



# Synchronous Machine Datasheet

## GE ENERGY POWER CONVERSION RUGBY, ENGLAND

Ref: CY.20326.01.40  
Design No: 47406/D1.5.25  
Frame Size: G220QQ4  
Date: 18 Oct 2016

### PROJECT: GE OIL & GAS FOR CELTEJO STG, PORTUGAL

#### NAMEPLATE RATING

Rated Output (kVA)	pf (kW)	Poles	Phases	Voltage (V)	Current (A)	Frequency (Hz)	Speed (Rev/Min)	
58700	49895	0.85	4	3	11000	3081	50	1500

Enclosure: IP54 IC8A1W7 (CACW Totally enclosed water cooled)  
Stator winding connection: STAR  
Governing Standard: IEC 60034

Maximum stator operating temperature	125	deg C
Maximum field operating temperature	130	deg C
Design water inlet temperature	25	deg C
Maximum operating altitude	1000	metres
Insulation system	Class F	
Total temperatures	Class B	
Overspeed	1800	rev/min

#### PERFORMANCE OF SALIENT POLE GENERATOR

All performance figures are subject to tolerances in IEC 60034.  
Efficiencies will be determined in accordance with IEC 60034 using the summation of losses method including excitation and stray load losses.  
Reactances are subject to a tolerance of +/- 15% unless otherwise stated.  
X'd is subject to tolerances of -15% +10%.  
X" d is subject to tolerances of -10% +15%.  
Time constants and pu resistances are subject to a tolerance of +/- 30%.  
Resistances in ohms and the short circuit ratio are subject to a tolerance of +/- 10%.  
All losses, efficiencies, pu resistances and time constants are quoted at a temperature of 95 deg C.  
Only the total loss at nameplate rating is guaranteed (subject to tolerance).

pu rated power	1	0.75	0.5	0.25
Output Power kW	49895	37421	24948	12474
Input power kW	50626	38002	25420	12878
Stator current amp	3081	2311	1541	770
Field current amp	623	511	408	315
Friction loss kW	220	220	220	220
Iron loss kW	134.6	134.6	134.6	134.6
St.Cu+str.loss kW	239.9	134.9	60	15
Excitation loss kW	136.1	91.6	58.3	34.9
Total loss kW	730.5	581.1	472.8	404.5
Efficiency	0.9856	0.9847	0.9814	0.9686
Power factor	0.85	0.85	0.85	0.85
compared with 1 pf	over-	over-	over-	over-
	excited	excited	excited	excited



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Base impedance 2.061 ohms

			Rated I (unsaturated)	Rated V (saturated)	
Synchronous reactance	D-Axis	Xd	1.897		pu
Transient reactance	D-Axis	X'd	0.301	0.251	pu
Sub-transient reactance	D-Axis	X''d	0.196	0.166	pu
Synchronous reactance	Q-Axis	Xq	1.035		pu
Sub-transient reactance	Q-Axis	X''q	0.239	0.188	pu
Stator winding leakage reactance		Xl	0.114		pu
Negative phase sequence reactance		X2	0.194		pu
Potier reactance		Xpot	0.266 pu at rated load		
Stator winding dc resistance		Ra	0.00231		pu
Positive phase sequence resistance		R1	0.00428		pu
Negative phase sequence resistance		R2	0.035		pu
Zero phase sequence reactance		X0	0.123		pu
Zero phase sequence resistance		R0	0.015		pu
OC transient time constant	DA	T'do	6.92		s
SC transient time constant	DA	T'd	1.102	0.825	s
OC sub-transient time constant	DA	T''do	0.046		s
SC sub-transient time constant	DA	T''d	0.030	0.045	s
OC sub-transient time constant	QA	T''qo	0.172		s
SC sub-transient time constant	QA	T''q	0.040		s
Armature dc time constant		Ta	0.338	0.276	s
Stator winding dc resistance (phase)			0.00367		ohm at 20 C
Field winding dc resistance			0.229		ohm at 20 C
Exciter armature dc resistance (phase)			0.00616		ohm at 20 C
Exciter field winding dc resistance			9.57		ohm at 20 C
Permanent field protective resistor			9		ohm
Short circuit ratio				0.548	
Maximum kVAR available at 0 pf under-excited				0.45	pu
Maximum kVAR available at 0 pf over-excited				0.73	pu
Saturation factor S(1.0)				1.04	
Saturation factor S(1.2)				1.27	

## EXCITATION

	Main field current	Main field voltage	Exciter field current	Exciter field voltage
Rated load at 0.85 pf over-excited	623	199	7.3	86
Rated kW at 1 pf	429	137	5.1	59
Rated voltage on open circuit	240	77	2.9	33
Rated current on short circuit	438	140	5.2	60
3 x rated current on short circuit	1321	422	16.2	189
Exciter response from rated load IEC 60034			4.38	pu/s

