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No.: 66301/Policy-07/DQA(N)/QA-07

09 Aug 16

All the Establishments under DQA (N)

GUIDELINES FOR ENVIRONMENTAL STRESS SCREENING (ESS) OF NAVAL ELECTRICAL/ELECTRONIC EQUIPMENT

Background

1. Refer to this Directorate letter of even number dated 14 Jun 13.

2. This Directorate, vide letter ibid, have brought out the requirement of carrying out Environmental Stress Screening (ESS) on Electronic items and emphasized about the methodology to be adopted for conduct of ESS. ESS is a product specific programme and therefore, specific screen strength needs to be defined for type of product. Stress screening is a part of manufacturing process in which the simulated environmental stresses are used to screen out those failures that would otherwise occur in the field. The stress should be closely tailored to the equipment's design capability to provide an effective screen without damaging good components.

3. Difficulties in formulating ESS plan has, however, been reported by few manufacturers as per the letter ibid. Most of the manufacturers resorted to use of sample screen strengths of ESS indicated in the letter ibid (for the purpose of guidance), for their ESS programs which were observed to be difficult for implementation on their products.

Aim

4. The aim of this letter is to lay down guidelines for formulation of effective ESS programme and methodology for conduct of ESS on Electronic Components/Units/ PCBs/Modules. The guidelines also provide directions to manufacturing agencies to incorporate tests at the design and manufacturing stage to weed out such deficiencies, which can manifest at a later stage causing avoidable down time of the equipment and expensive corrective action thereupon.

Applicability of ESS

5. **Indigenous Manufacturing**. The ESS is to be applied to 100% electronic components/units/assemblies as part of manufacturing process for indigenously manufactured electronics. Hardware incorporating purely mechanical system/elements including wire wrapped backplanes and fragile electronic items viz. LCD panels, Hard Disk Drives etc. may be exempted from ESS.

6. The present guidelines will be applicable for the new POs placed after promulgation of this policy. For all previous POs, ESS plan as per approved QAP may be followed. For new orders pertaining to spares of Systems/Equipment supplied earlier, ESS scheme as per guidelines in vogue/as conducted at the time of delivery of the system would be applicable.

7. **Applicability for Imported/COTS Items**. In case of imported and COTS items, following guidelines will apply:-

(a) During the course of production, a variety of imported/COTS items (components/PCBs/modules) may be used by the manufacturer of main system. ESS on such items is to be carried out at the next higher indenture level. The severities are to be decided based on designed parameter of weakest component as per data sheets of components in order to ensure that there is no damage to the used part whilst conduct of ESS.

(b) However, in case the Imported items are being supplied by the manufacturer in 'As It Is' condition with no addition/alternations, such items are to be accepted based on CoCs clearly endorsing the standards to which the items comply and physical values of test conditions the items have been subjected to ESS.

(c) Use of fully finished COTS items needs to be specifically approved by IHQ MoD(N)/(Professional Dtes)/OPA and are to be accepted against CoCs as in case of 'As It Is' imported items.

ESS Programme

8. It is necessary to conduct ESS at the earliest possible stages where it is possible to reveal latent defects and initiate necessary corrective actions. Following needs consideration while devising effective ESS programme:-

(a) A viable ESS program must be dynamic wherein the screen parameters must be actively managed and tailored to the particular characteristics of the equipment being screened.

(b) Effective ESS program generally involve more than one type of screen.

(c) Thermal cycling and random vibration are considered the first and second most effective screens respectively in identifying latent defects.

(d) While severity of the applied stress screen must be strong enough to effectively reveal the latent defects, care must also be taken not to over-stress the item which could either cause damage or reduction in residual life. At the same time, non-precipitation of latent defects is indication of weak stress level. The stress must conform to stringent level within designed parameters of the weakest component. Design parameters are generally much higher than the operating parameters.

(e) ESS is applied to 100% of the units manufactured including spares and repaired units.

ESS Process Sequence

9. The electronic hardware is recommended to be screened as per the following sequence:-

Stage-1 : Perform thermal cycling screening at PCB level

Stage-2 : Perform random vibration at PCB level or higher indenture

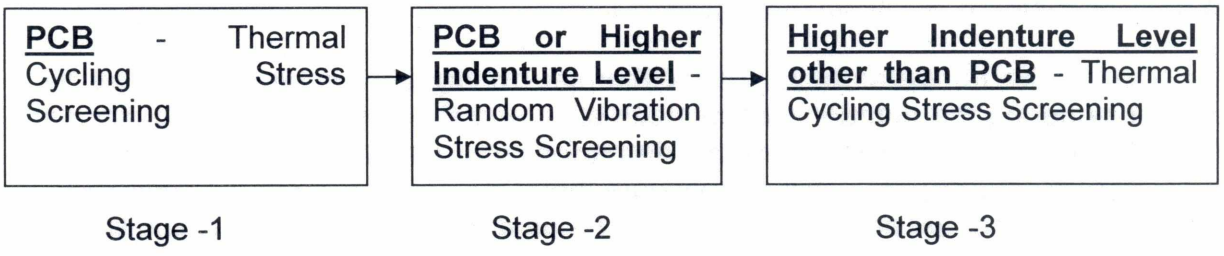
Stage-3 : Repeat thermal cycling screening at an indenture higher than PCB level

