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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: SPECIFICATION FOR L-828 CONSTANT CURRENT REGULATORS

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1. PURPOSE. This circular describes the subject specification requirements and is published by the Federal Aviation Administration for the guidance of the public.

2. CANCELLATION. Advisory Circular (AC) 150/5345-10B, Specification for L-828 Constant Current Regulator with Stepless Brightness Control, dated 8 April 1968, is cancelled.

3. HOW TO OBTAIN THIS CIRCULAR. Obtain additional copies of this circular, AC 150/5345-10C, Specification for L-828 Constant Current Regulators, from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

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Initiated by: AS-550

1. EXPLANATION OF REVISIONS. In addition to minor changes in the text, the following revisions were made:

   a. As a result of limited demand for 20.0 ampere ratings of 10 KW and 20 KW and all ratings of the 25 KW regulator, these sizes are deleted.

   b. Field experience indicated a need for improved power factor.

   c. As a result of new agency standards for controlling approach lights from runway circuit and the need for a positive interface between the runway lighting system and runway visual range equipment (RVR) provision is included for five brightness step (no stepless) control.

   d. Provisions added for regulating the output current under varying load conditions. The load may be switched at any brightness setting at locations where taxiway centerline lights are installed.

   e. Provision added for accelerated life testing of regulators.

   f. Provisions added to completely enclose input and output connections.

   g. Added requirement for lighting arresters on input power.

2. SCOPE OF PUBLICATION. The specification requirements presented are for a constant current regulator. Provisions are made for a discrete stepped brightness selection without interrupting load current. The assembly has essentially an insulating transformer, current detecting system, lightning arresters, brightness selection control circuit, open-circuit and overcurrent protection, and an instrument current transformer. In addition, a transfer switch is provided in the control circuit for an "off" position, local operation, and transfer to remote operation. (Options are detailed in paragraph 8g(3)). All parts are suitably enclosed for indoor or outdoor service. The regulator is wired at the factory as a complete assembly.

3. SIZES. Manufacture regulator assemblies in the sizes listed in paragraphs a through f below. Make primary input to the regulator assemblies 2400 volts, 60 hertz, connections. See paragraph 8q for regulators with optional requirements and modifications.

   a. 10KW, 6.6-ampere output

   b. 20KW, 6.6-ampere output

c. 30KW, 6.6-ampere output

d. 30KW, 20.0-ampere output

e. 50KW, 20.0-ampere output

f. 70KW, 20.0-ampere output

4. PERFORMANCE REQUIREMENTS.

a. Regulation. Design the regulator assembly to permit control of output current. The assembly automatically compensates for variations of input voltage and load. At all loads from no load (short circuit) to full load, the assembly automatically maintains its nominal output current within the limits setforth in figure 1a for the input voltage range shown with both local and remote control. The assembly meets these same requirements with 10 percent of the total load having consisted of suitably loaded isolating transformers which are then open- circuited at their secondaries. When a minimum of 12 percent of the total load consists of isolating transformers suitably loaded which are then similarly open-circuited, the output currents are not to exceed limit shown in figure 1a on both local and remote control.

b. Efficiency. Supply the regulator's input with 2400 volts and connect a unity power factor load to the output circuit. Measure the efficiency at full load and maximum brightness. The regulator's efficiency at an ambient temperature of 25°C. is not less than the values shown in Figure 1b.

c. Primary Power Factor. Operate the regulator as specified in paragraph 4b and calculate the primary power factors. The power factor is not less than 95 percent at full load and maximum brightness for all sizes of regulators when the power factor of the load is unity. Make the power factor on various steps the maximum, consistent with the regulating circuit. Make the power factor for any step lagging, however, if over correction is needed the power factor is not less than 95 percent leading. The power factor may be less than 95 percent on the lower brightness steps providing the input KVA will not exceed the KVA input on step 5.

d. Temperature Rise. Determine the winding temperature rise as measured by the resistance method for both primary and secondary coils. Obtain this temperature rise operating the regulator continuously at full load and unity power factor. The maximum

temperature rise of the regulator and regulator's oil under these conditions is 65°C. and 55°C., respectively, unless otherwise specified. Measure oil temperature within three inches of the top oil and within three inches of any side wall.

e. Service. Design and construct the regulator for continuous outdoor operation under all conditions including:

(1) Temperature. Any ambient temperature from a minimum of -43°C. to a maximum of 55°C. at sea level.

