

# Aviation Electrical Supplies, Safety and Compliance Provisions for Aircraft Ground Support Power Supplies – Consultant’s document

## Publication of Submissions

This document summarises the submissions received during the recent ‘call for submissions’ on the provisions and practices of the Consultant’s document.

It should be noted that the submissions listed in this document have yet to be reviewed and technically assessed. Once this assessment has been completed written responses will also be published on this web-site.

Note: During the assessment of these submissions the text will be reformatted, categorised with a response and re-published.

The Aviation Electrical Supplies Steering Committee (the AESSC) will meet to discuss the submissions, provide a response and determine the next steps.

## List of Submitters (alphabetical order)

| <b>Representing</b>         | <b>Submitter Name</b> |
|-----------------------------|-----------------------|
| Air New Zealand             | Kerry Marshall        |
| Airspec (NZ) Ltd.           | D Graham              |
| Auckland Airport            | Phil Grieve           |
| Douglas Watson              | Douglas Watson        |
| Swedish Standards Institute | Sven Radhe            |

## Table of Submissions (unordered)

| Item number | Submission text (text changed to areal and names removed, otherwise unedited)   |
|-------------|---|
| 1           | <p>Generally the document is very helpful but how it fits into the regulatory regime and how it is finally incorporated into a code of practice that is separate to other documents needs to be established to avoid overlap, lack of clarity and consequently confusion. Also somewhere who can approve compliant installations needs to be defined elsewhere rather than just in the document ie it needs to be in a clear regulatory framework.</p> <p>Specific comments on the document are as follows: -</p> <ol style="list-style-type: none"> <li>1 Clause 1.2 bullet point 4: the following highlighted item could be added: - "... the output power system and achieve low electrical noise <b>and harmonics</b>".</li> <li>2 Clause 2 (possibly or maybe elsewhere like under clause 2.3.3) it needs to be said that             <ol style="list-style-type: none"> <li>a. "Earthing: the resistance to ground needs to be regularly tested along with the frequency of test"</li> <li>b. GPU Extension Cable and fittings: needs to be water proof, abrasion proof and well protected.</li> </ol> </li> <li>3 Clause 2.3.3: An additional point we consider an important hazard is the inadequate maintenance of equipment. Regular inspection and maintenance is required of cables, fittings etc.</li> <li>4 Clause 2.3.7: One item not covered here is that "protection devices should be rated to fault current carrying capacity of the system".</li> <li>5 Cause 5.5.1: A possible addition to this clause is that all GPU installations shall be by registered electricians and the CoC shall be produced after completion – depending of course on the regulatory regime that covers training for suitable experience in this work.</li> </ol> |

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| 2 | <p>Under item 4.1: Operational and Maintenance rules (page 20) add:<br/> Engine driven GPU shall be equipped with oil catching facilities in order to prevent any pollution in to the ground, oil coming from leaking engines or other oil sources from the GPU.</p>   |
| 3 | <p><b>1.2 Technical Overview of Key Provisions</b></p> <p><b>1<sup>st</sup> Point.</b></p> <p><b>Allow older equipment to be used where the aircraft supplier allows this.</b></p> <p><i>Modern aircraft have built in protection on the input supply to ensure that the GPU meets the specifications required by the particular aircraft. Aircraft will reject a GPU that does not meet its requirements.</i></p> <p><i>One of my customers operates an aircraft that specifies Spec 704D and have a GPU that meets that requirement. Why should they change to one that meets 704F?</i></p> <p><b>1.2 2<sup>nd</sup> Point.</b></p> <p><b>This reference to ISO 6858 should be removed.</b></p> <p><i>ISO 6858 was published in 1982, prior to static converters and is very much dated. Most DC GPU's no longer meet many of the configurations specified in this document, especially in respect to interlock connections. There have been changes to aircraft design and digital control that now provide a level of safety the same or better than this Standard. Also, most GPU's now far exceed ISO 6858's performance specifications which most aircraft manufactures now require.</i></p> <p><b>3. Power Supply Performance</b></p> <p><b>Recommend Power Supply Performance is specified in other documents or by the Aircraft Manufacturer.</b></p> <p><i>Should it be contained in a compliance document as a result of this review it could well become outdated. What would take precedence, a compliance document or Mil Spec 704?</i></p> <p><b>4.2 Maintenance Rules</b></p> <p><b>(a) Remove the word monthly from the 1<sup>st</sup> paragraph and replace periods with:</b></p> |

