Industry Canada Industrie Canada

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Spectrum Management and Telecommunications

Consultation Paper on Broadband over Power Line (BPL) Communication Systems

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Canada

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1. Intent

As announced in Gazette Notice SMSE-005-05, Industry Canada is releasing this consultation paper to seek public and industry views on systems that deliver high-speed Internet and broadband services over power lines. These systems are often referred to as Broadband over Power Line (BPL) communication systems.

BPL communication systems function by coupling radio frequency (RF) energy to existing electrical power lines. These systems can be used to deliver high-speed voice and data communications to customers, or improve the management of the power distribution grid by facilitating monitoring and automated meter reading activities. Since power lines reach virtually every household in Canada, BPL could bring broadband services to rural and urban areas and improve competition where similar services are already provided by other technologies, such as digital subscriber line (DSL), cable modem and wireless access.

The intent of this consultation paper is to seek comment on the deployment and regulation of BPL systems in general, including the specific equipment standards and operational requirements that would be required if BPL systems were deployed. Moreover, the Department intends to take steps to facilitate the deployment of BPL technology in Canada while ensuring the protection of authorized radiocommunication services.

Gazette Notice SMSE-005-05 invites interested parties to submit their comments by November 28, 2005 to the Director General, Spectrum Engineering Branch.

2. Background

Historically, power utilities have used alternating current (AC) power line distribution facilities to carry information by coupling radio frequency (RF) energy to AC electrical wiring in houses or buildings. In the past, these devices have operated on frequencies below 2 MHz with limited communications capabilities.[1] Due to power line characteristics it has been difficult to achieve dependable high-speed communications. However, technological advancements have resulted in the development of new systems[2] which have overcome these technical obstacles. Trials have demonstrated that high-speed communication voice and data services can be achieved using the existing medium-voltage (MV) and low-voltage (LV) power distribution grid.

BPL technology has evolved rapidly over the past two years. While the technology appears promising, there are a number of issues with respect to its operation as well as the possibility of it interfering into radio services in the 2-80 MHz range.

The Department has received numerous enquiries from power companies, manufacturers and other organizations regarding BPL technology. We are working with the industry to understand the compatibility of BPL technologies and applications with other radio services. There have been a limited

[1] The original power line communication (PLC) systems operated on 135 kHz and were used for internal communications by power utilities. These systems were not capable of high-speed voice or data transmission.

[2] These new systems use spread spectrum or multiple carrier techniques with built-in algorithms to circumvent the noise in the power line. For example, orthogonal frequency division multiplexing (OFDM) is used to distribute the BPL signal over a wide bandwidth using many narrowband sub-carriers.

number of BPL trials in Canada where the Department has performed preliminary analyses on BPL emissions.

Since power lines reach virtually every home in Canada, BPL may provide an additional option to delivering broadband services to rural and urban areas. Furthermore, the introduction of BPL fits within the Government of Canada's Federal Broadband project, which was developed to narrow the "digital divide" between Canadians living in urban, rural and remote communities.

Since BPL systems can transmit and receive intelligence by wire, they may be considered as transmission facilities under the *Telecommunications Act*. Therefore, BPL operators may ultimately be subject to the regulatory requirements of the Act and to the oversight of the Canadian Radio-television and Telecommunications Commission (CRTC).

In considering BPL under the *Radiocommunication Act*, the Department can give regard to the policies outlined in section 7 of the *Telecommunications Act*, which includes:

(a) to facilitate the orderly development throughout Canada of a telecommunications system that serves to safeguard, enrich and strengthen the social and economic fabric of Canada and its regions;

(f) to foster increased reliance on market forces for the provision of telecommunications services and to ensure that regulation, where required, is efficient and effective; and,

(g) to stimulate research and development in Canada in the field of telecommunications and to encourage innovation in the provision of telecommunications services.

The United States (U.S.) Federal Communications Commission (FCC) has carried out a consultation to implement BPL and recently established technical and operational rules for BPL systems.[3] Considering the similarities between the U.S. and Canadian power distribution grids BPL manufacturers will view Canada and the U.S. as a common marketplace.

The Department is seeking comments on the technical and operational criteria which will facilitate the deployment of BPL systems in Canada with minimal impact on radiocommunication services.

