Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Parts 1, 2, 15, 90 and 95 of the Commission's Rules to Permit Radar Services in the 76-81 GHz Band	)	**ET Docket No. 15-26**
	)	
Amendment of Part 15 of the Commission's Rules to Permit the Operation of Vehicular Radar Services in the 77-78 GHz Band	)	**RM-11666**
	)	
Amendment of Sections 15.35 and 15.253 of the Commission's Rules Regarding Operation of Radar Systems in the 76-77 GHz Band	)	**ET Docket No. 11-90**
	)	
Amendment of Section 15.253 of the Commission's Rules to Permit Fixed Use of Radar in the 76-77 GHz Band	)	**ET Docket No. 10-28**
	)	
Amendment of the Commission's Rules to Permit Radiolocation Operations in the 78-81 GHz Band	)	

To: The Commission

REPLY COMMENTS OF ROBERT BOSCH, LLC

Robert Bosch, LLC (Bosch), by counsel and pursuant to Section 1.415(c) of the Commission's Rules [47 C.F.R. §1.415(c)], hereby respectfully submits its reply to certain of the comments previously filed in response to the *Notice of Proposed Rule Making and Reconsideration Order*, FCC 15-16, 80 Fed. Reg. 12120, released February 5, 2015 (the Notice). Bosch has heretofore filed comments in this proceeding in support of the authorization of 77-81 GHz automotive radar applications in the United States. There are in other comments filed to date in this proceeding proposals to permit other types of radiolocation services in this same frequency band and in the 76-77 GHz band. There are also comments concerning the

compatibility of automotive radar with incumbent services, specifically radioastronomy and the amateur and amateur-satellite radio services. Bosch herein responds to arguments made on those issues. For its reply comments, and in the interests of automotive and automotive equipment manufacturers in worldwide harmonization of automotive radar and in the development of important next-generation automotive safety equipment in the band 77-81 GHz, Bosch further states as follows:

I. The Record in this Proceeding Overwhelmingly Supports the Authorization of Automotive Radar Systems in the Band 77-81 GHz.

1. The comments filed in this proceeding without exception support or do not oppose the authorization of short-range automotive radar systems (SRRs) in the United States at 77-81 GHz. The majority of those comments urge that the addition of automotive radar systems in this band can be done compatibly with incumbent radio services. Literally, not one comment filed suggested that automotive radars should not be permitted in the band 77-81 GHz. Some individual amateur radio operators expressed reasonable concerns that they might be displaced from the band 76-81 GHz, and noted (1) their substantial individual investments in equipment with which to conduct important propagation research in the band, and (2) the value of Amateur Radio experimentation in the band generally. ARRL, the national association for Amateur Radio made a persuasive case for retaining the primary and secondary amateur and amateur-satellite service allocations in the band 76-81 GHz while at the same time accommodating the addition of automotive radar systems at 77-81 GHz. The National Radio Astronomy Observatory ("NRAO") and the National Research Council Committee on Radio Frequencies of the National Academy of Sciences (CORF) each urge restrictions on all 76-81 automotive radar operation, which they assert are necessary in order to protect the very few millimeter-wave radioastronomy

observatories in the United States from any chance of interference. However, neither CORF nor NRAO suggests preclusion of automotive radars in any portion of the 76-81 GHz band.

2. The remainder of the comments are from (1) automotive or automotive equipment manufacturers who support the proposal, and (2) proponents of other radiolocation systems that might be offered in that band in addition to automotive radars. In these reply comments, inasmuch as there appears to be universal acceptance of SRRs at 77-81 GHz, in general on a domestic allocation and "license-by-rule" basis under Part 95, Bosch addresses (a) the issue of fixed radiolocation systems in the band 76-81 GHz; (b) the arguments of the radioastronomy advocates and the issue of amateur radio compatibility with automotive radars; and (c) the arguments relative to authorizing airborne radiolocation, wingtip radar systems at airport runways and other applications. The variety of concerns expressed with respect to non-automotive radar applications in this band are indicative that the Commission cannot and should not take a generalized, unstudied view of the compatibility between and among various types of radiolocation systems, automotive radars, and incumbent services in this band. However, neither should the Commission further delay the authorization of 77-81 GHz automotive radars in the United States. Given the rather obvious safety benefits of SRR technology and the well-established need to incorporate it in automobiles of all price categories, any further delay[1] in implementing automotive radars (via Parts 2 and 95, or via Part 15) is costly in terms of avoiding personal injury and damage to property. Proceeding slowly, however, in considering the addition of potentially incompatible radiolocation applications in this band is equally urgent.[2] There is no necessary public interest rush to allow any type of fixed radiolocation in this band in particular,

[1] The Commission initiated this proceeding in response to Bosch's May 15, 2012 Petition for Rulemaking, RM-11666.

[2] Given the fact that all of the available information to date suggests that automotive radars and fixed radars in this frequency range are *not* compatible, exceptional caution is called for. See Section II, *infra*.

but there is certainly an urgent need to (1) permit, and (2) avoid interference to SRRs at 77-81 GHz and LRRs at 76-77 GHz. The public interest benefit in protection to persons and property from SRRs should be realized without delay; but on the other hand, the SRRs should not be rendered unreliable in the Commission's zeal to maximize the re-use of this band in particular.

II. Fixed Services in the Band 76-81 GHz Cannot be Authorized on a Generalized Basis; They are Unsuitable for Part 95 Blanket Licensing; and Each Must be Adjudicated on a Case-by-Case Basis Pursuant to a Compatibility Analysis.

3. The record in this proceeding does not support the Commission's proposal to allow, on the one hand, a regulatory framework that will allow automotive radars to operate on an interference-protected basis in the band 76-81 GHz and on the other hand an unlimited and unqualified number of fixed radiolocation devices and systems in the band 76-77 GHz. The Commission's proposal to permit radiolocation generally in the 76-81 GHz band, including, generically, fixed radar installations has few supporters in the comments. As the Alliance of Automobile Manufacturers, Inc. (AAM) put it, "the Commission should be careful not to allow services in the 76-81 GHz band that could cause harmful interference to vehicular radar services. For example, fixed infrastructure radar poses a significant threat to vehicular radar and should not be allowed to operate in the 76-81 GHz band, even at bandwidths of only one gigahertz." AAM further argued that fixed infrastructure radar can interfere with vehicular radar to the extent that serious safety concerns for motorists would be created[3] and that the only study that is now published on the subject suggests that vehicular radars and fixed infrastructure radars are, in fact, *not* compatible.[4]

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[3] AAM cited as authority for this conclusion its own December 3, 2012 Opposition in ET Docket Nos. 11-90 and 10-28, and the Comments of Toyota, filed July 18, 2011 at pp 6-9. As well, AAM referred to the More Safety for All by Radar Interference Mitigation ("MOSARIM") Consortium, *Results of Interference Tests Between Automotive Radar Systems and Navtech Traffic Monitoring System*, at 11 (Nov. 30, 2012), *available at* https://assrv1.hawaw.de/index.php/dataexchange/func-startdown/1319.

