



CAN/CSA-C22.3 No. 8-M91

(Reaffirmed 2003)

Railway Electrification Guidelines

Please Note:

**Δ Refers to a formally approved
revision dated January 1992**

**ΔΔ Refers to a formally approved
revision dated August 1993**

Copyright © Canadian Standards Association(1) — 1991
All rights reserved. No part of this publication may be
reproduced in any form, in an electronic retrieval system
or otherwise, without the prior permission of the
publisher.

Contents

Standards Steering Committee on CE Code, Part III

Technical Committee on Railway Electrification

Preface

1. Scope

2. Definitions and Reference Publications

- 2.1 General Definitions
- 2.2 Communications Definitions
- 2.3 Reference Publications

3. Insulation Coordination and Electrical Clearances

- 3.1 General
- 3.2 Voltage Classification
- 3.3 Overvoltages
- 3.4 Criteria for Electrical Clearances and Insulation Levels
- 3.5 Electrical Clearances
 - 3.5.1 General
 - 3.5.2 Static Clearance
 - 3.5.3 Dynamic Clearance
 - 3.5.4 Reductions
 - 3.5.5 Special Clearances
- 3.6 Electrical Requirements of OCS Insulators
 - 3.6.3 Additional Requirements
- 3.7 Electrical Insulation Characteristics of High voltage Switchgear and Transformers for Use with OCS Power Systems

4. Vertical and Lateral Clearances

- 4.1 General
- 4.2 Components of Design Clearances
 - 4.2.1 Load Clearance Limit (Ys)
 - 4.2.2 Dynamic Load Clearance Limit (Yd)
 - 4.2.3 Static Electrical Clearance (Cs)
 - 4.2.4 Dynamic Electrical Clearance (Cd)
 - 4.2.5 OCS Uplift (L)
 - 4.2.6 Pantograph Movements (Lt and S)
 - 4.2.7 OCS Sag (G)
 - 4.2.8 Live Vertical Distance of OCS Construction (D)
 - 4.2.9 Tolerances and Allowances (T, Ts, C, F1, and F2)
- 4.3 Physical Clearances
- 4.4 Determination of Total Clearance Requirements
- 4.5 OCS Equipment
 - 4.5.1 Phase Breaks
 - 4.5.2 Static Insulators
- 4.6 Parallel OCS Circuits

5. Overhead Contact Systems (OCS)

- 5.1 General
- 5.2 OCS Configurations
- 5.3 Variable and Constant Tension Systems
- 5.4 Pre-sag
- 5.5 Pantographs
- 5.6 Stagger
- 5.7 Gradient
- 5.8 Physical Clearance
- 5.9 Wire
- 5.10 System Depth (Encumbrance) and Droppers
- 5.11 Cantilevers
- 5.12 Poles
- 5.13 Foundations

- 5.14 Multiple Track Installations
- 5.15 Guying
- 5.16 Anchors
- 5.17 Weight Tensioning Assembly
- 5.18 Sectioning
- 5.19 Mechanical Design
- 5.19.2 Design Loadings
- 5.20 Phase Breaks and Section Breaks
- 5.21 Disconnects
- 5.22 Electrification Layouts

6. Interference with Communications Systems

- 6.1 General
- 6.2 Sources of Interference
- 6.3 Magnetic Induction
- 6.4 Electric Induction
- 6.5 Ground Potential Rise
- 6.6 Shielding
- 6.7 Susceptiveness
- 6.8 Interference Limits
 - 6.8.1 Longitudinal Voltage
 - 6.8.2 Circuit Noise and Balance
 - 6.8.3 Electromagnetic Noise (EMI)
- 6.9 Prevention and Mitigation of Interference
 - 6.9.1 General
 - 6.9.2 Route Separation
 - 6.9.3 Choice of Facility
 - 6.9.4 Ground Current and Shielding
 - 6.9.5 Harmonics
 - 6.9.6 Voltage to Ground
 - 6.9.7 Metallic Voltage
 - 6.9.8 Ground Potential Rise

7. Interference with and Protection of Railway Signalling and Communications Systems

- 7.1 General
- 7.2 Signalling and Communications Systems
- 7.3 Railway Signal Systems
- 7.4 Track Circuits
- 7.5 Signal Control Circuits
- 7.6 Automatic Grade Crossing Warning System
- 7.7 Impedance Bonds
- 7.8 Signal Supply Circuits
- 7.9 OCS Configuration

8. Grounding, Bonding and Fault Clearing

- 8.1 General
 - 8.1.1 Operational Grounding
 - 8.1.2 Safety Grounding
 - 8.1.3 Classification of Grounding Requirements
 - 8.1.4 Grounding in Territory with Signal Track Circuits
 - 8.1.5 Relevant Standards
- 8.2 Grounding of the Components of the OCS
 - 8.2.1 OCS Poles and Support Structures
 - 8.2.2 OCS Circuit Breakers, Disconnect Switches, and Fuses
 - 8.2.3 OCS Surge Arresters
 - 8.2.4 Detection and Clearing of Faults
 - 8.2.5 Traction Feeder Stations and Switching Stations
 - 8.2.6 Stub End Tracks
- 8.3 Other Railway Equipment and Installations within the Right-of-Way
 - 8.3.1 Stands, Switch Mechanisms, and De-rails
 - 8.3.2 Station Buildings, Platforms, Yards, and Maintenance Shops
 - 8.3.3 Grade Crossings and Pedestrian Crossings
 - 8.3.4 Bridges
 - 8.3.5 Tunnels