## MECHANICAL

Full load torque (1 pu)	322.25	kN.m
Rotor Inertia WR2	4925	kg.m <sup>2</sup>
Rotor inertia constant	1.04	s
Approx cooling water quantity (whole machine)	35	L/s



# Synchronous Machine Datasheet

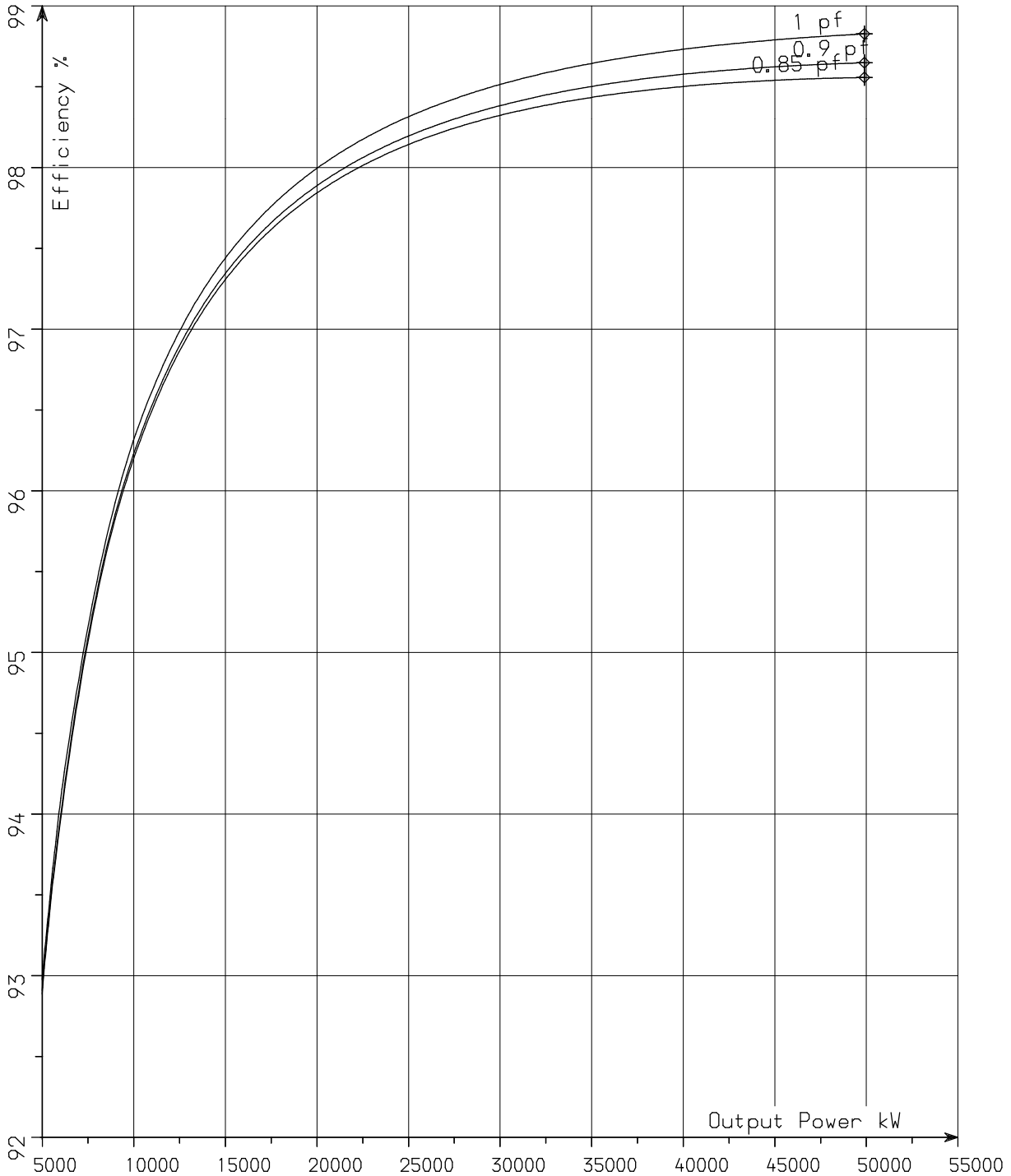
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Curve: 47406/D1/EC  
Ref. CY.20326.01.40

## EFFICIENCY - OUTPUT POWER

GE Oil & Gas for Celtejo STG, Portugal  
Synchronous Generator 58700kVA 0.85PF 4 Poles 11kV 50Hz 1500 rev/min

Efficiency is calculated in accordance with IEC60034 for a temperature of 95 Deg C and for rated voltage and frequency.



