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NEW ZEALAND ELECTRICAL CODE OF PRACTICE

for

HARMONIC LEVELS

Issued by the Office of
The Chief Electrical Inspector,
Energy and Resources Division, Ministry of Commerce

THE ELECTRICITY ACT 1992

APPROVAL OF ELECTRICAL CODE OF PRACTICE

FOR

HARMONIC LEVELS

Pursuant to Section 36 of the Electricity Act 1992 ("the Act")

On the 1st day of February 1993, the Secretary of Commerce issued the Electrical Code of Practice for Harmonic Levels ("the Code")

On the 4th day of February 1993, pursuant to Section 38 of the Act the Secretary published in the Gazette a notice of intention to apply to me for approval of the code, and there has been consultations with such persons (or their representatives) as will be affected by the Code and they have had the opportunity to consider possible effects and comment on those effects.

I have considered the comments concerning those effects and where necessary amendments were made to the Code.

Therefore Pursuant to Section 38 of the Act, I, John Luxton, Minister of Energy, have this day approved the Code as attached to this approval, which Code shall come into force on the 1st day of April 1993.

Dated this 18th day of March 1993.

John Luxton
Minister of Energy.

COMMITTEE REPRESENTATION

This Code of Practice was prepared by the Ministry of Commerce, Chief Electrical Inspector's Office.

ACKNOWLEDGEMENT

The source material for this Code was derived from the Limitation of Harmonic Levels Notice 1981.

REVIEW

This Code of Practice will be revised as occasions arise. Suggestions for improvement of this Code are welcome. They should be sent to the Chief Electrical Inspector's Office, Ministry of Commerce, P O Box 1473, WELLINGTON.

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INTRODUCTION

This Code is based on the Limitation of Harmonic Levels Notice 1981, issued by the Office of the Chief Electrical Inspector, Ministry of Commerce.

This Code sets acceptable levels of harmonic voltages and currents which may be introduced into an electricity supply system by a consumer’s installation.

SECTION 1

SCOPE, INTERPRETATIONS AND NUMBERING

1.1 SCOPE

1.1.1 This Code sets acceptable levels of harmonic voltages and currents which may be introduced into an electricity supply system by a consumer's installation.

1.1.2 This Code shall not apply to signals introduced by any Electricity Distributor for the purpose of load control.

1.1.3 The levels specified in section 3 shall not apply to the works of any Electricity Distributor.

1.2 INTERPRETATIONS

In this Code, unless the context otherwise requires:

1.2.1 Current - means root mean square current.

1.2.2 Harmonic - means a sinusoidal component of an alternating current or voltage, with a frequency which is an integral multiple of the actual system frequency.

1.2.3 Harmonic order(n) - means the number of times the harmonic frequency is an integral multiple of the actual system frequency.

1.2.4 Point of common coupling - means that busbar electrically closest to any consumer through which any current must flow to that consumer and one or more other consumers

1.2.5 Voltage - means root mean square voltage.

1.3 NUMBERING SYSTEM OF THIS CODE

1.3.1 Sections are numbered 1 to 4.

1.3.2 Subsections are numbered by one full stop between two numbers. (eg 1.4)

1.3.3 Clauses are numbered by two full stops between three numbers. (eg 1.1.1)

1.3.4 Subclauses are numbered by three full stops between four numbers. (eg 2.1.1.1)

SECTION 2

2.1 ACCEPTABLE LEVELS OF HARMONIC VOLTAGE

2.1.1 The phase-to-earth harmonic voltage at any point of common coupling with a nominal system voltage of less than 66 kV shall not exceed 4 percent for any odd numbered harmonic order, or 2 percent for any even numbered harmonic order, where these percentages are a percentage of the nominal phase-to-earth system voltage.

2.1.1.1 Any measurement of harmonic voltages to ascertain if they are within the levels set out in clause 2.1.1 shall be made under the conditions and in the manner set out in section 4 of this Code.

2.1.2 The total harmonic voltage distortion at any point of common coupling with a nominal system voltage of less than 66 kV shall not exceed 5 percent. The total harmonic voltage distortion (U_1) shall be calculated according to the following formula:

$$U_1 = \sqrt{\sum_{n=2}^{50} U_n^2}$$

where U_n is the measured phase-to-earth harmonic voltage of harmonic order n expressed as a percentage of the nominal phase-to-earth system voltage.