(2) Salt Spray. Exposure to salt laden atmosphere.

(3) Altitude. Any altitude from sea level to 10,000 feet above sea level.

(4) Humidity. A relative humidity range from 10 percent to 100 percent.

f. Radio Frequency Interference. Design and construct regulator to prevent interference with radio equipment on the airport.

5. DETAILED REQUIREMENTS.

a. Rating. Design the regulator to supply the applicable range of current to a load of incandescent filament lamps, with each lamp connected to an individual insolating transformer. Determine the regulator load by multiplying the output voltage and current obtained at brightness step 5. This calculated KW is not less than the KW rating of the regulator. The nominal primary voltage is 2400 volts, single phase, 60 hertz; however, the regulator operates and meets the output current regulation requirements shown in figure 1a for primary voltages varying from 2280 to 2640 volts.

b. Constant Current System. Completely isolate (electrically) the input power circuit of the regulator from the output series circuit. Make the root mean square (RMS) value of the open-circuited output voltage of the regulator not in excess of 140 percent of the rated load voltage when operating at nominal input voltage. Prior to initiating any test to demonstrate compliance, the brightness setting is at maximum and the over-voltage protection circuit is invalidated.

c. Control Equipment. Provide a control system as part of the assembly to obtain brightness steps. The control is capable of completing its full travel cycle in a minimum time period. The regulator control system is capable of holding at the required output current. Limit oscillations or hunting of intensity level to less than 5 seconds. For remote control, use a 5 position selection switch in

accordance with Advisory Circular 150/5345-3B, Specification for L-821 Remote Control Airport Lighting Panel. The remote control switch is not a part of this specification.

d. Control and External Power. Make provisions in the regulator to have an optional integral remote controlled oil switch utilizing an internal control voltage. See paragraph 5q(3) for details on the integral remote controlled oil switch. If the integral remote controlled oil switch is not specified, make provisions for the use of control power from an external 115 to 120-volt, 60 hertz external source. This external control voltage will be provided to the regulator at the installation. Provide internally any other control power requirements which may be needed for the brightness control.

e. Open-Circuit Protection. Provide an automatic open-circuit protective device to prevent damage or injury in the event that an open circuit develops in the secondary. The protective device operates when the secondary circuit is opened. The device operates by opening the main primary control circuit in not more than 2 seconds after the open circuit occurs. It resets automatically within 2 seconds after the master control switch (not a part of the regulator assembly) is opened and then closed again or after the remote and local control switch (a part of the regulator assembly) is closed after it is returned to the "off" position, provided the open circuit condition has been corrected.

f. Overcurrent Protection. Provide an automatic overcurrent protective to operate by opening the main primary control circuit when the output current is outside the 6.6 ampere output current by no less than 8 percent and no more than 12 percent. The device operates in not more than 5 seconds after the overcurrent occurs. Provide the protective system with a 2-second maximum reset feature.

g. Remote and Local Control Switch. Provide a three-position selector switch for switching from "remote to off and to local" control. Mount this selector switch on the regulator with the operating control externally located for easy access to an operator. Mark the 3 positions of the selector switch as follows: "remote, off, and local." Provide connections for these positions as listed below.

(1) Remote. Remote control circuits connected and local control circuits open. (The remote control station is not furnished as part of this assembly).

(2) Off. Remote and local control circuits open.

(3) Local. Local control circuits connected and remote control circuits open. Provide a brightness selector switch of suitable rating to control the regulator locally. Alternatively, the remote and off functions may be combined with the local brightness switch.

h. Instrument Current Transformer. Provide a suitable current transformer with provisions for obtaining an indication of output current through an RMS indicating ammeter. Mount the indicating ammeter (not less than 3 inches in diameter) flush on the side of the control cabinet or in the control cabinet door so that it can be read externally. Provide a 3" x 5" cardholder near the ammeter for the user's "current-brightness calibration." Alternatively, calibrate the ammeter to indicate output current with an accuracy better than ±10 percent at any brightness level load condition.

i. Terminal Board and Wiring. Provide a suitable pressure-type terminal board in the control compartment. Label the terminals as shown below. Delete terminals not required when the remote controlled primary oil switch is integral as specified in paragraph 8q(3).

