

**BEFORE THE  
FEDERAL COMMUNICATIONS COMMISSION  
WASHINGTON, DC 20554**

In the Matter of	)	
	)	
Modification Applications of Ligado	)	IB Docket Nos. 11-109, 12-340
Networks LLC	)	
	)	IBFS File Nos. SES-MOD-20151231-
	)	00981, SAT-MOD-20151231-00090,
	)	SAT-MOD-20151231-00091, SES-AMD-
	)	20180531-00856

**REPLY COMMENTS OF AVIATION SPECTRUM RESOURCES, INC.**

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## EXECUTIVE SUMMARY

Ligado's Amendment fails to resolve fully the GPS interference issues it was designed to address, and its extremely narrow focus leaves untouched numerous other long-standing questions related to concerns critical to aviation safety and efficiency of operations. Ligado's failure to address the full set of numerous important matters – which involve the potential for harmful interference to certified aviation GPS receivers and other non-certified GPS receivers used in aviation, degradation of satellite communications (“SATCOM”) essential to aviation operations, and the continuity of and access to satellite weather data – has now persisted for several years with minimal progress on some fronts and seemingly none on others. Unless these matters are resolved fully and promptly, as described herein, the Commission should deny the Modification Applications.

Ligado misconstrues the scope of the assessment of the United States Department of Transportation (“DOT”) and Federal Aviation Administration (“FAA”) when they reviewed the adjacent band compatibility of Ligado's planned operations with certified GPS receivers. The DOT and the FAA conducted a full assessment of the technical model component – leading to the power reduction recommendation Ligado has included in its Amendment – *not* the equally, and at least as critical, operational model component. The DOT's GPS Adjacent Band Compatibility Assessment (the “*DOT ABC Report*”) plainly states that this key operational component remains to be further examined, and the values provided are based on an operational assumption. Consequently, as the comments confirm, Ligado's proposal for a 500-foot-diameter “standoff cylinder” presents a number of operational issues that require resolution before the Commission could consider granting the Modification Applications. The existing record firmly demonstrate that an overwhelming majority of the aviation community that has spoken believes

the “standoff cylinder” poses a threat to helicopter and other aviation operations. Further, the record makes clear that Ligado must complement its “standoff cylinder” and power reduction proposals with deployment commitments, such as those related to site spacing, base station tower density, and other parameters necessary to reduce the potential for harmful interference to GPS receivers. Ligado’s Amendment contains no such proposed commitments.

Ligado’s proposal that it protect GPS receivers that adhere to an *active* Technical Standard Order (“TSO”) glosses over the reality that, under FAA regulations, equipment will still be operated on aircraft under TSOs that are no longer active or even manufactured. As a result, Ligado’s proposal will not account for existing equipment that would legitimately continue operating under previously-active TSOs, with potentially disastrous consequences for aviation operations and safety.

The comments make clear that major GPS receiver manufacturers, government appointed industry experts, and the aviation industry concur that a 1 dB  $C/N_0$  interference protection criterion (“IPC”) is the only objective, administrable choice. There remains broad rejection of Ligado’s proposed use of key performance indicators (“KPIs”) in lieu of a 1 dB  $C/N_0$  IPC. Further, the use of such a protection criterion to protect receivers against interference from operations in adjacent bands, such as Ligado’s proposed terrestrial systems, is consistent with international regulatory processes of which the Commission is aware.

Finally, the Modification Applications leave unaddressed critically important concerns regarding the effect of Ligado’s proposed operations on SATCOM, including issues raised by Iridium and Boeing, and reflected in Inmarsat’s statements.

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	)	20180531-00856

**REPLY COMMENTS OF AVIATION SPECTRUM RESOURCES, INC.**

Aviation Spectrum Resources, Inc. (“ASRI”), by its attorney, hereby responds to comments filed on the May 31, 2018, Ligado Networks LLC (“Ligado”) amendment (“Amendment”) to its earlier applications to modify its license in the above-referenced File Numbers (“Modification Applications”).<sup>1</sup> As stated herein, the amended modified proposal fails to address numerous key related issues important to ensuring aviation safety and operations that have persisted for several years with, at best, only minimal progress on some fronts. Unless these matters are resolved fully and promptly, the Commission should deny the Modification Applications.

**I. INTRODUCTION**

The record developed in response to the Ligado Amendment makes clear that Ligado’s proposal still fails to address the wider aviation community’s operational concerns stemming from GPS, SATCOM, and weather data issues. Ligado’s proposal for a 500-foot-diameter GPS exclusion zone, which it terms a “standoff cylinder,” remains unacceptable to many in the

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<sup>1</sup> Ligado Networks LLC, Amendment to License Modification Applications, IBFS File No. SES-AMD-20180531-00856 (May 31, 2018) (the “Amendment”).

aviation community because of operational concerns that Ligado fails to take into account.<sup>2</sup> Moreover, while Ligado purports to lower its base stations' maximum power levels by way of the Amendment, the comments make clear that the power reductions, standing alone, do not resolve the issues for potential harmful interference affecting aviation safety. Ligado fails to complement its power reduction proposal with ancillary deployment commitments, such as minimum spacing between base station installations and other technical criteria. Further, the new and modified base station and tower notification proposal in the Amendment does not meet the requirements of aviation operators and would fail to give them a timely and complete picture of potential hazards created by the Ligado base stations and towers. In addition, the Amendment does not address the concerns of potential interference to non-certified GPS receivers used in aviation. Tellingly, three major GPS manufacturers disavowed endorsement of the Ligado proposal to assess interference, and each reiterated the propriety of the 1 dB degradation in carrier-to-noise ratio as the standard for assessing interference to GPS receivers, contrary to Ligado's reliance on key performance indicators ("KPIs"), which the manufacturers all described as subjective and not administrable.<sup>3</sup> Finally, the comments underscore, as ASRI noted in its

