CANADIAN STANDARDS ASSOCIATION
(INCORPORATED 1919)

CANADIAN ELECTRICAL CODE
PART IV

RADIO

C22.4 NO. 103—1948

TOLERABLE LIMITS AND SPECIAL METHODS OF MEASUREMENT OF RADIO INTERFERENCE FROM HIGH VOLTAGE LINES AND APPARATUS

CSA STANDARD
1948

PUBLISHED—OTTAWA, DECEMBER, 1948
FIRST REPRINT - JUNE, 1954

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CONTENTS

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PREFACE

The problem of setting tolerable limits of radio interference from high voltage lines and apparatus is being dealt with by Sub-panel 9 of Panel No. 5, of the Canadian Electrical Code Part IV (Radio), as a matter of co-ordination of certain features of two public services, i.e.,

(1) The transmission and distribution of power, and

(2) Radio communication.

Consideration is given to the practicability of the limits specified both from the standpoint of technical practice, and, also, of economic feasibility.

This Code specifies tolerable limits of radio interferences from the system operating under normal dry weather conditions. The intensity of the interference is usually greater when insulators are dry. Moisture on the insulators provides a conducting surface producing an effect similar to that provided by the manufacturer on silent type insulators.

The tolerable limits specified are intended to provide a degree of protection to radio reception corresponding to that provided by other sections of Part IV (Radio) of the Canadian Electrical Code, and required by Federal legislation.

The Appendices dealing with apparatus, which have been included, are not mandatory, but merely state good engineering practice, which will tend to prevent excessive radio interference.

It is generally considered more satisfactory and economical to provide tolerable limits for the system as a whole, than to set such limits on the apparatus. In this way the operating company is free to apply remedial measures to the part of the system where they would be most effective.

It is recognized that these recommendations represent the voluntary contribution of power and distribution companies towards a solution of a problem which has arisen through the development of radio services.

This Code will be revised and extended from time to time as data are collected. Comments or data bearing on this subject will be welcomed and correspondence on this matter should be sent in duplicate to:

The General Manager, Canadian Standards Association,
National Research Building,
Sussex Street, Ottawa, Ontario.

and will be recorded and brought to the attention of the committee in charge of drafting this Code.

This Code was formally approved, by letter ballot, by Panel 5, CE Code Part IV in January, 1945; by the Committee on CE Code Part IV in August, 1945, and by the CSA Main Committee, with authority to publish it as a CSA Standard, in August, 1946.

Ottawa, December, 1948.

Note: *Publication of this Code was held up pending recent developments towards international unification of procedures and practices relative to the subject and it is now considered practical for the CSA to publish the Code for the purpose of obtaining field experience in the application of its details.*

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SECTION I

SCOPE

Rule 101

GENERAL

General

(a) This Code applies to radio interference arising from high-voltage lines and apparatus associated therewith.

(b) This Code applies to lines of which the construction was commenced subsequent to the effective date of the Code.

NOTE 1. *This Code does not apply to cases where interference originates on existing lines, and is conducted along new lines of approved construction.*

NOTE 2. *Existing lines which exceed the tolerable limits should be altered so as to reduce the interference as far as is technically and economically feasible.*

(c) The tolerable limits herein specified are based on the operation of the system as a whole.

Rule 102

VOLTAGE

Voltage

(a) This Code applies to lines and apparatus operating on voltages from 750 to 70,000 volts.

Rule 103

RADIO FREQUENCY

Radio Frequency

(a) The tolerable limits specified herein apply to any frequency within the standard broadcast band—i.e., from 540 to 1,600 kilocycles per second.

Rule 104

MEASUREMENT

Measurement

(a) The special method of measuring **interference field intensity** which is to be used when measuring interference

from power lines is outlined in Section 3. This method of measurement is described in detail in C22.4 No. 101—"Interference Measuring Instruments and Methods of Measurement".

Rule 105

OPERATING CONDITIONS

Operating Conditions

(a) This Code is intended to apply to the operation of the system under normal, dry weather conditions.