[4] *Id*. Preliminary results from the MOSARIM study indicated that: (1) Fixed 76-77 GHz installations result in significant interference to automotive radar sensors; (2) Simulation results show that the interference power of an

4. The MOSARIM study aside,[5] Bosch, AAM and the comments of the former Strategic Automotive Radar Frequency Allocation Group (SARA) each noted that the European Conference of Postal and Telecommunications Administrations ("CEPT") has undertaken and is now engaged in additional testing designed to squarely examine fixed infrastructure radar to vehicular radar interference.[6] That testing is now ongoing, and the results should be known by or about the end of 2015. It would be irresponsible to be guided by assumptions such as those made in the Notice in this proceeding, made without reference to fully vetted, empirical evidence, or to allow fixed infrastructure radars to operate within the 76-81 GHz band before the results of this ongoing, further testing are known and analyzed (especially given the safety issues that are manifest should harmful interference to automotive radars occur). There must in this context be some competent, technical ascertainment of the level of compatibility between automotive radar systems and fixed radar systems as a predicate to any authorization at all for the latter. The same studies would also, of course, facilitate a determination of the proper operating parameters of any fixed radar installations and the necessary level of regulation of them.

5. The principal proponent of fixed radar installations at 76-77 GHz is Navtech Radar Ltd. (Navtech). It asserts that its fixed radar technology is useful, *inter alia*, along roadways and in tunnels to address stopped vehicles or pedestrians on a highway and in emergency highway conditions using scanning radars. This would place fixed radar systems along roadways in the

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interferer with +45 dBm EIRP is up to 75 dB above the noise floor of the 76-77 GHz automotive radar sensor will disrupt its operation and such interference cannot be mitigated in the radar sensor; and (3) By contrast, interference between and among different automotive radar sensors is avoidable. As Bosch noted in its comments in this proceeding, the automotive industry is developing countermeasures to facilitate compatibility between and among automotive radars. However, an unlimited number of fixed radars in the same band would make it extremely difficult to develop countermeasures for all possible interference scenarios.

[5] The principal goal of the MOSARIM study was to evaluate the interaction between and among different types of vehicular radars, not to evaluate automotive radar compatibility with fixed radar installations. However, the MOSARIM study indicated a specific interference potential and *for that reason*, CEPT is now studying specifically the issue of fixed and automotive radar interaction. By contrast, however, there is *no* study indicating *compatibility* now between the two categories of radiolocation applications.

[6] *See, e.g.*, SE24, Outcome of the 80th Meeting of SE24 (Dec. 10, 2014, 5:00 p.m.), (CEPT PT SE24 WI 51) http://www.cept.org/ecc/groups/ecc/wg-se/se-24/page/outcome-of-the-80th-meeting-of-se24.

same horizontal plane and in immediate geographic proximity to long-range automotive radar systems (LRRs) which, among other things, govern emergency braking systems. Navtech's only argument relative to compatibility between its fixed radar systems and automotive radars is the following:

> Fundamentally given the principles of the FMCW radar operation within the 76-77 GHz band and within the operating limits as defined by the regulations, interference is equally likely with any two given systems. An individual system may suffer the consequences of interference more or less than another system based on how the received signal is processed and how well any proprietary or agreed mitigation techniques are implemented with the respective system. In addition, given that a typical fixed infrastructure radar system has a narrow azimuth beamwidth, often scanning over 360 degrees and mounted at 4m or more above the road surface the risk of interference from it is further reduced compared to the vehicle to vehicle situation.

This argument is not well-taken. The only (anecdotal) evidence offered by Navtech in support of it is the *alleged* absence of complaints of interference from installations of its tunnel radar system installed in one roadway tunnel in England and one in Sweden. It is impossible to conceive of a situation where Navtech, a manufacturer, would be the recipient of complaints of RF interference to LRR automotive radar systems, so the alleged absence of interference complaints relative to these anecdotal deployments is meaningless. Furthermore, motorists cannot be expected to know in a given instance whether or not their LRR automatic braking system for example is or is not disabled due to boresight-to-boresight RF energy from a fixed radar facility aimed along the roadway, inside a tunnel. It is precisely this type of roadside application proposed by Navtech that necessitates a comprehensive compatibility analysis. Navtech's cavalier assertion that "interference is equally likely with any two given systems" begs the question. What *is* the level of compatibility between Navtech's roadside deployments and different manufacturer's 76-77 GHz LRR systems? That has not been evaluated. Automotive radar manufacturers have, from studies such as MOSARIM, evaluated compatibility among

certain types of *automotive* radar systems (and only incidentally reported that there is fundamental incompatibility between automotive radar systems. Only now, due to the CEPT PT SE24 WI 51 study referenced above is the issue of fixed radar interference to automotive radar systems being specifically and comprehensively studied.

6. Navtech's statement that "(a)n individual system may suffer the consequences of interference more or less than another system based on how the received signal is processed and how well any proprietary or agreed mitigation techniques are implemented with the respective system" begs the question as well. What mitigation techniques are called for? The answer is that Navtech doesn't know, and neither does the Commission, and there cannot be assumptions made on the record as it stands. Motorists that are dependent on LRRs (and, soon, SRRs) must be able to rely on the fact that those radars are working at all times. Finally, Navtech argues that, because "typically" a fixed radar uses a narrow azimuth beamwidth and scans at up to 360-degree azimuths, there is a "reduced" chance of interference to automotive radars.[7] To the contrary, the scanning function certainly can increase the chance of boresight-to-boresight interference in fixed roadside applications, especially if such fixed radar installations are permitted at 76-77 GHz. Moreover, the vague generalizations of Navtech have no proper place in this analysis. The Commission should await the completion and review of the CEPT PT SE24 WI 51 study before making any decisions about any fixed facilities anywhere in the 76-81 GHz range.

7. The same concerns exist with respect to the fixed perimeter security systems that manufacturer Mantissa, Ltd. urges be permitted Mantissa claims that "fixed radar used for security applications will most often (sic) be deployed in relatively remote locations, away from traveled roadways". Even if this vague generalization was provably true - which it is not - there

[7] It is unclear how "typical" narrow beamwidth antennas would have to be in this context to ensure that interference potential to automotive radar is minimized or to what extent that factor "reduces" the interference potential.

is no proposal by Mantissa to limit by rule the installation of fixed perimeter security systems to areas at <u>any</u> distance from roadways. It can be easily anticipated, contrary to Mantissa's vague assurances, that residential installations of these systems will be the norm and, without any specific regulatory restriction, will proliferate in areas adjacent to roadways *and across driveways where SRRs in vehicles are often needed most, in order to alert a driver to a pedestrian behind a vehicle that is backing out of a driveway, and to the presence of pedestrians on sidewalks*.[8] A substantial benefit of SRR automotive radar systems is their ability to detect objects in close proximity to the vehicle, such as pedestrians or bicycles.

