ANSI C50.13-1977
(Revision of C50.13-1965)

American National Standard Requirements for Cylindrical-Rotor Synchronous Generators

Secretariat
Edison Electric Institute
Institute of Electrical and Electronics Engineers, Inc
National Electrical Manufacturers Association

Approved August 4, 1975
American National Standards Institute, Inc

Published by

Institute of Electrical and Electronics Engineers, Inc
345 East 47th Street, New York, N. Y. 10017

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review and users are cautioned to obtain the latest editions.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of publication. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Foreword

(This Foreword is not a part of American National Standard Requirements for Cylindrical-Rotor Synchronous Generators, C50.13-1977.)

Developed over a period of more than two years within a working group that reflected wide industrial experience in both the manufacture and use of Synchronous Generators, American National Standard C50.13-1977 received the unanimous approval of the C50.1 Subcommittee on Synchronous Machines as well as the full endorsement of American National Standards Committee C50 on Rotating Electrical Machinery.

It is the intent of C50 to revise and update this standard at regular intervals, and comments on this document, including recommendations for its revision, will be welcomed by the Committee. Please forward comments to the Secretary, American National Standards Committee C50, American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

At the time it approved this standard, American National Standards Committee C50 on Rotating Electrical Machinery had the following membership:

The C50.1 Subcommittee on Synchronous Machines consisted of the following members:

C. E. Asbury, *Chair*
J. P. Markey, *Secretary*

R. E. Appleyard	R. A. Huse	W. J. Sheets
J. W. Batchelor	J. R. Imbertson	E. C. Whitney
O. K. Brown	P. R. Landrieu	G. L. Wilson
N. Derewianka	J. A. Oliver	R. L. Winchester
W. C. Dumper	C. Rahe	H. C. Ward, Jr
J. P. Fitzgerald	J. J. Ray	J. Q. Wray, Jr.
A. Hoffman	F. von Roeschlaub	
C. H. Holley	L. T. Rosenberg	

The working group responsible for developing this document consisted of:

J. P. Fitzgerald, *Chair*

J. W. Batchelor	C. H. Holley	W. J. Sheets
O. K. Brown	J. A. Oliver	G. L. Wilson
D. R. Green	L. T. Rosenberg	R. L. Winchester

CLAUSE PAGE

American National Standard Requirements for Cylindrical-Rotor Synchronous Generators

1. Scope

The requirements in this standard apply to 60 hertz cylindrical-rotor synchronous generators, except those covered in C50.14-1977.

All requirements and definitions, except as specifically covered in this standard, shall be in accordance with American National Standard C50.10-77.

2. Classification

A cylindrical-rotor synchronous generator is classified by one of the stator and one of the rotor types.

2.1 Stator Types[1]

The type of stator is defined by the method of armature winding cooling, either directly or indirectly.

2.2 Rotor Types[1]

The type of rotor is defined by the method of field winding cooling, either directly or indirectly.

3. Usual Service Conditions

The usual service conditions upon which the requirements for cylindrical-rotor synchronous generators are based are given in ANSI C50.10-1977. In addition to these usual service conditions, the following requirements shall be met.

[1]Refer to ANSI C50.10-1977 for definitions.

3.1 Variation from Rated Voltage

Generators shall operate successfully at rated kilovolt-amperes (kVA), frequency, and power factor at any voltage not more than five percent above or below rated voltage, but not necessarily in accordance with the standards of performance established for operation at rated voltage.

3.2 Variation from Rated Hydrogen Pressure

Capabilities at hydrogen pressures other than rated pressure shall be available from the manufacturer. The capabilities at hydrogen pressures other than rated shall be determined such that the hottest spot temperature of the winding which is limiting at the specified capability shall be essentially the same as that at rating.

3.3 Variation from Rated Frequency

Capabilities at frequencies other than rated frequency shall be available from the manufacturer.

4. Rating

4.1 Output Rating

The output rating shall be expressed in kilovolt-amperes available at the terminals at a specified speed, frequency, voltage, and power factor.

The output rating of hydrogen-cooled generators shall be at the maximum hydrogen pressure imposed on the generator enclosure. The output rating, specified temperatures, and observable temperature rises shall be based only on rated hydrogen pressure. The preferred maximum hydrogen pressures are:

1) For indirectly cooled generators: 30 psig (pounds per square inch gage)
2) For directly cooled generators: 30, 45, 60, or 75 psig

4.2 Capability

The capability of a synchronous generator is the highest acceptable continuous loading (kVA) through the full range of power factor at a specified condition.