2.1.2.1 All harmonic voltages referred to in the formula set out in clause 2.1.2 shall be measured within a 30 minute period under the conditions and in the manner set out in section 4 of this Code.

2.1.3 The harmonic voltage corresponding to any of the odd numbered harmonic orders listed in the Table 1 of this Code shall not exceed at any point of common coupling at a nominal system voltage of 66 kV or above, the levels specified in the said Table 1 for that harmonic order.

TABLE 1

Harmonic Order (n)	*Voltage Levels (Phase-to-earth harmonic voltage expressed as a percentage of the nominal phase-to-earth system voltage)*
3	2.3
5	1.4
7	1.0
9	0.8
11	0.7
13	0.6
15	0.5
17 to 21	0.4
23 to 49	0.3

2.1.3.1 The harmonic voltage corresponding to any of the even numbered harmonic orders listed in the table 2 of this Code shall not exceed at any point of common coupling at a nominal system voltage of 66 kV or above, the levels specified in the said table 2 for that harmonic order.

TABLE 2

Harmonic Order (n)	*Voltage Levels (Phase-to-earth harmonic voltage expressed as a percentage of the nominal phase-to-earth system voltage)*
2	1.2
4	0.6
6	0.4
8 and 10	0.3
12 to 50	0.2

2.1.3.2 Any measurement of harmonic voltages to ascertain if they are within the levels set out in clause 2.1.3 and subclause 2.1.3.1 shall be made under the conditions and in the manner set out in section 4 of this Code.

2.1.4 The equivalent disturbing voltage shall not exceed 1 percent on any phase at any point of common coupling with a nominal system voltage of 66 kV or above, calculated in accordance with subclause 2.1.4.1.

2.1.4.1 The equivalent disturbing voltage (EDV) shall be calculated according to the following formula:

$$EDV = 6.25X10^{-5} \sqrt{\sum_{n=2}^{50} (nP_nU_n)^2}$$

Where P_n is the weighting given to frequency 50n in the psophometric weighting table.

U_n is the measured phase-to-earth harmonic voltage of harmonic order n expressed as a percentage of the nominal phase-to-earth system voltage.

The psophometric weighting table referred to is that which is labelled table 1 and set out in paragraph 1.3.1 of chapter XV of the International Telegraph and Telephone Consultative Committee (CCITT) Directives concerning the protection of communication lines against harmful effects from electricity lines and is reproduced in Appendix 1 to this Code.

2.1.4.2 All harmonic voltages referred to in the formula set out in clause 2.1.4.1 shall be measured within a 30 minute period under conditions and in the manner set out in section 4 of this Code.

SECTION 3

3.1 ACCEPTABLE LEVELS OF HARMONIC CURRENT

3.1.1 The harmonic current, flowing between any consumer's electrical installation and that consumers's point of common coupling, which corresponds to any of the odd numbered harmonic orders listed in the table 3 of this Code shall not exceed the levels specified in the said table 3 for that harmonic order.

TABLE 3

Harmonic Order	*Harmonic Current Levels (amperes at nominal system voltage)*		
	220 kV	110 kV	66 kV
3	5.7	2.9	1.7
5	3.4	1.7	1.1
7	2.5	1.3	0.8
9	1.9	1.0	0.6
11	1.6	0.8	0.5
13	1.4	0.7	0.4
15	1.2	0.6	0.4
17	1.0	0.5	0.3
19 and 21	0.9	0.5	0.3
23	0.8	0.4	0.3
25 to 49	0.7	0.4	0.3

3.1.1.1 The harmonic current, flowing between a consumer's electrical installation and that consumer's point of common coupling, which corresponds to any of the even numbered harmonic orders listed in the table 4 of this Code, shall not exceed the levels specified in the said table 4 for that harmonic order.

TABLE 4

Harmonic Order	*Harmonic Current Levels (amperes at nominal system voltage)*		
	220 kV	110 kV	66 kV
2	2.9	1.5	0.9
4	1.5	0.8	0.5
6	1.0	0.5	0.3
8	0.8	0.4	0.3
10	0.6	0.3	0.2
12 and 14	0.5	0.3	0.2
16 and 18	0.4	0.2	0.2
20 to 50	0.3	0.2	0.2

3.1.1.2 Any measurement of harmonic currents to ascertain if they are within the levels set out in clause 3.1.1 and subclause 3.1.1.1 shall be made under the conditions and in the manner set out in section 4 of this Code.