8. Mantissa also argues that its fixed radar technology can accommodate many of the techniques suggested by the MOSARIM study that contribute to the compatibility between and among various type of automotive radars. The simple fact, however is that there have been heretofore no dedicated tests of compatibility that evaluate the potential interaction between Mantissa's fixed perimeter protection radar application and any type of automotive radar. Given this, it is highly inappropriate for Mantissa to attempt to "piggyback" its compatibility argument on the MOSARIM study in which Mantissa was *not* a participant and in which its fixed radar technology for perimeter protection was *not* evaluated. It is precisely because of the negative preliminary conclusions about fixed radar compatibility with automotive radars[9] that the now-ongoing CEPT study was initiated.

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[8] Mantissa "doubles down" on its conjectural and anecdotal argument by stating that "(i)n practice… the potential interference between the MSHRS-300X devices and automotive radar sensors should be significantly less than among vehicle-mounted radars, since the MSHRS-300X is intended to be installed primarily off roads, mounted 5 to 10 times higher than typical vehicular radar mounting height, and with a well-defined, relatively narrow, and specifically directed antenna beam width. Compatibility in this context cannot be ensured by reference to the manufacturer's "intent" as to where the fixed transmitters are "primarily" to be located.

[9] *See* Footnote 4 *supra*.

9. The comments of both Navtech and Mantissa are silent with respect to the ETSI Technical Report [TR 102 704 V1.2.1 (2012-2013)][10] which recommends that radar operations in the band 76-77 GHz be limited to ground-based vehicles only and does not recommend fixed outdoor radar operation at 76-77 GHz. Section 6.2.1.2 of the 2012 version of the Technical Report, entitled "Sharing and compatibility issues still to be considered" states in relevant part that:

> Particular attention needs to be given to restrict the application in the band 76 GHz to 77 GHz to surveillance ground based vehicular radar applications and not allow applications for installations to fixed sites or certain mobile installations in order to ensure compatibility…The most critical potential interference aspect for general surveillance radar applications is that this kind of application may overlap in the direction of automotive SRRs on public roads. In such scenarios, the surveillance radars potentially blind automotive radars operating in the same frequency and area.

Thus the vague generalizations of Navtech and Mantissa are in direct conflict with the specific recommendations of a 2012 ETSI technical report specifically recommending that the fixed radars not be permitted in the band 76-77 GHz.

10. Until now, the Commission has, responsibly, preserved the ability of automotive radars to proliferate at both 76-77 GHz and 77-81 GHz (and has preserved the long-acknowledged public safety benefit of LRRs and SRRs) by specifically authorizing fixed and other non-automotive radar systems only on a case-by-case basis, and only premised on a specific finding that there will not be geographic proximity of fixed radars and public roadways. Tank level probing radars (LPRs) and foreign object detection (FOD) radars were individually found to be compatible with LRRs at 76-77 GHz. In the case of FOD radars, this was done by limiting the FOD radars to airports only and by conditioning their use on the absence of

[10] See, *Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Radar sensors for non-automotive; ground based vehicular applications in the 76 to 77 GHz frequency range* (2012), available at: http://www.etsi.org/deliver/etsi_tr/102700_102799/102704/01.02.01_60/tr_102704v010201p.pdf

illumination of any public roadway.[11] By virtue of these specific findings and the regulatory limitations imposed on FOD radars, the Commission ensured that there would be no interaction with LRR automotive radars at 76-77 GHz. In authorizing LPRs the Commission carefully analyzed the characteristics of that *specific* fixed application and made specific findings that it would not interact with automotive LRR radars due to marked differences in the operating environments of each.[12] The Commission also relied on extensive ETSI studies from Europe which established standards for LPRs. This, Bosch submits, is the proper course in each case. Neither Navtech nor Mantissa offers any comparable authorities in support of their proposals to permit unspecified fixed radars in the band 76-81 GHz or any portion of the band.

11. Also notably absent from either the Navtech comments or the Mantissa comments (and this is a shortcoming of the Notice in this proceeding as well) is any reference at all to alternative millimeter-wave bands for fixed applications. The comprehensive, worldwide effort to standardize automotive radar operation at 76-81 GHz is the result of years of international work and study. By contrast, *there is no authority known to Bosch which identifies 76-81 GHz as a uniquely appropriate band for fixed radar installations*. As Bosch argued in its comments, Navtech's interest in 76-77 GHz in particular is due to the fact that it already has on hand products for that band which are, for a limited time, authorized in Europe. In Europe, however, fixed radar installations at 76-77 GHz are being phased out. Avoidance of potential

[11] Amendment of Sections 15.35 and 15.253 of the Commission's Rules Regarding Operation of Radar Systems in the 76-77 GHz Band, *Report and Order*, 27 FCC Rcd 7880, at 7888-7889, para. 26 (2012).

[12] The Commission held that "(a)s for spectrum sharing between vehicular radars and LPR, we believe that LPR devices will be able to co-exist successfully with vehicular radars because the LPR is installed in a downward-looking position at fixed locations and the main-beam emission limits have been carefully calculated to avoid harmful interference to other radio services. We further find that the extreme propagation losses of radio signals at these frequencies would mitigate any potential harmful interference beyond a very short distance from the LPR device, as noted above. See, Amendment of Part 15 of the Commission's Rules To Establish Regulations for Tank Level Probing Radars in the Frequency Band 77-81 GHz, FCC 14-2, *Report and Order and Order*, 29 FCC Rcd 761, 775, para. 29, released January 15, 2014.

incompatibility between automotive radars and fixed radiolocation facilities and the resultant risk to motorists and pedestrians could be guaranteed by the use of millimeter-wave spectrum other than 76-81 GHz for fixed radar installations. It is thus useful to consider alternative spectrum for unspecified fixed radar installations, especially those of Navtech and Mantissa, whose applications may be expected to illuminate roadways, or be installed in residential areas, potentially illuminating roadways and driveways in very close geographic proximity to LRRs and SRRs.