4.3 Voltage Ratings

4.3.1 Armature

Armature voltage ratings shall be

240*	4160
480	4800*
600*	6900*
2400*	13 800

NOTE — The asterisk indicates recognized for use on established systems but not preferred for new undertakings.

Generator voltages above 13 800 V are desirable in large-capacity generators that usually are connected directly to their own step-up transformers.

4.3.2 Excitation System Voltage Ratings

The preferred excitation system voltage ratings for field windings are 62.5, 125, 250, 375, 500, 625, and 750 direct voltage. These excitation system voltages do not apply to generators of the brushless type with direct-connected exciters.

5. Temperature Rise

5.1 Air-Cooled Machines

The observable temperature rise of each of the various parts of the machine above the temperature of the cooling air, referred to as the cold air temperature, shall not exceed the values given in Table 1 when the machine is operated at output rating conditions. The temperature rises in Table 1 are based on a maximum cold air temperature of 40 °C.

For open machines and for parts of enclosed machines that are cooled by open ventilation passages, that is, collector rings, the cold air temperature is the average temperature of the external air as it enters the ventilating openings of the machine.

For totally enclosed machines, the cold air temperature is the average temperature of the air leaving the cooler or coolers. The cold air temperature at rating, when the coolers are supplied with water of the rated amount and temperature, is usually specified as 40 °C.

Table 1—Limiting Observable Temperature Rise of Air-Cooled Cylindrical-Rotor Generators

Item	Machine Part	Method of Temperature Determination	Temperature Rise (°C) Class B	Class F	Class H
(1)	Armature winding				
	(a) below 10 000 kVA	resistance	80	105	125
	(b) 1563 kVA and less	embedded detector*	90	115	140
	(c) 1564 kVA to 10 000 kVA				
	(1) 7000 V and less	embedded detector*	85	110	135
	(2) over 7000 V	embedded detector*	80	105	125
	(d) 10 000 kVA and above	embedded detector*	70†	90†	110†
(2)	Field winding	resistance	85	105	125
(3)	Cores and mechanical parts in contact with or adjacent to insulation	detector or thermometer	70	90	110
(4)	Collector rings	thermometer	85	85	85
(5)	Miscellaneous parts (such as brushholders, brushes, etc) may attain such temperatures as will not injure the machine in any respect				

*Embedded detectors are located within the slot of the machine and can be either resistance elements or thermocouples. Embedded detector temperatures shall be used to demonstrate conformity with the standard for generators so equipped.
†These values are for insulation systems with thermosetting materials. For thermoplastic materials the equivalent temperatures shall be 60 °C for Class B; Class F and Class H do not apply.

For machines that operate under prevailing barometric pressure and are designed not to exceed standard temperature rise at altitudes from 3300 ft (1000 m) to 13 000 ft (4000 m), the temperature rises, as checked by test at low altitude, shall be less than those listed in Table 1 by 1 percent of the specified temperature rise for each 330 ft (100 m) of altitude in excess of 3300 ft (1000 m).

When designing to meet the temperature rises of Table 1, it is intended that the hottest-spot temperature should not exceed 130 °C for Class B, 155 °C for Class F, and 180 °C for Class H insulation systems.

For machines of 10 000 kVA and above, the relationship between hottest-spot temperature and the temperatures as specified in Table 1 for the armature and field windings shall be demonstrable by direct measurement or recognized methods of calculation correlated to special factory tests on a basically similar machine.

Table 2—Limiting Observable Temperature and Temperature Rise of Hydrogen-Cooled Cylindrical-Rotor Generators in Degrees Celsius

		Indirectly Cooled Windings (rated at 30 psig)		Directly Cooled Windings (rated at 30, 45, 60, 75 psig)		
					Class B*,† Type of Coolant	
Item	Machine Part	Method of Temperature Determination	Class B*,†	Method of Temperature Determination	Liquid	Gas
(1)	Temperature of cold coolant	detector	46	detector	45–50‡	45–50‡
(2)	Temperature rise of armature winding	embedded detector	54§,‡‡	coolant**	55–50‡,§	65–60‡,§
(3)	Temperature rise of field winding					
	(a) Generators below 100 000 kVA	resistance	79§	resistance		65–60‡,§
	(b) Generators 100 000 kVA and above	resistance	74§	resistance		65–60‡,§
(4)	Temperature rise of core and mechanical parts in contact with or adjacent to armature winding insulation††	detector	64	detector	85–80§	85–80§
(5)	Temperature rise of collector rings brushes and brushholders	thermometer	85	thermometer		85
(6)	Other metal parts such as shielding devices in the end region, structural members, amortisseur windings, and the rotor surface may be operated at temperatures that are considered safe for the particular metals used, providing these parts do not appreciably influence the temperature of insulating material either by conduction or radiation					

