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	Engineering and Design ELECTRONIC BALLASTS FOR FLUORESCENT LIGHTING FIXTURES	
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DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
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Engineer Technical
Letter 1110-3-441

20 August 1992

Engineering and Design
ELECTRONIC BALLASTS FOR FLUORESCENT LIGHTING FIXTURES

1. Purpose. This letter establishes interim guidance and criteria for use of electronic ballasts for fluorescent lighting fixtures.

2. Applicability. This letter applies to HQUSACE, major subordinate commands, districts, laboratories, and field operating activities (FOA) having military design and construction responsibility.

3. Discussion.

a. There is no single area of current technology which has a greater opportunity for energy savings than the lighting discipline. Within that field electronic ballasts for fluorescent lighting fixtures are the most significant development. These ballasts have been evolving and improving over the last decade and have now reached a point of generally accepted reliability. Unfortunately, the establishment of industry standards for electronic ballasts has trailed the growing interest and demand for their implementation. This interest has been heightened by the availability in some geographical areas of utility rebates for use of energy saving technology, including electronic ballasts. The unavailability of industry standards has made it necessary to implement this interim guidance and criteria.

b. Electronic ballasts are available for both dimmed and undimmed fluorescent lighting. This letter addresses only the undimmed variety. Electronic dimming ballasts hold great promise for more precision and wider range of control than other types of dimming ballasts, as well as the advantages of lower control voltages. In very limited trial usage observed by CECER, however, there have been extreme interference problems between one line of these ballasts and building video systems.

4. Action to be Taken.

a. Pending update and publication of permanent media guidance, the criteria contained in Appendices A and B shall be incorporated in all interior lighting designs. This revised criteria impacts CEGS 16415, Electrical Work, Interior and Standard Detail Number 40-06-04, Lighting Fixtures. The use of Appendix A is to be terminated upon the availability of Change Notice 2 to CEGS 16415 (Dec 91 edition). The use of Appendix B

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is to be terminated upon the availability of Change 2 to Standard Detail No. 40-06-04 (Feb 91 edition).

b. It is not mandatory that electronic ballasts be used or permitted on each project, only that their utilization be evaluated by the designers. The following points should be considered.

(1) Electronic ballasts are the most efficient available. They eliminate flicker. They are quiet. As many as four lamps may be operated from a single ballast.

(2) Utility rebates may be available for the use of electronic ballasts. If so, it is important to be aware of the criteria for the rebate. Some utilities stipulate a harmonic distortion limit of 20% for rebate eligibility. There may be other requirements.

(3) Electronic ballasts promise longer life and greater long term reliability, however, they do have a greater infant mortality than magnetic ballasts. These failures are almost exclusively within the early portion of the warranty period.

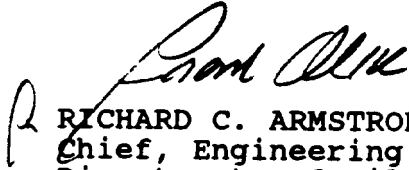
(4) The commitment of the User is important in properly maintaining an electronic ballasted lighting system. It is critical to the efficiency of the system that ballasts and lamps are properly matched. The User will be required to stock additional types of lamps and ballasts for system maintenance and to take care to properly replace lamps and ballasts to sustain the energy savings.

(5) Electronic ballasts normally generate more harmonics than magnetic ballasts. This can add to the non-linear loads in a building and introduce noise/interference related problems to some sensitive electronic systems. This area should be closely coordinated with the User.

5. Implementation. This letter will have routine implementation as defined in paragraph 6c, ER 1110-345-100.

FOR THE DIRECTOR OF MILITARY PROGRAMS:

2 Encls


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APPENDIX A

CHANGES TO CEGS 16415

1. Paragraph 1.2: Add the following references in the appropriate sections.

- a. \-FCC Part 18-\ (Oct 1991) Rules and Regulations: Industrial, Scientific and Medical Equipment
- b. \-IEEE C62.41-\ (1991) IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits

2. Paragraph 2.1.16.3.a: Revise this paragraph to read as follows.

"a. Fixture: \-NEMA LE 4-\ for ceiling compatibility of recessed fixtures and \-UL 1570-\ . Plainly mark all fixtures for proper lamp and ballast type to include lamp diameter, wattage, color and start type. Markings shall be readily visible to service personnel, but not visible from normal viewing angles."