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# Synchronous Machine Datasheet

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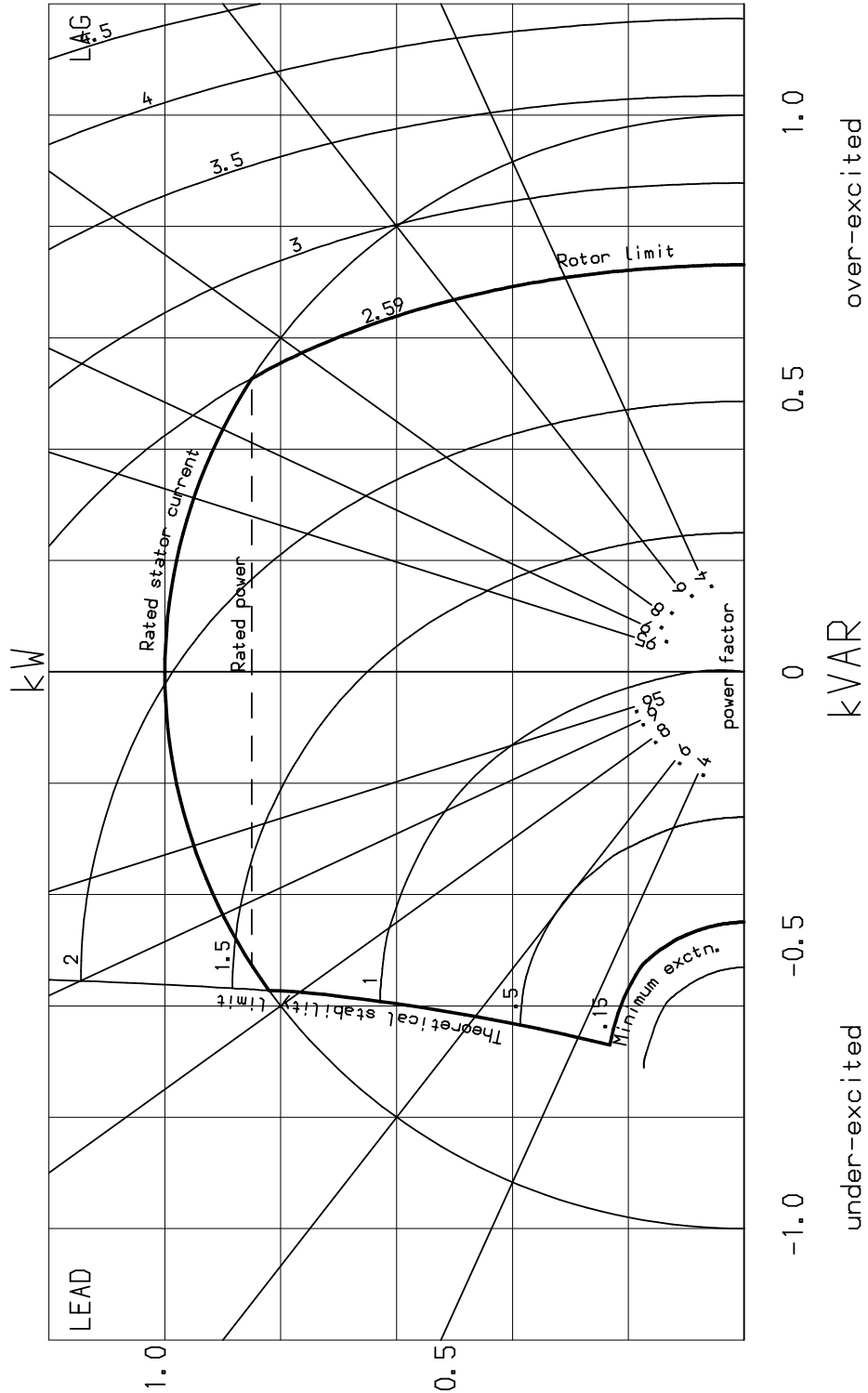
Curve: 47406/D1/PC

Ref.: UK. CY. 20326. 01. 40

## SYNCHRONOUS MACHINE POWER CHART

GE Oil & Gas for Celtejo STG, Portugal

Synchronous Generator 58700kVA 0.85PF 4 Poles 11kV 50Hz 1500 rev/min  
1 pu kVA = 58700 1 pu Field Current = 240.2 Amps