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<sup>2</sup> See, e.g., Letter of Dr. Joel N. Myers, Founder, AccuWeather, *et al.*, to Chairman Ajit Pai, FCC, IB Docket Nos. 11-109, 12-340, RM-11681, IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, SES-AMD-20180531-00856, SAT-AMD-20180531-00044, SAT-AMD-20180531-00045, at 2 (July 18, 2018); Letter of Capt. Tim Canoll, President, Air Line Pilots Association, International, *et al.*, to Daniel K. Elwell, Acting Administrator, FAA, IB Docket Nos. 11-109, 12-340, at 2 (June 15, 2018) ("*June 15 Aviation Letter*").

<sup>3</sup> See Comments of Trimble Inc., IB Docket Nos. 11-109, 12-340, IBFS File Nos. SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, SES-MOD-20151231-00981, SAT-AMD20180531-00044, SAT-AMD-20180531-00045, at 4-12 (July 9, 2018) ("*Trimble Comments*"); Comments of Deere & Company, IB Docket No. 11-109, IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, SAT-AMD-20180531-00044, SAT-AMD20180531-00045, at 4-6 (July 9, 2018) ("*Deere Comments*"); Comments of Garmin International, Inc., IB Docket Nos. 11-109, 12-340, IBFS File Nos. SAT-MOD-20120928-00160, SAT-MOD-20120928-00161, SAT-MOD-

comments, that the scope of the Amendment leaves completely unaddressed serious concerns about potential interference to SATCOM and disruption to the receipt of important operational weather data by a plethora of users in government and many industry sectors.<sup>4</sup>

In short, Ligado says its amended modified proposal protects aviation, yet the majority of aviation users, representatives, and manufacturers clearly remain unconvinced. Despite Ligado's repeated assertions, and the support of a lone aviation company, it fails to answer in its voluminous and repeated filings how the proposal addresses the foregoing operational concerns, similar to an exam student that writes a long answer but fails to read the question before attempting to respond.

## **II. LIGADO MISCONSTRUES A KEY ASPECT OF THE FAA ASSESSMENT IN THE DOT ABC REPORT AND DRAWS THE WRONG CONCLUSIONS**

In its comments and reply comments on the Amendment, Ligado does not discern a critical distinction in assessing the potential for interference to certified aviation GPS receivers arising from its proposal.

To examine the threat to certified GPS receivers from Ligado's proposal, two components need to be considered. First, the *operational* model that determines if, what, and how harmful GPS interference zones should be established and managed in the US national airspace must be well understood and accounted for. Second, the appropriate *technical* model must be developed to calculate a suitable transmit power for a base station subject to limits at a

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20101118-00239, SES-MOD-20121001-00872, SAT-AMD-20180531-00044, SAT-AMD-20180531-00045, at 9-13 (July 9, 2018) ("*Garmin Comments*").

<sup>4</sup> Comments of Aviation Spectrum Resources, Inc. on the Amendment to the Applications of Ligado Networks Subsidiary LLC, IB Docket Nos. 11-109, 12-340, IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, SAT-AMD-20180531-00856, at 2 (July 9, 2018) ("*ASRI Comments*").

defined distance, including appropriate propagation models, aggregate interference, and antenna orientation.

Ligado overlooks the fact that, in the *DOT ABC Report*, the FAA only conducted a full assessment of the technical model component, not the operational model component. Although the FAA states that a 9.8 dBW power limit would be needed to protect a certified aviation GPS receiver, it does so “operating under the *assumption* of the described 250 foot (76.2 m) radius assessment zone,” *i.e.*, Ligado’s 500-foot-diameter “standoff cylinder.”<sup>5</sup> The FAA is careful to offer no endorsement in the *DOT ABC Report* of the sufficiency of the “standoff cylinder” concept from an operational perspective. Rather, the FAA leaves no doubt that it “has not completed an exhaustive evaluation of the *operational* scenarios in developing this assessment zone.”<sup>6</sup> In other words, work remains to be done before the “standoff cylinder” can be found to pass muster.

Consequently, the ultimate conclusion of Declarant James H. Williams in support of Ligado’s comments – that the “FCC can therefore act confidently, based on the data it has now, and grant Ligado’s license modification applications” – is unfounded.<sup>7</sup> Instead, the Commission should take the *DOT ABC Report* at face value; the FAA has developed a suitable *technical* model to calculate Ligado’s necessary transmit power to protect aircraft GPS receivers at an *assumed* distance. But it has not endorsed Ligado’s 500-foot “standoff cylinder” being

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<sup>5</sup> U.S. Department of Transportation, “Global Positioning System (GPS) Adjacent Band Compatibility Assessment,” Final Report (April 2018), available at <https://www.transportation.gov/sites/dot.gov/files/docs/subdoc/186/dot-gps-adjacent-band-final-reportapril2018.pdf>, at Section 5.2.3.9, p. 153 (emphasis added) (“*DOT ABC Report*”).

