2006 UPDATE OF IEEE/ANSI C50.13-2005 STANDARD FOR LARGE TURBINE GENERATORS AND HARMONIZATION WITH THE IEC 60034 SERIES

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INTRODUCTION

WG-2 (Advisory Group to IEC) of the Generator Subcommittee (Synchronous Machinery Subcommittee) completed the task of comparing the updated IEEE Std C50.13-2005[13] standard for electrical machinery with the corresponding International Electrotechnical Commission (IEC 60034-3[4], 60034-1[3]) standards.

IEC 60034-1 covers general requirements for all rotating electrical machinery and IEC 60034-3 covers the specifics of cylindrical rotor synchronous machines to be applied with steam and combustion turbines. IEEE/ANSI C50.13-2005 covers cylindrical-rotor synchronous generators driven by steam and combustion turbines.

The objective of this paper is to highlight the main differences that remain between the newly revised IEEE Std C50.13-2005 and the recently revised 2004 eleventh edition of IEC 60034-1 and the 2005 fifth edition of IEC 60034-3.

The IEEE Std C50.13-2005 is a consolidation of the previously separate ANSI C50.10[5], ANSI C50.13[7], ANSI C50.14[8], and ANSI C50.15[9].

HIGHLIGHTS OF DIFFERENCES IN IEC 60034 SERIES AND IEEE C50.13 STANDARDS

There have been significant strides in harmonizing the IEEE and IEC Standards. The following points highlight the key differences that still exist.

Temperature Limits

Table 1 shows a brief comparison of the new IEEE and IEC observable temperature limits. The table clearly shows the close alignment of the IEEE and IEC observable temperatures for Class B operation. IEEE maintains the requirement for hot spot temperature limits in addition to observable temperatures while IEC continues to reference the requirement for observable temperatures only.

Sudden Short Circuit

Both IEEE and IEC are pretty consistent on this requirement. However, IEC does clearly specify the subsequent high voltage test requirements.

Faulty Synchronization

IEEE has specific guidelines for faulty synchronizations and estimates on the extent of possible damage and repair requirements. However, IEC only briefly reference faulty synchronizations in the sudden short circuit section.

Over-speed Testing

Both IEEE and IEC are consistent on this 120% requirement. However, IEEE requires a 2 minute test but has a safety stipulation. IEC requires 2 minutes without any special consideration.

Winding Short-time Thermal Requirements

Both IEEE and IEC have the same requirements for stator windings. However, IEEE has specific short-time rotor thermal requirements as stated below, while the IEC does not specify any short-time rotor thermal requirements.

125% of rated load rotor current for 1 minute

$I = 100\sqrt{\frac{33.75}{t} + 1}$ for 10s to 120s

Short-time negative-sequence current capability

Both IEEE and IEC have the same requirements for negative sequence currents. However, they differ in short-time capability requirements as seen below.

IEEE short-time negative-sequence current capability:

Type of generator rotor	Minimum $I_2^2 t$
Indirectly cooled	30
Directly cooled up to 800MVA	10
800MVA to 1600MVA	10-(0.00625)(MVA-800)

IEC short-time negative-sequence current capability:

Type of generator rotor	Maximum $I_2^2 t$
Indirectly cooled	15
Directly cooled between 350 and 900MVA	8-0.00545(MVA-350)
900MVA to 1600MVA	5

Required Slot Embedded Temperature Detectors

IEEE require minimum of 12 stator slot embedded temperature detectors for indirectly cooled generators while IEC require only 6 slot embedded temperature detectors.

Shaft Vibration

IEEE reference ISO 7919 shaft vibration limits while IEC doesn't reference any specific requirement.

Hydrogen Cooled Generator Precautions

This new Annex A (normative) added to IEC 60034-3 fifth edition was added to give guidance on design features and operating procedures that are intended to avoid the occurrence or ignition of an ignitable mixture of hydrogen and air either in or around the generator. IEEE C50.13-2005 doesn't have an equivalent section or appendix.

Machine housing and cover plates

IEC 60034-3 fifth edition has a re-wording of the following requirement:

Section 6.3
… A hydrostatic pressure test shall be made to check the strength of the housing and cover plates….

The previous edition of this standard had the following stipulation:

"If required by the purchaser at the time of the order".

Several members of the IEC working group noticed this change after the fifth edition was release and submitted requests to have the language changed back to its original text. This will be an action of the next working group of IEC 60034-3.

SUMMARY AND CONCLUSIONS

As seen above, there has been significant work in harmonizing IEEE and IEC cylindrical synchronous generator standards. There are several key points to continue to follow and harmonize. WG-2 (Advisory Group to IEC) of the Generator Subcommittee (Synchronous Machinery Subcommittee) suggest that we continue with the harmonization efforts and request input from end users of both IEEE C50-13-2005 and IEC 60034-1 and 60034-3 Standards to provide input to assist in continuing to identify the key requirements to further align and harmonize between the standards.

TABLE 1 (COMPARISON OF IEC AND IEEE TEMPERATURE LIMITS)

Indirectly-Air-Cooled Stator and Radially- Air-Cooled-Rotor Generator Limits

Items Codes	ANSI B	IEC B	ANSI F
Hot spot temperature, °C	130		155
Stator RTD observable, °C	125 - (KV-12) old value = 110	125 - (KV-12)	150 - (KV-12) old value = 130
Rotor Average, °C	120 old value = 125	120	135 old value = 145

Indirectly-Hydrogen-Cooled Stator and Radially- H2-Cooled-Rotor Generator Limits

Items Codes	ANSI B	IEC B	ANSI F
Hot spot temperature, °C	130		155
Stator RTD observable, °C	110 - (KV-12) old value = 110	110 - (KV-12)	130 - (KV-12) old value = 130
Rotor Average, °C	120 old value = 125	120	135 old value = 145

Water-Cooled-Stator & Hydrogen-Axially-Cooled-Rotor Generator Limits

Items Codes	ANSI B	IEC B	
Hot spot temperature, °C	130		
Stator RTD observable (not preferred) , °C		120	
Stator Cooling Water Outlet, °C	90	90	
Rotor Average (axially cooled) , °C	105	105	

NOTE: The total temperatures above assume a cold coolant of 40°C and directly cooled rotor outlets greater than 14.

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