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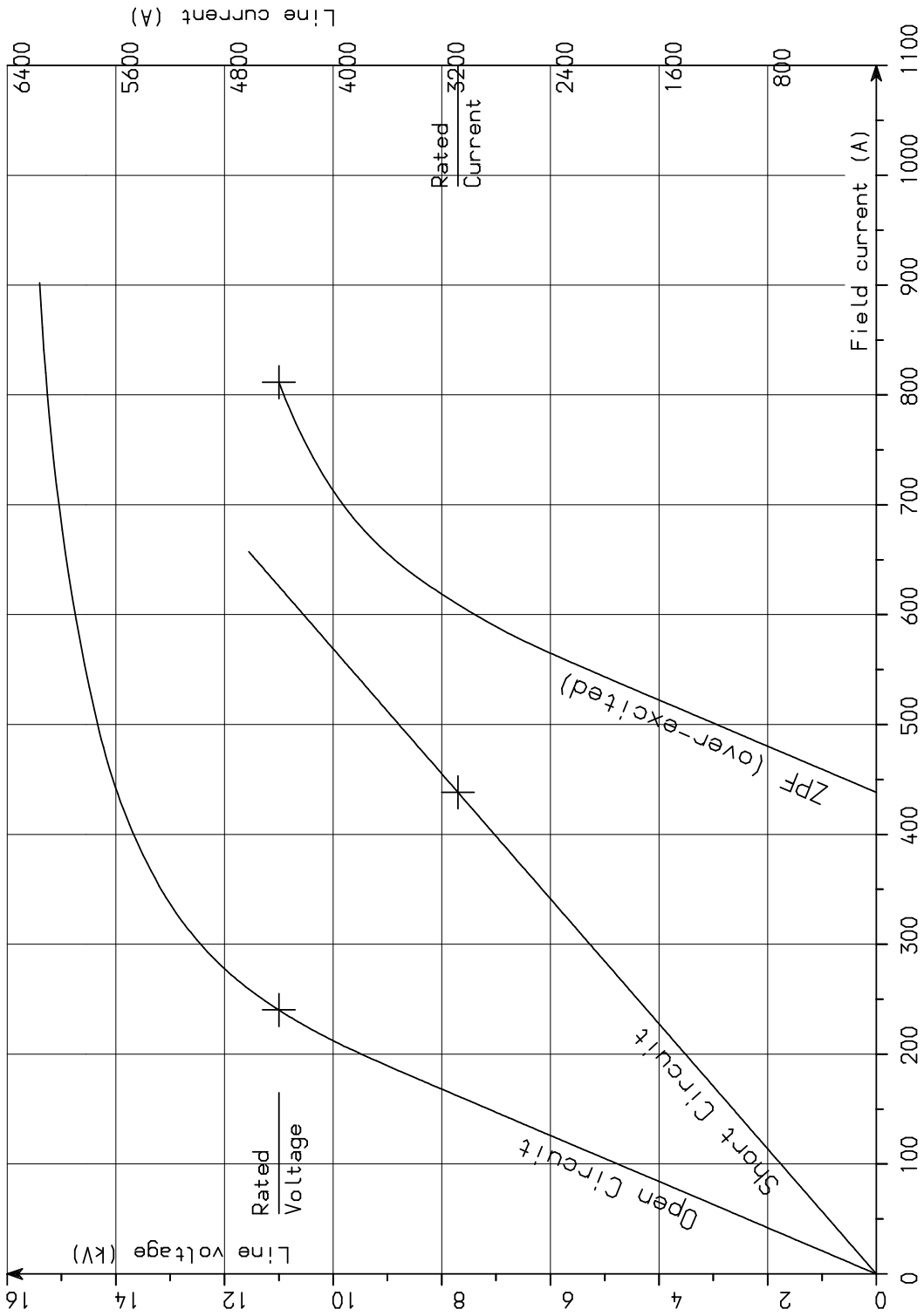
Curve: 47406/D1/SAT