<sup>6</sup> *Id.* at Section 5.1.1., p. 120 (emphasis added).

<sup>7</sup> Comments of Ligado Networks LLC, IB Docket No. 11-109, IBFS File Nos. SAT-AMD-20180531-00044, SAT-AMD-20180531-00045 (“*Ligado Comments*”), at Exhibit A, Declaration of James H. Williams, at ¶ 10 (July 9, 2018) (“*Williams Declaration*”).



implemented in the national airspace because it has not fully studied the *operational* implications of the Ligado proposal for certified GPS receivers.<sup>8</sup> Although Mr. Williams has a significant background, it is the FAA alone which has the authority and responsibility to assess *operationally* whether, as he broadly claims, it is “extremely improbable that Ligado’s proposed network will cause harmful interference to FAA-certified GPS devices.”<sup>9</sup>

### **III. THE COMMENTS CONFIRM THE LACK OF SUPPORT IN THE COMMERCIAL AVIATION COMMUNITY AS A WHOLE FOR LIGADO’S 500-FOOT-DIAMETER “STANDOFF CYLINDER” PROPOSAL**

As ASRI explained in its comments, prior to the filing of the Amendment, opposition to the Ligado proposal for a 500-foot-diameter “standoff cylinder” was widespread within the commercial aviation community.<sup>10</sup> The record developed since the Amendment was filed only confirms this. A large coalition of aviation interests reasserted their opposition less than three weeks after Ligado filed the Amendment, emphasizing that the potential for Ligado’s amended license modification proposal to impact adversely the operational aviation environment remains unresolved, requiring testing and evaluation before any system deployment.<sup>11</sup> And Garmin, in its comments on the Amendment, underscores the many troubling operational issues with the

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<sup>8</sup> Moreover, as Boeing points out in its comments, the DOT made clear that interference levels that may not affect certified aviation receivers may still affect “other categories of GPS/GNSS receivers, including those used in general aviation and in drones,” warranting “[f]urther review.” Comments of the Boeing Company, IB Docket Nos. 11-109, 12-340, IBFS File Nos. IBFS File Nos. SAT-AMD-20180531-00044, SAT-AMD-20180531-00045, at 3 (July 9, 2018) (“*Boeing Comments*”). See *DOT ABC Report* at vii (“[C]urrent analyses do not include an operational assessment of the impact of the assessment zone in densely populated areas, which may present additional variables, including the risk posed to people and property for operations such as UAS using certified avionics.”).

<sup>9</sup> *Williams Declaration* at ¶ 10.

<sup>10</sup> See *ASRI Comments* at 4.

<sup>11</sup> See *June 15 Aviation Letter* at 1.

“standoff cylinder” proposal that require resolution before action can be taken on the Modification Applications.<sup>12</sup>

Despite Ligado’s claims in its comments on its own Amendment that it has engaged in multiple “consultation[s] with the FAA, RTCA, DOT, and numerous stakeholders,” the Commission’s records and other public sources of which ASRI is aware indicate that only one active aviation operator has expressed support for the 250-foot “standoff cylinder” concept.<sup>13</sup> That isolated commenter, Metro Aviation, observes that it has “more than 130 rotary and fixed-wing aircraft.”<sup>14</sup> Notably, the *June 15 Aviation Letter* overwhelmingly offsets the views of Metro Aviation as a representative of the aviation community. The *June 15 Aviation Letter* includes the concerns of aviation associations representing more than 230,000-plus aircraft operators and owners regularly flying in the United States national airspace. ASRI contends that the Commission should not base its decision on the view of a lone operator that captures such a miniscule fraction of a percentage of represented aircraft flying, but rather on the consensus amongst the wider aviation community.

In addition, Metro Aviation’s comments are at odds with many other aviation organizations when it asserts that degradation of GPS within the “standoff cylinders” is inconsequential as an operational matter.<sup>15</sup> As ASRI and others have made clear, helicopter

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<sup>12</sup> See *Garmin Comments* at 6-7.

<sup>13</sup> *Ligado Comments* at 4. Ligado never explains the identities of the “numerous stakeholders” it references, but presumably, given that lack of identification, these stakeholders are not aviation interests that have endorsed the Ligado proposal.

<sup>14</sup> Letter of Mike Stanberry, President, Metro Aviation, to Marlene Dortch, Secretary, FCC, IB Docket No. 11-109, RM-11681, IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-0009, at 1 (July 9, 2018) (“*Metro Aviation Comments*”).

<sup>15</sup> See *id.* at 2-3.

pilots do rely on GPS, in addition to sight, within 250 feet of a tower.<sup>16</sup> Loss of GPS could be catastrophic for operations in close proximity to Ligado's base station towers. This danger is exacerbated given the difficulties for operators in obtaining up-to-date information regarding Ligado's base station tower deployments, as ASRI explained in its opening comments.<sup>17</sup>

And While Metro Aviation asserts that, in any event, there has been an absence of GPS interference complaints from its own database during Visual Flight Rules operations,<sup>18</sup> this is not representative of all operators, and the Commission should be mindful that Ligado's proposed terrestrial operations eventually may have tens of thousands of base stations.<sup>19</sup> Such a massive deployment would completely transform the operational environment for aircraft, such

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<sup>16</sup> See, e.g., Letter of Edward A. Yorkgitis, Jr., Counsel to ASRI, to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 12-340, RM-11681, IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, at 2-3 (June 20, 2017).