*Because of the large thermal gradient between hottest spot and observed temperatures of large high-voltage generators and because of mechanical considerations of thermal expansion, it is often desirable to design for lower temperatures than shown in Table 2 on large or high-voltage machines or machines intended for operation with highly variable loads.

†Hydrogen-cooled generators that operate under controlled pressure do not require a correction for temperature rise at altitude if the pressure of the cooling medium is maintained at the absolute pressure corresponding to the rated value.

‡Cold coolant temperatures may be provided within the range of 45 °C to 50 °C, at the manufacturers' option, so long as compensating adjustments are made in the rise of the respective parts so that the sum of the cold coolant temperature and respective part rise does not exceed

(1) 100 °C for liquid-cooled and 110 °C for gas-cooled armature windings listed in Items (2) and (4)

(2) 110 °C for gas-cooled field windings listed in Item (3)

§Refer to Section 5.2.

**The temperature rise of the coolant at the outlet of the hottest coil shall be considered the observable temperature rise of conductor-cooled armature winding.

††The values shown for Item 4 are limiting regardless of the operating power factor.

‡‡These values are for insulation systems with thermosetting materials.

5.2 Hydrogen-Cooled Machines

The observable temperature rise of each of the various parts of the machine above the average temperature of the cold coolant, when tested in accordance with the rating, shall not exceed the values given in Table 2. The temperature of the cold coolant shall be the average temperature of the coolant leaving the coolers when tested in accordance with the rating. The cold coolant temperature shall not exceed the appropriate value for the rated hydrogen pressure as listed in Table 2. Temperatures shall be determined by the methods specified in Table 2.

The hottest-spot temperature shall not exceed 130 °C for Class B insulation systems.

The relationship between hottest-spot temperature and the temperatures as specified in Table 2, for the armature and field windings, shall be demonstrable by direct measurement or recognized methods of calculation correlated to special factory tests on a basically similar machine.

6. Requirements for Abnormal Conditions

6.1 Armature Winding Short-Time Thermal Requirements

The generator armature shall be capable of operating at 130 percent of rated armature current for at least 1 min, starting from stabilized temperatures at rated conditions.

NOTE — (1): The permissible armature currents at times up to 120 s, based upon the same increment of heat storage as defined in 6.1, will be

Time (seconds)	10	30	60	120
Armature current (percent)	226	154	130	116

NOTE — (2): It is recognized that armature temperatures will exceed rated load values under these conditions and, therefore, the machine construction is based upon the assumption that the number of such operations at armature currents to the limits specified in Note (1) will occur not more than two times per year.

6.2 Field Winding Short-Time Thermal Requirements

The generator field winding shall be capable of operating at a field voltage of 125 percent of rated-load field voltage for at least 1 min starting from stabilized temperatures at rated conditions.

NOTE — (1): The permissible field voltages at times up to 120 s, based upon the same increment of heat storage as defined in Section 6.2, will be

Time (seconds)	10	30	60	120
Field voltage (percent)	208	146	125	112

NOTE — (2): It is recognized that field winding temperatures under these conditions will exceed rated-load values and, therefore, the machine construction is based upon the assumption that the number of such operations at field voltages to the limits specified in Note (1) will occur not more than two times per year.

6.3 Rotor Short-Time Thermal Requirements for Unbalanced Faults

The generator rotor shall be capable of withstanding, without injury, unbalanced short circuits or other unbalanced conditions on the system or at the armature terminals resulting in values of I_2^2t as listed below.

Type of Cylindrical—Rotor Synchronous Generator	Minimum Generator Short-Time Capability Expressed in Terms of I_2^2t (Note)
Indirectly cooled	30
Directly cooled, up to 800 MVA	10
800 MVA to 1600 MVA	10—(0.00625) (MVA—800)

I_2^2t in the preceding table is the integrated product of the square of the generator negative-phase-sequence current (I_2), expressed in per unit stator current at rated kilovolt-amperes and duration of the fault in seconds (t).