10. The conduct of thermal cycling prior to random vibration pre-stresses potential defects which can then be surfaced more effectively by random vibration. Random vibration also conditions some defects to the point of failure which are detected by a subsequent thermal cycling with performance monitoring. All ESS requirements must be accomplished at the lowest feasible level of assembly. The following three indenture levels have been identified for conduct of ESS: -

(a) PCB level

(b) Module/ sub-unit level

(c) Unit/Cabinet level



ESS Flow Diagram

11. **Screens for Conduct of ESS**. A tailored screen requires that specific parameters of equipment being screened, be reviewed such that defects are detected and removed without incurring undue damage to the equipment. The screening levels should not exceed design limits, but they must be of sufficient strength to precipitate failures due to weak parts and manufacturing defects at the earliest time such that corrections are most cost effective. Two screens each for Thermal Cycling Stress Screening (TCSS) and Random Vibration Stress Screening (RVSS) have been defined at **Encl 1 & 2** respectively. **In case a screen with severity below the above two screens is proposed for any item, approval of *Professional Directorate* is to be sought for use of such items with suitable justification. The screen for such cases would then be worked out based on the limitations imposed by the specifications of the items approved to be used.** Accordingly, the applicable screen severities can be categorized as follows: -

(a) **Screen-A (Severe)**. This would be the default screen with most stringent severity based on design parameters of weakest component for effective precipitation of latent defect.

(b) **Screen-B (Moderate)**. To be selected based on parameters of the items necessitating use of screen severity below the above Screen 'A' category. Prior approval for use of such items has to be obtained by the firm from Professional Directorate. The tailored screen would accordingly be specified in the QAP with suitable justifications. Reason for application of this screen for the item instead of Screen 'A' is to be justified in the QAP and list to be attached with QAP.

12. Based on the above process sequence and categorisation of screens, it is proposed to denote the stress severity of products as per the notation "Product (XXX)", where the first "X" represents thermal screen severity for Stage-1, the second "X" represents screen severity for random vibration at Stage-2 and third "X" represents thermal screen severity for Stage-3. For example "Item (ABB)" would indicate that the item is to be subjected to thermal stress as per screen 'A' in Stage-1, random vibration as per screen B in Stage-2 and thermal stress as per screen B in Stage-3. A proposed format for ESS plan is placed at Encl. 3.

13. **Thermal Cycling Stress Screening (TCSS)**. The following aspects are to be considered whilst conducting TCSS:-

(a) The temperature range for thermal cycling should be established by considering the component characteristics and the equipment specifications for maximum and minimum designed values under operating and storage conditions. The temperature range should be as large as component characteristics will permit regardless of the products intended operational limits.

(b) The rate of change of temperature between the extremes must be as rapid as possible to create the optimum level of thermal stress. The minimum acceptable rate of change is 5° C per minute.

(c) The number of cycles is more closely related to the temperature range and rate of change than to the equipment complexity or number of parts. Tailoring of this parameter is generally done based on the analysis of failures observed with the incremental number of cycles.

(d) Dwell time at maximum and minimum operating and storage temperatures should be only enough to achieve thermal stability.

14. **Random Vibration Stress Screening (RVSS)**. The following aspects are to be considered whilst conducting RVSS:-

(a) Random Vibration Stress Screening may be performed preferably at lower indenture level.

(b) The attitude or orientation of item for RVSS shall be decided based on the plane which provides maximum shear force to the soldered joints and components during random vibration. The RVSS is to be conducted preferably in all three axes.

(c) For a module level testing, the fixture shall be structurally rigid without causing resonance and further amplification to the Unit Under Test (UUT).

(d) EUT shall be subjected to sinusoidal sweep between 20-2000 Hz to identify the existence resonance prior to conduct of RVSS. If the equipment resonance frequencies fall within the input frequency range, excessive energy could be seen by the equipment and damage could occur. One of the following two measures may be taken in such cases: -

(i) Modify the equipment design to achieve a more rugged item to obtain a resonance falling outside the input frequency range.

(ii) Make a notch on the input profile eliminating frequency band of 5 Hz before and after the resonating frequency.

15. **Approval of ESS Programme**. The manufacturer is solely responsible for drawing up the ESS programme as the design parameters of the components are known to them. Once the ESS screen is finalized as per Encl.-1&2, the same is to be submitted to DQA(N) through respective field units for approval. Such ESS plan will be annexed to the QAP.

16. In view of the foregoing, following guidelines be adhered to regarding formulation and conduct of ESS: -

(a) Based on category of items viz. indigenously manufactured, Imported, COTS and applicability of ESS thereon, a draft ESS plan is to be submitted by the vendor to the Field Inspection agency as part of draft QAP and forwarded to DQA(N) for approval.

(b) The draft plan must conform to Screen Strength 'A' and 'B' of Encl. 1&2 and ESS severity plan as per Encl.3.

