

TABLE OF CONTENTS

VOLUME II

	TABLE OF CONTENTS	iii
	GLOSSARY	viii
APPENDIX A	RELEVANT PART 15 PROVISIONS	
A.1	Provisions Regarding Field Strength Limits	A-1
A.2	Provisions Specifying Compliance Measurements	A-2
APPENDIX B	SUMMARY OF FOREIGN TECHNICAL REPORTS	
B.1	Introduction	B-1
B.2	Implementation Reports	B-1
B.3	Measurement Reports	B-2
B.4	Modeling and Analysis Reports	B-8
APPENDIX C	CHARACTERIZATION OF FEDERAL GOVERNMENT SPECTRUM USAGE AND OPERATIONS, REPRESENTATIVE SYSTEMS AND TYPICAL PARAMETERS	
C.1	Introduction	C-1
C.2	Services And Example Systems	C-1
C.2.1	Fixed Service (1.7-29.7 MHz)	C-1
C.2.2	Fixed Service (29.7-80 MHz)	C-3
C.2.3	Mobile Service	C-4
C.2.4	Land Mobile Service	C-7
C.2.5	Maritime Mobile Service	C-8
C.2.6	Broadcasting Service	C-11
C.2.7	Aeronautical Mobile Service	C-12
C.2.8	Standard Frequency and Time Signal	C-16
C.2.9	Aeronautical Radionavigation	C-17
C.2.10	Radiolocation Service	C-18
C.2.11	Amateur and Amateur-Satellite Services	C-19
C.3	Federal Government Special Operations	C-21
C.3.1	Automatic Link Establishment (ALE) Systems	C-21
C.3.2	Sounders	C-21
C.3.3	Over the Horizon (OTH) Radars	C-22
C.4	Special Operational Considerations	C-24
C.4.1	Operational Requirements for Access to Several Frequency Assignments Within an Allocation	C-24
C.4.2	Federal Government Use of Radio Frequencies Below 30 MHz for Domestic Fixed Service	C-25
C.4.3	Summary of the Emergency Use of Federal Government HF Frequencies for the Shares Program	C-26

C.4.4	National Criteria Established Jointly by NTIA and FCC on the Use of Frequencies from Appendix 27 Allotment Plan	C-26
-------	---	------

APPENDIX D BROADBAND OVER POWER LINE EMISSION MEASUREMENTS

D.1	Introduction	D-1
D.2	The Measurement System	D-1
D.3	BPL Measurements	D-3
D.3.1	Background on BPL Emissions Measurements	D-3
D.3.2	Measurements of BPL Along the Energized Power Line	D-10
D.3.3	Measurements of BPL Away From the Energized Power Line ...	D-23
D.3.4	Measurements of BPL Using Various Detectors	D-37
D.3.5	Measurements of BPL Varying Antenna Height	D-41
D.3.6	Measurements of BPL APDs	D-47
D.4	Background on Amplitude Probability Distributions	D-50
D.5	Gain and Noise Figure Calibration Using a Noise Diode	D-59

APPENDIX E BPL MODELING OUTPUT

E.1	Introduction	E-1
E.2	Tables and NEC plots	E-1

APPENDIX F NTIA PHASE 2 STUDY BPL DEPLOYMENT MODELS

F.1	Introduction	F-1
F.2	Neighborhood Deployment Model	F-1
F.3	Antenna Coverage Area Deployment Model	F-3
F.4	Regional Deployment Model	F-4
F.4.1	Regional Deployment Model Description	F-5
F.4.2	Density and Distribution of Households	F-5
F.4.3	Density and Distribution of BPL Devices	F-6
F.4.4	Other Factors	F-6
F.4.5	Regional Model Output	F-9

VOLUME I

ACKNOWLEDGEMENTS	iii
PREFACE	iv
EXECUTIVE SUMMARY	v
TABLE OF CONTENTS	viii
GLOSSARY	xiii

SECTION 1 INTRODUCTION

1.1	Background	1-1
1.2	Objectives	1-1
1.3	Approach	1-2

1.4	Scope	1-2
SECTION 2	TECHNICAL DESCRIPTION OF BPL SYSTEMS	
2.1	Introduction	2-1
2.2	BPL System Architectures	2-2
2.2.1	BPL System #1	2-2
2.2.2	BPL System #2	2-3
2.2.3	BPL System #3	2-4
2.3	Potential Future Systems	2-5
2.4	Summary	2-7
SECTION 3	BPL RELATED STUDIES AND REGULATIONS	
3.1	Introduction	3-1
3.2	Regulations	3-1
3.2.1	Part 15 of the Commission's Rules	3-1
3.2.2	Foreign Regulations	3-2
3.3	Studies	3-6
3.3.1	Analyses of Interference from BPL Filed Under the FCC NOI ...	3-6
3.3.2	International Telecommunications Union (ITU) Activities	3-10
3.3.3	Other Technical Literature	3-12
3.4	Summary	3-12
SECTION 4	CHARACTERIZATION OF FEDERAL GOVERNMENT RADIO SYSTEMS AND SPECTRUM USAGE	
4.1	Introduction	4-1
4.2	Allocations Overview	4-2
4.3	Overview of Federal Government Spectrum Use	4-4
4.4	Summary of the Representative Federal Government Systems in the 1.7-80 MHz Band	4-6
4.5	Representative Technical Characteristics of Federal Equipment .	4-7
4.6	Sensitive or Protected Frequencies in the 1.7-80 MHz Band	4-8
4.7	Conclusion	4-13
SECTION 5	CHARACTERIZING BPL EMISSIONS THROUGH COMPUTER MODELING AND MEASUREMENTS	
5.1	Introduction	5-1
5.2	Theory	5-1
5.2.1	Relevant Radiation Theory	5-1
5.2.2	Propagation Modes	5-2
5.3	BPL Measurements	5-3
5.3.1	Approach	5-3
5.3.2	Identification and Characterization of BPL Signals	5-4
5.3.3	BPL Signal Power Along an Energized Power Line	5-4
5.3.4	BPL Signal Power Away from the Energized Power Line	5-5
5.3.5	Measurement of BPL Using Various Detectors	5-5