(1)	71	Control Neutral
(2)	72	Control Power
(3)	73	Remote Control Power
(4)	74	Remote Oil Switch Control
(5)	75	Primary Oil Switch Coil
(6)	B1-B2-B3-B4-B5	Brightness Control

j. Tank and Control Cabinet. House the reactors and/or the coils of the transformer in a sheet metal steel tank. Equip the tank with a removable gasketed cover held securely in place by bolts or clamps. Set the tank on a steel base plate with feet or channels and provide a drain plug (for oil filled regulators) and a sampling valve on the side of the tank not more than 2 inches above the bottom. Provide the tank with 4 stud terminals (2 labeled "input" and 2 labeled "output") suitable for the voltage involved. Completely enclose input and output connections. Provide the tank

with lifting lugs. Attach a suitable sheet steel control cabinet permanently to the side of the tank for housing the relays, sensing device, protective relay, control terminal board, and the control and transfer switch. Provide not less than four one-inch i.p.s. threaded bosses at suitable locations on the sides and bottom of the cabinet. Make the complete assembly weatherproof for installation outdoors.

(1) Make all low voltage control components accessible by opening the cabinet door. Permit no voltage over 600 volts within the control cabinet. Make the door capable of being tightly fastened to minimize entrance of insects and wind blown foreign material. Make the knob of the control and transfer switch accessible without opening the cabinet door. The exact shape of the tank and attached control cabinet is optional provided that all other requirements are met. Ship the regulator filled with oil and ready for service. For all connections leaving the tank, provide means to prevent siphoning. Mount a clamp-type terminal lug on the outside of the regulator case for ground connections. Install an oil level gauge in the tank.

(2) Make the overall physical dimensions of the regulator assembly for all sizes and types so as to permit passage through a doorway 39 inches wide and 78 inches high.

k. Capacitors. Provide capacitors for power factor correction and circuits that are adequately rated to insure long life at the normal working voltage. Provide adequate cooling to insure long life. Provide capacitors with ratings to perform within the temperature limits specified in paragraph 4e(1). The capacitors may be attached externally to the regulator tank providing the terminals are enclosed when the equipment is in the installed configuration.

l. Output Current Surge Limitation. Design the regulator so that any output surges caused by switching the regulator on and off, changing brightness steps, or shorting the load will not damage a series incandescent lamp. Time delay, if incorporated, when switching the regulator on and off, will not cause an interval of more than 2 seconds to elaspe before the unit operates to deliver the current selected. Limit pulsation or hunting of output current to 5 seconds or less under all conditions of switching.

m. Wiring Diagram. Mount a wiring diagram permanently inside the control cabinet. Make it legible and readily accessible.

n. Painting and Finish. Give the inside and outside of the tank one prime coat and one finish coat of oilproof and weatherproof paint. Give the outside of the tank a touchup after final assembly.

o. Nameplate. Securely attach a nameplate to the outside front of the regulator housing. Permanently and legibly fill in at least the following information:

(1) Constant current regulator, single phase

(2) Input: _____ Volts _____ Hertz _____ Amperes

(3) Control: _____ Volts _____ Hertz

(4) Output: _____ KW at _____ amperes _____ Serial No.

(5) Output Current: _____ to _____ amperes. Gallons of oil ___.

(6) Identification: FAA-L-828

p. Parts List and Installation Instructions. Furnish a parts list and installation and maintenance instructions with each regulator assembly. Provide sufficient drawings or illustrations to clearly indicate the methods of installation and maintenance. Furnish a recommended listing of spare parts.

q. Special Provisions. In exceptional cases, special modifications to this specification may be required to meet local conditions. Modifications permitted are listed below:

(1) Input voltage may be specified other than 2400 volts, 60 hertz. In this event, adjust the performance and testing requirements proportionately.

(2) Regulator ratings of not more than 90KW will be permitted when the 20-ampere output is specified.