3. General Description of BPL Systems

BPL systems are comprised of different components which function together to deliver broadband services to customers. Briefly, data is carried by fibre optic or telephone lines to avoid high-voltage (HV - greater than 69 kV) transmission power lines. The data is injected onto the MV power distribution grid and special electronic devices, known as repeaters, re-amplify and re-package the signal because the signal loses strength as it travels along the MV power line. Other technologies are used to detour the signal around transformers. The signal is delivered directly into homes via their regular electric current.

[3] FCC. *In the Matter of Amendment of Part 15 regarding new requirements and measurement guidelines for Access Broadband over Power Line Systems (ET Docket No. 04-37) and Carrier Current Systems, including Broadband over Power Line Systems (ET Docket No. 03-104)*. Report and Order. October 2004.

3.1 The Power Distribution Grid

The power distribution grid is made up of a number of components aimed at delivering electricity to customers, and includes overhead and underground MV and LV power lines and associated transformers. MV power lines carry electricity in the range of 12.5-36 kV and the voltage is decreased by step-down transformers to provide LV power to houses and buildings. In general, the LV power lines carry electricity at 120/240 volts or 347/600 volts.

3.2 BPL Systems

Historically, power utilities have coupled RF energy to AC electrical wiring in houses or buildings to carry information. Although simple communication was possible, these systems were not capable of delivering dependable broadband services. Recent technological advancements have resulted in the development of new systems that promise to deliver broadband services over the existing power distribution grid. These systems are comprised of Access BPL, In-house BPL, or a combination of both technologies.

3.2.1 Access BPL

Access BPL systems utilize the power distribution network, owned, operated and controlled by an electricity service provider, as the means of broadband delivery to and from premises such as the home or office. Access BPL systems use injectors, repeaters, and extractors to deliver high-speed broadband services to the end-user.

Injectors provide the interface between the Internet backbone and the MV power lines. Once the signal has been injected onto the MV power line, it is extracted to deliver the information to the end-user. Extractors provide the interface between the MV power lines which carry the signals to the customers in the service area. Extractors are generally installed at LV distribution transformers that service groups of homes. Since the BPL signal loses strength as it passes through the LV transformer, extractors are required to retransmit the signal. In other cases, couplers on the MV and LV lines are used to bypass the LV transformers and relay the signal to the end-user. At least one company has designed a third type of extractor which transmits a wireless signal directly from the MV power line to end-users.

To transmit signals over long distances, repeaters are employed to overcome losses resulting from physical characteristics of the power line.

At this time, the Department is proposing to adopt the following definition[4] for Access BPL systems:

Access Broadband over Power Line (Access BPL): A carrier current system installed and operated on an electric utility service as an unintentional radiator that sends radio frequency energy on frequencies between 1.705 MHz and 80 MHz over medium-voltage lines or over low-voltage lines to provide broadband communications and is located on the supply side of the utility service's points of interconnection with customer premises.

[4] This definition is used in the FCC BPL rules.

The Department seeks comment on the above definition and its suitability for describing Access BPL.

