STAMFORD | AvK ™

POWERING TOMORROW, TOGETHER

Application Guidance Notes: Technical Information from STAMFORD | AvK

AGN 007 - Testing

POLICY

The following is offered as an explanation of the policy and procedures followed by STAMFORD I AvK (Cummins Generator Technologies) to provide traceable and Quality Management System supported technical documentation regarding the performance details of their range of AC generators (alternators).

Qualification

National and International Engineering Standards exist which are aimed at identifying the technical performance capabilities of rotating electrical machines, and this includes AC generators as manufactured by STAMFORD | AvK. Within the library of such Engineering Standards are Sections and Parts, which specifically describe test methods for establishing machine quantities, and also identify the allowable tolerances associated with each parameter's quantity.

Examples of the most commonly encountered documents that describe test methods for rotating electrical machines are:

IEC60034, ISO 8528, NEMA-MG1, MIL-STD-705, IEEE115.

Within the existing library of National and International Engineering Standards are technical descriptions of performance levels qualified by various codes, which identify the 'performance class', and also technical explanations regarding use of the various machine quantities for calculating the performance of an alternator under various operating conditions.

Authentication

When a manufacturer of an alternator claims compliance to a particular National or International Engineering Standard, then this claim has to be supported by a Quality Management System that this manufacturer has in place to monitor and maintain compliance.

It must be understood that the bodies which control and support National and International Engineering Standards do not issue compliance certificates. That is not the responsibility of such organisations; they are formed to offer technical guidance, and a common language for users of technical products, to qualify and explain performance abilities.

A certification document will only be provided by a Body which issues a Specification, examples of such bodies are: CSA, UL and Marine Classifying Societies.

For detailed information on Quality Management, refer to **AGN006 – Codes, Standards and Directives.**

Validation (Routine Test)

STAMFORD | AvK have a Quality Management System covering the design and testing of the products that comply with the test methods described within the above mentioned examples of National and International Engineering Standards, which identify the methods for determining synchronous machine quantities from tests.

All STAMFORD | AvK alternators are tested in accordance with the requirements of IEC 60034-1. ‘Routine” (or Factory) Tests, which should not be confused with prototype or quality sample testing, specifically complies with Section 9.1, Table 15, of this standard. There follows, a list of tests carried out during ‘Routine Testing’ on products in the STAMFORD and AvK ranges:

S0/S1, UC22, UC27, S4, HC5 (S5), S6 & P7 (S7) Products

Test Description		Standard routine test
1.	Visual inspection and mechanical check	**x**
2.	Winding and accessory resistances measurement	**x**
3.	Winding insulation resistance	**x**

4.	Phase sequence test	**x**
5.	AC high voltage test	**x**
6.	Functional test of AVR system	**x**
7.	Adjustment of Droop/ Power Factor Controller (if fitted)	**x**
8.	Output voltage balance check	**x**
9.	No-load losses at unity power factor	**x**
10.	No-load excitation current at rated speed	**x**
11.	Vibration measurement (S4 and above) – for other frame sizes: tested as part of Quality Sampling process only	**x**

In accordance with the ISO9001 QA System, STAMFORD | AvK adopt a 'paperless' method of testing for the majority of the STAMFORD products (S0 to S7 range). This means that the results of the routine tests carried out during production are not recorded, or documented.

The STAMFORD | AvK Quality Management System is based on each component test station having a pre-programmed test procedure, which operates on a; **Go / No Go** control basis, with this system not issuing a test certificate. If a customer order includes a request for 'Factory Test Certificate', this will be produced at final point of documentation control for the alternator, prior to despatch.

S9 and MV7 Products

For the S9 and MV7 products, a different test process is used, to that used on other STAMFORD products, in that a Routine Test Certificate is issued together with every alternator despatched from the factory. The list of Routine Tests are as outlined in the following table:

Notes:
LV (Low Voltage): 0 – 1100V
MV (Medium Voltage): 1101V – 4400V
HV (High Voltage): 4401V – 15000V

Test Description		LV	MV	HV
1.	Winding insulation resistance	**x**	**x**	**x**
2.	Polarisation index		**x**	**x**
3.	Tan delta characteristic		**x**	**x**
4.	Insulation time constant		**x**	**x**
5.	Winding and accessory resistances measurement	**x**	**x**	**x**
6.	Vibration measurement	**x**	**x**	**x**
7.	No-load losses and excitation at rated voltage, speed	**x**	**x**	**x**
8.	No-load losses unexcited at rated speed; residual voltage	**x**	**x**	**x**

9.	No-load voltage regulation	x	x	x
10.	Output voltage balance	x	x	x
11.	Output current balance	x	x	x
12.	Short-circuit losses at rated current and speed	x	x	x
13.	Phase sequence test	x	x	x
14.	Functional test of AVR system	x	x	x
15.	AC high voltage test	x	x	x

AvK – DIG, DSG and DSU Products

AvK products (DIG, DSG and DSU) undergo a more comprehensive Routine test programme, which is detailed in the following table. A 'Routine Test Certificate' is issued with the supply of each alternator.