12. Finally on the subject of fixed radar installations, in the event that the Commission concludes (which it should *not*) that some fixed infrastructure radar is to be authorized in the 76-77 GHz band, it should be done only on a specific, licensed basis. Bosch is constrained to disagree slightly in this respect with the former SARA group comments which suggest that, should the Commission permit fixed infrastructure radar to operate in the 76-81 GHz band, it "could be allowed on an unlicensed basis under Part 15 of the Commission's rules". Under *no circumstances should the Commission permit any Part 15 or Part 95 blanket licensing of fixed infrastructure radar systems in any portion of the 76-81 GHz band*. Unlicensed operation or license-by-rule arrangements would make interference from fixed radar systems impossible to address, or to be remedied *post hoc* through enforcement procedures. The Commission's Enforcement Bureau has demonstrated time and again that it has neither the resources nor the ability (or interest) to address radio frequency (RF) spectrum incompatibilities involving unlicensed or blanket-licensed RF devices and systems once they are deployed in the field.[13] All regulation of unlicensed or blanket licensed devices and systems has to be done *ex ante* by

[13] Notably, the Commission has under present consideration the elimination of 2/3rds of its already overworked and understaffed Enforcement Bureau field offices. It would be completely ridiculous to suggest that the Commission would have the ability to enforce the Part 15 non-interference requirement to any extent whatsoever going forward, since it is not capable of doing so now.

avoiding the incompatibilities that are impossible to address once they occur. The SARA group's alternative suggestion, on the other hand, that fixed infrastructure radar in this band should be regulated by individual licensing on a secondary allocation basis and subject to a site-based licensing or registration requirement, has merit.

III. The Arguments of NRAO and CORF are Substantially Misleading Relative to the Compatibility Between Automotive Radar Systems and Millimeter-Wave Radio Astronomy Observatories

13. The arguments made in the comments filed by NRAO asserting some incompatibility are not accurate. These same arguments were raised in ITU forums relative to the United States' preparation for WRC-15 Agenda Item 1.18. The United States has already rejected these same arguments in formulating its position going into WRC-15. Specifically with respect to NRAO's arguments at page 3 of its comments concerning the so-called "Kitt Peak Study," the optical path of the telescope was *intentionally diverted toward the radar*. Only in this condition was it possible for the vehicular radar to be detected. This is discussed in the joint report of that Study at page 2, in the second paragraph: " ..the beam of the feed was redirected from the sub reflector by mounting a plane mirror in front of it… With this arrangement, the (twelve meter) dish mount was used to point the beam of the telescope feed at the radar to achieve a 'line of sight' path from the radar to the telescope receiver." It was confirmed that due only to this this unique arrangement was it possible to determine the atmospheric absorption around the observatory. However, this operating condition with the optical path of the observatory antenna intentionally diverted towards the radar does not represent in any sense the normal operation of an observatory. ITU-R Recommendation RA.1513-1: states, in Sections 2 and 3, figure 1, that "Radio astronomy observations are generally made with pointing angles above 5 degrees elevation". The above factors vitiate the comments filed by NRAO relative to its assumptions

regarding interaction between automotive radars and millimeter-wave radio astronomy because the conditions cited by NRAO will not occur in normal operation of the very few such observatories.[14]

14. As NRAO would have it, there should be restrictions on LRRs and SRRs nationwide in order to protect millimeter-wave radioastronomy observatories. In fact, however, the number of such sites which conduct operation in the 77-81GHz band (the 76-77 GHz band is already available for LRRs under Part 15 and has been for years without reported interference from the radio astronomy community) is significantly low. The millimeter-wave radioastronomy sites are located geographically at remote locations specifically to protect them generally from manmade RF noise. Because of the remote location of these few sites, motor vehicle traffic in these areas is low, and is generally precluded entirely in close proximity to the RAS sites. At Kitt Peak, for example, the nearest roadways were between 3 and 10 miles away, depending on the azimuth, and the telescope was far higher (i.e. on the order of 1000 meters) higher than the ground level. And those roadways that are proximate to the observatory are very lightly traveled.

15. At paragraph 8 of its comments, NRAO, citing ITU Recommendation M.2057-0, criticizes the Kitt Peak tests because the bumper mount automotive radar sensor was located behind the bumper of the vehicle under test. NRAO also suggests that the tests were run with the automotive radar using abnormally low power. The fact is that the tests at Kitt peak were carried out with the equipment that was available at that time. This is a fact that was clearly noted in the Study itself.[15] As stated correctly in paragraph 6 of the NRAO comments, the EIRP of the

[14]Bosch a major contributor to the Kitt Peak Study is in agreement with the statement that "radar signals were detected fully" during the tests, but as mentioned herein, this occurred only during the specific operating condition whereby the optical path of the observatory was abnormally diverted toward the vehicle under test.

[15] The hardware that was available at that time, in 2011, made it impossible to provide a test car with sensors mounted behind the bumper. All of the participants in the test were aware of this fact and performed the tests under those conditions and with full understanding of the circumstances.

vehicular radars used in the experiment were found to be between 9-11dBm EIRP while the EIRP levels contained in ITU Recommendation M.2057-0 (which was not available at the time) are considerably higher. Here is the explanation of this discrepancy: Since the Kitt peak experiment in 2011, the RF hardware for vehicular radar in the band 77-81 GHz has evolved, providing the possibility to design SRR radar sensors in that band with higher transmitted output power. However, it should be noted that the transmitter output power values of the radar systems B, C and E in Table 1 of ITU Recommendation M.2057-0 reflect the power limits as they are in force in European regulation. (*See*, ECC/DEC/(04)/03). The values can only be considered as maximum values. The transmitter output power of real world SRRs is less than the maximum values. It should be additionally noted that in Europe, besides the maximum limits, the transmit output power is limited to -3dBm/MHz for the sensor and -9dBm/MHz outside the vehicle. There is no direct correlation between the EIRP values that were measured in the Kitt Peak experiment and the "maximum transmit power to the antenna" for radars B,C and D as shown in Recommendation M.2057-0, at table 1. The EIRP for a 76-77 GHz LRR system, as referenced to as system "A" in Table 1 in rec M.2057-0 is the maximum EIRP of a system. The EIRP for contemporary 76-77 GHz systems is *significantly* lower.

16. At paragraph 10 of its comments, NRAO states as follows:

> In discussing the calculated size of the avoidance zone on p. 12 of the Kitt Peak test report, the study participants stated what seemed to be obvious at the time, namely "Mitigation factors such as any terrain shielding, orientation of the transmitter antenna with respect to the observatory, or attenuation of the transmitter if mounted behind the vehicle bumper have not been taken into account, and would tend to reduce the avoidance radius." In retrospect, this statement is misleading. If mounted behind a bumper the outgoing radar EIRP would have been 23 dB stronger according to M.2057 or 35 dB stronger according to M.1452 and this was the major factor that was not taken into account in the test.