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|  | <p><b>3 Monthly</b> AC GPU's are to be tested to ensure that the protection systems and any safety systems are functioning correctly including the condition and insulation resistance of the wiring.</p> <p><b>6 Monthly</b> AC &amp; DC GPU's, carry out a full functional test using loadbank to ensure performance specifications are met.</p> <p><b>NOTE 1</b> The period between testing may be extended provided that from documented evidence it can be shown that due to its usage, and environment, the failures and wear are well below the average.</p> <p><b>NOTE 2</b> The maintenance programme is to be continually reviewed and adjusted if required for abnormal failures or abnormal wear conditions.</p> <p><i>The document calls for monthly checks. I believe that this may be a typo but I will make the point anyhow as this would increase the cost to the airlines considerably. This recommendation is the current maintenance programme for most operators and works well. The programme is agreed between the operator and the maintenance provider.</i></p> <p><b>(f) Allow broader technical qualifications. Suggest "Qualified Electrical Engineer familiar with Aircraft and Industrial Power Equipment".</b></p> <p><i>This would add a major cost to the industry for little or no value. None of the manufactures I am aware of have a Chartered Engineer available.</i></p> <p><b>(h) (v) exclude Diesel trailer from these requirements.</b></p> <p><i>Portable Trailer type GPU's cannot sense an electrical earth.</i></p> <p><b>(vi) RCD's to be checked as per NZ AS/NZ 3760:2001 (or later)</b></p> <p><i>This document should also be referred to in section 1.6.1, Directly Applicable Standards and Guidance Material.</i></p> <p><b>5. Technical Requirements and System Design.</b></p> <p><b>5.2 Ref comments 4.2 (f) above</b></p> |
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**5.5.1 (a) (i) Exclude Trailer mounted diesel GPU's from these requirements.**

*I am not aware of any trailer type portable GPU in which the output neutral is not connected to the frame. Removing this connection causes faults which would require the rewiring of all units.*

**(b) (i) Replace complete paragraph with: "The output neutral of the GPU (aircraft power supply) shall be connected using "Option A" as the preferred method. However it may also be connected using "Option B" providing a "Lost Neutral" protection system is fitted.**

**Option "A" The Output Neutral shall not be solidly bonded to earth (floating) provided the earth/neutral voltage is monitored as specified in 5.5.1 (b) (iii). This requirement does not preclude a very high impedance coupling to earth that may be required to control noise on the aircraft power supply.**

**Option "B" The Neutral shall be solidly bonded to earth provided a system of monitoring the neutral for failure is fitted. (Lost Neutral)"**

*Refer general comments below.*

**(b) (iii) 50V should read "50 Volts AC or DC and varying frequency range".**

*Self explanatory.*

**(B) (iv) Remove paragraph.**

**(b) (vi) Exclude DC GPU's., Replace the word "continuity" with "connection"**

*This should only apply to AC units where a good earth is required for monitoring of the earth/neutral displacement. It would be very costly to include DC units.*

**ADD: RCD's to be mandatory for all mains powered GPU's.**

*Twenty years experience has shown that RCD's on the mains input provides a high level of safety and has no doubt prevented serious injury to operators.*

**Extra Items recommended to be added.**

- 1. All safety requirements should be included in any new compliance document.**

*For example "Insulation testing"*

2. **Current units shall be exempt from any new requirement if they are unable or it is impractical to comply with any new requirements. (Grandfather clause)**

*The cost of replacing 90% of all GPU's in NZ would be unacceptable to the industry.*

3. **Protection systems should be fail-safe**

*GPU's should be designed so that if the protection system faults, the output cannot be energised.*

4. **Insulation standards and procedures from NZ AS/NZ 3760:2001 (or later) should be included.**

*Self explanatory*

5. **Multi-boxes on the output of AC GPU's to be prohibited.**

*Prevents live output leads sitting on the hangar floor*

6. **Lost Neutral protection is mandatory for all AC GPU's.**

*All new AC GPU's have been fitted with this system in the last 4 years and has been a major improvement to safety.*

**General Comments:**

The method of connecting the output **earth** and **neutral** either together or to leave the neutral "floating" has been hotly debated over the last few years and has probably been the main driver of this review.

It is my option, both methods are acceptable provided certain safety protection is provided for each type of connection.

- a. For earth and neutral to be connected together, a "Lost Neutral System" must be fitted.
- b. For the earth and neutral to be separate (floating), a earth/neutral voltage displacement system must be fitted and regularly tested.

A cost/benefit study should be carried out on the recommendations or changes made in the document.

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**General comment**

- Agree with most of document but the proposed maintenance periodicities and some specific technical requirements would be very costly to industry. A detailed cost benefit analysis on all aspects of these proposals should be carried out See comments below.
- It should be mandatory to supply all mains powered GPUs via a personnel protection residual current device. The RCD must be within easy access of the users of the GPU. (The majority of GPUs in NZ are currently supplied via RCDs and experience has shown no nuisance tripping.
- The suggested periodicities for maintenance are prescriptive, there should be a performance based system prescribed. A maintenance regime should be performance based so that a hard used GPU in a hostile environment used by poorly trained or supervised staff will receive the required inspections and performance checks to keep it in good safe working order. The periodicity of these inspections and checks will be very quickly known to the maintenance personnel. A GPU which is kept in a hangar sees little use and is operated by aircraft engineers will not require anywhere near as many periodic inspections and performance checks.
- The requirements should be applicable to all areas of aviation where commercial activity takes place and all areas where the public may come into contact with GPUs or their associated electrical cabling - for example persons boarding an aeroplane.

