EXECUTIVE SUMMARY

On April 23, 2003, the Federal Communications Commission (Commission or FCC) adopted a Notice of Inquiry (NOI) seeking information on potential interference from Broadband over Power Line (BPL) systems and associated changes that may be needed to accommodate BPL systems in Part 15 of the Commission's rules.[1] As described in the NOI, "access" BPL systems transmit Internet and other data at radio frequencies over neighborhood power lines and use electrical outlets in BPL users' premises as data ports for computers and other devices. "In-house" BPL systems use indoor wiring for networking within the user's premises.

In its response to the NOI, the National Telecommunications and Information Administration (NTIA) described Federal Government usage of the 1.7-80 MHz frequency range, identified associated interference concerns, and outlined the studies it planned to conduct to address those concerns.[2] NTIA reviewed relevant studies and regulations in order to help refine the scope and priorities for its studies. NTIA parsed its planned studies into two time phases, first addressing technical issues of the most immediate importance. As reported herein, Phase 1 defines interference risks to radio reception in the immediate vicinity of overhead power lines used by "access" BPL systems. It also suggests means for reducing these risks and identifies techniques for mitigating local interference should it occur. Phase 2 of NTIA's studies will evaluate the effectiveness of NTIA's Phase 1 recommendations and address potential interference via ionospheric propagation of BPL emissions from mature large-scale deployments of BPL networks.

NTIA reviewed the comments submitted in response to the NOI in order to characterize existing and potential future BPL systems and deployments. Simple BPL deployment models were addressed in the Phase 1 interference risk analyses. NTIA also developed more sophisticated deployment models for use in future studies.

NTIA summarized technical and operating parameters of over fifty-nine-thousand (59,000) Federal Government frequency assignments in the 1.7-80 MHz frequency range. This information may help operators of BPL systems in development of BPL frequency plans. NTIA then defined representative radio systems for consideration in interference analyses: (1) a land vehicular receiver; (2) a shipborne receiver; (3) a receiver using a rooftop antenna (e.g., a base or fixed-service station); and (4) an aircraft receiver in flight. Federal communications require exceptional protection on frequencies amounting to about 5.4% of the 1.7-80 MHz frequency range. NTIA will address the associated protection requirements in on-going studies.

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[1] *Inquiry Regarding Carrier Current Systems, including Broadband over Power Line Systems*, Notice of Inquiry, ET Docket No. 03-104, April 28, 2003 ("BPL Inquiry").

[2] Comments of the National Telecommunications and Information Administration, BPL Inquiry, August 13, 2003.

NTIA executed three two-week measurement campaigns and used Numerical Electromagnetic Code (NEC) software to characterize BPL signal radiation and propagation. These efforts revealed that BPL systems generate the highest electric field strength near the BPL device for horizontal-parallel polarized signals. However, these systems generate peak vertically-polarized field strength under and adjacent to the power lines and at impedance discontinuities at substantial distances from the BPL device. BPL systems generate peak field strength having horizontal-perpendicular polarization at small distances (e.g., less than 30 meters) from both the BPL device and power lines. Thus, measurements intending to demonstrate compliance with the Part 15 field strength limits should not focus solely on the BPL device.

Using NEC, NTIA evaluated interference risks in terms of the geographic extent of locations where interference may occur to radio reception at four frequencies used by outdoor, overhead BPL systems conforming to existing Part 15 rules. Interference to land vehicle, boat, and fixed stations receiving moderate-to-strong radio signals is likely in areas extending to 30 meters, 55 meters, and 230 meters, respectively, from one BPL device and the power lines to which it is connected. With low-to-moderate desired signal levels, interference is likely at these receivers within areas extending to 75 meters, 100 meters and 460 meters from the power lines. Assuming that co-frequency BPL devices are deployed at a density of one per km^2 within a circular area of 10 km radius, interference to aircraft reception of moderate-to-strong radio signals is likely to occur below 6 km altitude within 12 km of the center of the BPL deployment. Interference likely would occur to aircraft reception of weak-to-moderate radio signals within 40 km of the center of the BPL deployment area. However, at two of the four BPL frequencies considered with the assumed power lines, NTIA predicted smaller areas over which interference is likely.

Critical review of the assumptions underlying these analyses revealed that application of existing Part 15 compliance measurement procedures for BPL systems results in a significant underestimation of peak field strength. Underestimation of the actual peak field strength is the leading contributor to high interference risks. As applied in current practice to BPL systems, Part 15 measurement guidelines do not address unique physical and electromagnetic characteristics of BPL radiated emissions. Refining compliance measurement procedures for BPL systems will not impede implementation of BPL technology because BPL networks reportedly can be successfully implemented under existing field strength limits.[3] Accordingly, NTIA does not recommend that the FCC relax Part 15 field strength limits for BPL systems. Further based on studies to date, NTIA recommends several "access" BPL compliance measurement provisions that derive from existing Part 15 measurement guidelines. Among these are requirements to: use measurement antenna heights near the height of power lines; measure at a uniform distance of ten (10) meters from the BPL device and power lines; and measure using a calibrated rod antenna or a loop antenna in connection with appropriate factors relating magnetic and electric field strength levels at frequencies below 30 MHz.

[3] Comments of PowerWAN, Inc., BPL Inquiry, July 3, 2003 at 8-9; Comments of Amperion, Inc., BPL Inquiry, July 7, 2003 at ¶4.8; Reply Comments of PowerComm Systems, Inc., BPL Inquiry, August 20, 2003 at ¶40.

NTIA suggested several means by which BPL interference can be prevented or eliminated should it occur. Mandatory registration of certain parameters of planned and deployed BPL systems would enable radio operators to advise BPL operators of anticipated interference problems and suspected actual interference; thus, registration could substantially facilitate prevention and mitigation of interference. BPL devices should be capable of frequency agility (notching and/or retuning) and power reduction for elimination of interference. NTIA further recommends that BPL developers consider several interference prevention and mitigation measures, including: routine use of the minimum output power needed from each BPL device; avoidance of locally used radio frequencies; differential-mode signal injection oriented to minimize radiation; use of filters and terminations to extinguish BPL signals on power lines where they are not needed; and judicious choice of BPL signal frequencies to decrease radiation.