UNITED STATES GOVERNMENT

memorandum

Date: April 17, 2006

To: D'wana Terry
Chief of Staff, Wireless Telecommunications Bureau

From: Ira Keltz, Chief, Electromagnetic Compatibility Division, Office of Engineering and Technology
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Subject: Peer Review of a Report Relied Upon in the draft *Report and Order, Further Notice of Proposed Rulemaking, and Fourth Memorandum Opinion and Order* (WT Docket No. 04-344)

On March 27, 2006, the Wireless Telecommunications Bureau (WTB) requested that the Office of Engineering and Technology convene a review panel to conduct a peer review of a February 2004 report (JSC Report) prepared by the Department of Defense Joint Spectrum Center (JSC) and submitted by the National Telecommunications and Information Administration (NTIA) as comments in WT Docket No. 04-344. The review panel welcomes the opportunity to perform a peer review of the JSC Report relied upon by WTB. Our review is below:

On August 26, 2004, the Commission adopted a Notice of Proposed Rule Making (*AIS NPRM*) in WT Docket No. 04-344.[1] In this NPRM, the Commission proposed to designate VHF maritime Channels 87B (161.975 MHz) and 88B (162.025 MHz) on a wideband simplex basis exclusively for Automatic Identification Systems (AIS), a relatively new technology that promotes maritime safety and homeland security by facilitating Coast Guard tracking of vessels.

In response to the NPRM, MariTEL, Inc. and equipment manufacturers submitted studies into the record that purportedly demonstrate that adoption of the Commission's proposal would result in harmful interference to adjacent channel VHF public coast (VPC) station operations of such magnitude as to effectively preclude such VPC operations. These reports – a January 14, 2004 report prepared by inCode Telecom Group, Inc., and submitted by MariTEL, Inc. (the inCode Report), and a December 2, 2004 report prepared by Dorr Engineering Services, Inc., and submitted by the equipment manufacturer RF Neulink (the DESI Report) – purport to show that wideband simplex AIS communications on Channels 87B and 88B would cause a maritime data system planned by MariTEL, the licensee of all nine of the maritime VPC geographic service areas, to incur performance degradation of at least fifty percent, that could not be overcome using any available technology. MariTEL opposes the Commission's proposal for that reason.

NTIA, which supports the Commission's proposal, countered MariTEL's technical arguments by submitting the JSC Report as well as JSC's January 27, 2005 response (JSC Response) to criticisms of

[1] *See* Amendment of the Commission's Rules Regarding Maritime Automatic Identification Systems, *Memorandum Opinion and Order and Notice of Proposed Rule Making*, WT Docket No. 04-344, 19 FCC Rcd 20071, 20074 ¶ 5 (2004) (*AIS NPRM*).

that report by MariTEL (in its December 30, 2004 comments and in its March 30, 2005 and April 11, 2005 *ex parte* presentations to WTB) and to the DESI Report. The JSC Report concludes that any interference incurred by MariTEL's planned maritime data system from AIS operations can be effectively mitigated through the use of soft decision forward error correction coding and interleaving technologies, and the need to incorporate such technologies in VPC equipment would not impose an unreasonable burden on MariTEL or other VPC licensees. The JSC Response reaffirms the JSC Report.

The review panel discussed the assumptions, calculations, and methodology in the JSC Report referenced in the draft AIS Report and Order in WT Docket 04-344. Specifically, as requested in the WTB memo, the review panel discussed the following:

1. Do the assumptions contained in the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?
2. Do the calculations in the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?
    a. Are the results accurate?
    b. If statistical methods are used, are the techniques appropriate for the problem?
    c. If software is used, is the software appropriate for the problem and current?
3. Does the methodology contained in the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?
4. Do the conclusions contained in the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?
5. Are there any revisions, improvements, or extensions the reviewer recommends to ensure that the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conforms to generally accepted standards in the radio engineering field?

The response of the review panel is presented below for each question shown above:

1. Do the assumptions contained in the JSC Report, with consideration of the inCode Report, MariTEL's Comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?

Based on the review panel's knowledge, it believes that the assumptions used by JSC in conducting their analysis are appropriate and conform to generally accepted standards. These assumptions include, but are not limited to:

- Measurement of bit error rate (BER) for data system performance. On this measure, the review panel points out that inCode and DESI assert that packet error rate (PER) should be used instead or BER. We note that BER and PER are both generally accepted methods to measure digital system performance. Additionally, we note that frame error rate is also a generally accepted performance measure and could be used.

- Improvements can be made to the existing error correcting capabilities of the NL6000 Receiver. RF Neulink points out in their comments that one mode of the NL6000 currently employs a (31, 6) Reed-Solomon code combined with a depth 6 interleaver. Thus, JSC's assumption that this receiver can be improved by implementing an interleaver with depth 16 with little difficulty is facially reasonable.

- Use of forward error correction (FEC) with interleaving can mitigate AIS interference. We note that use of FEC with or without interleaving are well established techniques for correcting bit errors; the

number of errors that can be corrected is determined by the specific design of the code and the interleaver. Such correction occurs regardless of the source of interference, whether it is a fade or an AIS pulse. Therefore, we believe that JSC's assumption that this technique is appropriate to mitigate AIS interference is reasonable.