<sup>17</sup> *ASRI Comments* at 5-7.

<sup>18</sup> *Metro Aviation Comments* at 2.

<sup>19</sup> See National Space-Based Positioning, Navigation, and Timing National Engineering Forum, Assessment to Identify Gaps in Testing of Adjacent Band Interference to the Global Positioning System (GPS) L1 Frequency Band, at 14 (March 1, 2018), available at <https://www.gps.gov/spectrum/ABC/2018-03-NPEF-gap-analysis.pdf> ("*NPEF Report*") (stating that "the actual implementation of an LTE network requires thousands of base-stations strategically arranged in an architecture that optimizes the network's performance. As such, the true impacts of an adjacent-band LTE network can only be assessed in the context of the aggregated interference from the LTE network"). Notably, in its recent reply comments, Ligado contends that its system will be part of next-generation mobile broadband network solutions. See Reply Comments of Ligado Networks LLC, IB Docket No. 11-109, IBFS File Nos. SAT-AMD-20180531-00044, SAT-AMD-20180531-00045, at 23-24 (July 19, 2018) ("*Ligado Reply Comments*"). This appears at odds to its previous plans, which ASRI understood to be more narrowly focused on mission-critical applications for critical infrastructure industry sectors, and any material change in Ligado's plans should be clarified as it may impact potential interference effects, especially on an aggregate basis.

that past results offer no assurances regarding future performance, particularly when issues of notification of Ligado deployments remain unsatisfactorily unaddressed.<sup>20</sup>

Metro Aviation also cites Ligado's commitments to ensure that no Ligado base station will be deployed in an area where a "standoff cylinder" would encroach upon zones defined in 14 C.F.R. Part 77.<sup>21</sup> Ligado and Metro Aviation mistakenly assume all Instrument Flight Rule ("IFR") operations are conducted within areas registered to the FAA under Part 77 Obstacle Clearances. For example, several major helicopter operators have private airfields that do not publish data to the FAA, as only their company and pilots use the airfield. These sites provide IFR services for bad weather and nighttime helicopter operations. Therefore, Ligado might be unaware of such locations and could install base stations affecting IFR operations for such operators to disastrous effects.

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<sup>20</sup> Notably, Metro Aviation itself explains that "a pilot will likely not know whether a particular tower contains a Ligado antenna," meaning that it is a potential source of GPS interference. *Metro Aviation Comments* at 2. In its opening comments, ASRI explained its concerns with Ligado's brief proposal to submit information regarding new and modified base station deployments to the Commission and the FAA on a confidential basis rather than through an open system that provides all aviation operators with the necessary information needed to maintain aviation safety, similar to the Notice to Airmen system used by the FAA. *ASRI Comments* at 5-7. In its recent reply, Ligado apparently seeks to blame ASRI for this state of affairs because ASRI and the commercial aviation community declined to take on the burdens of establishing, maintaining, and operating a private notification database to all private and commercial aviation operators nationwide, a process that should be federally controlled for very good reasons. *Ligado Reply Comments* at 11, n.22 (July 19, 2018). While ASRI is somewhat hesitant to respond to Ligado's baseless accusation, ASRI will state that it and the members of the aviation community, as a courtesy in response to Ligado's request, discussed this prospect among themselves and, based on the limited information provided, concluded that the commercial aviation community was not the appropriate entity to assume this burden on Ligado's behalf, and that Ligado should discuss such a process with the FAA. Given this, it is ludicrous for Ligado to suggest that its obligation in this matter has been discharged without further effort on Ligado's part.

<sup>21</sup> *Metro Aviation Comments* at 3.

#### IV. LIGADO'S COMMITMENT TO LOWER POWER LEVELS FAILS TO ADDRESS OTHER CRITICAL DEPLOYMENT ISSUES

Leaving aside the inadequacy of the “standoff cylinder” proposal to protect aviation operations, the Amendment glosses over other operational issues that Ligado’s proposed base station power reduction leaves unaddressed. Referencing the *DOT ABC Report*, Ligado states that the Commission should “adopt the judgment of the expert agencies that 9.8 dBW (10 W) will protect certified aviation devices.”<sup>22</sup> This is not the whole story because Ligado fails to explain how the base stations will be deployed or commit to earlier statements and assumptions in its *ex partes* regarding network configurations. As Garmin’s comments make abundantly clear, Ligado fails to commit to site spacing, base station tower density, antenna height and down tilt, and polarization parameters that would, in combination, make the power reduction effective at reducing the potential for interference to GPS receivers.<sup>23</sup> For example, as ASRI explained in its opening comments, Ligado appeared to commit during the RTCA technical assessment process in 2016 to a minimum Inter-Site Distance (“ISD”) of 433 meters between base stations operating in the 1526-1536 MHz range as a license condition.<sup>24</sup> Yet, the Amendment does not request such a condition on Ligado’s licenses. This is significant because, as the *June 15 Aviation Letter* explains, “within areas of high density tower deployment, operators could potentially experience repeated loss of GPS.”<sup>25</sup> Even under Ligado’s previous apparent

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<sup>22</sup> *Ligado Comments* at 6.

<sup>23</sup> *See Garmin Comments* at 3-6.

<sup>24</sup> *ASRI Comments* at 7 (citing Ligado, A method for calculating adjacent band RF interference power received by a certified aviation GPS receiver from proximate terrestrial base stations (Sept. 19, 2016) (attached to RTCA SC-159) (stating that Ligado “will propose that its license be conditioned to limit deployment of sites only where the inter-site distance is 433 meters or greater”)).