3.1.2 The equivalent disturbing current for any of the nominal system voltages listed in table 5 of this Code, shall not at any point of common coupling exceed the value set out in the said table 5 for that nominal system voltage.

TABLE 5

Nominal System Voltage	*Equivalent Disturbing Current (EDI)*
66 kV	0.8 amperes
110 kV	1.3 amperes
220 kV	2.6 amperes

3.1.2.1 The equivalent disturbing current (EDI) shall be calculated according to the following formula:

$$EDI = 6.25X10^{-5} \sqrt{\sum_{n=2}^{50} (nP_n I_n)^2}$$

Where P_n is the weighting of frequency 50n in the psophometric weighting table.

I_n is the measured harmonic current of harmonic order n expressed in amperes.

The psophometric weighting table referred to is that which is labelled table 1 and set out in paragraph 1.3.1 of chapter XV of the International Telegraph and Telephone Consultative Committee (CCITT) Directives concerning the protection of telecommunication lines against harmful effects from electricity lines, and is reproduced in Appendix 1 to this Code.

3.1.2.2 All the harmonic currents referred to in the formula set out in subclause 3.1.2.1 shall be measured within a 30 minute period under conditions and in the manner set out in section 4 of this Code.

SECTION 4

4.1 MEASUREMENTS

4.1.1 Harmonic current and voltage measurements shall be made when the system frequency is within 0.5 percent above or below the standard of 50 Hz.

4.1.2 The measurements shall be made using a system, including transducers, which complies with the following requirements:

- The error in measuring a constant harmonic voltage shall not exceed 0.1 percent of the nominal phase-to-earth system voltage;

- The error in measuring a constant harmonic current shall not exceed 0.2 amperes;

- The selectivity of the measuring system shall be such that a signal with 50 Hz separation from that being measured shall have a minimum attenuation of 40 dB;

- The measuring system shall either have a measurement time constant between 0.08 seconds and 0.12 seconds inclusive or shall average the input over 4, 5 or 6 cycles of the actual system frequency; and

- When a constant harmonic signal in the range 100 Hz to 2500 Hz is applied to the measuring system, the maximum indication by overshoot shall not exceed the steady state indication by more than 5 percent.

SECTION 5

5.1 HARMONIC ALLOWANCES

5.1.1 The acceptable levels of harmonic voltage levels shall be divided among different consumers at a point of common coupling in proportion to their maximum demand.

5.1.1.1 A *harmonic allowance multiplier* (H_c) is defined for each consumer at a point of common coupling as:

$$H_c = S_c/S$$

Where S_c is the maximum kVA demand for that consumer.

S is the supply capacity at the point of common coupling in kVA.

5.1.1.2 Where there are several consumers on a feeder or ring main all consumers may be treated as being on the one point of common coupling and "S" of the formula specified in subclause 5.1.1.1 is the supply capacity to the aggregate.

5.1.2 The *harmonic allowance multiplier* (H_c) sets the proportion of the acceptable harmonic level at a point of common coupling which is allocated to a consumer by virtue of that consumer’s demand. A consumer may or may not utilise this harmonic allowance.

APPENDIX A

PSOPHOMETRIC WEIGHTING TABLE

(refer to subclauses 2.1.4.1 and 3.1.2.1)

Frequency (Hz)	Weighting Factor P_r	Frequency (Hz)	Weighting Factor P_r
100	8.91	1350	928
150	35.5	1400	905
200	89.1	1450	881
250	178	1500	861
300	295	1550	842
350	376	1600	824
400	484	1650	807
450	582	1700	791
500	661	1750	775
550	733	1800	760
600	794	1850	745
650	851	1900	732
700	902	1950	720
750	955	2000	708
800	1000	2050	698
850	1035	2100	689
900	1072	2150	679
950	1109	2200	670
1000	1122	2250	661
1050	1109	2300	652
1100	1072	2350	643
1150	1035	2400	634
1200	1000	2450	625
1250	977	2500	617
1300	955		