5.3.6	Measurement of BPL Using Different Antenna Heights	5-6
5.3.7	Measurements of BPL Amplitude Probability Distributions (APDs)	5-6
5.4	Analytical Models of Power Line Radiation	5-7
5.4.1	Numerical Electromagnetics Code (NEC)	5-7
5.4.2	Modeling of Power Lines by NEC	5-8
5.4.3	Effects of a Neutral Line	5-10
5.4.4	Environmental Noise	5-11
5.5	Conclusion	5-15
SECTION 6	ANALYSIS OF INTERFERENCE POTENTIAL TO VARIOUS SERVICES	
6.1	Introduction	6-1
6.2	Methodology	6-1
6.3	Risk Evaluation Criteria	6-2
6.3.1	Interfering Signal Thresholds	6-2
6.3.2	Noise Calculations	6-5
6.4	Interference Models	6-5
6.4.1	Receiving Systems	6-5
6.4.2	Power Line Model	6-7
6.5	Interference Calculations	6-7
6.5.1	Scaling Output Power to Meet FCC Part 15 Limits	6-7
6.5.2	Analysis Methodology for Land-mobile, Fixed and Maritime Services	6-8
6.5.3	Analysis Methodology for Aeronautical Service	6-9
6.6	Results of Interference Calculations	6-11
6.6.1	Land – Mobile Service	6-11
6.6.2	Fixed Service	6-15
6.6.3	Maritime Service	6-15
6.6.4	Aeronautical Service	6-20
6.7	Conclusion	6-23
SECTION 7	BPL COMPLIANCE MEASUREMENT PROCEDURES	
7.1	Introduction	7-1
7.2	Measurements Must Address Radiation from Power Lines to Which BPL Devices are Connected	7-2
7.3	Measurements Should Address Aggregated Emissions for the Fully Deployed BPL Network	7-2
7.4	Measurement Antenna Heights Should Address All Important Directions of BPL Signal Radiation	7-3
7.5	A Single Measurement Distance Should Be Used For Overhead Power Lines and BPL Devices	7-4
7.6	A Modified Distance Extrapolation Factor is Needed for BPL ...	7-5
7.7	BPL Frequency Agility and Power Line Frequency Selective Effects Must Be Addressed in the Measurement Procedures	7-5
7.8	Near Field Measurement Errors Must be Mitigated	7-5

7.9	Appropriate Choice of Power Lines Used for BPL Measurements Will Reduce Statistical Sampling Uncertainties ...	7-6
7.10	BPL Device Output Power Should Be Reduced as Needed for Compliance with Radiated Emission Limits	7-7
7.11	The Results of Radiated Emission Measurements Should Be Properly Recorded in Measurement Reports and Applied in BPL Operations	7-7
7.12	Conclusion	7-8
SECTION 8	INTERFERENCE PREVENTION AND MITIGATION TECHNIQUES	
8.1	Introduction	8-1
8.2	Power Level	8-1
8.3	Avoidance of Locally Used Frequencies	8-1
8.4	Differential-mode Signal Injection	8-2
8.5	Filters and Signal Terminations	8-3
8.6	Implementation of a “one active device per area” rule	8-3
8.7	Judicious Signal Carrier Choice	8-4
8.8	Maintenance of a Single Point of Control	8-4
8.9	Web-based Access to Radio License Information	8-4
8.10	BPL Installation and Equipment Registration	8-5
8.11	Conclusion	8-5
SECTION 9	SUMMARY OF RESULTS	
9.1	Introduction	9-1
9.2	Preliminary Investigations	9-1
9.2.1	Description of BPL Systems	9-1
9.2.2	Studies and Relevant Regulations	9-1
9.2.3	Federal Government Radio Systems and Spectrum Usage	9-2
9.2.4	Characterization of BPL Emissions	9-2
9.3	Phase 1 Analyses	9-4
9.3.1	Evaluation of Potential Interference Risks	9-4
9.3.2	Risk Reduction Through Compliance Measurement Procedures ..	9-6
9.3.3	Techniques for Prevention and Mitigation of Interference	9-7
9.4	Topics for Further Study	9-9