# **12. ACRONYMS**

AM	Amplitude Modulation
ANSI	American National Standards Institute
APCO	Association of Public-Safety Communications Officials
CSG	Council of State Governments
EIA	Electronics Industry Alliance
FCC	Federal Communications Commission
FM	Frequency Modulation
IRAC	Interdepartmental Radio Advisory Committee
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
IM	Intermodulation
ITS	Institute for Telecommunication Sciences
ITU	International Telecommunications Union
JAN	Joint Army-Navy
JUSTNET	Justice Technology Information Network
LMR	Land Mobile Radio
MMTA	MultiMedia Telecommunications Association
NASTD	National Association of State Telecommunications Directors
NFPA	National Fire Protection Association
NIJ	National Institute of Justice
NIST	National Institute of Standards and Technology
NLECTC	National Law Enforcement and Corrections Technology Center
NTIA	National Telecommunications and Information Administration
OLES	Office of Law Enforcement Standards
OSHA	Occupational Safety and Health Administration
PSWN	Public Safety Wireless Network
RCC	Radio Common Carrier
RF	Radio Frequency
RG	Radio Grade (very old term)
RMA	Radio Manufacturers Association

SMR	Specialized Mobile Radio
SWR	Standing Wave Ratio
TDR	Time-Domain Reflectometry
TIA	Telecommunications Industry Association
UHF	Ultra-High Frequency
USTSA	United States Telecommunications Suppliers Association
VHF	Very-High Frequency
VSWR	Voltage Standing Wave Ratio
WWW	World Wide Web

### **13. REFERENCES**

- [1] NTIA, *Manual of Regulations and Procedures for Federal Frequency Management*, U.S. Government Printing Office, Superintendent of Documents, Washington, DC.
- FCC, "Private Land Mobile Services," Title 47, Code of Federal Regulations, Part 90, Oct. 1, 1997, U.S. Government Printing Office, Superintendent of Documents, Washington, DC.
- [3] FCC, "Private Radio Services Applications and Proceedings," Title 47, Code of Federal Regulations, Part 1, Subpart F, Oct. 1, 1997, U.S. Government Printing Office, Superintendent of Documents, Washington, DC.
- [4] Telecommunications Industry Association, "Project 25, the TIA-Published 102–Series Documents," Jun. 1998, Arlington, VA.
- [5] J.C. Maxwell, "A Dynamical Theory of the Electromagnetic Field," *Proc. Royal Soc.* (London), Vol. 13, p. 531, 1864.
- [6] H. Hertz, "Uber Schnelle Electrische Schwingungen," *Wied. Ann.*, Vol. 31, p. 421, 1887.
- [7] W.L. Weeks, *Antenna Engineering*, M<sup>c</sup>Graw-Hill, 1968.
- [8] W.F. Snyder and C.L. Bragaw, "Achievement in Radio," NBS Sp. Pub. 555, Oct. 1986.
- [9] V.H. Rumsey, "Reaction Concept in Electromagnetic Theory," *Phys. Rev.*, Vol. 94, No. 6, pp. 1483–1491, Jun. 1954.
- [10] IEEE, "Standard Dictionary of Electrical and Electronics Terms," ANSI/IEEE Std. 100–1996.
- [11] IEEE, "Standard Definitions of Terms for Antennas," IEEE Std. 145–1993.
- [12] J.D. Kraus, Antennas, M<sup>c</sup>Graw-Hill, 1950, pp. 69, 81, and 83.
- [13] W.A. Kissick and J.M. Harman, *Communications Range Predictions for Mobile Radio Systems*, NIJ Rept. 201–88, Jan. 1988.
- [14] E.C. Jordan, "Acoustic Models of Radio Antennas," Ohio State Experiment Station, Bulletin 108, 1938.
- [15] Dept. of Defense, "RF Transmission Lines and Fittings," MIL-HDBK-216, Jan. 1962.

- [16] M. Hata, "Empirical Formula for Propagation Loss in Land Mobile Radio Services," *IEEE Trans. on Veh. Tech.*, Vol. VT-29, No. 3, Aug. 1980, pp. 317–325.
- [17] R.D. Jennings and S.J. Paulson, *Communication System Performance Model for VHF and Higher Frequencies*, OT Rept. 77–128, Oct. 1977.
- [18] G.A. Hufford, A.G. Longley, and W.A. Kissick, *A Guide to the Use of the ITS Irregular Terrain Model in the Area Prediction Mode*, NTIA Rept. 82–100, Apr. 1982.
- [19] Telecommunications Industry Association, "Minimum Standards for Communication Antennas, Part I Base Station Antennas," EIA/TIA-329-B, Sep. 1989.
- [20] National Institute of Justice, *Mobile Antennas*, NIJ Standard-0205.02, Oct. 1997.
- [21] National Institute of Justice, *Fixed and Base Station Antennas*, NIJ Standard-0204.02, Jun. 1998.
- [22] Telecommunications Industry Association, "Minimum Standards for Communication Antennas, Part II Vehicular Antennas," EIA/TIA-329-B-1, Sep. 1989.
- [23] National Fire Protection Association, *Lightning Protection Code*, NFPA No. 78–1983, Quincy, MA.
- [24] IEEE, "IEEE Standard Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE Std. C95.1-1991, revised 1997.