The assumptions made in this paragraph are not correct. There is no direct correlation between the transmit power and the mounting of the radar sensor in front of or behind a bumper. To the contrary, if a sensor is mounted behind the bumper, the material and coating of the bumper would introduce additional loss in the transmit path and therefore reduce the EIRP outside the vehicle. Additionally, NRAO ignores the above-cited condition of the test, which is a key point: "In the Kitt Peak experiment, the vehicle with the sensor mounted was stationary and pointing towards the observatory. This is not the normal operation scenario for a vehicle." For normal operation, the vehicle should be considered to be moving along a roadway and not in a stationary position. In no circumstance would the vehicle be in a stationary position pointing toward the observatory. Furthermore, in normal operation, the radar sensors on the vehicle are pointing *downwards* and the sensor has a height over the ground of between 0.5 to 1.5 meters. By contrast, a radio astronomy antenna has a height of between 10 and 20 meters above ground and is operated with a minimum 5 degree elevation. These are important, sufficient mitigation factors completely ignored by NRAO which, given (1) the small number of radioastronomy observatories operating in the 76-81 GHz range; (2) the remote siting of the antennas for the purpose of reducing man-made interference; and (3) the low vehicle density on those rural roads, will reduce the probability of interference to a nominal level.[16]

17. Regarding NRAO's comments with respect to separation and aggregation beginning at page 4 thereof, NRAO asserts that:

> vehicle radars tend to illuminate diverse objects, including telescopes, with very

[16] Interestingly, NRAO and CORF express less concern about fixed radars than about automotive radars in the same band. Their concerns should be exactly reversed. Fixed radars can easily constitute a continuous noise source, and fixed radar antennas would be expected to have a higher mounting location above ground (i.e. up to 10 meters above ground) and the downward elevation of the beam of the antenna would also be less than with automotive radars. Therefore, fixed radars in the band could be anticipated to create a larger interference potential, especially if the fixed radars were operated on an unlicensed or blanket licensed basis.

> nearly the same eirp at which they operate. At the 50 dBm eirp that is proposed in the NPRM, the nominal line of sight separation distance is 190 km (or 109 km for eirp of 33 dBm), where we use the threshold power flux density -125 dB W/m2 for continuum observations in Table 1 of RA. 769 (because the radar emission is broadband) and the atmospheric attenuation of 0.15 dB/km. These distances are much longer than those noted in the Kitt Peak study owing to the higher eirp levels.

The parameters used by NRAO to draw these conclusions call for careful review. The transmitter power values for 76-77 GHz radars, (50 dBm EIRP) and 77-81GHz (33 dBm EIRP)[17] cited by NRAO reference the maximum power limits, in line with the existing regulation in other parts of the world. Typical real world automotive radar systems operating at 76-77 GHz and 77-81 GHz have lower transmitter power.

18. NRAO's doomsday predictions at paragraph 14 of their comments relative to aggregate noise levels from "millions of vehicles" lack substance. Radio astronomy observatories will not be located in "large metropolitan areas." With respect to NRAO's mention of the Robert C. Byrd Green Bank Telescope (GBT), it should be noted that the probability that all 10 vehicles cited by NRAO that are estimated to be "in view" (but at unspecified distances) of GBT during daylight hours being equipped with vehicular radars is quite low. Even if all of these vehicles were to be equipped with radar sensors, the movement of the vehicle along the road with the radar sensors mounted in low elevations above the road surface and the antenna patterns as described in ITU Recommendation M.2057 would mitigate the alleged interference potential to the observatory.

19. At paragraph 15 of its comments, NRAO speaks of the visibility of the Kitt Peak observatory and the GBT from nearby roadways, and NRAO's observation of "car headlamps moving about on lower terrain from a typical mountain observatory." NRAO concludes from this that "mm-wave radar signals would also impinge." This claim implies that the observer of the

[17] Notably, the ECC/EC adopts a -3 / -9dBm/MHz limit.

headlights is looking downward toward the headlamps. As discussed above, radioastronomy antennas are normally not directed downwards. ITU Recommendation M1513-1 references a minimum elevation of 5 degrees. So, NRAO's conclusion does not follow from the premise of the claim of visibility of automobiles at a lower elevation than the viewpoint at the antenna of the observatory.

20. Both NRAO and CORF argue, as they have numerous times in the past, for an on/off switch, GPS operated for (apparently) all SRR and LRR radars. This argument is repeated despite a dearth of complaints about 76-77 GHz LRRs which have been permitted in the United States for years, and despite the fact that only a miniscule fraction of the vehicles that might have radar systems in the future would ever be operated anywhere near a radioastronomy observatory. With respect to this, as Bosch has explained to CORF and other radio astronomy advocates repeatedly, implementing a deactivation mechanism via GPS would require that each radar equipped vehicle is also equipped with a GPS system. This assumption cannot be made, as automotive radar and GPS features are promoted and sold by vehicle OEMs independently. Combining these two features would create a restriction on automotive radar to certain vehicle types or equipment packages, and significantly constrain the deployment of the safety features of SRR technology. It would also frustrate the goal of increasing the deployment of automotive radar in all vehicle platforms, especially the mid- to low-cost vehicle segment. Furthermore, any deactivation mechanism, whether GPS-based or with a manual on/off switch, would also limit the usability of the features provided by vehicular radar sensors. The safety functions are depended upon by the passengers in the vehicle; they are for the safety of those passengers, and they have to be available everywhere at any time without restriction. Automatic or manual

deactivation would negate the value of the radar for the passengers and also for the driver, as she or he could never be sure whether the system would be deactivated in certain conditions.

21. At paragraph 19 of its comments, in connection with its argument that the proposed unwanted emission limits set forth in the Notice are too lax, NRAO makes an incorrect assumption. It states that because " the primary emission standard proposed for SRR at 77 – 81 GHz, 50 dBm over 4 GHz or an average eirp density of -16 dB W/MHz," therefore "the unwanted emission levels proposed for SRR are only about 15 dB below that level of wanted emissions." This is incorrect. The proposed power in 77-81 GHz is 33 dBm over 4 GHz (consistent with systems B, C and E in Table 1 of ITU Recommendation M2057-0). Thus, the maximum mean power density is -3dBm/ MHz. Nor are the NRAO calculations and assumptions made at paragraphs 20 and 21 with respect to the separation distances between automotive radars and 76-81 GHz observatory antennas correct. Due to the technical implementation of vehicular radars (i.e. the bandwidths of the deployed millimeter wave amplifiers and the bandwidths of the antennas) the unwanted emissions drop substantially. NRAO's assumptions are not relevant when considering real world vehicular radar sensors.

22. At paragraph 22 of its comments, NRAO states that:

> The Commission might wish to consider that the limits it proposes for unwanted emissions exceed by 30 – 32 dB the standards under which such radars are manufactured in Europe by petitioner Bosch. These are given for 76 – 77 GHz LRR in ETSI EN 301 091-1 as -30 dBm/MHz at frequencies of 1 – 300 GHz and for 77 – 81GHz SRR in document ETSI EN 302 264-1 as -30 dBm/MHz at frequencies of 1 – 100 GHz.

