.7 GHz, 14-14.5 GHz, 18.1-18.8 GHz and 27.5-28.6 GHz; the bands 12.5-12.75 GHz, 19.7-20.1 GHz and 29.5-29.9 GHz in Regions 1 and 3; the band 11.7-12.2 GHz in Region 2; the band 12.2-12.5 GHz in Region 3; and the band 17.3-17.7 GHz in Region 1 are also allocated to the aeronautical mobile-satellite (R) service on a primary basis limited to aircraft earth stations communicating with space stations in the fixed-satellite service for the purposes of control and non-payload communications for unmanned aircraft systems in accordance with Resolution **[AUS-A5-FSS-UA-CNPC] (WRC‑15)**.    (WRC‑15)

**Reasons:** To provide a footnote allowing the use of UAS CNPC links in the fixed-satellite service.

ADD AUS/NZL/94/9

5.AUS5B In Region 2 the bands 19.7-20.2 GHz and 29.5-30 GHz and, in Regions 1 and 3, the bands 20.1-20.2 GHz and 29.9-30 GHz use of the aeronautical mobile-satellite (R) service is limited to aircraft earth stations communicating with space stations in the fixed-satellite service for the purposes of control and non-payload communications for unmanned aircraft systems in accordance with Resolution **[AUS-A5-FSS-UA-CNPC] (WRC‑15)**.    (WRC‑15)

**Reasons:** To provide a footnote identifying the use of UAS CNPC links in the fixed-satellite service in bands already allocated to the mobile-satellite service on a primary basis.

SUP AUS/NZL/94/10

5.527 In the bands 19.7-20.2 GHz and 29.5-30 GHz, the provisions of No. **4.10** do not apply with respect to the mobile-satellite service.

**Reasons:** To provide clarity on the status of aeronautical mobile-satellite (R) service stations operating in the mobile-satellite service for the purposes of unmanned aircraft systems command and non-payload communications.

ADD AUS/NZL/94/11

Draft New Resolution [AUS-A5-FSS-UA-CNPC] (WRC-15)

Regulatory provisions related to aircraft earth stations on board unmanned aircraft in the aeronautical mobile-satellite (R) service which operate with geostationary satellites in the fixed-satellite service in a Region where the frequency bands are not subject to the Plans or Lists of Appendices 30, 30A, and 30B for the control and non-payload communications of unmanned aircraft systems

The World Radiocommunication Conference (Geneva, 2015),

considering

*a)* that worldwide use of unmanned aircraft systems (UAS) ,which includes the unmanned aircraft (UA) and the unmanned aircraft control station (UACS), is expected to increase significantly in the near future;

*b)* that UA need to operate seamlessly with piloted aircraft in non-segregated airspace;

*c)* that the operation of UAS in non-segregated airspace requires reliable control and non-payload communication (CNPC) links, in particular to relay air traffic control communications and for the remote pilot to control the flight;

*d)* that there is a demand for the control of UAS CNPC links via satellite communication networks for communications beyond the radio horizon while operating in non-segregated airspace as shown in Annex 1;

*e)* that there is a need to provide internationally harmonized use of spectrum for UAS CNPC links;

*f)* that the use of fixed satellite service (FSS) frequency assignments by UAS CNPC links should take into account their Article **11** notification status,

considering further

*a)* that there is a need to limit the amount of communication equipment onboard a UA;

*b)* that there is urgency to conclude on the regulatory basis for the use of the FSS frequency bands to support short- and medium term implementation of UAS CNPC links because a dedicated satellite system for this application is not likely to be implemented in this time frame;

*c)* that there are various technical methods that may be used to increase the reliability of digital communication links, e.g. modulation, coding, redundancy, etc. that can be used to ensure safe operation of UAS in all air space;

*d)* that UAS CNPC relate to the safe operation of UAS and have certain technical, operational, and regulatory requirements;

*e)* that the requirements in *considering further d)* can be specified for UAS use of FSS networks,

noting

*a)* that Report ITU‑R M.2171 provides information on the vast number of applications for UAS needing access to non-segregated airspaces;

*b)* that, although Recommendation **724 (WRC-07)** notes that FSS is not a designated safety service, FSS can be used, under certain conditions, on a permanent or temporary basis for safeguarding human life or property;

recognizing

*a)* that the power flux-density limits in Section V of Article 21 apply to space-to-Earth transmissions for communications with Unmanned Aircraft Systems;

*b)* that the UAS CNPC links shall be operated in accordance with international standards and recommended practices and procedures established in accordance with the Convention on International Civil Aviation;

*c)* that in this context, ITU develops the conditions for operation of CNPC links, and then, International Civil Aviation Organization (ICAO) would be in a position to develop further operational conditions to ensure safe UAS operation,

resolves

1 that FSS networks in this frequency band in a Region where the frequency band is not subject to the Plans or lists of Appendices **30**, **30A**, or **30B** may be used for the control and non-payload communications of unmanned aircraft systems;

2 that aircraft earth stations on-board UA can communicate with a space station operating in the fixed satellite service, including while the UA is in motion;

3 that the use of UAS CNPC links and their associated performance requirements shall be in accordance with the international standards and recommended practices (SARPS) and procedures established by ICAO consistent with Article 37 of the Convention on International Civil Aviation;

4 that aircraft earth stations on-board UA operating in accordance with *resolves 2* shall meet all the technical and regulatory requirements for fixed-satellite service earth stations operating in the same frequency band as well as the additional technical requirements identified in Annex 2;

5 that UAS CNPC aircraft earth stations shall operate within the envelope of the parameters of typical earth stations associated with the notified FSS network and shall not cause more interference and shall not claim more protection than a typical FSS earth station located on the surface of the Earth;