<sup>25</sup> *June 15 Aviation Letter* at 2.

commitment to a 433-meter ISD, a congested urban area could have significant GPS interference from Ligado's operations.<sup>26</sup> A helicopter or drone moving through such an environment would only have a quarter-mile between interference zones, with a certified GPS receiver oscillating between interference and then reacquisition of GPS satellites within short periods. Given that aircraft systems are expecting a consistent GPS signal, an assessment of aircraft system-level responses in this repeated interference situation is needed to resolve the variables before the FAA and the Commission have assurances that such a Ligado deployment would not cause operational issues, a point specifically mentioned two years ago in the RTCA report that assessed Ligado's operational proposal.<sup>27</sup>

Lastly, as the *DOT ABC Report* recognizes, a power level of 9.8 dBW may also "cause interference with, or degradation to, most other categories of GPS/GNSS receivers including those used for General Aviation and drones."<sup>28</sup> Accordingly, any proposed modification to Ligado's licenses must be granted only if additional control measures, such as those described above, are imposed on Ligado's base station deployments that make the power reduction effective to ensure safe aircraft operations.

## **V. LIGADO'S PROPOSED TSO CONDITION IS UNSUITABLE**

Ligado maintains in its comments that it will "limit its power as necessary to achieve compatibility with current and any future [Minimum Operational Performance Standards] insofar

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<sup>26</sup> RTCA, Operational Review of Ligado Networks Proposal for Standoff Cylinders, at 3 (December 2016).

<sup>27</sup> *See id.* at 7 ("The FAA should consider implementation of the Ligado Networks proposal as a significant change to the NAS [National Airspace System] and conduct the corresponding thorough safety analysis.").

<sup>28</sup> *DOT ABC Report* at Section 6, p. 158.

as they are incorporated into an active Technical Standard Order [TSO] by the FAA.”<sup>29</sup>

Ligado’s claims that this will ensure aviation systems will be protected while in use is a simplification of the FAA TSO process and corresponding commercial equipage rates that has serious implications that Ligado will not provide the continuing necessary protection for aviation users. Ligado is aware of this deficiency, as Garmin pointed out two years ago that “[t]he Commission must consider the practical effect of what will occur when a ‘current’ [Minimum Operational Performance Standard] is no longer ‘incorporated into an active [Technical Standard Order (“TSO”)].”<sup>30</sup>

Simply stated, the removal of active status neither stops the production of equipment designed to the standards of a previously-active TSO nor, more importantly, that equipment’s use, as the FAA’s regulatory framework allows manufacturers to continue to produce equipment for *inactive* TSOs under their existing FAA authorizations.<sup>31</sup> Only if the FAA specifically *withdraws* a TSO must manufacturing to previous standards cease.<sup>32</sup>

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<sup>29</sup> *Ligado Comments* at 5 (quoting Letter of Gerard J. Waldron, Covington & Burling LLP, Counsel to Ligado Networks LLC, to Marlene H. Dortch, Secretary, FCC, IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, IB Docket No. 11-109, Amendment to License Modification Applications, at 2 (May 31, 2018)).

<sup>30</sup> Comments of Garmin International, Inc., IB Docket Nos. 11-109, 12-340, IBFS File Nos. SAT-MOD-20120928-00160, SAT-MOD-20120928-00161, SES-MOD-20121001-00872, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, SAT-MOD-20151231-00981, at 7 (May 23, 2016).

<sup>31</sup> FAA, “Technical Standard Orders (TSO) Authorization, Cancellation and Withdrawal (Feb. 8, 2017), available at [https://www.faa.gov/aircraft/air\\_cert/design\\_approvals/tso/tso\\_cancel/](https://www.faa.gov/aircraft/air_cert/design_approvals/tso/tso_cancel/).

<sup>32</sup> 1 FAA Order 8150.1C, at 8, ¶¶ 4-5 (Mar. 8, 2012) (“In certain circumstances, AIR-100 [Aircraft Engineering Division] may determine that all TSOAs and LODAs [Letters of TSO Design Approval] should be withdrawn when a TSO is cancelled. AIR-100 must publish proposals for withdrawal of all TSOAs and LODAs for public comment. After consultation, if AIR-100 determines that withdrawal is appropriate in order to cease production of articles to the cancelled TSO, they will notify the ACOs to withdraw each holder’s approval.”).

Consequently, were Ligado's proposal to be accepted, a new *active* TSO standard could be agreed for certified aviation GPS receivers and the previous TSO standard could be removed from active status, but not withdrawn. This would remove Ligado's obligation to protect certified GPS receivers on all existing aircraft that operate under the previous technical standard or GPS receivers that may still be manufactured and deployed under the now-inactive TSO's standard. Indeed, even if Ligado's proposal was clarified to account for the distinction described above between inactive and withdrawn TSOs, Ligado's commitment still would not address the existing equipment manufactured and deployed on already-flying aircraft under withdrawn standards, as federal aviation practices do not require that already-manufactured equipment be modified or retrofitted as previous standards are withdrawn. The continuing improvement of aviation systems that revise TSOs, combined with the sheer number of aircraft that will continue operating under existing TSO performance requirements, requires Ligado's plans for and commitments in light of this potential situation to be fully clarified.