Ref. CY. 20326.01.40

## SYNCHRONOUS MACHINE SATURATION CURVES

GE Oil & Gas for Celtejo STG, Portugal

Synchronous Generator 58700kVA 0.85PF 4 Poles 11kV 50Hz 1500 rev/min



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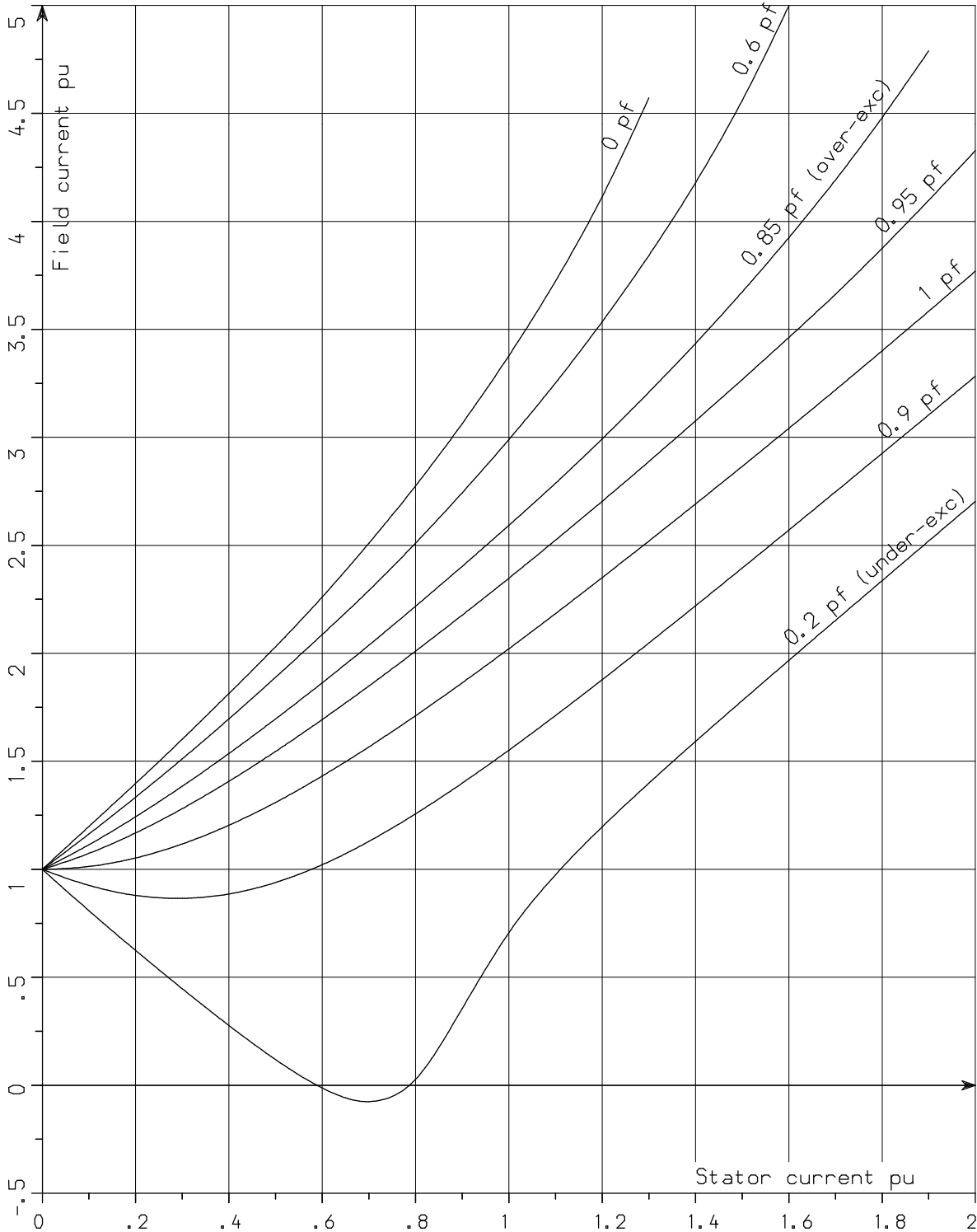
# Synchronous Machine Datasheet

GE Energy Power Conversion

Curve: 47406/D1/VC  
Ref. UK. CY. 20326. 01. 40

## V-CURVES

GE Oil & Gas for Celtejo STG, Portugal  
Synchronous Generator 58700kVA 0.85PF 4 Poles 11kV 50Hz 1500 rev/min  
Operation at 1 pu voltage 1 pu speed. 1 pu Field Current = 240.2 Amps