In the case of multiple alternator orders of the same specification - ordered together - the 'Repeat Tests' are carried out on the second and subsequent alternators rather than the full Standard Tests. Standard Tests, as listed, are carried out on the first alternator only, in this case.

Test Description		Standard test	Repeat test
1.	Measurement of resistances (cold)	x	x
2.	No-load characteristic, remanent voltage, winding test	x	
2.1	No-load characteristic	x	
2.2	Winding test	x	x
2.3	Remanent voltage	x	x
3.	Short-circuit characteristic, overload test, SCR, Xd	x	
3.1	Short-circuit characteristic	x	
3.2	Overload test	x	x
3.3	Short-circuit ratio SCR	x	
3.4	Evaluation of synchronuous reactance Xd	x	
4.	Rotating field control / phase sequence check	x	x
5.	Output voltage balance	x	x
6.	Functional test of AVR-System	x	x
6.1	Adjustment of voltage regulator	x	x
6.2	Adjustment of underspeed protection	x	x
6.3	Check of voltage adjustment range	x	x

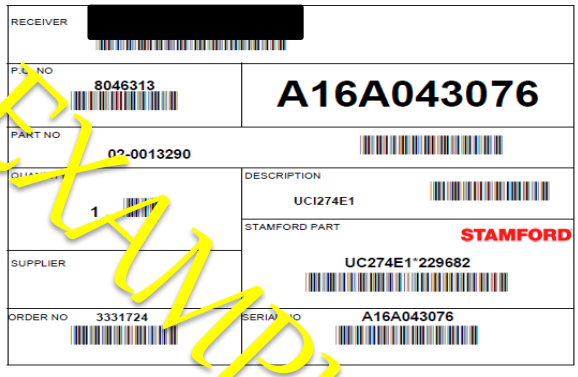
6.4	Adjustment of the parallel operation mode/ static droop (def. -3%@In)	x	x
6.5	Adjustment of additional modules/ features for voltage regulator	x	x
7.	Load characteristic at p.f. = 0,1	x	x
8.	Overspeed test	x	x
9.	Vibration measurement	x	x
10.	AC high voltage test	x	x
11.	Measurement of insulation resistance	x	x
12.	Determination of efficiency (calculated based on Tests 2.1, 3.1+13)	x	
13.	Determination of rated field current	x	
14.	Sustained short circuit test	x	x

Certificate of Conformity (C of C)

STAMFORD alternators are dispatched with a Certificate of Conformity (C of C). This should not be confused with the EU Declaration of Conformity.

During the manufacture of the alternator's components parts, tests are conducted to ensure that each stage of the manufacturing process has resulted in the building of a component that complies with design performance criteria. The "C of C" document offers assurance that the despatched alternator has been manufactured and tested in compliance with the Standards claimed within the Quality Management System.

An example of the Certificate of Conformity follows:


RECEIVER [redacted]

P.O. NO 8046313

A16A043076

PART NO 02-0013290

QUANTITY 1

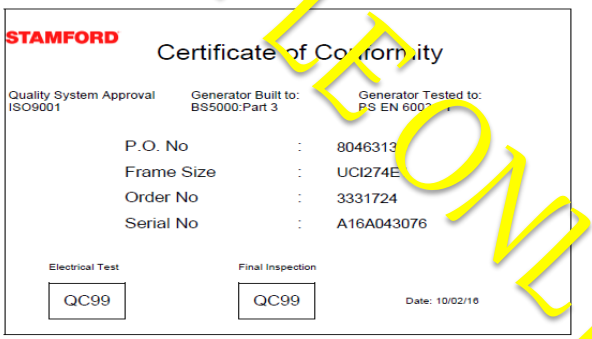
DESCRIPTION UCI274E1

STAMFORD PART UC274E1*229682

SUPPLIER STAMFORD

ORDER NO 3331724

SERIAL NO A16A043076


STAMFORD

Certificate of Conformity

Quality System Approval ISO9001

Generator Built to: BS5000:Part 3

Generator Tested to: BS EN 600[illegible]

P.O. No : 8046313

Frame Size : UCI274E

Order No : 3331724

Serial No : A16A043076

Electrical Test QC99

Final Inspection QC99

Date: 10/02/16

Typical Test Data (Type Test Data)

If typical test data is requested for an alternator, then this is provided as “Typical of the Design” and with values that have tolerances as described in IEC 60034-1, not an individual alternator’s C of C.