3.2.2 Multiple Formats of Access BPL

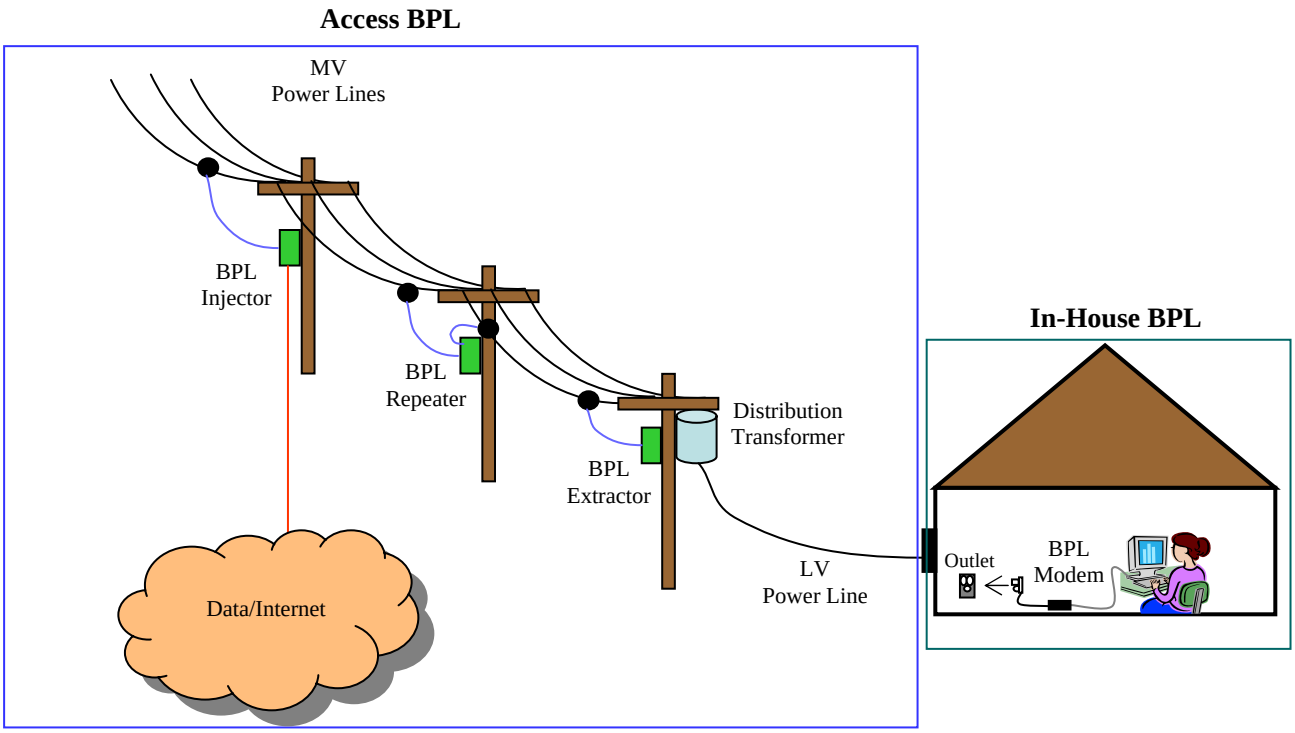
The Department is aware of various implementation/deployment architectures of Access BPL systems. However, the Department believes that Access BPL systems can be generally classified as either: (1) an end-to-end system, or (2) a hybrid system.

3.2.3 End-to-End Access BPL

End-to-end Access BPL systems use either a combination of MV and LV power lines or LV power lines only. These systems represent the classical architectures for Access BPL. In this case the BPL signal is injected onto and carried by the MV power line. The BPL signal is then transferred to the LV power line via couplers or through the LV transformer and delivered directly to the end-user.

In the case of LV only BPL systems, the BPL signal is injected onto the LV power line at the transformer or the utility meter.

Figure 1: Overview of End-to-End Access BPL System[5]