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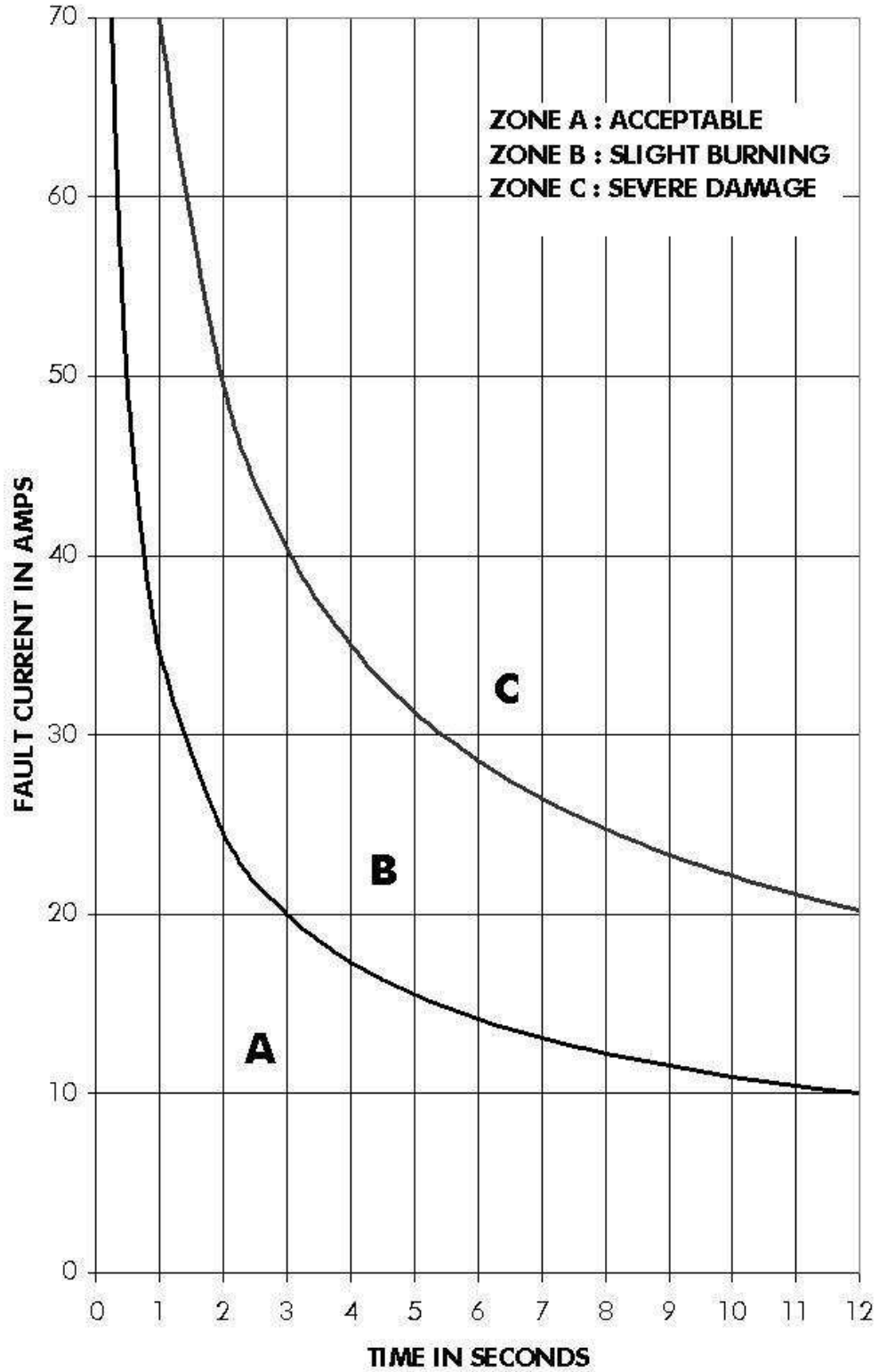
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### STATOR CORE LAMINATION CURRENT - TIME CURVE