NOTE: *Abnormal conditions over which the operating companies have no control, and which temporarily may cause excessive interference, are not covered by this Code.*

However, during abnormal operating conditions due to sleet storms, accidental damage, repair or extension work, etc., it is recommended that individual consideration be given to reduction of the interference as far as is technically and economically feasible.

Rule 106

DEFINITIONS

Definitions

(a) The following definitions refer to terms printed in bold-faced type in the body of the Code.

The **interference field intensity** is the electric field intensity produced by the interference as measured on a standard interference measuring instrument, having an antenna of known effective height located at a point prescribed in the section of the Canadian Electrical Code Part IV for the particular type of apparatus, line or system concerned.

Unit—Microvolts per metre.

For the purpose of this Code, **Residence** is defined as a building equipped for radio reception and located within two hundred feet of a line under investigation from which it does not directly receive its power or, a building similarly equipped, receiving its power supply directly from the line under investigation.

Rule 107

APPENDICES

Appendices

(a) The Appendices deal with some fundamental considerations regarding the design of apparatus operated at high voltages, which will tend to prevent excessive interference.

SECTION 2

GENERAL REQUIREMENTS

Rule 201

GENERAL

General

(a) For general information regarding requirements of the Canadian Electrical Code Part IV, see C22.4 No. 100—

"General Requirements, Definitions and Procedure Relative to the Control of Radio Interference".

Rule 202

MEASUREMENT

Measurement

(a) For details of measuring equipment and technique, see C22.4 No. 101—"Interference Measuring Instruments and Methods of Measurement".

SECTION 3

METHOD OF MEASUREMENT

Rule 301

GENERAL CASE

General Case

(a) The standard interference measuring instrument shall be located on or near the ground immediately below the power line, at a position where the power line is thirty-five (35) feet from the ground, and the test antenna shall be not more than four (4) feet in height and at a location as free as possible from conductors which might increase or decrease the **interference field intensity.**

Rule 302

SPECIAL CASES

Special Cases

(a) In cases where the line is not thirty-five feet above the ground, or the test antenna is more than four feet in height a correction factor shall be applied according to the following table:

CORRECTION FOR HEIGHT OF LINE

Height of Line	Add to db. Reading		Multiply Microvolts per Metre by	
	4′ Ant.	7′ Ant.	4′ Ant.	7′ Ant.
50 ft.	+4	+3	1.6	1.4
45 ft.	+3	+2	1.4	1.25
40 ft.	+2	+1	1.25	1.1
35 ft.	0	−1	1.0	0.9
30 ft.	−2	−3	0.8	0.7
25 ft.	−4	−5	0.63	0.55
20 ft.	−6	−7	0.5	0.45

NOTE: *This table is based on experimental data obtained by the Department of Transport.*

Rule 303

FREQUENCY

Frequency

(a) It is recognized that the interference varies with frequency but for the present it is considered to be sufficient to make these measurements at 1,000 kilocycles per second,

APPENDIX "B"

MEASUREMENT AND SUGGESTED TOLERABLE LIMITS OF RADIO INTERFERENCE FROM HIGH VOLTAGE APPARATUS AND INSULATORS

Apparatus (including insulators) for use on high voltage transmission systems may be design tested at the factory to assure that when placed in service on a line the interference due to the apparatus will be well below the tolerable limit for the system.

Tolerable limits suggested for this test are shown in the table below:

Normal Voltage Rating in KV Line to Line	Radio Interference Influence Units at 10% Above Usual Line to Ground Voltage at 1000 Kcs. per Second
3 to 15	50
15 to 37	100
37 to 120	200
120 to 300	500

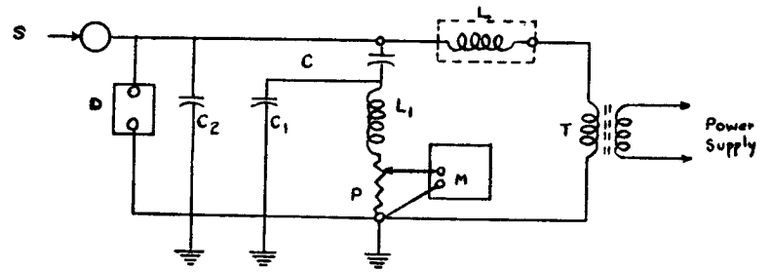
The standard interference measuring instrument should be used for making these noise measurements, and it should be coupled to the device under test by a suitable coupling circuit which blocks out the 60 cycle potential and permits the radio frequency potential from the apparatus under test to be applied to the terminals of the standard interference measuring instrument.