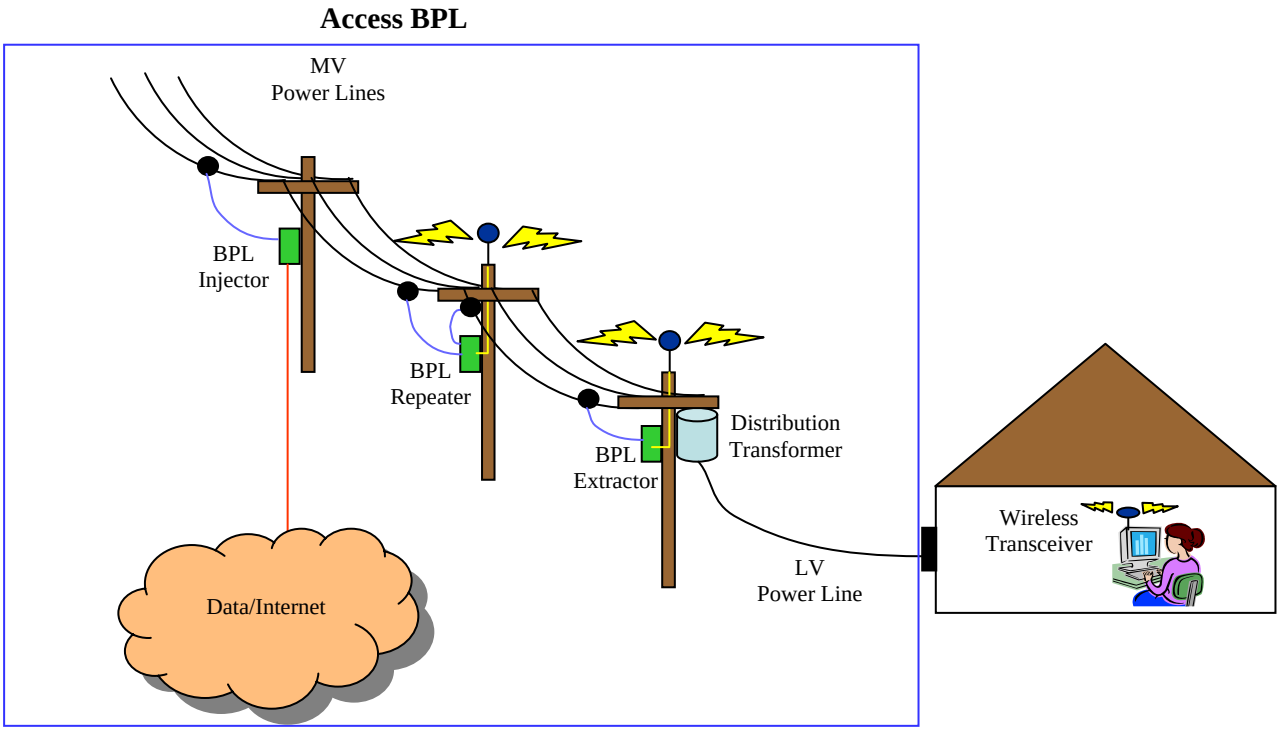
[5] The diagram is based on the National Telecommunications and Information Administration's (NTIA) Report 04-413: *Potential Interference from Broadband over Power Line (BPL) Systems to Federal Government Radiocommunications at 1.7-80 MHz Phase 1 Study*.

3.2.4 Hybrid Access BPL

Hybrid systems use a combination of power lines and wireless transmission. For example, a hybrid system may inject a BPL signal onto an MV power line and use a special extractor to translate the signal into a wireless channel which is delivered to the end-user.

More recently, a second hybrid system has been developed. These systems capture wireless signals and inject them directly onto the LV power line. The signal is distributed using the LV power line and in-house wiring to the end-user.

Figure 2: Overview of Hybrid Access BPL System[5]



As shown in Figure 2, the hybrid Access BPL system uses repeaters and extractors which are capable of transmitting and receiving wireless signals to and from end-users.

3.3 In-house BPL

In-house BPL systems utilize electric power lines not owned, operated or controlled by an electricity service provider, such as the electric wiring in a privately owned building. Broadband devices are connected to the in-building wiring and use electrical sockets as access points (see Figure 1).

In-house BPL technologies are largely designed to provide short-distance communication solutions which compete with other in-home interconnection technologies. Product applications include networking and sharing common resources such as printers.

In Canada, In-house BPL equipment is regulated under Interference Causing Equipment Standard 006, *AC Wire Carrier Current Devices (Unintentional Radiators)* (ICES-006).[6] Since there are established regulations for In-house BPL systems in Canada, the intention of this consultation paper is not to address these systems.

Although the main focus of this consultation is to address Access BPL systems, after reviewing the FCC's final rules in the context of the Canadian regulatory environment, the Department believes that separate definitions are required to differentiate between the two forms of BPL to prevent confusion. ICES-006 will be modified accordingly to reflect the adopted definitions for in-house systems.

At this time, the Department is proposing to adopt the following definition[7] for In-house BPL systems:

In-house broadband over power line (In-house BPL): A carrier current system, operating as an unintentional radiator, which sends radio frequency energy by conduction over electric power lines that are not owned, operated or controlled by an electric service provider. The electric power lines may be aerial (overhead), underground, or inside the walls, floors or ceilings of user premises. In-house BPL devices may establish closed networks within a user's premises or provide connections to Access BPL networks, or both.

The Department seeks comment on the above definition and its suitability for describing In-house BPL.

4. Benefits and Deployment Issues of Access BPL

4.1 Benefits

Access BPL systems have the potential to offer a number of benefits including: (1) increasing the availability of broadband services to homes and businesses; (2) improving the competitiveness of the broadband services market; and, (3) improving the quality and reliability of electric power delivery.