(3) A remote controlled primary oil switch and internal control voltage may be furnished as an integral part of the regulator. Provide a primary oil switch with a voltage and current rating adequate for installation in the regulator's input circuit. The internal control voltage eliminates the requirement for utilizing a separate 115-120 volt external voltage at the regulator's installation.

r. Lightning Arresters. Install lightning arresters across the input and output terminals of the regulator. Connect the ground side of the arresters to the ground clamp of the regulator case. Size the arresters to prevent lightning damage to the regulator. Make the installation of the lightning arrester in accordance with the equipment manufacturers. Disconnect the arresters for all high voltage testing of the regulator.

s. Warning. Place a plate or decal with the following legend on the front of the regulator control cabinet door as warning:

WARNING

TURN LOCAL CONTROL TO "OFF" POSITION BEFORE OPENING COMPARTMENT DOOR

6. TESTING.

a. Qualification Testing.

(1) Supply one sample regulator for the tests to be performed.

(2) Subject the regulator to the electrical and physical tests described below, the applicable detailed requirements under paragraph 5, and the tests described in paragraph 6b.

(a) Test the preproduction model by energizing at 2400 volts (nominal), at 2640 volts (plus 10 percent), and at 2280 volts (minus 5 percent) to determine that it meets the regulation requirements of paragraph 4a. Tests shall be performed at short circuit, one-half full load and at full load of essentially unity power factor as outlined below. Make the tests using the control set for local operation with the local selector switch set to each brightness level, respectively (no transformers open circuited) and with input voltage at 2400 volts. Repeat this test using the remote control switch specified in paragraph (b) below. With the regulator so set, vary the input voltage to determine the regulator's ability to compensate for input voltage and to meet regulation requirements. The tests shall then be repeated with the equivalent of 10 percent of the load having been isolating transformer suitably loaded which have been open circuited at their secondaries.

(b) With control set for remote operation, check the regulator's output current.

1 Connect the remote switch by simulated 100-foot lengths of No. 12 AWG wire (a resistance equal to 0/16 ohms per wire). Operate regulator remotely on steps 1 through 5 to determine compliance with figure 1a.

2 Connect the remote switch by simulated 10,000-foot lengths of No. 19 AWG telephone wire (a resistance equal to 87 ohms per wire and a capacitance between any two wires of 0.16 microfarads). Operate the regulator remotely on steps 1 through 5 to determine compliance with figure 1a.

(c) Determine the temperature rise by the resistance method of the regulator with unity power factor load of the nominal regulator rating unless there are other brightness settings which will produce greater total losses in the regulator. Operate the regulator continuously until ultimate temperatures are reached.

(d) With 2400 volts connected to the primary and with a unity power factor load operating at the step 5 position, the overall efficiency and power factor at rated full load are not less than the values specified in paragraphs 7b and 7c.

(e) Check the output current of the regulator using the remote control. A resistance load may be used in lieu of a lamp nominal regulator rating unless there are other conditions of load and brightness settings which will produce greater total losses in the watts of the regulator by the square of the rated output current. F711-load resistance for each of the lower steps can be obtained by multiplying the step 5 resistance by the factors shown in figure 1c. The output current at each brightness position setting is in accordance with figure 1a, while the regulator is operated under the following conditions:

1 Room temperature and 60 hertz input.

2 With input voltage of 2280 volts, 2400 volts, and 2640 volts.

(f) High Temperature. Place the regulator in a test chamber and maintain the ambient temperature at 55°C. ±2°C. Energize and operate the regulator for at least a four-hour period after temperature stabilization of components has been achieved. The operation of the regulator is at rated input and output values. Improper operation is cause for rejection.

(g) Low Temperature. Place the regulator in a test chamber and maintain the ambient temperature at -43°C. ±2°. Energize and operate the regulator for at least a four-hour period after temperature stabilization of components has been achieved. The operation of the regulator is at rated input and output values. Improper operation is cause for rejection.

(h) Subject the primary and secondary of the regulator to the impulse test as described in ANSI C57 at the basic impulse insulation levels (BIL) shown in figure 1d.