The generator unbalanced fault capability expressed in terms of I_2^2t applies for times up to 120 s, based on a constant increment of heat storage and negligible heat dissipation.

In the above criteria, the generator shall be capable of withstanding the thermal effect of unbalanced faults at the machine terminals, including the decaying effects of

1) Field current, where protection is provided by causing field current reduction, such as with an exciter field breaker or equivalent
2) Direct-current component of the stator current

NOTE — Generators subjected to faults between the preceding values of I_2^2t and 200 percent of these values may suffer varying degrees of damage; for faults in excess of 200 percent of these limits, serious damage may be expected.

6.4 Mechanical Requirements for Short Circuits

The generator shall be capable of withstanding, without mechanical injury, any type of short circuit at its terminals for times not exceeding short-time thermal requirements, when operating at rated kilovolt-amperes and power factor and 5 percent overvoltage, provided the maximum phase current is limited by external means to a value which does not exceed the maximum phase current obtained from the three-phase fault.

NOTE — In the case of stator windings, the criteria for no injury is that the windings can satisfactorily withstand a normal maintenance high-potential test. There shall also be no visible abnormal deformation or damage to the winding coils and connections.

6.5 Continuous Unbalance Requirements

A generator shall be capable of withstanding, without injury, the effects of a continuous current unbalance corresponding to a negative-phase-sequence current of the following values, providing the rated kVA are not exceeded, and the maximum current does not exceed 105 percent of rated in any phase. Negative-phase-sequence current is expressed in percent of rated stator current.

Type of Generator	Permissible I_2 (percent)
Cylindrical rotor indirectly cooled	10
directly cooled, to 960 MVA	8
961 to 1200 MVA	6
1201 to 1500 MVA	5

These values also express the negative phase sequence current capability at reduced generator kilovolt-ampere capabilities, in percent of the stator current corresponding to the reduced capability.

7. Efficiency

The following losses shall be included in determining efficiency:[2]

1) I^2R losses of armature and field winding
2) Core loss
3) Stray load loss
4) Excitation system losses, if required by specifications, shall include the exciter, voltage regulator, and associated devices comprising the excitation for a particular synchronous machine. Include motor loss if unit motor-generator exciter set is used; if a unit rectifier is used, include the loss of the rectifier and rectifier transformer.
5) Friction and windage loss

8. Overspeed

Cylindrical-rotor generators shall be so constructed that they will withstand, without injury, an overspeed of 20 percent.

9. Telephone Influence Factor

9.1 Balanced

The balanced telephone influence factor (TIF) of synchronous generators, based on the weighting factors given in 9.3, shall not exceed the following values:

[2]Refer to ANSI C50-10-1977 for definition of losses.

kVA Rating of Machine	Balanced TIF
62.5 to 299	350
300 to 699	250
700 to 4999	150
5000 to 19 999	100
20 000 to 99 999	70
100 000 and above	40

9.2 Residual Component

The residual-component TIF of synchronous generators having voltage ratings 2000 V and higher, based on the weighting factors given in Section 9.3, shall not exceed the following:

kVA Rating of Machine	Residual TIF
1000 to 4999	100
5000 to 19 999	75
20 000 to 99 999	50
100 000 and above	30

9.3 Single Frequency

The single-frequency telephone influence weighting factors (TIF_f) according to the 1960 single-frequency weighting are shown in Table 3.

Methods of measurement for TIF shall be in accordance with IEEE Std 115-1965, Test Procedure for Synchronous Machines.

9.4 Other

Special consideration may be necessary where trouble exists or may be anticipated from difficult exposure conditions.

Table 3—1960 Single-Frequency TIF_f Weighting Factors

Frequency	TIF_f	Frequency	TIF_f
60	0.5	1860	7820
180	30	1980	8330
300	225	2100	8830
360	400	2160	9080
420	650	2220	9330
540	1320	2340	9840
660	2260	2460	10 340
720	2760	2580	10 600
780	3360	2820	10 210
900	4350	2940	9820
1000	5000	3000	9670
1020	5100	3180	8740
1080	5400	3300	8090
1140	5630	3540	6730
1260	6050	3660	6130
1380	6370	3900	4400
1440	6650	4020	3700
1500	6680	4260	2750
1620	6970	4380	2190
1740	7320	5000	840
1800	7570		