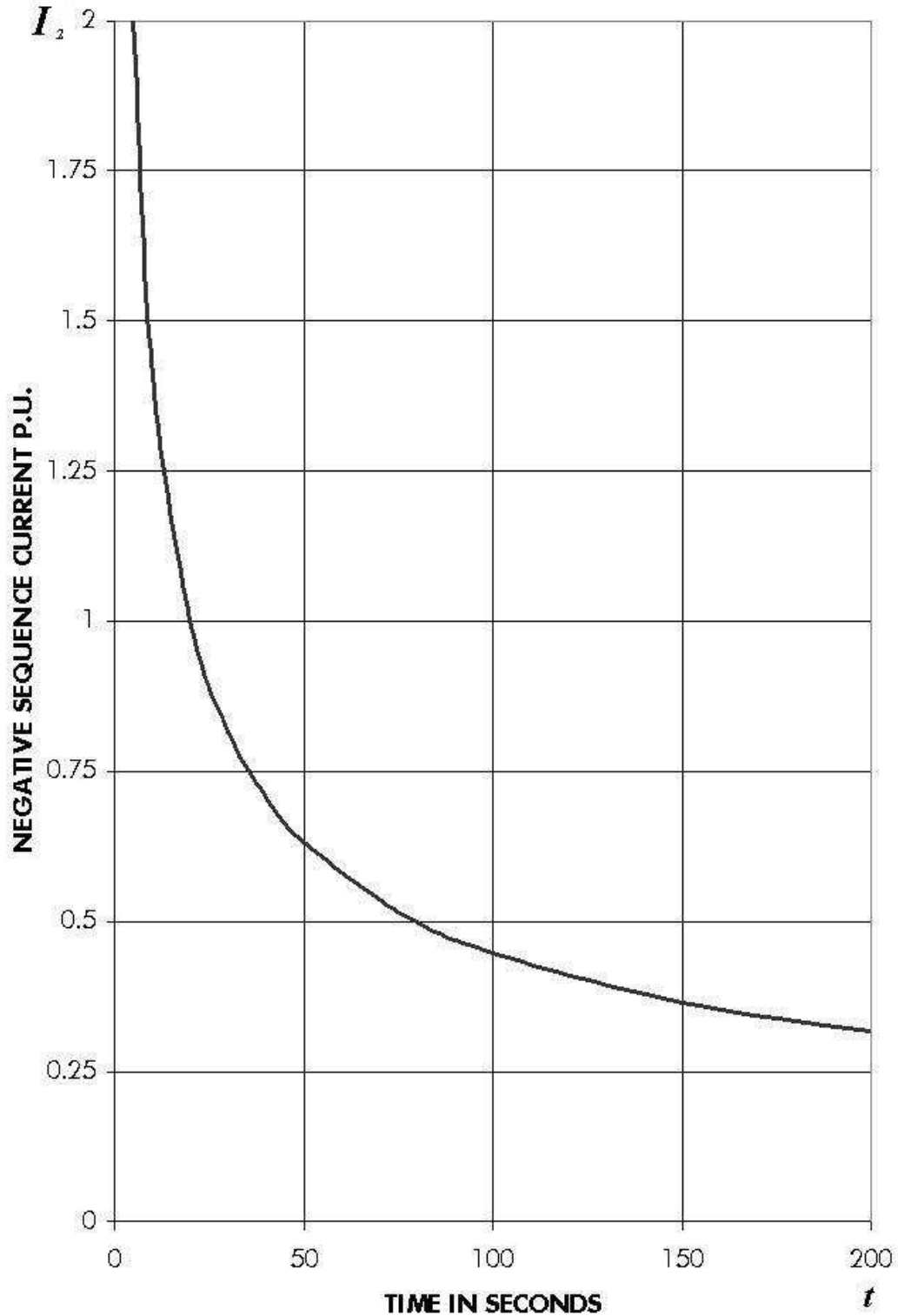




### NEGATIVE PHASE SEQUENCE CURRENT WITHSTAND

Maximum continuous negative sequence current is 8% for generators as defined in Table 2 of BS EN/IEC 60034-1 (2010).