With regard to increasing broadband services to Canadian homes and businesses, Access BPL systems can potentially provide high-speed data access and other broadband services to areas that do not currently have access to these services. Furthermore, Access BPL systems could potentially improve the competition for broadband services in Canada by providing another option for high-speed Internet access.

Access BPL systems have also been identified as a means of improving the quality and reliability of electric power delivery and creating a more intelligent power grid. BPL technology could allow utilities to more effectively manage power, perform automated metering and monitor the existing power grid for potential failures.[8]

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[6] ICES-006 can be found on the Spectrum Management and Telecommunications Web site at: http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf02134e.html.

[7] This definition is used in the FCC BPL rules.

[8] National Association of Regulatory Utility Commissioners (NARUC). *Report of the Broadband Over Power Lines Task Force*. February 2005.

4.2 Deployment Issues

International and Canadian activities have established that the deployment of Access BPL systems could potentially impact the current radiocommunication environment by creating interference to existing services. Moreover, some authorized radiocommunication service users have expressed concern about the potential interference to their respective services from Access BPL systems.
In Canada, there are a number of authorized radio services in the 2-80 MHz frequency range. These services include amateur radio, fixed mobile, maritime mobile, aeronautical mobile, fixed broadcasting, space research, radio astronomy and aeronautical radio navigation. They are used by public safety organizations, Federal government agencies, aeronautical navigation licensees, amateur radio operators, international broadcasting stations, and General Radio Service (i.e. citizens band or CB radio) operators (see *Canadian Table of Frequency Allocations*[9]).

Access BPL systems are designed to send information within parts of the 2-80 MHz frequency range along unshielded power lines, which results in the unintended emission of RF energy. This unintentional radiation can create interference to the radiocommunication services mentioned above.

The Department continues to assess Access BPL systems to understand the technology and the interference mechanisms.

5. Current Status of BPL

5.1 International Activities

A number of foreign governments including Australia, Austria, China, Finland, Hong Kong, Hungary, Ireland, Italy, Korea, Japan, Netherlands, Poland, and Switzerland are currently studying BPL technology or have permitted equipment trials. The outcomes have shown mixed results and have led some administrations to ban BPL systems while other administrations have allowed deployment under various conditions. A number of administrations have suspended BPL trials pending international developments.

5.2 United States Activities

The Department has closely followed the FCC's proceedings from the release of the Notice of Inquiry[10] to the final Report and Order[11], which established technical and operational rules for Access BPL systems. During the FCC's proceedings, many individuals and organizations expressed and documented concerns about the potential of Access BPL systems interfering with radiocommunication services.

In October 2004, the FCC published their final rules with regard to the deployment of Access BPL systems. The FCC's final rules outlined a number of technical and operational requirements for Access

[9] http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/h_sf01678e.html

[10] FCC. *In the Matter of Inquiry Regarding Carrier Current Systems, including Broadband over Power Line Systems (ET Docket No. 03-104).* Notice of Inquiry. April 2003.

[11] FCC. *In the Matter of Amendment of Part 15 regarding new requirements and measurement guidelines for Access Broadband over Power Line Systems (ET Docket No. 04-37) and Carrier Current Systems, including Broadband over Power Line Systems (ET Docket No. 03-104).* Report and Order. October 2004.

BPL systems and included: definitions of BPL systems; the frequency range of operation; emission limits; excluded frequency bands; exclusion zones and consultation areas; interference mitigation requirements; and equipment authorization procedures.

5.3 Industry Canada Activities

The Department is closely monitoring international activities relating to Access BPL systems and the potential interference to radiocommunication services. In particular, Industry Canada is monitoring the activities of: the International Telecommunication Union (ITU)[12]; the International Special Committee on Radio Interference (CISPR)[13]; the European Conference of Postal and Telecommunications Administrations (CEPT)[14]; the Institute of Electronics and Electronic Engineers (IEEE)[15]; the FCC; the U.S. National Telecommunications and Information Administration (NTIA)[16]; foreign regulators; the amateur radio relay league (ARRL) and other organizations.