Table 4—Tests on Cylindrical-Rotor Synchronous Generators

Tests	Generators Completely Assembled for Test in Factory	Generators Not Completely Assembled in Factory: Factory Tests	Generators Not Completely Assembled in Factory: Field Tests
Resistance of armature and field windings	X*	X	X
Dielectric tests of armature and field windings	X	X	X
Voltage balance	X	—	X
Phase sequence	X	—	X
Mechanical balance	X†	X†	X†
Open-circuit saturation curve	X	—	X
Overspeed	X	X	—
Short-circuit saturation curve‡	—§	—	—
Harmonic analysis and measurement of TIF	—§	—	—§
Heat runs	—§	—	—§
Short-circuit tests at reduced voltage to determine reactance and time constants	—§	—	—§
Measurement of segregated losses	—§	—	—
Measurement of rotor impedance	X††	—	X
Measurement of insulation resistance of armature and field windings	X	—	X
Measurement of bearing insulation resistance	—**	—	X

*An X indicates that test shall be made on each unit.
†A field check of mechanical balance of all generators is recommended after installation.
‡On brushless generators, readings of exciter field current instead of generator field current may be obtained.
§This test, or copies of a certified test report covering test made on an essentially duplicate generator, may be specified.
††For units less than 10 000 kVA and less than 7000 V, measurement of rotor impedance is not required.
**On all generators furnished with one or more insulated bearings, a field measurement of the bearing insulation resistance is recommended.

NOTE — (1): Although TIF is designed basically as a measure of the influence of current or voltage in a power circuit on parallel telephone circuits, the TIF of open-circuit generator voltage has been used for many years as an approximate index of the influence of generator wave shape. There has been no experience to indicate that generators designed in accordance with ANSI C50.1-1955 have caused inductive coordination problems. However, accumulated measurements by manufacturers indicate that generator open-circuit TIF measured in accordance with the 1960 weighting averaged higher than with the 1935 weighting. Accordingly, in adopting the 1960 weighting in this revision of ANSI C50.1-1955 , the limiting TIF values of lower capacity machines were increased. At the same time the greatly improved wave shape of modern high-capacity generators is recognized in setting a lower limit of balanced TIF for the larger units.

NOTE — (2): For information on TIF, see "Supplement to Engineering Report 33, The Telephone Influence Factor of Supply System Voltages and Currents," *Engineering Reports of the Joint Subcommittee on Development and Research,* Edison Electric Institute and Bell System, Edison Electric Institute Publication 60–68. For further information on methods of measurement of TIF, see W. C. Ball and C. K. Poarch, "Telephone Influence Factor (TIF) and Its Measurement," *AIEE Transactions,* pt I, vol 79, Jan 1961, pp 659–664.

10. Tests

The tests specified in Table 4 shall be conducted in accordance with IEEE Std 115-1965 and ANSI C50.10-1977.

11. Direction of Rotation

The direction of rotation of the generator shall suit the prime mover requirements.

12. Nameplate Marking

A nameplate having the following minimum information shall be provided: manufacturer's name, serial number, or other suitable identification.

The following information at rating shall be supplied:[3]

1) Voltage
2) Output kilovolt-amperes
3) Revolutions per minute
4) Armature amperes
5) Frequency
6) Temperature rise of armature
7) Temperature rise of field
8) Number of phases
9) Power factor
10) Excitation voltage
11) Excitation amperes
12) Hydrogen pressure (if hydrogen cooled)

NOTE — Direction of rotation should be shown on machine when necessary for correct operation.

13. Performance Specification Forms

Fig 1 shows the form that shall be used for specifying the performance of steam, hydraulic-turbine-driven, and motor-driven air-cooled synchronous generators.

Fig 2 shows the form that shall be used for specifying the performance of steam-turbine-driven hydrogen-cooled synchronous generators.

[3]For hydrogen-cooled machines, the values shall be given for maximum hydrogen pressures.

14. Revision of American National Standards Referred to in This Document

When the following American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Incorporated, the revision shall apply:

ANSI C50.10-1977, General Requirements for Synchronous Machines

ANSI C50.14-1977, Requirements for Combustion Gas Turbine Driven Synchronous Generators

(The following data shall be given in accordance with ANSI C50.13-1977)

Date ______________________

Output Rating

kVA	Power Factor	kW	Speed r/min	No of Poles	No of Phases	Freq Hertz	Volts	Amperes	Type or Frame

Description ______________________

— Type of excitation system ______________________

— Maximum speed of generator (and exciter if shaft-driven) is ________ r/min without mechanical injury.