## **VI. THE COMMENTS CONFIRM THAT ISSUES REMAIN REGARDING PROTECTIONS FOR UNCERTIFIED GPS RECEIVERS BECAUSE LIGADO FAILS TO RECOGNIZE THE ACCEPTED HARMFUL INTERFERENCE PROTECTION CRITERION**

In their comments, the three GPS receiver manufacturers that reached settlement agreements with Ligado after Ligado's predecessor LightSquared sued them in federal court in New York unanimously reiterated their support for the 1 dB  $C/N_0$  IPC as the only objective, administrable choice.<sup>33</sup> ASRI, too, continues to fully support the *DOT ABC Report* on non-

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<sup>33</sup> *Garmin Comments* at ii (“Garmin remains a strong supporter of a 1 dB decrease in a GPS devices’ carrier-to-noise density ratio ( $C/N_0$ ) . . . as a threshold determinant of harmful interference to the device’s operations.”); *Deere Comments* at 4 (stating that Deere “reaffirms its staunch support for application of a one (1) dB decrease in Carrier-to-Noise Power Density ( $C/N_0$ ) . . . as the appropriate metric for determining whether a GPS receiver has experienced harmful interference.”); *Trimble Comments* at 12 (“[T]he Commission should



certified GPS receivers, which in conjunction with the recent *NPEF Report*, validates the use of the 1 dB protection criteria for GPS receivers.<sup>34</sup> Critical of Ligado's contrary proposal to assess impacts on GPS receiver models using KPIs, which "would require that unique test scenarios be developed for each application," Trimble, for example, underscores that, "[w]ithout application of the 1 dB standard, it is not possible to evaluate and define whether 'material degradation' across a wide range of applications actually occurs. Therefore, relying upon any proposal other than a  $C/N_0$  standard for interference analysis and protection would devolve into an unmanageable quagmire of 'picking winners and loser' based upon subjective definitions of 'material degradation.'"<sup>35</sup> Statements such as these in the comments confirm the manufacturers' long-standing position in these proceedings.<sup>36</sup> Notably, the manufacturers also each take the

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use the 1 dB standard and reject the use of KPIs to determine potential for harmful interference to GNSS devices.”).

<sup>34</sup> See *NPEF Report* at 9.

<sup>35</sup> *Trimble Comments* at 11-12. See *Garmin Comments* at 9 (“[W]ithout use of the 1 dB Standard, individual and unique test scenarios would need to be developed for thousands of use cases.”); *Deere Comments* at 6 (“[T]he KPI approach that Ligado advocates is highly unreliable and falls far short as an adequate replacement for the long-standing, widely accepted 1 dB Standard.”).

<sup>36</sup> See, e.g., Letter of Catherine Wang, Morgan, Lewis & Bockius LLP, Counsel to Deere & Company, to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 12-340, at 1-2 (July 7, 2018); Reply Comments of Deere & Company, IB Docket Nos. 11-109, 12-340, at 7 (June 21, 2016); Letter of M. Anne Swanson, Wilkinson Barker Knauer LLP, Counsel for Garmin International, Inc., to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 12-340, at 2-6 (May 16, 2018); Reply Comments of Garmin International, Inc., IB Docket Nos. 11-109, 12-340, at 2 (June 21, 2016); Comments of Trimble Navigation Limited, IB Docket Nos. 11-109, 12-340, at 15 (May 23, 2016). See also Letter of Timothy St. J. Ellam, McCarthy Tetrault, Counsel to NovAtel Inc., to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 12-340, at 2 (May 19, 2016).

opportunity in their comments to specifically reject the notion that they endorse the overall Ligado proposal.<sup>37</sup>

The comments of the manufacturers, especially as a group, constitute a sharp rebuke to Ligado's attempt to challenge the propriety of the 1 dB IPC. Ligado, on April 12, 2018, in a reply to the *NPEF Report* filed in the Commission's record in the above proceedings, claims that the *NPEF Report*'s support for the 1 dB standard is "at odds with the position of major GPS manufacturers," stating that the manufacturers have "taken a markedly different approach than the one reflected in the NPEF report."<sup>38</sup> However, despite the confirmation by the major manufacturers that they are not Ligado's allies on this specific issue, Ligado continues to maintain that the 1 dB IPC is inappropriate in its comments and reply comments.<sup>39</sup>

Ligado claims that "neither the Commission nor the ITU has ever used a standard of a 1 dB C/N<sub>0</sub> degradation to protect a service from transmissions in an adjacent band."<sup>40</sup> Ligado similarly asserted in its *April 12 Letter* on this point that NPEF, in suggesting to the contrary, has

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<sup>37</sup> *Garmin Comments* at 3 ("Garmin's execution of the [settlement] agreement did not constitute an endorsement by Garmin of Ligado's proposal, and Ligado agreed not to make any statement or representation to that effect."); *Trimble Comments* at 2 ("Trimble and other manufacturers of GNSS equipment negotiated agreed-upon technical parameters for terrestrial use of some or all of Ligado's licensed MSS spectrum. In no cases, however, do these agreed-upon technical requirements constitute endorsement of Ligado's position on the appropriate standard for determining the potential for harmful interference to GNSS devices and applications."); *Deere Comments* at 1 ("Deere neither opposes nor affirmatively endorses the amended Modification Application.").

<sup>38</sup> Letter of Gerard J. Waldron, Covington & Burling LLP, Counsel to Ligado Networks LLC, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 11-109, IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, at 1 (April 12, 2018) ("*April 12 Letter*").