## **14. ACKNOWLEDGMENTS**

Numerous manufacturers have kindly granted permission for photographs and measured data for certain of their products to be used in this report. As stated in Footnote 1 (sec. 1), these products and data have been referenced as typical examples or to explain more clearly the technical concepts and principles being presented. In no case does such reference to these sources, their products, and their data imply recommendation or endorsement by the National Institute of Justice, or any other U.S. Government department or agency, nor does it imply that the sources, products, or data identified are necessarily the best available for the selected purpose.

Those manufacturers who have granted permission for photographs of their products or plots of their measured data to be included in this report and the World Wide Web references for the information are the following:

#### ■ <sup>©</sup>Andrew Corporation

Orlando Park, IL

► Figure 29(a)—coaxial cable commonly used for LMR base-station applications. Accessed at *http://www.andrew.com/products/basestation/heliax/lowd.asp* on 03/17/99.

#### ■ <sup>©</sup>Antenna Specialists

Cleveland, OH

► Figure 6(b)—a typical monopole antenna for mobile applications.

Accessed at http://www.decibelproducts.com/marketing/catalog/asp-701/pasp-701.html on 03/12/99.

► Figure 29(b)—coaxial cable commonly used for LMR mobile applications. Accessed at *http://allentele.com/antenna/lm\_cat/lmrpg35.html* on 03/09/99.

#### <sup>®</sup>Bluewave Antenna Systems Ltd.

Calgary, Alberta, Canada ► Figure 9 —a typical folded-dipole antenna.

Accessed at http://www.bluewave.ab.ca/bw421e.html on 03/16/99.

#### ©Decibel Products

Dallas, TX

► Figure 6(a)—a typical monopole antenna for base-station applications.

Accessed at *http://www.allentele.com/antenna/lm\_cat/lmrpg09.html* on 03/15/99.

► Figure 8—a typical monopole antenna horizontal-plane pattern, base-station application.

Accessed at *http://www.decibelproducts.com/patterns/patterns.cfm?path=patterns/ASP682\_Series* on 03/12/99.

► Figure 13—a typical corner-reflector antenna.

Accessed at http://www.decibelproducts.com/marketing/catalog/db252/pdb252.html on 03/13/99.

► Figure 14—a typical corner-reflector antenna horizontal-plane pattern.

Accessed at *http://www.decibelproducts.com/patterns/patterns.cfm?path=patterns/ASP960\_Series* on 03/09/99.

► Figure 16—a typical Yagi antenna.

Accessed at *http://www.decibelproducts.com/marketing/catalog/asp-960/pasp-962.html* on 03/12/99.
Figure 17—a typical Yagi antenna horizontal-plane pattern.

Accessed at http://www.decibelproducts.com/patterns/patterns.cfm?path=patterns/ASP816\_Series on 03/12/99.

► Figure 20—a typical log-periodic antenna horizontal-plane pattern.

Accessed at *http://www.decibelproducts.com/patterns/patterns.cfm?path=patterns/ASP2894\_Series* on 03/15/99.

► Figure 21—a typical vertical array using folded dipoles.

Accessed at *http://www.decibelproducts.com/marketing/catalog/db404/pdb404.html* on 03/12/99.

► Figure 24—a typical vertical-plane radiation pattern without "tilt." Accessed at *http://www.decibelproducts.com/patterns/patterns.cfm?path=patterns/DB420\_Series/420C* on 03/15/99.

► Figure 25—a typical vertical-plane radiation pattern with 8° "tilt." Accessed at

*http://www.decibelproducts.com/patterns/patterns.cfm?path=patterns/ASP975\_Series/ASPD975* on 03/15/99.

► Figure 30—a VHF duplexer.

Accessed at http://www.decibelproducts.com/marketing/catalog/db4060/pdb4060.html on 03/17/99.

► Figure 31(a)—a hybrid combiner.

Accessed at *http://www.decibelproducts.com/marketing/catalog/db43516/pdb4351-2.html* on 03/17/99.

► Figure 31(b)—a cavity combiner.

Accessed at http://www.decibleproducts.com/marketing/catalog/db4360/pdb4360.html on 03/17/99.

Figure 32—an intermodulation suppression device.

Accessed at http://www.decibelproducts.com/marketing/catalog/db47104/pdb4713ht.html on 03/17/99.

► Figure 33—a multicoupler.

Accessed at http://www.decibelproducts.com/marketing/catalog/db8100/pdb8100.html on 03/17/99.

#### ■ <sup>©</sup>R.N. Electronics Ltd.

Mountnessing, Essex, UK

► Figure 19—a typical log-periodic antenna.

Accessed at *http://www.rfdesign.co.uk/mlpa30121.htm* on 03/18/99.