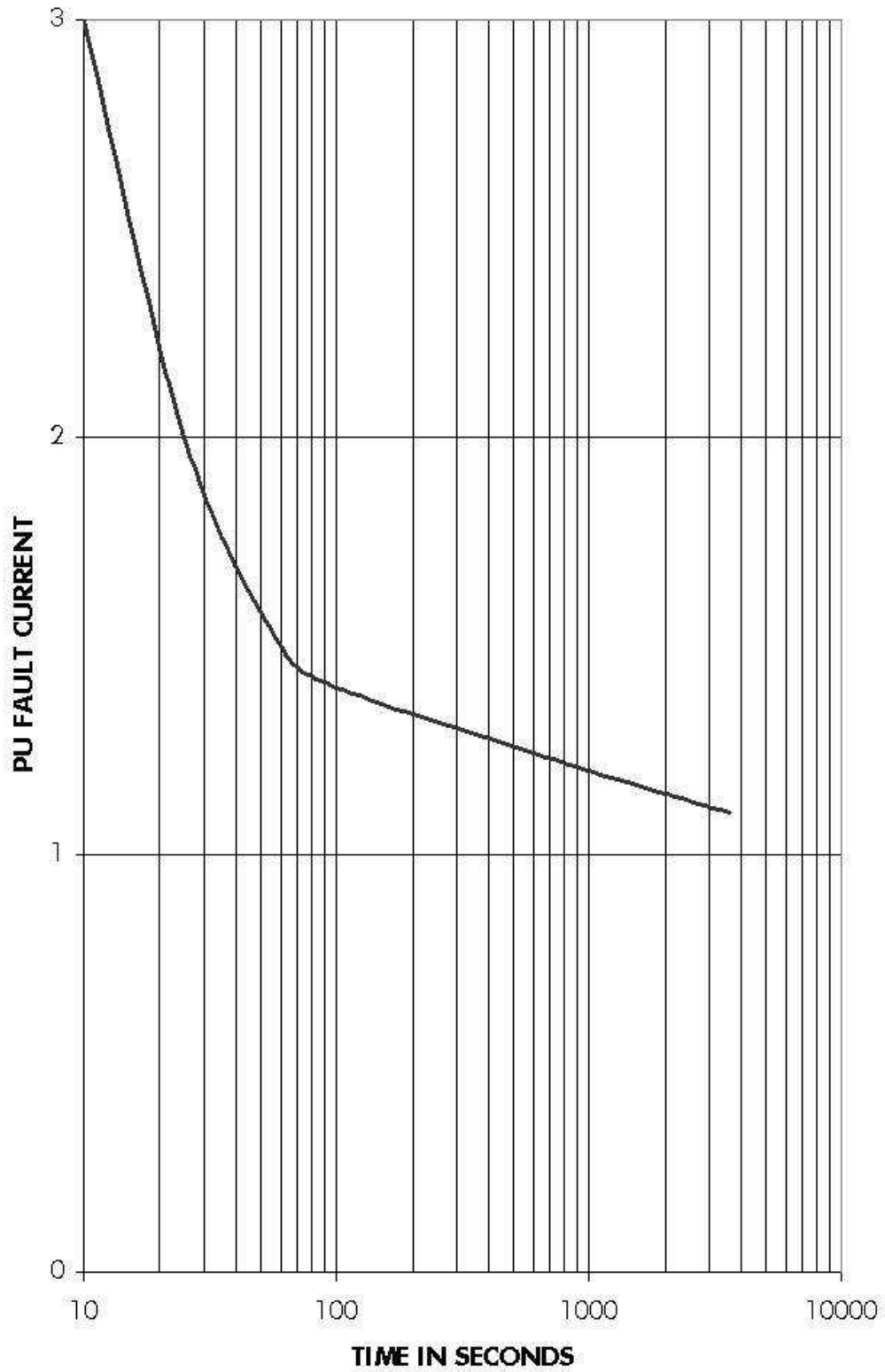
$$I_2^2 t = 20$$





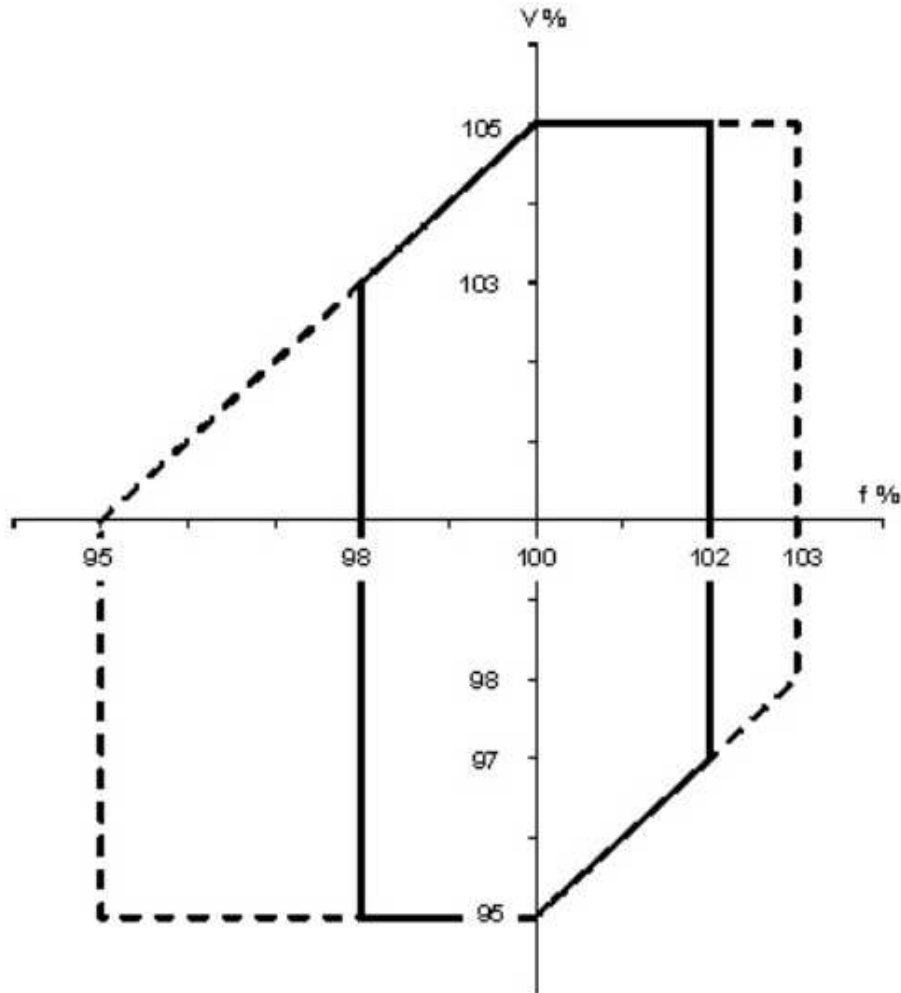


### THERMAL DAMAGE CURVE





**Operation Over Ranges of Voltage and Frequency**



**In accordance with clause 4.6 of IEC 60034-3:2007 & BS EN 60034-3:2008**

Generators shall be capable of continuous rated output at the rated power factor over the ranges of  $\pm 5\%$  in voltage and  $\pm 2\%$  in frequency, as defined by the solid boundary above.

The temperature rise limits in Tables 7 and 8, or the temperature limits in Table 12 of IEC/BS EN 60034-1 shall apply at the rated voltage and frequency only.

NOTE 1 As the operating point moves away from the rated values of voltage and frequency, the temperature rise or total temperatures may progressively increase. Continuous operation at rated output at certain parts of the solid boundary causes temperature rises to increase by up to 10K approximately. Generators will also carry output at rated power factor within the ranges of  $\pm 5\%$  in voltage and  $+3\%$ - $5\%$  in frequency, as defined by the dotted boundary above, but temperature rises will be further increased. Therefore, to minimise the reduction of the generator's lifetime due to the effects of temperature or temperature differences, operation outside the solid boundary should be limited in extent, duration and frequency of occurrence. The output should be reduced or other corrective measures taken as soon as practicable.