<sup>39</sup> *Ligado Comments* at 11-13; *Ligado Reply Comments* at 14-18.

<sup>40</sup> *Ligado Reply Comments* at 15 (emphasis removed). See *Ligado Comments* at 11 ("[A] 1 dB change in a device's C/N<sub>0</sub> has no reliable relationship to the actual performance of GPS devices.").

a “basic misunderstanding of spectrum policy and well-established law.”<sup>41</sup> As an initial matter, these assertions are at odds with ASRI’s own thirty-plus years’ experience in the ITU-R at the committee and chairmanship levels. Moreover, the three manufacturers’ comments also note the long-established nature of the 1 dB standard, in contrast with the subjective KPI-based IPC that Ligado proposes.<sup>42</sup> Trimble explains that the “the 1 dB standard is supported by well understood and critical aspects of GNSS engineering”<sup>43</sup> and that the GNSS industry has “found that monitoring changes in a receiver’s  $C/N_0$  provides a quantifiable and empirical measure of receiver performance that directly influences [accuracy, integrity, availability, and continuity].”<sup>44</sup>

Apart from challenging the 1 dB standard by proposing a subject KPI approach, Ligado’s unconvincing contention that imposing conditions on an adjacent band system somehow grants a form of “adverse possession” conflicts with modern spectrum management.<sup>45</sup> A spectrum allocation does not grant the owner or user total authority to implement any system or use it desires regardless of impact on users in adjacent bands. Furthermore, ASRI notes that even Ligado itself previously requested that adjacent band compatibility be assessed in separate proceedings, stating that for the implementation of the adjacent band Galileo system in the United States “the EC must demonstrate that the proposed Galileo operations will neither cause interference to MSS nor require additional interference protections from Ligado’s existing MSS or proposed ATC operations.”<sup>46</sup>

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<sup>41</sup> *April 12 Letter* at 2.

<sup>42</sup> Ligado acknowledges in its recent reply comments that 1 dB  $C/N_0$  degradation is an appropriate in-band IPC. *See Ligado Reply Comments* at 15.

<sup>43</sup> *Trimble Comments* at 4.

<sup>44</sup> *Id.* at 7. *See Deere Comments* at 3-6; *Garmin Comments* at 9-10, 12-13.

<sup>45</sup> *April 12 Letter* at 2.

<sup>46</sup> Comments of Ligado Networks LLC, IB Docket No. 17-16, at 4 (Feb. 21, 2017).

Finally, the ITU-R assesses adjacent band compatibility for passive or safety services such as the RNSS on a regular basis.<sup>47</sup> For example, ITU-R Resolution 233 (WRC-12)<sup>48</sup> addressed WRC-15 Agenda Item 1.1 looking for new IMT allocations in the 400 MHz to 6 GHz range, which specifically resolved to “include sharing and compatibility studies with services already having allocations in the potential candidate bands and in adjacent bands.”<sup>49</sup> Ligado’s assertion that protecting certain adjacent band users using established protection criteria is somehow an unusual process is unfounded and at odds with well-established spectrum management principles.

## **VII. SATCOM ISSUES REMAIN UNADDRESSED BY THE MODIFICATION APPLICATIONS**

Like ASRI, Iridium and Boeing note that the Amendment, being limited to an attempt to alleviate GPS interference issues that have been raised by the aviation community, does not address critically important concerns related to the impact of Ligado’s proposed operations on SATCOM.<sup>50</sup> Iridium correctly observes that Ligado does nothing to address the concerns that it

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<sup>47</sup> For instance, Recommendation ITU-R M.1903 concerned characteristics and protection criteria for receiving earth stations in the radionavigation service and receivers in the aeronautical radionavigation service. *See* Recommendation ITU-R M.1903 (January 2012), available at <https://www.itu.int/rec/R-REC-M.1903-0-201201-I/en>. Similarly, Recommendation ITU-R M.1904 concerned characteristics and protection criteria for receiving stations of the radionavigation-satellite service. *See* Recommendation ITU-R M.1904 (January 2012), available at <https://www.itu.int/rec/R-REC-M.1904-0-201201-I/en>.

<sup>48</sup> ITU, Resolution 233, Studies on frequency-related matters on International Mobile Telecommunications and other terrestrial mobile broadband applications (February 2012), available at [https://www.itu.int/dms\\_pub/itu-r/oth/0c/0a/R0C0A00000A0011PDFE.pdf](https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A00000A0011PDFE.pdf).

<sup>49</sup> *Id.* at 3.

<sup>50</sup> *See* Letter of Bryan N. Tramont, Counsel to Iridium Communications Inc., to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 12-340, IBFS File Nos. SAT-AMD-20180531-00045, SAT-AMD-20180531-00044, SES-AMD-20180531-00856, SES-MOD-20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, at 1-4 (July 9, 2018) (“*Iridium Comments*”); *Boeing Comments* at 3-6. As ASRI noted in its comments, the Amendment also fails to address the long unresolved issues raised by the aviation

has raised regarding SATCOM interference, which ASRI itself has raised several times before.<sup>51</sup> Boeing sums it up well by saying “the critical nature of aeronautical communications necessitates that an appropriate resolution be reached to ensure that harmful interference does not result to aircraft operating using the Iridium network.”<sup>52</sup>