— Amortisseur winding is (closed) (open) (not supplied)

— Generator cooling (shall) (shall not) include a closed-circuit air system.

— Insulation Classes: Armature Winding _______ ; Armature Connections _______ ; Field Winding _______ .

— Direction of rotation viewing the end opposite the drive __________ if of unidirectional design or construction.

Temperature Rise Guarantees				
		Rise C Not to Exceed		
		Armature Winding		Field Wdg by Resist
kVA	Power Factor	By Resist	By Detector	
Exciter (1)				

Max Excitation Requirements					
Gen Excitation Slip-Ring Type		Exciter Input Brushless		Excit System	
Amp	Volts	Amp	Volts	Response Ratio	Nominal Ceiling Volts

(1) At "Maximum Excitation Requirements" operating level.

Rating and temperature rises are based on an ambient temperature of 40°C at an altitude not exceeding 3300 ft (1000 m).

Minimum Efficiencies							
kVA	Power Factor	kW		Rated Load	3/4 Load	1/2 Load	

Efficiencies are determined by including I^2R losses of armature and field windings at _______ °C, core loss and stray load loss. Friction and windage loss (are) (are not) included; exciter and field rheostat losses (are) (are not) included.

Reactances (Calc per Unit)			Rotor Wk^2 $lb\text{-}ft^2$	Short Circuit Ratio
Synch X_d	Rated I Dir Axis Transient X'_{di}	Rated V Dir Axis Sub trans X''_{dv}		

Approx Weights in Pounds			
Total Net	Rotor Net	Heaviest Part for Crane	Total Shipping

— Approximate Operating Data for Cooling System with generator at rated load:

Totally enclosed with water coolers

Temperature of inlet water to coolers, __________ °F

Volume of cooling water, __________ gallons per minute (gpm) (for ventilating air and bearing oil, when required)

Enclosed, self-ventilated (no external blower)

Volume of cooling air, __________ cfm

Pressure drop available for external ducts, filters, etc __________ inch of water.

Figure 1—Performance Specification Form for Steam, Hydraulic-Turbine-Driven, and Motor-Driven Air-Cooled Cylindrical-Rotor Synchronous Generators

(The following data shall be given in accordance with ANSI C50.13-1977)

Date ____________________

Output Rating

kVA	Power Factor	kW	Speed r/min	No of Poles	No of Phases	Freq Hertz	Volts	Amperes	Type or Frame

Description ____________________

— Type of excitation system ____________

— Amortisseur winding is (closed) (open) (not supplied)

— Insulation Classes: Armature Winding __________ ; Armature Connections __________ ;
Field Winding __________ .

— Direction of rotation viewing the end opposite the drive __________ if of unidirectional design or construction.

Temperature Rise Guarantees			
		Rise C Not to Exceed	
kVA	Power Factor	Arm Winding by Embedded Defector	Field Winding by Resistance
Exciter (1)			

Max Excitation Requirements					
Gen Excitation Slip-Ring Type		Exciter Input Brushless		Excit System	
Amp	Volts	Amp	Volts	Response Ratio	Nominal Ceiling Volts

(1) At "Maximum Excitation Requirements" operating level.

Rating and temperature rises shall be in accordance with Table 2 of ANSI—C50.13-1977 and are based on a temperature of _______ °C of the cooling gas at the exit from the coolers, at _______ psig pressure and at an altitude not exceeding 3300 ft (1000 m).

Efficiencies: Efficiencies of the generator are included in the over-all turbine-generator set efficiencies.

Reactances (Calc per Unit)				
Synch X_d	Rated I Dir Axis Transient X'_{di}	Rated V Dir Axis Sub trans X''_{dv}	Rotor Wk^2 $lb\text{-}ft^2$	Short Circuit Ratio

Approx Weights in Pounds			
Total Net	Rotor Net	Heaviest Part for Crane	Total Shipping

Operating Data (at rated load and hydrogen pressure):

(a) Temperature of inlet water to coolers, ________ °F

(b) Volume of cooling water, __________ gpm

Figure 2—Performance Specification Form for Steam-Turbine-Driven Hydrogen-Cooled Cylindrical-Rotor Synchronous Generators