In addition to monitoring international BPL developments and the results of engineering studies, Industry Canada has undertaken preliminary assessments of Access BPL technology in cooperation with utilities currently performing Access BPL trials. These assessments were performed to supplement the Department's current understanding of the technology; to understand the potential for interference; to characterize emissions generated by Access BPL systems; and, to develop a measurement method to characterize the emissions. Furthermore, the Communications Research Centre (CRC) has performed preliminary computational modeling studies for the Department.

6.0 Discussion and Proposals

Although there are currently no specific standards in Canada to address the deployment of Access BPL systems, the current regulatory environment provides mechanisms to address interference complaints. In particular, the *Radiocommunication Act* provides the authority for the Minister to take steps to resolve cases of interference to authorized services.[17]

To address the needs of all stakeholders, the Department intends to develop technical standards and establish operational requirements in accordance with its powers under the *Radiocommunication Act.* The Department is of the opinion that this approach will allow Access BPL systems to operate in the

[12] ITU-T Recommendation K.60 *Emission limits and test methods for telecommunication networks*. Document1A/20, E Document 1C/20-E 28. October 2003

[13] International Electrotechnical Commission (IEC). *EMC of Information technology, multimedia equipment and receivers*. Committee Draft - CISPR/I/89/CD. November 2003.

[14] Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT). ECC REPORT 24. *PLT, DSL, Cable Communications (including Cable TV), LANs and their effect on Radio Services*. Cavtat, May 2003.

[15] In July 2004, the IEEE created working group P1675: *Standard for Broadband over Power Line Hardware*.

[16] NTIA. *Potential Interference from Broadband over Power Line (BPL) Systems To Federal Government Radiocommunications at 1.7 - 80 MHz Phase 1 Study*. Report 04-413.

[17] The Minister has the authority to take steps ordering operators to cease or modify the operation of the equipment and to prohibit the manufacture, sale and use of such equipment.

current radiocommunication environment while minimizing the potential for interference to authorized radiocommunication services.

The following sections outline the Department's proposals with regard to regulating Access BPL. This consultation process represents the first step in developing specific requirements and standards for this technology. This process will allow the Department to identify pertinent issues and develop a regulatory framework. The next step will involve a consultation with stakeholders[18] to discuss and develop specific technical standards including a measurement procedure.

The following sections invite comment on specific standards and requirements for Access BPL systems. The Department also seeks comment on any other specific issue or concern relating to the Department's role in the deployment and regulation of BPL systems in general.

6.1 Equipment Standard and Approval Process

The Department is considering the development of a new Interference Causing Equipment Standard (ICES) for Access BPL equipment. With regard to demonstrating compliance with the technical standards, the Department has a number of options ranging from Declaration of Compliance to Certification.

Industry Canada believes that the potential for interference to existing radiocommunication services warrants an approach that will ensure equipment compliance with the technical standard. Therefore, the Department is proposing that the certification process be used for Access BPL equipment. The certification process will include the submission of a test report that will demonstrate compliance with the standards in the appropriate ICES.

The Department seeks comment on the proposed certification process and what, if any, alternative approaches could be used to authorize BPL equipment and systems.

Please provide rationale.

6.2 Prospective Technical Requirements

The Department is cognizant of the similarities between the U.S. and Canadian power distribution environments. Therefore, Industry Canada believes that technical harmonization with the U.S. is an important step towards facilitating the deployment of BPL technologies. As a starting point, the Department seeks comment on emission limits and is proposing that BPL equipment must conform to the standards outlined below.

[18] This process generally involves the Radio Advisory Board of Canada.

In addition, components of Hybrid Access BPL that send and receive wireless signals will be required to comply with the applicable established standard[19].

(a) **Emission Limits**

The International Special Committee on Radio Interference (CISPR) develops electromagnetic compatibility standards for electronic equipment. In particular, the CISPR 22 standard establishes limits and measurements techniques for radiated and conducted emissions from information technology equipment. The content of CISPR 22 is currently being revised to address BPL systems. Although this work was to be completed by August 2003, discussions on the potential interference to authorized radiocommunication services have slowed progress.