- Assumed parameters to calculate interference power levels. The JSC Report, in Appendices D and E show several parameters used to calculate the interference power from AIS into a victim receiver. In general, these seem reasonable to the review panel (*i.e*., assumed system losses of 1 dB, antenna gain of 2.1 dB). In addition, the JSC Report specifies antenna coupling loss of 26.3 dB, 66.4 dB, and 97.4 dB for horizontal separations of 10 feet, 1,000 feet, and 10,000 feet, respectively. From observation of these coupling loss parameters, it appears that the JSC Report assumes free space loss. This assumption is borne out by simple calculation. If this is the case, then the JSC Report apparently overstates the loss for the 10,000 foot separation case by 11 dB; by our calculation the coupling loss for this case should be 86.3 dB, not the stated 97.4 dB. However, recognizing that this error occurs only for the best case situation (*i.e*., largest distance separation) and that because free space loss assumes worst case interference so that in practice the expected propagation loss will exceed the assumed free space loss, the review panel believes that this error does not affect the overall conclusions of the JSC Report.

2. Do the calculations in the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?
    a. Are the results accurate?
    b. If statistical methods are used, are the techniques appropriate for the problem?
    c. If software is used, is the software appropriate for the problem and current?

The JSC Report provides several equations in Appendix D of its report that show how the interfering signal which is defined as the mean effective on-tune undesired power (P_{ino}), is calculated. The review panel believes that the methodology shown is correct for this calculation. Further, the JSC Report states that the impact of interference by AIS was analyzed using the Cosite Analysis Model (COSAM), which is a statistical model used to account for uncertainties in equipment characteristics and coupling losses in the calculation of signal power levels. The JSC Report describes that samples from the various distributions are selected randomly during simulation. In the opinion of the review panel, this is an appropriate way to model the system being investigated in this proceeding. However, the JSC Report does not describe the choice of values used for many of the inputs required by the model or the actual distributions that are being used to characterize the various parameters and therefore, the review panel cannot reach any conclusions regarding the correctness of the actual data used or the results. As a final point, the review panel notes that it is not familiar with the COSAM computer simulation model, but based on the review panel's understanding that its use has not been challenged by any commenter, the review panel is comfortable with its use. A more thorough review, however, would include an in-depth evaluation of this model.

3. Does the methodology contained in the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?

In the opinion of the review panel the methodology contained in the JSC Report conforms to generally accepted standards in the radio engineering field. For more description, see Nos. 1 and 2 above.

4. Do the conclusions contained in the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conform to generally accepted standards in the radio engineering field?

In the opinion of the review panel the conclusions contained in the JSC Report conform to generally accepted standards in the radio engineering field. For more description, see Nos. 1 and 2 above.

5. Are there any revisions, improvements, or extensions the reviewer recommends to ensure that the JSC Report, with consideration of the inCode Report, MariTEL's comments and *ex parte* presentations, the DESI Report, and the JSC Response, conforms to generally accepted standards in the radio engineering field?

The review panel points out that the JSC Report recommends further studies to determine appropriate mitigation techniques. These studies include an examination that the impact of the recommended FEC with depth 16 interleaver would have on design of the receiver. The review panel agrees and also recommends examining the effects that adding such capability to the receiver would have on latency of the system and throughput. Additionally, such a change in equipment could have adverse affects on the overall business plan of MariTEL. Therefore, additional study could also include an analysis of the impact on equipment cost, and manufacturing timelines. The JSC Report also states that a further area for study includes the effects of Rayleigh fading, multipath, and interference from existing radio systems. The review panel agrees that further study of the areas pointed out by the JSC Report could shed additional light on potential mitigation techniques.

The review panel also notes that the JSC Report analyzed the effect that a vertical separation of 60 feet has on the articulation score (AS), which relates to interference to voice communications, but does not conduct the same analysis with respect to BER which relates to data communications. It appears that antennas omnidirectional in the horizontal plane were used in the JSC Report. Because such antennas exhibit discrimination in the vertical plane, the review panel believes that this property could be capitalized on for better results. Likewise, antennas with even higher gain in the horizontal plane could also be employed to lessen the impact of interfering signals. Thus, the review panel believes that further studies in these areas could also shed additional light on potential mitigation techniques.

Additionally, as pointed out above, the review panel notes that the JSC Report does not describe the actual statistical distributions that are being used to characterize various parameters used as input to COSAM. If this data were made available, a more rigorous review of the results would be possible.

The review panel points out that the JSC Report relies on a free space propagation model. However, simply by suggesting that FEC and interleaving are appropriate mitigation techniques, the JSC Report implies that the signal propagation of these systems is not free space (*i.e.*, FEC is generally used to correct for bursts of errors which do not generally occur in a free space environment). Thus, in the opinion of the review panel, a free space propagation model does not adequately describe the actual environment in which these radios will operate. The review panel points out that a free space propagation model is conservative and that more realistic propagation models may yield results showing even lower predicted interference. In this connection, any further study could include the use of a more realistic propagation model, if one is known, or a study could be initiated to determine an appropriate propagation model.

The review panel also points out that the JSC Report examines a single data receiver. A study that includes an examination of other receivers that may exist to determine if they have better interference mitigation properties would provide a more comprehensive result.

Respectively submitted,

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