Such a coupling circuit is shown on the following page.

It is recommended that the term "radio interference influence units" be used to designate the radio noise-voltage determined with the standard interference measuring instrument coupled to the device under test by the circuit described.

NOTE: *The foregoing defines in a very general way the method of measuring interference from high voltage insulators and apparatus. The circuit diagram shown below is from the EEI-NEMA-RMA publication "Methods of Measuring Radio Noise—1940" identified as NEMA publication 107. This publication considers the measurement of radio disturbances in more detail than outlined above, and shows both the ordinary circuit and the compensated circuit. In the United States all radio interference specifications include the reference to NEMA publication 107 (or its other designations—EEI Publication G-9 or RMA Engineering Bulletin No. 32) and no attempt is made to duplicate the material therein contained.*

CIRCUIT FOR THE MEASUREMENT OF RADIO INTERFERENCE INFLUENCE UNITS OF HIGH VOLTAGE DEVICES



T —Testing Transformer.
L —RF Choke, not less than 20,000 ohms at radio frequency at which measurement is made.
M —Standard Interference Measuring Instrument.
C —Coupling Capacitor, not less than 0.0025 mfd.
D —Device under test.
P —Potentiometer, or tapped resistor 600 ohms resistance, non-reactive.
L_1 —Inductance between Capacitor and Potentiometer, 10 microhenries, approximate.
C_1 —Stray capacitance on Potentiometer side—not over 50 micro-microfarads.
C_2 —Stray capacitance on bus side—not over 60 micro-microfarads.
S —Sphere for prevention of corona—Note: Corona must be avoided by shielding or other means.

The constants of the above circuit should be maintained as nearly as possible to assure the duplication of results in other testing laboratories.

ADDITIONAL INFORMATION

Further recommendations on the methods of measuring and the tolerable limits of radio interference from various types of high voltage apparatus may be found in the following publications of the National Electrical Manufacturers Association:

Publication No. 37–42—Current and Potential Transformers;
" 38–53—Switchgear;
" 42–72—Switchgear;
" 42–73 (8th Edition) Distribution and Power Transformers;
" 42–83—Insulators;
" 44–89—Lightning Arresters.

APPENDIX "C"

APPARATUS DESIGN

NOTE: *The following is based on extracts from fourth draft (November 1932) "Principles and Practices for the Prevention or Reduction of Radio Interference" prepared by the Sub-panel on Inductive Co-ordination of C.E. Code, Part III.*

PRACTICES APPLICABLE TO THE DESIGN, CONSTRUCTION AND INSTALLATION OF APPARATUS

INSULATING MATERIAL

Insulating material should have a sufficiently high resistance under all normal conditions to prevent leakage of current, which might produce excessive potential gradients.

DESIGN OF APPARATUS:

1—Contacts:

All electrical connections should be so designed as to ensure that they do not become loose during the operating life of the apparatus. Where the elasticity of the material is depended upon to ensure good electrical connection, the contacts should be so designed and constructed that the elasticity is not destroyed by mechanical strain, heat or other causes during the normal life of the apparatus. This has reference particularly to the spring contacts of transformer cutouts, disconnecting switches, etc.

2—Prevention of Corrosion:

Reasonably non-corrosive material should be used for joints, contacts and other electrical connections whether between conductors or between non-current carrying metal parts.

Special care is required in the design, construction and installation of bimetallic contacts in order to avoid corrosion. This refers to such connections as copper to aluminum line wires, copper ground wires from iron transformer cases, etc.