6 that UAS CNPC aircraft earth stations shall be designed so as to be able to operate in the interference environment created by terrestrial services allocated on a co-primary basis in accordance with the Radio Regulations in these frequency bands;

7 that the freedom from harmful interference to UAS CNPC links is imperative to ensure safe operation and administrations shall act immediately when their attention is drawn to any such harmful interference;

8 that the FSS operator will ensure that the assignments associated with the FSS networks to be used for UAS CNPC links (see figure 1 in Annex 1) have obtained the necessary protected status under the provisions of No. **11.32**, **11.32A**, **11.42**, or **11.42A** including the examinations made by the BR and have been successfully registered in the MIFR;

9 that, real-time interference monitoring and predicting interference risks, and planning solutions for potential interference scenarios, shall be addressed in the specific agreements between FSS operators and UAS operators with guidance from aviation authorities;

10 that the protection of the incumbent fixed service from UAS CNPC transmissions shall be ensured by implementing measures shown in Annex 2,

encourages concerned administrations

to cooperate with administrations which license UAS CNPC while seeking agreement under the abovementioned provisions,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the ICAO.

Annex 1 to Resolution [AUS-A5-FSS-UA-CNPC] (WRC‑15)

UA CNPC links

Figure 1

**Elements of UAS architecture using the FSS**



Annex 2 to Resolution [AUS-A5-FSS-UA-CNPC] (WRC‑15)

Protection of the fixed service and of other fixed-satellite service
networks from UA CNPC emissions

# 1 Introduction

Because of the fundamental assumption made that to use the frequency bands allocated to the FSS the UAS CNPC link must operate within the same regulatory and performance limitations as any other FSS earth station and that, from an interference perspective, it must perform its function in exactly the same manner as any other FSS earth station, there are only a limited number of additional requirements, over and above those of a typical FSS, that need to be imposed on UAS CNPC operations to ensure compatibility with other services sharing the same frequency bands. These additional requirements are listed in Sections 2, 3, and 4 of this Annex.

# 2 Protection of the fixed service

The fixed service is allocated by footnotes in several countries with a co-primary status to the FSS. Conditions of UA using CNPC shall be such that the fixed service is protected from any harmful interference as defined below.

1) UA shall not operate at latitudes above 70 degrees.

2) UA shall not operate on frequencies in the band 14.00 to 14.5 GHz in altitudes below 5000 ft.

3) UA shall not operate on frequencies in the band 27.5-29.5 GHz in altitudes below 3000 ft.

4) Earth station on UA shall comply with the two band-specific PFD masks described below.

In the 14-14.5 GHz frequency band as used by fixed service networks, within line-of-sight of the territory of an administration where fixed service networks are operating in this band, the maximum pfd produced at the surface of the Earth by emissions from a single UA should not exceed:

|  |  |
| --- | --- |
|  -97 dB(W/(m2  ⋅ 14MHz)) | for θ ≤ 5° |
|  -97 + 2.1 ⋅ (θ - 5°)2 dB(W/(m2  ⋅ 14MHz)) | for 5° < θ ≤ 7.5° |
|  -91.7 - 25 ⋅ log10 (θ) dB(W/(m2  ⋅ 14MHz)) | for 7.5° < θ ≤ 53° |
|  -49.7 dB(W/(m2  ⋅ 14MHz)) | for 53° < θ ≤ 90° |

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE 1 – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

**PFD mask as function of angle of arrival for 14.0-14.5 GHz**

In the 27.5-29.5 GHz frequency band as used by fixed service networks, within line-of-sight of the territory of an administration where fixed service networks are operating in this band, the maximum pfd produced at the surface of the Earth by emissions from a single UA should not exceed:

|  |  |
| --- | --- |
|  -91 dB(W/(m2  ⋅ 14MHz)) | for θ ≤ 5° |
|  -91 + 0.6 ⋅ (θ - 5°)2 dB(W/(m2  ⋅ 14MHz)) | for 5° < θ ≤ 9.4° |
|  -79.4 dB(W/(m2  ⋅ 14MHz)) | for 9.4° < θ ≤ 90° |

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE 1 – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

**PFD mask as function of angle of arrival for 27.5-29.5 GHz**

# 3 Protection of other fixed-satellite service networks

Conditions of UA using CNPC shall be such that the fixed-satellite service is protected from any harmful interference as defined below.

1) UAS CNPC shall comply with ITU-R S.524, or other coordinated levels agreed between administrations, at all times including when the aircraft is manoeuvring.

# 4 Protection of radio astronomy

No. 5.149 of the Radio Regulations urges administrations to take all practicable steps to protect the radio astronomy service from harmful interference in certain bands, including 14.47-14.5 GHz, noting that emissions from airborne stations can be particularly serious sources of interference to the radio astronomy service. In the band 14.47-14.5 GHz, consultations will be needed between radio astronomy stations and UAS operating co-frequency UAS CNPC (Earth-to-space) within radio line-of-sight of radio astronomy service observatories in order to address potential incompatibilities.

**Reasons:** To provide suitable conditions to ensure compatibility with other services and other applications of the fixed-satellite service for the use of geostationary satellites in the fixed-satellite service in a Region where the frequency band is not subject to the Plans or Lists of Appendices 30, 30A, and 30B for the control and non-payload communications of unmanned aircraft systems.

SUP AUS/NZL/94/12

RESOLUTION 153 (WRC‑12)

The use of frequency bands allocated to the fixed-satellite service not subject to Appendices 30, 30A and 30B for the control and non-payload communications
of unmanned aircraft systems in non-segregated airspaces

**Reasons:** No longer required.

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