Boeing also underscores that Ligado itself has never adequately addressed the potential impact of its operations on the Inmarsat SATCOM system.<sup>53</sup> Inmarsat itself has acknowledged publicly that “the provision of integrated MSS/ATC services could interfere with our satellites and user terminals, which may adversely impact our services, costs and revenues.”<sup>54</sup> The service Inmarsat references is the AMS(R)S service that provides Air Traffic Control and other aviation services. Despite such questions and the implications of interference to a safety service, there is a deafening silence from Ligado on this issue. Boeing indicates in its comments on the Amendment that a retrofit or replacement may be adequate to address potential interference, and that it, Inmarsat, and Ligado are working toward a solution.<sup>55</sup> But it acknowledges that the FAA approvals (*i.e.*, new Type Certifications) and the responsibility for the retrofit (including the costs) across tens of thousands of in-service aircraft still need to be addressed and resolved.<sup>56</sup>

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community, weather forecasters, and other weather data users regarding the impacts of Ligado’s proposal to use the 1675-1680 MHz band, which would adversely impact the direct downlink of meteorological data from the GOES-R weather satellites. *ASRI Comments* at 2, n.4.

<sup>51</sup> *Iridium Comments* at 2-4.

<sup>52</sup> *Boeing Comments* at 5-6.

<sup>53</sup> *Id.* at 3-4.

<sup>54</sup> Inmarsat Group Limited – Inmarsat Group Limited Interim Results 2016 – Supplemental Disclosure 14 September 2016, at 5 (Sep. 14, 2016).

<sup>55</sup> *Boeing Comments* at 3-4.

<sup>56</sup> *Id.*

ASRI therefore reiterates that, given the potential impact to installed SATCOM systems onboard thousands of aircraft operating domestically with Inmarsat service, and potentially several times that number of systems for international operators who provide global transport that United States business, government, and citizens rely upon, these issues should be fully addressed and resolved, as Boeing notes, before the Commission acts on the Modification Applications. While some of this work may be carried out in the Airline Electric Engineering Committee (“AEEC”), as commented on by Inmarsat, the AEEC subcommittee does not involve itself with the regulatory implications of such work.<sup>57</sup> Nor would it be able to implement any non-technical control measures, such as potential separation zones around aircraft operating areas. Inmarsat’s comment, acknowledging that a resolution is still being worked on,<sup>58</sup> also presupposes that compatibility can be achieved; but no technical assessment has been entered into the record to confirm this by Ligado.

## VIII. CONCLUSION

ASRI does not dispute that use of the DOT technical model to calculate interference at different power levels should be the tool that the Commission implements in its decision. But from DOT’s own comments in the report, drawing a conclusion that the FAA and the aviation community have accepted and endorsed Ligado’s proposed 500-foot “standoff cylinder” is more than a stretch. Indeed, it is an interesting that Ligado says it protects aviation, yet most of the aviation users, representatives, and manufacturers that have spoken in this proceeding clearly do

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<sup>57</sup> Reply Comments of Inmarsat Inc., IB Docket No. 11-109, SAT-AMD-20180531-00044, SAT-AMD-20180531-00045, at 2 (July 19, 2018).

<sup>58</sup> *Id.* See Ligado Reply Comments at 22 (indicating that Ligado and Inmarsat “are developing” a commercial and technical plan to address retrofitting, but they have not completed anything yet).

not back up that notion. This hole in Ligado's proposal is in addition to the other issues raised here for other systems, some repeatedly over several years, all of which show Ligado's plan is still not ready. While Ligado and its supporters may be unhappy with such a statement given their efforts, even their own aviation expert points out that for such assessments, "[i]n the interest of aviation safety, the model is 'conservative,'" to properly account for "even those [conditions] with a one in a million chance of occurring."<sup>59</sup> All of Ligado's proposals to protect aviation safety operations should be held up to this level of scrutiny and rigor, as stated by its own aviation expert. Unfortunately, when that standard is applied, Ligado clearly fails the test in many areas. Given that ASRI and others in the GPS and aviation industry, the SATCOM industry, and the community of weather data users have been pointing out the same flaws for

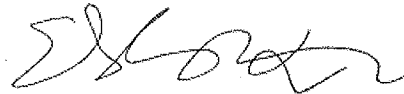
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<sup>59</sup> *Williams Declaration* at ¶ 8.

years with only minimal response, unless Ligado can quickly address the shortcomings of its proposal promptly, the Commission should deny the amended Modification Applications.

Respectfully submitted,

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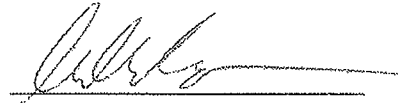
July 24, 2018



**DECLARATION**

In accordance with 47 C.F.R. §§ 1.16, 25.154, I declare under penalty of perjury under the laws of the United States of America that the facts contained in the foregoing Reply Comments of Aviation Spectrum Resources, Inc. are true and correct.

Executed on July 24, 2018

A handwritten signature in black ink, appearing to read "Andrew Roy", is written over a horizontal line.

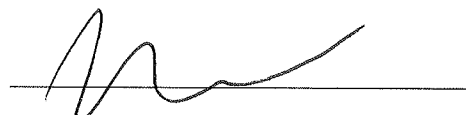
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## CERTIFICATE OF SERVICE

I, J. Bradford Currier, hereby certify that on July 24, 2018, a copy of the forgoing Reply Comments of Aviation Spectrum Resources, Inc. was served by first class mail on the following:

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