(c) Approval of IHQ MoD(N)(Professional Directorates) will be mandatory for use of item/component imposing restriction on default ESS screen 'A'.

(d) The draft ESS plan will be submitted alongwith draft QAP as an annexure for approval.

17. This letter supersedes all previous letters on ESS.

(Amit Rastogi)
Commodore
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Enclosure: As above

Copy to:-

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Enclosure-1 to DQA(N) letter No.: 66301/Policy-07/DQA(N)/QA-07 dated 09 Aug 16

THERMAL CYCLING STRESS SCREENING (TCSS)

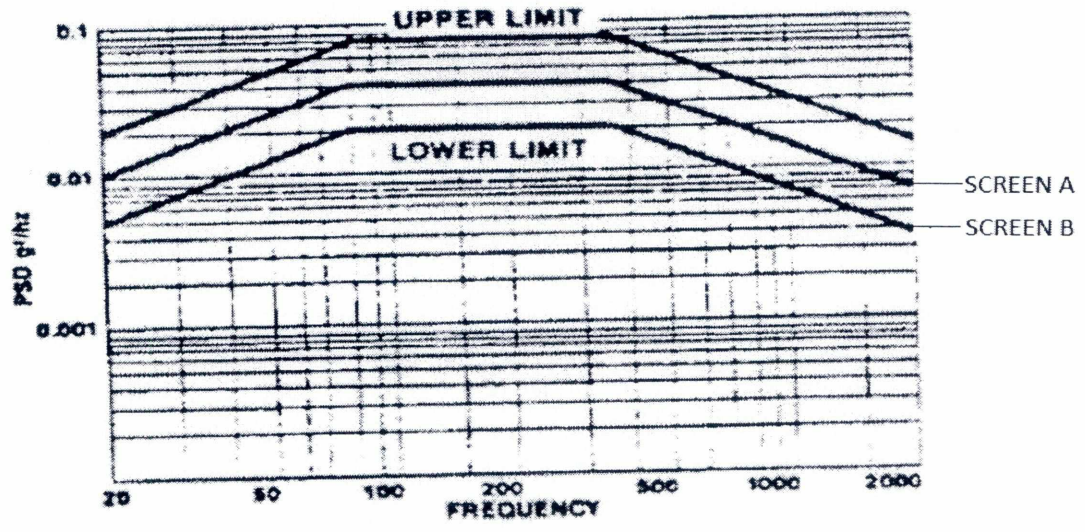
Sl. No.	Level	Screen	Test Details	Remarks
1	PCB Level	A	-40 °C to +70 °C, 10 Cycles (Ramp 10° C/min) or 20 Cycles (Ramp 5° C/min) Dwell: 10 min	Power OFF condition
		B	-20 °C to +55 °C, 10 Cycles (Ramp 10° C/min) or 20 Cycles (Ramp 5° C/min) Dwell: 10 min	
2	Sub Unit / Equipment	A	-30 °C to +55 °C, 6 Cycles (Ramp 10° C/min) or 12 Cycles (Ramp 5° C/min) Dwell: 10 min	Power ON condition
		B	-10 °C to +50 °C, 6 Cycles (Ramp 10° C/min) or 12 Cycles (Ramp 5° C/min) Dwell: 10 min	

Enclosure-2 to DQA(N) letter No.: 66301/Policy-07/DQA(N)/QA-07 dated 09 Aug 16

RANDOM VIBRATION STRESS SCREENING (RVSS)

Sl. No.	Level	Screen	Test Details	Remarks
1	PCB Level / Sub Unit / Equipment	A	20-80 Hz, +3db Octave 80-350 Hz, PSD 0.04 g^2/Hz 350-2000 Hz, -3db Octave 10 min per axis, G rms = 6.06 (Profile given below)	1. On all three axes. 2. Power ON condition
		B	20-80 Hz, +3db Octave 80-350 Hz, PSD 0.02 g^2/Hz 350-2000 Hz, -3db Octave 10 min per axis, G rms = 4.284 (Profile given below)	

Random Vibration Profile



Enclosure-3 to DQA(N) letter No.: 66301/Policy-07/DQA(N)/QA-07 dated 09 Aug 16

ESS: STRESS SEVERITY PLAN

Sl. No.	PCB Level/Sub Unit/ Equipment	Screen Parameters	Remarks
1	**SUB UNIT-1**		
	Nomenclature	XAA	
	Part No.		
	PCB LEVEL		
(A)	PCB Assy – A (MIL)	AXX	
	Part No.		
(B)	PCB Assy B(NON MIL)	BXX	
	Part No.		
2	**SUB UNIT -2**		
	Nomenclature	XBB	
	Part No.		
(A)	**PCB LEVEL**		
	PCB Assy – A (MIL)	AXX	
	Part No.		
(B)	PCB Assy – B (NON MIL)	BXX	
	Part No.		
3	**CABINET/EQUIVALENT LEVEL**		
(A)	Nomenclature – (MIL)	AAA	
	Part No.		
(B)	Nomenclature – (NON MIL)	BBB	
	Part No.		