In fact, it was not Bosch's intention to propose higher limits for unwanted emissions, and Bosch suggests that the values should be in line with the values in the European ETSI standards. It is important to have harmonized regulation of both desired and undesired signal levels for LRR and

SRR dev devices around the world. It is unlikely that manufacturers will develop different sensors for automotive radar systems in this frequency range. ETSI therefore made out of band and the spurious domain dependent on the real bandwidth of the desired signal. This is urged as well for the United States. This concept is quite new within ETSI and was not developed at the time of the Bosch Petition for Rule Making. In any case, the unwanted power levels of SRRs will be below -30dBm/MHz.

23. In summary with respect to NRAO's conclusions at paragraph 25 of its comments, a stationary vehicle is not a situation that will be found and because of its rarity it is not a problem that calls for a regulatory solution. The expected situation, albeit rare in terms of geographic proximity of a radar-equipped vehicle to a 76-81 GHz radio astronomy observatory is that a moving vehicle, with the antenna of the LRR radar sensor pointing ahead of the vehicle and SRR sensors mounted at low heights in downward orientations will contribute significantly as mitigation factors to reduce the interference potential. Furthermore, the roads near into a radio astronomy observatory site do not lead directly toward the antenna. They are instead tangential and thus there will not occur a boresight-to-boresight situation. NRAO's conclusion at paragraph 26 of its comments that "cars must be safely operable without radars" is true, but completely beside the point. Vehicular radar is an emerging technology that promises to dramatically improve safety by accident avoidance and by reduction of damage from automobile collisions. SRRs are following the same path as did ABS (antilock braking systems). Years ago, ABS was a new feature, available only in high-end vehicles. Over the years they became commonplace and now, every vehicle is ABS equipped. Vehicles might work without and can be used without ABS but the current perception of motorists is that vehicles without ABS are considered to be unsafe. Current generation automotive radars have all of the promise stated in Bosch's initial petition in

this proceeding and the restrictions proposed on it by NRAO are completely unjustified. NRAO's recommended definition and use of coordination zones would put unnecessary burdens on vehicular radar systems. While its concerns about protection of radio astronomy observatories is understood, it is uncontroverted that generally, observatory sites are located in remote locations, and the Commission has justifiably relied on this fact. The definition of coordination zones proposed by NRAO would require that radar could only be used with a GPS system on a vehicle. The unnecessary and unfeasible correlation between these 2 systems would limit the application of LRR and SRR systems on medium and low-end vehicles, and frustrate the entire purpose of the proposal of worldwide harmonization in the first place. Such restrictions are not proposed in and do not exist in other countries, including Europe where radio astronomy observatories are located in less rural areas than they are in the United States.

24. Bosch is, however, in complete agreement with NRAO's statement at paragraph 29 of its comments that "automotive radar unwanted emissions should at least be limited to the eirp density levels -30 dBm/MHz given by the ETSI standards under which the devices are manufactured in Europe by petitioner/vendor Bosch." Bosch also supports NRAO's argument that unwanted emissions should not rise above 200 GHz. Bosch disagrees however with the request for specific, strict limits for unwanted emissions for the radioastronomy passive bands. The unwanted emissions of vehicular radar sensors decrease significantly over the frequency range. This effect is already provided by the limited operation bandwidth of the millimeter-wave chipsets and the antennas used. Specific limits in specific bands would introduce unnecessary burdens in the design of vehicular radar sensors.

25. With respect to NRAO's concern about interference from airborne helicopter radar, Bosch likewise urges a careful study of this issue before authorizing airborne radar systems.

NRAO correctly notes that millimeter-wave radar in flight at any but the very lowest elevations could be potentially harmful given the absence of terrain shielding and the large footprint of the radar from aircraft in flight. Bosch acknowledges NRAO's citation of ECC Report 2226 which notes potential interference to European radio astronomy operations helicopter millimeter-wave inflight transmissions.

26. There are few comments uniquely made by CORF. Most were also made by NRAO and are addressed hereinabove. However, CORF notes that the LRR radars have only a negligible chance of impacting a radioastronomy observatory due to the narrow beamwidth of the antenna and the constant movement of the vehicle along roads. CORF is concerned, however about the SRRs despite their lower power due to the fact that they are used around the entire vehicle. This consideration might to some extend be valid, but for the fact that the vehicle density on roads in close proximity to radioastronomy observatory sites is low. These are non-public roads, or else the location of the public roads is so remote that traffic flow is low there. CORF correctly notes at page 8 of its comments that the radar-equipped vehicle has to be considered moving . As already pointed out, vehicles pointing towards the RAS antenna are not a normal typical operating condition. Therefore, automotive radar signals need to be considered transient, as they are moving. By virtue of the FMCW principle, the transmit frequency is varied over time in specific schemes.

27. Bosch's comments in this proceeding noted that the radio astronomy service has been sharing the 76-77 GHz band with automotive radars since 1996,[18] by <u>all</u> accounts compatibly. Lower power SRRs with downward-directed signals and a lower power spectral density (due to wider bandwidth) will not be a significant noise source in this frequency range, where high of

[18] See, *Amendment of Parts 2, 15 and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications,* First Report and Order and Second Notice of Proposed Rule Making, at Paragraph 17; ET Docket No 94-124, 11 FCC Rcd 4481 (1996).

signal attenuation occurs through free space path loss and where even moderate terrain shielding can attenuate the signals by up to an additional 50 dB.[19] Given these factors and those discussed above, there is no justification for any of the regulatory restrictions on automotive radars suggested by NRAO or CORF.

IV. There is no Need to Relocate the Amateur Radio Service or the Amateur Satellite Service from the 76-81 GHz Band; Wing-tip Mounted Radars on Aircraft and operated while on Airport Taxiways, and Helicopter-mounted Radars at 76-81 GHz Could Be Permitted.

28. Bosch has taken the position that at all times, generally speaking, SRRs at 77-81 GHz are compatible with incumbent Amateur Radio stations and with the few millimeter-wave radio astronomy observatories in the United States. Unlike the situation with respect to fixed radar facilities, there are no studies that indicate any incompatibility between automotive radars and incumbent services at 77-81 GHz. Instead, based on its own research and on ITU Report M.2322, Bosch remains convinced that there is no factual predicate for the conclusion that there is incompatibility between amateur radio operation and automotive radars due to the nature of amateur radio operation in this band,[20] and that there is sufficient compatibility between incumbent uses and automotive radar operations in order that the authorization of SRR automotive radar systems at 77-81 GHz can be safely implemented immediately.