3—Hardware—Non-current carrying metal parts

Metal parts of apparatus within the electrostatic field should, wherever possible, be either thoroughly bonded to the live conductor, or to a ground conductor.

Where it is necessary to provide metal parts not so bonded, they should be insulated from all other metal parts whether

(a) Live,
(b) Grounded, or
(c) of floating potential,

in order that no electrostatic spark can occur which may cause radio interference.

Apparatus (except lightning arresters) should be subjected to an over-voltage test of ten (10) per cent above normal-rated voltage applied from line to all grounded parts, and no cascading nor static sparks which cause interference should occur during such a test.

Lightning arresters should be subjected to a similar over-voltage test, but below the voltage at which the arrester is designed to break down.

As the potential gradient between unbonded metal parts may vary due to the proximity of exterior conductors, either live or ungrounded, the set-up for the test should correspond to the most severe potential gradient likely to occur in practice.

APPENDIX "D"

LINE CONSTRUCTION PRACTICES APPLICABLE TO POWER AND DISTRIBUTING SYSTEMS

General

It is found, in practice, that electrostatic discharges in the form of corona may cause radio interference.

All high voltage conductors and associated apparatus in the electrostatic field should be designed, constructed and maintained, so as to avoid, as far as economically feasible, excessive potential gradient which would be sufficient to cause an electrostatic discharge under the highest voltage at which the system is intended to operate normally, and under ordinary dry weather conditions.

Potential gradient depends on potential difference, length of dielectric gap, discontinuities in dielectric properties, and form of the conducting surface.

Loose contacts carrying current are a source of radio inductive interference, and particular care should be taken to avoid their occurrence.

Clearances

High voltage conductors should be installed with sufficient clearances between conductors and grounded or ungrounded metal, so that no spark discharge will occur under normal operating conditions. Drop leads to pole type apparatus should be supported, wherever necessary, and care exercised to prevent conductors coming in contact with transformer cases, pole line hardware and guys.

Conductors

Sharp projections on conductors should be removed where practicable.

Tie-wires on lines over 7,500 volts between wires should be so installed that good contact is maintained with the conductor. The ends of such tie-wires should preferably be left in close contact with the conductor, and, in any case, as remote as practicable from the insulator.

Where it is necessary to have conductors of small diameter (such as fuses) or sharp points (such as clamping screws) on high voltage lines, these small conductors or sharp points should be electrostatically shielded so that the potential gradient will not be sufficient to break down the air or dielectric and cause radio inductive interference. The shield in this case should be thoroughly bonded to the conductor.

The size of the conductor itself should be considered where extra high voltage is involved.

Hardware—Non-current-carrying Metal Parts

In order to prevent minute sparks which cause radio inductive interference, non-current carrying metal parts should be thoroughly insulated from electrical conductors, and should be either well-bonded to each other, or well insulated from each other.

Prevention of Corrosion

Reasonably non-corrosive material should be used for joints, contacts and other electrical connections whether between conductors or between non-current carrying metal parts.

Special care should be taken in the design, construction and installation of bimetallic contacts in order to avoid corrosion. This refers to such connections as copper to aluminum wires, copper ground wires from transformer cases, etc.

Thorough bonding of conductors and non-current-carrying metal parts is particularly important in districts where there are two or more radio transmitters or industrial radio-frequency generators. Poor bonding (particularly where there is corrosion at the bond) may cause rectification of radio-frequency currents which produces a type of radio interference known as external cross-modulation.

Insulation

Insulators and insulating material should be designed, constructed and maintained according to good engineering practice. They should be as nearly free from areas of high electrostatic stress as is economically feasible.

Primary Cutouts, Disconnecting Switches and Lightning Arresters

In all new construction primary cutouts, disconnecting switches and lightning arresters should be of a type which will not cause radio interference (inductive) during their normal life.

Types of primary cutouts, disconnecting switches and lightning arresters which are known to be potential sources of radio interference should be repaired or replaced.