3. Paragraph 2.1.16.3.b: Delete this paragraph in its entirety and replace with the following.

"b. Ballasts

(1) Magnetic Ballast, Energy-Saving, High Power Factor, Class P, Automatic-Resetting Type, approved for the application by the Certified Ballast Manufacturers: \-ANSI C82.1-\ and \-UL 935-\ . Two-lamp ballasts shall be used for each pair of lamps within a fixture or within continuous mounted fixtures. Single-lamp ballasts shall be used for individually mounted single-lamp fixtures and where an odd single-lamp fixture occurs at the end of a continuous group. Magnetic fluorescent lamp ballasts shall have a Ballast Efficacy Factor (BEF) not less than shown in the following table:

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MAGNETIC FLUORESCENT BALLAST EFFICACY FACTORS*
Design starting temperature above 40 degrees F, with 60 Hz input frequency

NUMBER OF LAMPS	LAMP TYPE	NOMINAL OPERATIONAL INPUT VOLTAGE	MAX. LAMP OPERATING TEMPERATURE	MIN. BALLAST EFFICACY FACTOR
1	4 ft rapid start	120 or 277	less than 1000 m amp	1.805
2	4 ft rapid start	120	less than 1000 m amp	1.060
2	4 ft rapid start	277	less than 1000 m amp	1.050
2	8 ft slim-line	120 - 277	less than 1000 m amp	0.570
2	8 ft high output, rapid start	120 - 277	less than 1000 m amp	0.390

* For ballasts not specifically designed for use with dimming controls

The BEF is calculated using the formula:

BEF = Ballast Factor (in percent) I Power Input
where Power Input = Total Wattage of Combined Lamps and Ballasts

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(2) Electronic Ballast. Electronic ballasts shall consist of a rectifier, high frequency inverter, and power control and regulation circuitry. The ballasts shall be UL listed, Class P, with a Class A sound rating and shall contain no PCBs. Ballasts shall meet FCC Rules and Regulations, Part 18 for electromagnetic interference and shall not interfere with the operation of other electrical equipment. Design shall withstand line transients per IEEE C62.41, Category A. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture, using one, two, three or four lamp ballasts. A single ballast may be used to serve multiple fixtures if they are continuous mounted, factory manufactured for that installation with an integral wireway and are identically controlled.

- (a) Light output regulation shall be $\pm 10\%$.
- (b) Voltage input regulation shall be $\pm 10\%$.
- (c) Lamp current crest factor shall be no more than

1.7.

(d) Ballast factor shall be not less than 85 % nor more than 100 %, unless otherwise indicated.

(e) A 60 Hz filter shall be provided. Flicker shall be no more than 15 % with any lamp suitable for the ballast.

(f) Ballast case temperature shall not exceed 25 degree celsius rise above 40 degree celsius ambient, when tested in accordance with UL 935.

(g) Input current third harmonic shall not exceed 32 percent total harmonic distortion or 27.5 percent of the third triplens.

(h) Power factor shall not be less than 0.9.

(i) Ballasts shall operate at a frequency of 20 KHZ or more.

(j) Operating filament voltage shall be 2.5 to 4.5 volts.

(k) Warranty. Three year full warranty including a \$10 labor allowance.

(l) Ballast Efficacy Factor (BEF) shall be in accordance with the following table. Ballasts and lamps shall be matching rapid start or instant start as indicated on the following table. If 32W-F32-T8 lamps and ballasts are used, they must be either all rapid start or all instant start.

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ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS*

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL INPUT VOLTAGE	NUMBER OF LAMPS	MIN. BALLAST EFFICACY FACTOR
40W F40 T12	rapid start	120 or 277 V	1	2.3
			2	1.2
			3	0.8
			4	0.6
34W F40 T12	rapid start	120 or 277 V	1	2.6
			2	1.3
			3	1.0
			4	0.7
40W F40 T10	rapid start	120 or 277 V	1	2.2
			2	1.1
			3	0.8
32W F32 T8	rapid or instant start	120 or 277 V	1	2.4
			2	1.4
			3	1.0
			4	0.8

* For ballasts not specifically designed for use with dimming controls

The BEF is calculated using the formula:

BEF = Ballast Factor (in percent) / Power Input
where Power Input = Total Wattage of Combined Lamps and Ballasts"

4. Paragraph 3.17.1.2:

a. Add an additional sentence to the text of this subparagraph as follows.