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[19] Bosch cited in its comments a Spectrum Planning Discussion Paper (SPP 2006-11) dated December, 2006 released by the Australian Communications and Media Authority entitled *Planning of the 71-76 GHz and 81-86 GHz Bands for Millimetre Wave High Capacity Fixed Link Technology*, in which there was an extensive discussion of the effects of foliage and vegetation loss as well as penetration loss in the millimeter-wave spectrum near 70 GHz. This document showed that the foliage losses near 70 GHz are "significant." Where foliage depth is 10 meters, for example (which is roughly equivalent to a large tree or two in tandem) the foliage loss is approximately 50 dB. Similarly, when millimeter-waves are propagated through various materials, they are more or less strongly attenuated. Given the high degree of attenuation through free-space path loss, atmospheric absorption loss, and the high degree of foliage and penetration attenuation applicable at 79 GHz, it is suggested that the actual interference contour around any of the few radioastronomy observatories due to automotive SRRs is predictably very low.

[20] Bosch remains committed to establishing private-sector interference avoidance protocols in order to insure compatible sharing with incumbent radio services.

29. In this respect, Bosch disagrees with the position of the former SARA group which stated that "the findings (sic) of the Commission and European regulators" with respect to amateur radio compatibility with automotive radar "should be considered." The former SARA group claims that the Commission found "evidence of potential interference conflicts between the amateur-satellite service and vehicular radar systems." Actually, there was no such evidence at all. Nowhere in the 2004 Report and Order in Docket 03-102 cited by the former SARA group was there any "evidence" of any incompatibility between amateur or amateur-satellite Service operations and LRRs at 76-77 GHz. Nor was there any finding of potential interaction between Amateur Radio and SRRs at 77-81 GHz. Rather, there were only hypothetical concerns about such interaction:

> In addition, we find evidence of potential interference conflicts between the amateur-satellite service and vehicular radar systems. Specifically, amateur stations are operated by hobbyists (sic) who could deploy their earth stations anywhere and amateurs are permitted great flexibility in the type of antenna and the power they use to transmit. On this basis, we anticipate that an amateur earth station could either receive interference to its operations or cause interference to a passing vehicular radar device. Therefore, we are not implementing the proposed secondary amateur-satellite allocation for the 76-77 GHz band at this time. We will, however, retain the existing secondary amateur service allocation. We note that the existing secondary amateur service allocation in this band is currently suspended and restricted until technical sharing criteria are developed to address potential sharing problems in this band. We continue to find that not allowing amateur operations in the 76-77 GHz band is not a significant burden on this service because amateurs typically do not operate at these higher frequencies and they are permitted to operate in the adjacent 77-81 GHz band.

Thus, the Commission was comfortable continuing the suspension of Amateur Radio operation at 76-77 GHz during the time that LRRs were developing in that band, *not* because of an affirmative finding of interference potential but instead because of the absence in 2004 of criteria to address unspecified "potential sharing problems". There was no substantial burden on Amateur Radio operators from that continued suspension at 76-77 GHz, the Commission said,

because the entirety of the 77-81 GHz band continued to be available for amateur radio operation.[21] Bosch agrees with ARRL that the only definitive study of this subject now exists in ITU Report M.2322 and that the Commission's concern in the Notice should be resolved by no change to the domestic table of allocations or in the Part 97 Service Rules relative to Amateur Service operation at 76-81 GHz. Indeed, such a position is consistent with the United States' proposal for WRC-15 Agenda Item 1.18 [which is intended to consider a primary allocation to the radiolocation service *for automotive applications* in the 77.5-78.0 GHz frequency band in accordance with Resolution 654 (WRC 12)]: to create a co-primary allocation to the radiolocation service (with the amateur service) at 77.5-78.0 GHz.

30. The former SARA group notes that amateur radio service rules are flexible with respect to the type of antenna and the power they use, and the location of amateur stations. However, based on the substantial differences in the type of amateur radio operations conducted in this band and the geographic separation, it is highly unlikely that there will be any interaction between automotive radar operations and amateur radio operations. Indeed, this is the same conclusion reached in ITU Report M.2322 which is a very recent study. If there is an interference victim in any case, it would be the sensitive amateur radio receivers deployed in this band. For that reason, Bosch has urged the Commission to consider additional allocations for the amateur and amateur-satellite service to offset any diminution in the ability of Amateur stations to use any portion of the 77-81 GHz band in any environment due to aggregate noise floor level increases. The bands 75.5-76 GHz and the 81-81.5 GHz band are both suitable for allocation to the amateur and amateur-satellite services in addition to the 76-81 GHz band.

[21] The 1998 restriction on 76-77 GHz Amateur Radio operation, codified at 47 C.F.R. §97.303 was imposed in Docket 94-124. See, *Amendment of Parts 2, 15, and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications, Third Report ad Order*, 13 FCC Rcd 15074 (1998).

31. Finally on this subject, the former SARA group cites a 2004 ECC decision[22] which, it says, "cautions that the use of SRR may be incompatible with Amateur Radio service." As a result, says the former SARA group, "the ECC positioned Amateur Radio service in a different band: the 75.5-76.0 GHz band." What the eleven year old ECC Decision stated precisely (and there is no citation of any authority for the statement) was "that the use of SRR within the band 77-81 may be incompatible with the Radio Amateur Service which has been resolved by allowing the Amateur Service to remain in the 75.5-76 GHz band after 2006 (see footnote 5.559A)". The interference potential that "may" exist, referenced in that Decision was never studied; the action taken in Europe in 2004 was not duplicated in the United States because the band 75.5-76 GHz band was not available to the amateur services in the United States between 2006 and the present time; and the comprehensive ITU Report M.2322 certainly supersedes that old ECC Decision. [23]

32. It has been and it remains Bosch's position that there should be no change in the radioastronomy allocations in the 76-81 GHz band, and there need be no change in the Amateur Radio domestic primary allocation at 77.5-78 GHz, or in the secondary Amateur allocation at 77-77.5 GHz or 78-81 GHz in order to accommodate new SRR automotive radar systems at 77-81 GHz. Nor are any additional Part 97 rules necessary to accommodate compatible sharing of that band between radio amateurs and automotive radar systems. Indeed, that position is consistent with the position of the United States in anticipation of consideration of WRC-15 Agenda Item

[22] *See* Electronics Communications Committee, Decision (04)03, at 3 (2004), *available at* http://www.erodocdb.dk/Docs/doc98/official/Pdf/ECCDec0403.pdf

[23] Citing an ECC Report (56), ITU Report M.2322 at Section 6.1.3. describes typical Amateur Radio operation in these frequency ranges as follows: "antennas are in general mounted on masts as high as practical, high buildings, hills or mountaintops in order to obtain the least obstruction towards the horizon in order to make long distance contacts possible".