(i) Demonstrate the longevity of the regulator by cycling 5,000 times (by remote operation) from off through steps 1, 2, 3, 4, and 5. The regulator should be energized and supplying rated load when longevity test is performed. Improper operation at the conclusion of this test is cause for rejection.

(j) Make additional inspections and tests as deemed necessary by the Federal Aviation Administration, Airports Service, Washington, D.C. 20591, to determine compliance with this specification.

b. Production Testing. Make the following tests on each regulator after final assembly.

(1) Dielectric Test. Test the circuits of all regulator sizes to determine the equipment's ability to withstand the following RMS 60 hertz test voltages for one minute without failure:

(a) Input circuit to ground - 19,000 volts

(b) 120-volt control circuits to ground - 1,000 volts

(c) 48-volt control circuits to ground - 500 volts

(d) Output circuit to ground - 19,000 volts

(2) Performance Test. Test each regulator assembly for output current as required in paragraph 6a(2), sentences one, two, and three.

(3) Protective and Control Device Tests. Test all controls and protective devices for proper operation as specified in paragraphs 5c through 5g. This includes tests to determine that the open-circuit voltage does not exceed 140 percent of the rated load voltage as specified in paragraph 5b.

(4) Leakage Test. Test each oil filled regulator assembly to determine that all welds and gasketed seals are oiltight and weathertight. Utilize an internal air pressure of 10 p.s.i. for 5 minutes.

(5) Output Current Surge. Check regulator to determine compliance with paragraph 51.

c. Certification. The manufacturer certifies that all components and materials will operate satisfactorily within the requirements of paragraph 4e.

7. QUALIFICATION. Send requests for approval to the Federal Aviation Administration, Airports Service, Washington, D.C. 20591.

a. Furnish a sample regulator to an independent testing laboratory acceptable to the Federal Aviation Administration, Airports Service, to be tested as described herein to obtain certification regarding the ability to manufacture regulators meeting the requirements of this specification. Furnish copies of the testing laboratory's reports to Airports Service for review and approval consideration. Upon approval of the test reports which show satisfactory certification of compliance, the Airports Service will list the name of the qualified manufacturer and a description of their regulator in the latest issuance of Advisory Circular 150/5345-1C, Approved Airport Lighting Equipment. The cost of testing is borne by the manufacturer offering the material for qualification.

b. If the manufacturer has satisfactory laboratory facilities, the tests may be performed at the factory and such tests witnessed by a representative of the Federal Aviation Administration, Airports Service. The manufacturer furnishes written reports of these tests.

c. Submit for review and approval parts list, installation instructions, drawings, and theory of operation of all components installed as part of the regulator.

d. At anytime after approval has been granted under the above conditions, test records shall be retained on file for a period of 2 years so they may be made available for a certified copy of factory test reports on the latest production run upon written request by the Federal Aviation Administration, Airports Service, Washington, D.C. 20591.

FIGURE 1a. OUTPUT CURRENT

Brightness Position	Nominal Output Current (Amperes)	Output Current Limits
5	6.6	6.47 - 6.70
4	5.2	5.07 - 5.33
3	4.1	4.00 - 4.20
2	3.4	3.22 - 3.49
1	2.8	2.73 - 2.87
5	20.0	19.50 - 20.50
4	15.8	15.41 - 16.20
3	12.4	12.09 - 12.71
2	10.3	10.04 - 10.56
1	8.5	8.29 - 8.71

FIGURE 1b. REGULATOR INPUT EFFICIENCY

Regulator Size	Percent Overall Efficiency (Minimum)
10KW	88
20KW	90
30KW	92
50KW	93
70KW	94

FIGURE 1c. FACTOR FOR RESISTANCE VALUES

Step	Multiplier
5	1.00
4	0.82
3	0.67
2	0.57
1	0.48

FIGURE 1d. BASIC IMPULSE INSULATION LEVELS

Regulator KW Rating	Primary Voltage	Secondary Amperes	Primary BIL (KV)	Secondary BIL (KV)
10	2400	6.6	60	45
20	2400	6.6	60	60
30	2400	6.6	60	60
30	2400	20.0	60	45
50	2400	20.0	60	60
70	2400	20.0	60	60

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