"Fluorescent lamps for electronic ballasts shall be as indicated."

b. Add a designer note before this subparagraph as follows.

"NOTE: Indicate all fluorescent lamps other than cool white, rapid start on the Lighting Fixture Schedule."

APPENDIX B

CHANGES TO STANDARD DETAIL NUMBER 40-06-04

1. Preface, paragraph 7: Delete the existing first sentence: "Most sheets .. Certified Ballast Manufacturers." Replace with the following sentence.

"The specification information for fluorescent ballasts is contained in Corps of Engineers Guide Specification (CEGS) 16415, Electrical Work, Interior rather than on the Detail sheets for fluorescent fixtures."

2. Sheet Numbers 19-42, 71-72: Delete the sentence, "Standard [two lamp] ballast(s) shall be the Class P, high power factor type which has been approved for the application by the Certified Ballast Manufacturers."

3. Sheet Number 19, 23, 34: Delete, "Single-lamp ballast shall be used for individually mounted single-lamp fixtures and where single-lamp fixtures occur at the ends of continuous rows [, except two-lamp ballasts shall be used for tandem mounted single-lamp fixtures]."

4. Sheet Number 20: Delete: "Two-lamp ballasts shall be used for individually mounted two-lamp fixtures."

5. Sheet Number 21, 22: Delete: "Two-lamp ballasts shall be used for each pair of lamps."

6. Sheet Number 24: Delete: "Two-lamp ballasts shall be used for individually mounted two-lamp and four-lamp fixtures."

7. Sheet Number 30: Delete: "Type 218 fixture shall use a single-lamp ballast for individually mounted fixtures and where single-lamp fixtures occur at the ends of continuous rows. Two-lamp ballasts shall be provided for the Type 219 fixtures and for tandem mounted Type 218 fixtures."

8. Sheet Number 71: Delete: "Ballast shall be Class P thermally protected."

9. Sheet Number 72: Delete: "Ballast shall be thermally protected or fuse protected. Any fuses shall be installed in fuse holders that will not permit line connections to be accessible when the fuses are removed."

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10. SD No.40-06-04, Appendix B, paragraph 4: Delete the entire paragraph, "The electronic type ... by CBM." and replace with the following paragraph.

"4. In general, electronic ballasts offer the most efficient fluorescent lighting alternative. Many utility companies offer incentives for their implementation. These ballasts use solid-state switching techniques to convert 50 or 60 Hz input power to a higher frequency (20 - 60 KHZ). When matched with a fluorescent lamp compatible with the higher frequency, the lamp/ballast combination typically operates at a wattage close to or lower than the rating of the lamp. The higher frequency also eliminates visual flicker. The electronic ballast is additionally more quiet than its magnetic counterpart. There are two areas of concern when using these ballasts. The solid-state switching generates harmonics which contribute to the non-linear loads on the neutral conductors of the electrical distribution system. The overall electrical design must take this into account. Secondly, the electromagnetic energy (noise) emitted by the ballasts can be carried back into the electrical distribution system or be radiated into space. Although the ramifications of this effect do not normally appear to be serious, this noise can in some cases block certain frequencies or introduce erroneous data. Care should be exercised in locating sensitive electronic equipment near electronic ballasts or in using the same power supply for both sensitive equipment and lighting. Specific areas which should not have electronic ballasts are hospital critical care units and areas equipped with infrared remote control or security devices. It is important to inform Users of the benefits and risks of electronic ballasts and to involve them in the decision regarding their use. If 32W-F32-T8 lamps are to be employed, the User may want to choose between rapid start or instant start types. Instant start is more energy-efficient, but reduces lamp life by 25%. For this lamp size there may also be problems finding sufficient numbers of manufacturers of the rapid start configuration. There is no clear cut life cycle advantage of one type over the other."

11. Appendix C, paragraph 1b(1)(f): Delete the existing sentence, "Lower wattage ... lamps)." Replace with the following sentence.

"(f) Use of more efficient ballast/lamp combinations."