1.18 later this year.[24] The Notice, at paragraph 33, states that the Commission believes that new proposed radar operations will be compatible with incumbent operations in the 76-81 GHz band. This is provably true with respect to the compatibility between automotive radars and incumbent radioastronomy and amateur radio operation. Thus, the former SARA group's summary statement (at page 15 of its comments) that "the available evidence suggests that the risk of interference to vehicular radar systems from Amateur Radio operations may be significant throughout the 76-81 GHz band" is plainly incorrect. However, any diminution in the ability of amateur stations to use any portion of the 77-81 GHz band in any environment due to aggregate noise floor level increases can and should be ameliorated by additional access to the 76-77 GHz band, the 75.5-76 GHz band and/or the 81-81.5 GHz band.[25]

33. With respect to aircraft-mounted, wingtip radars for use when aircraft are taxiing on the ground, there are no studies submitted by the proponent, Honeywell, which demonstrate compatibility between and among incumbent uses and the proposed new use of the band. However, based on the substantial geographic separation between airport taxiways versus public roadways and the fact that wingtip radars are moving objects as are automobiles, Bosch does not anticipate a significant likelihood of interference.

34. The proposal of Rockwell Collins to authorize aeronautical mobile operation at 76-81 GHz for helicopter radars is addressed by CEPT ECC Report 222: *The Impact of Surveillance*

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[24] The United States proposal for WRC-15 Agenda Item 1.18 is for a co-primary allocation to the radiolocation service and the amateur service at 77.5-78.0 GHz and to continue the secondary allocation for the Amateur Service at 76-77.5 GHz and 78-81 GHz.

[25] The Band75.5-76 GHz was formerly allocated to the Amateur Service on a primary basis but that primary allocation was relocated to 77.5-78 GHz due to actions taken at WRC-03. The amateur allocation at 75.5-76 GHz was removed after 2006 in the United States. (See, RR 5.559A). As a separate matter, RR 5.561A states that the band 81-81.5 GHz is also allocated to the amateur and amateur-satellite services. A continued allocation for amateur radio in the entirety of 77-81 GHz is reasonable and a 500 MHz co-primary allocation in that range for the amateur and amateur-satellite service is both necessary for radio amateurs and, based on a definitive study, compatible with automotive radars. There are, however, alternatives for primary replacement spectrum for the amateur and amateur-satellite services.

Radar Equipment Operating in the 76 to 79 GHz Range for Helicopter Application on Radio Systems (September 2014). The conclusions of that study (at page 4 thereof) relative to automotive radar interaction with helicopter mounted radars in this frequency range is as follows:

> **Vehicular radars**
> The only critical situation is when the helicopter is coming to the mainbeam of the vehicular radar. However, this situation is not expected to cause a problem because
> ● This happens only when the helicopter is flying at very low altitudes below 30m close to a highway and when the helicopter is landing on a highway;
> ● For a helicopter assisting in a road accident the traffic is considered to be stopped, rerouted or be moving slowly. Traffic will be kept at a safe distance from the landing helicopter. The helicopter is also not necessarily landing on the road;
> ● Because of the relatively low number of helicopter and because only a small percentage of helicopter operations is performed close to road traffic (only emergency missions) the probability of interference is considered to be low;
> ● Both radar types (vehicular and helicopter radar) are likely to use FMCW modulation that mitigates the mutual interference. Here it should be considered that the distance between interferer and victim is assumed to be much larger than in the inter-vehicle situation;
> ● The beam and frequency scanning capabilities of both radar types can reduce the intercept probability even further.

Based on this ECC study, Bosch anticipates no significant interference potential to automotive radars in the band 76-81 GHz.

V. Conclusions.

35. The Commission should proceed with the proposed allocation for SRR automotive radars in the 77-81 GHz band without delay, either pursuant to the Part 95, licensed-by-rule regulatory paradigm (pursuant to a co-primary allocation at 77.5-78 GHz) or alternatively as a Part 15 rule change as proposed by Bosch in RM-11166. The record in this proceeding, however, does not support any expansion of radar operations in the 76-81 GHz band to include authorization for generic fixed services in any portion of the 76-81 GHz band. There is a pending study that involves all stakeholders, but pending the outcome of that study and a competent

evaluation of it, it cannot be assumed that there is compatibility between or among fixed radar applications and incumbent operations or with SRR and LRR automotive radar applications in the 76-81 GHz band. Until that time, the only fixed radar applications that should be considered must be on a case-by-case basis, premised on a showing of compatibility and providing an analysis of the methodologies used and data gathered. Because there is now a dearth of studies relative to the effects of mixing fixed and automotive radars and because the only evidence that exists at this point compels the conclusion that fixed radars are in fact *not* compatible with automotive radars in this range. The Commission's Notice reverses the process, proposing to create an allocation and adopting service rules premised on nothing other than an incorrect assumption and an incorrect assertion that there are no studies indicating *incompatibility*. Especially inappropriate for deployment are the Navtech tunnel and roadside fixed radar systems which can be expected to have direct, boresight-to-boresight interaction with automotive radars in close geographic proximity, and the Mantissa perimeter security radars which would be expected to be installed in residential areas where the transmitters would illuminate driveways, sidewalks and residential streets where pedestrians and bicyclists and motorists backing out of driveways need the benefit of SRRs the most. The only fixed radar facilities that should be considered are those submitted on a case-by-case basis where technical compatibility studies are submitted and where the systems do not illuminate roadways at all.

36. The comments of NRAO and CORF attempt to reargue issues long ago settled and mischaracterize and misstate the Kitt Peak study results. The Kitt Peak study does in fact indicate compatibility between competent, determinative study shows that there is compatibility between SRR automotive radars at 77-81 GHz and (both) radioastronomy and amateur radio. The allocations for those services in the band should remain intact. ITU-R Report M.2322 establishes

that there is compatibility in this frequency range between automotive radar, radioastronomy and amateur radio, and urges all parties to cooperate in making that compatibility:

> Theoretical studies and observations indicated that the required separation distance between automotive radars and incumbent services could range from less than 1 km to up to 42+km, depending on the interference scenario and deployment environment. These results were based on worst-case assumptions and did not take into account for the effects of terrain shielding, terrain occupation and the implementation of mitigation techniques to reduce the possibility of interference to incumbent services. When these factors are taken into account, the possibility of co-channel interference to incumbent services from automotive radars is sufficiently low and manageable. Therefore, it can be concluded that in the 77.5-78 GHz band, sharing is feasible between automotive radars and incumbent services.
>
> It is expected that any potential cases of interference between automotive radars and incumbent services could be addressed by mitigation factors such as terrain shielding, emission power limits and quiet zones. Some areas of concern remain and may need to be further analysed and dealt with by administrations. It is anticipated that the radio astronomers, radio amateurs and the automotive radar manufacturers will continue their cooperative effort to examine and implement mitigation techniques that can be employed to address potential interference concerns.[26]

As to other services, the Commission should not consider open-ended requests for non-automotive vehicular radars except on a case-by-case basis.

Therefore, the foregoing considered, Robert Bosch LLC again respectfully requests that the Commission resolve this proceeding in accordance with the recommendations contained in

[26] ITU-R Report M.2322 at page 33.

Bosch's comments filed in this proceeding and those contained in these reply comments, and not otherwise.

Respectfully submitted,

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