Declaration of Conformity and Declaration of Incorporation

To comply with EU Directives regarding CE Marking, every alternator is despatched with either a Declaration of Conformity or Declaration of Incorporation as part of the Quality Management System documentation. These documents provide evidence that the despatched alternator has been designed, manufactured and tested in compliance with the statutory requirements of the relevant EU Directives for AC generators (alternators).

A Declaration of Conformity is issued with every completely built synchronous AC generator and declares that the alternator is designed for installation into a Generating Set or power system. It declares provisions and requirements of the relevant European Directives when installed in accordance with the installation instructions of these directives.

The Declaration of Incorporation is issued for partly completed synchronous AC generators, where the alternator leaves the factory in a format that meets the customer’s contractual requirement for the alternator, but a CE mark cannot be applied, because the alternator is not complete (for example – without a terminal box).

For further detail, refer to **AGN006 – Codes, Standards and Directives.**

Additional Tests

In line with IEC 60034-1, additional post production tests may be carried out, as requested by the customer at the time of alternator order. Documented results will be despatched with the alternator. It is also possible for the customer, or his representative, to witness the tests carried out on his alternator. These additional tests are chargeable.

STAMFORD Products

The list of tests on the following page, can also be found on the Pricing Guide.

ES100	Insulation Resistance	
ES101	Polarisation Index	
ES110	Winding Resistance	
ES120	High Voltage AC Breakdown	
ER100	Phase Sequence	
ER110	Voltage Unbalance	
ER120	Voltage Regulation	
ER121	Residual Voltage (Self exciting machines)	
ER130	Open-circuit Characteristics OCC	
ER131	Short-circuit Characteristics SCC	
ER132	D-axis Unsaturated Synchronous Reactance Xdu (+ ER130 & 131)	
ER140	Temperature Rise Test (Heat Run)	
ER150	Sustained Short-circuit Self Excited	
ER152	Momentary Overload	
ER160	Transient Voltage Dip And Recovery Time (1 Dip)	
ER161	Transient Voltage Rise And Recovery Time	
ER162	Volts Dip Characteristic (5x dip @ Zero Power Factor)	
ER170	Waveform Analysis.(NL,FL, 0.8, 1.0,L-L,L-N)	
ER171	Waveform Distortion Factor (+ ER170)	
ER172	Telephone Harmonic Factor (50Hz) (+ ER170)	
ER173	Telephone Influenece Factor (60Hz) (+ ER170)	
ER180	Waveform Graph (+ ER170)	
ER181	Waveform Deviation Factor	
ER190	Short Circuit Decrement Curve With Separate Excitation **3 Phases	Not recommended on Customer machines. Calculations are available through our Engineering Department.
	Note: This includes the following results for reactances and time constants.	
	ER191 - D-axis Saturated Synchronous Reactance Xd	
	ER192 - D-axis Transient Reactance X'd	
	ER193 - D-axis Subtransient Reactance X"d	
	ER194 - D-axis Transient Short-circuit Time Constant T'd	
	ER195 - D-axis Subtransient Open-ciruit Time Constant T"d	
ER200	D-axis Transient Open Circuit Time Constant Tdo (Only If Slip Rings Fitted)	
ER210	Negative Sequence Reactance X2	
ER220	Zero Sequence Reactance Xo	
ER230	No-load Losses	
ER231	Full-load Losses (Machine Required To Be Up To Temperature)	
ER232	Full-Load Losses + Efficiency (Includes ER230 &231)	
MR100	Overspeed (120%)	
MR110	Vibration	
MR120	Airflow	

AvK – DIG, DSG and DSU Products

The available additional tests are as follows.

1.	Temperature rise test
2.	Sudden short circuit test at partial voltage (for X_d', X_d'', T_d', T_d'') only for Low Voltage - 50% U nominal
3.	Harmonic analysis of voltage waveform, THD
4.	Sudden load application at p.f.0,1 , diagram; max 2000 kVA for HV and 2500 kVA for LV
5.	Noise pressure level measurement without harmonics
6.	Polarization index measurement
7.	Shaft voltage measurement
8.	Tan delta measurement for each stator winding phase
9.	Negative-phase sequence test *(R_2, X_2)*
10.	Zero resistance R_0 and reactance X_0

stamford-avk@cummins.com
www.stamford-avk.com

STAMFORD | AvK ™

POWERING TOMORROW, TOGETHER