8.4 Grounding of Structures, Buildings, and Fences Adjacent to Electrified Rail Tracks

8.4.1 Danger Zones

8.4.2 Grounding in Zone 1

8.4.3 Grounding in Zone 2

8.4.4 Grounding in Zone 3

8.5 Pipelines and Fuel Tanks

8.5.1 Pipelines

8.5.2 Above Ground Fuel Tanks

9. Electric Utility Interface Unbalance and Harmonics

9.1 General

9.2 Load Curves

9.3 In-Rush Currents

9.4 Negative Sequence Voltages

9.5 Harmonics

9.5.1 Harmonic Generation

9.5.2 Effect of Harmonics on the Power System

9.5.3 Mathematical Definition of the DF and I-T Product

9.5.4 Tentative Limits to Harmonic Distortion

9.5.5 Harmonic Suppression by Use of Filters

Appendix A Bibliography

Standards Steering Committee on CE Code, Part III

S.W. Guzik

Bell Canada,
Toronto, Ontario
Chairman

M. Leclerc

Hydro-Québec,
Montréal
Vice-Chairman

J.K.A. Bourassa

Transport Canada,
Ottawa, Ontario

R.T. Bradley

Unitel Communications,
Toronto, Ontario

L. Citulec

British Columbia Telephone Company,
Burnaby

J. Coblentz

British Columbia Hydro and Power Authority,
Vancouver

K.L. Edwards

Windsor Utilities Commission,
Windsor, Ontario

G.A. Fraser

New Brunswick Telephone Company,
Fredericton

W. Hassan

Municipal Electric Association,
Toronto, Ontario

R. Lapp

Edmonton Telephones,
Edmonton, Alberta

R.J. Poirier

National Energy Board,
Ottawa, Ontario

B.T. Power

CP Rail,
Montreal, Quebec

D.M. Singleton

Macleam Hunter Cable TV,
Sarnia, Ontario

K.C. Tikkanen

Transport Canada,
Ottawa, Ontario

T.E. Tymofichuk

Manitoba Hydro,
Winnipeg

C.R. White

Alberta Department of Labour,
Edmonton

J.C.H. Davis

Canadian Standards Association,
Rexdale, Ontario
Standards Administrator, Nonvoting

Technical Committee on Railway Electrification

G.T. Fisher

CPCS Ltd.,
Montreal, Quebec
Co-Chairman

N.E. Rudback

Transport Canada,
Montreal, Quebec
Co-Chairman

G.R. Blair

CN Rail,
Montreal, Quebec

M. Bouchard

Hydro-Québec,
Montréal

P. Detmold

Railway Advisory Board,
Montreal, Quebec

J. Duncan

Ontario Ministry of Transport and Communications,
Downsview

K.H. Englehardt

BC Hydro,
Vancouver

G.W. English

Queen's University,
Kingston, Ontario

P.A. Fournier

Transport Québec,
Québec

G.B. Furst

GB Furst Consultants Inc.,
Montreal, Quebec

S. Labrosse

VIA Rail,
Montreal, Quebec

P.J. Lambeth

Hydro-Québec,
Varenne

W.F. McGarry

Energy, Mines and Resources Canada,
Ottawa, Ontario

I.A. Nattress

Transport Canada,
Winnipeg, Manitoba

J. Popoff

B.C. Rail Ltd.,
Vancouver

A.H. Powell

GO Transit,
Downsview, Ontario
Associate

S.L. Tait

CPCS Ltd.,
Montreal, Quebec
Associate

S.K. Vasdev

Unitel Communications,
Toronto, Ontario

C.A. Versailles

Transport Canada,
Montreal, Quebec

D.H. Walkington

CP Rail,
Montreal, Quebec

J.C.H. Davis

Canadian Standards Association,
Rexdale, Ontario
Standards Administrator, Nonvoting

Preface

This is the second edition of No. 8 in a Series of Standards issued under Part III of the Canadian Electrical Code. It supersedes the first edition, published as a Preliminary Standard in 1986.

Development of these guidelines was initiated by Transport Canada's Transportation Development Center and by the Railway Association of Canada in anticipation of the need to electrify long distance rail lines.

This Standard contains guidelines on the power supply and overhead distribution system as well as on grounding and interference with communications and signalling systems. It is recognized that this edition does not cover all aspects and that some of the quantitative values included must be taken as preliminary, being still under consideration nationally and internationally. The Committee believed that making the guidelines available with these deficiencies was preferable to waiting for resolution of the outstanding issues. The Committee continues to encourage comment and further work towards resolution of the guidelines.

Appendix A is not a mandatory part of the guidelines, but provides a bibliography of papers that were referred to by the Committee.

This Standard was prepared by the Technical Committee on Railway Electrification Guidelines under the jurisdiction of the Standards Steering Committee on the CE Code, Part III, and was formally approved by these Committees. It has been approved as a National Standard of Canada by the Standards Council of Canada.

July 1991

Notes:

- (1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
- (2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
- (3) *CSA Standards are subject to periodic review, and suggestions for their improvement will be referred to the appropriate committee.*
- (4) *All enquiries regarding this Standard, including requests for interpretation, should be addressed to Canadian Standards Association, Standards Division, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3.*

Requests for interpretation should

(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;

(b) provide an explanation of circumstances surrounding the actual field condition; and

(c) be phrased where possible to permit a specific "yes" or "no" answer.

Interpretations are published in CSA Information Update. For subscription details and a free sample copy, write to CSA Sales Promotions or telephone (416) 747-4116.