Several administrations and organizations have proposed or established rules for BPL deployments. A number of proposals have been presented on a regional basis for consideration to regulate emissions from cable and BPL equipment to minimize the potential for interference to authorized services. Since BPL manufacturers will view Canada and the U.S. as a similar marketplace, the Department is proposing technical harmonization with the U.S. In particular,

Access BPL systems operating below 30 MHz will be subject to following limits:

Frequency (MHz)	Field strength (microvolts/metre)	Measurement Distance (metres)
1.705-30.0	30	30

Access BPL systems operating above 30 MHz will be subject to the following limits:

Frequency (MHz)	Field strength (microvolts/metre)	Measurement Distance (metres)
30-80	90	10

The Department seeks comment on the above limits and their suitability for Access BPL systems in Canada.

Please provide technical rationale.

(b) **Interference Mitigation Requirements for Access BPL Systems**

In addition to establishing appropriate emission limits, the Department is proposing that Access BPL equipment/systems incorporate adaptive interference mitigation techniques to minimize the potential for interference to radiocommunication users. These include:

[19] For example, a hybrid system that transmits signals using licence-exempt spectrum (e.g. 2.4 GHz) would be required to comply with Radio Standards Specification 210, *Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)* (RSS-210).

- remote controllable shut-down features;
- remote power reduction; and,
- notch filtering and/or frequency avoidance.

The Department seeks comment on whether:

(1) Access BPL equipment should incorporate adaptive interference mitigation techniques as described above; and,

(2) additional or alternative interference mitigation techniques, if any, should be used to minimize the potential for interference to authorized services.

Please provide rationale.

The Department has proposed a number of technical requirements to address the use of Access BPL equipment and to minimize the potential for interference to authorized services from deployed Access BPL systems.

The Department seeks comment on any additional technical requirements for Access BPL systems.

Please provide supporting technical rationale.

6.3 Operational Requirements

In addition to equipment standards, the Department is of the opinion that operational requirements should be established for deployed Access BPL systems to minimize the potential for interference to specific radiocommunication users. The proposed operational requirements are outlined below.

(a) **Prohibited Frequency Bands**

The Department is proposing to prohibit Access BPL systems from operating in specific frequency bands including bands used for aeronautical services, public safety and national defence. The Department believes that this approach is necessary to ensure the protection of safety-related services.

The Department seeks comment on:

(1) the suitability of the above approach to protect safety-related services;

(2) what other approaches, if any, should be taken to protect safety-related radiocommunications; and

(3) what bands, if any, should be excluded from use by Access BPL systems.

Please provide rationale.

(b) **Geographical Frequency Restrictions and Coordination Requirements**

The Department believes that there could be specific geographic areas where Access BPL systems should not be deployed and that coordination with specific authorized users may be necessary.

The Department seeks comment on:

(1) What specific geographic locations, if any, should Access BPL systems be prohibited from operating?
(2) As opposed to total ban, should Access BPL systems be able to operate in these locations if specific frequencies were avoided?
(3) What procedure, if any, should be used to facilitate coordination between BPL operators and specific authorized users?

Please provide rationale.

(c) **Interference Resolution**

The Department is considering requirements for BPL operators to address potential interference complaints. In particular, individuals and organizations with complaints would be asked to directly contact Access BPL operators to investigate and resolve problems. If a problem could not be resolved satisfactorily or in a timely manner, the Department would address the problem as an interference complaint under the *Radiocommunication Act*.

The Department seeks comments on:

(1) its proposal that individuals and organizations refer problems to BPL operators to investigate and resolve matters on a timely basis; and
(2) what other approaches could be taken to ensure the resolution of interference complaints?

Please provide rationale.

Industry Canada believes that establishing a publicly accessible database would assist in the timely resolution of interference complaints. Therefore, the Department is of the opinion that a database of BPL installations should be developed and maintained.

The Department seeks comment on the establishment of a publicly accessible database and its potential to ensure the timely resolution of interference complaints. In particular:

(1) What specific information should be included in the database?
(2) How could the information be accessed and who should have access to the database?
(3) Who should develop, maintain and manage the database?

Please provide rationale.

7. Next Steps

Based on the comments in response to this notice, the Department will develop appropriate policies, standards, and/or operational requirements to facilitate the introduction and use of BPL technology in Canada.

In developing the appropriate regulatory measures, including technical standards, the Department will consider the status of BPL applications in the market, standardization developments within the industry, as well as other regional and international regulatory and technical developments.

Issued under the authority
of the Radiocommunication Act

June 10, 2005

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R.W. McCaughern
Director General
Spectrum Engineering Branch