**Comment on 1.1.2 Scope and Limitations of Provisions**

Refer last paragraph.

I feel the requirements for the quality of the electrical supply to aeroplanes is best specified by the aeroplane manufacturer and this document should concentrate on safety of supply. See comment on “3 Power Supply Performance” below.

**Comment on 1.2 Technical Overview of Key Provisions**

Refer to list of documents:

Bullet point 1. MIL-STD704F This may be too recent for a lot of in use GPUs.

Bullet point 2. ISO6858:1982 This is too old to cover modern inverter GPUs.

Bullet point 5. The neutral output wire is normally connected to the ground chassis of the unit in diesel powered 400Hz units – the chassis is not earthed.

**Comment on 1.4 Scope**

Refer to 1.4.2(b) Out of Scope 1.4.2(b)(ii) & (vi) & (vii) This document should apply to all operations for hire and reward, all sized aeroplanes. It should protect anybody associated with aeroplanes on the ground. The scope should not be limited to Jet A and Jet A1. There are still piston engined aeroplanes in use in NZ and smaller commercially used aeroplanes are often not turbine powered. Also bio fuels are already being trialled.

1.4.2(b)(iv) There could be commercially used aeroplanes in this classification in the future which should be covered by these requirements. See Civil Aviation Authority project scope statement for adventure aviation. The Scope Statement does not expressly exclude the experimental registration category and expressly encompasses all commercial activity in this area. See CAA website Rules Development CAR Part 115 - Adventure Aviation – Certification and Operations 5/CAR/1 Project Scope Statement Dated 20 October 2006.

#### **Comment on 1.7 Definitions and Terminology**

Refer to 1.7 (19) Multiboxes to allow 1 output cable to be split into 2 extension output cables should be specifically banned in this document. (1 GPU can be used to power 2 aeroplanes by the use of output multi boxes and extension cables.) Single extension cables ok.

#### **Comment on 2.2.2 Key Hazards**

Refer 2.2.2(a) Reword as follows: Flammable levels of fuel vapour can exist around aircraft and within enclosed servicing areas. System design and operating practice and procedures shall be designed to ensure that the use of electricity in the vicinity of aircraft when being fuelled, defuelled or having fuel transferred will not generate sources of ignition.

#### **Comment on 2.3 Specific Hazards**

Refer 2.3.2(c) Reword as follows: Spark ignition within the potentially hazardous vapour areas near aircraft when aircraft are being refuelled, defuelled or having fuel transferred; and

#### **Comment on 3 Power Supply Performance**

The required GPU performance should not be specified in this safety document, it should be left to the aircraft manufacturer to specify (via the aircraft operator).

Some aircraft are designed for very low quality external power and will check the quality and drop off critical systems if the power is not satisfactory – leaving the engine starting on line allowing lower cost GPUs to be used for engine starting.

**Comment on 3.1.2 28 VDC Power System Performance Requirements.**

Refer 3.1.2(c) This is not correct in NZ. A DC control conductor is not normally fitted to output cables. The link between the output plug +ve tube and the control socket in the plug is fitted.

**Comment on 4.2 Maintenance Rules**

In general the level of maintenance appears too high. Current experience would indicate that 6 monthly on busy ramps would be satisfactory, this period could be extended on a case by case basis where the GPU gets little use. Some GPUs are not used every day or week whereas on busy ramps they are heavily used with rough handling and in this latter situation 6 monthly checks have been found to be satisfactory with intermediate inspections.

No requirement for testing input insulation resistance has been included – should be included in periodic maintenance as per appliance testing. AS/NZS 3760

No requirement for physical inspection of input and output cables has been included. Physical inspection of both cables, general equipment condition and operation of all controls and indicators should be included in periodic maintenance. Examples of exposed 400V phase conductors have been found while GPUs are in operation!

Refer 4.2(a)(ii) See above for periodicity - and over/under frequency checks should be where practicable. (A GPU powered by a synchronous electric motor is very difficult to check for over frequency – it can be loaded down in frequency but its speed cannot be increased.

Refer 4.2(f) Maintenance personnel must not only have appropriate electrical trade qualifications and experience but also *competency* in *appropriate* industrial power systems.

Refer 4.2(f) Modifications, changes to design or systems should be reviewed and signed off by a professional electrical engineer who can demonstrate currency and competence in aircraft ground power systems. It could be difficult find a competent chartered engineer in these systems – most manufacturers and transformer winders do not employ them. REA level would normally be used.

Refer 4.2(h) Experience shows that this level of checks would normally be carried out 6 monthly with visual inspections in between. Daily visual inspection of cables, plugs and sockets and general condition by users should be mandatory.

**Comment on 4.3 Use of Portable Electrical Equipment On-board Aircraft**

Refer 4.3 There should be a requirement here to only allow double insulated appliances if they are mains powered.

**Comment on 5.2 Design of GPU Systems and Supplies**

There needs to a "grandfather" clause to allow older GPUs where the manufacturer is no longer in business to continue in use where it is practical to add any safety features required. The design sign off should be able to be carried out by an REA level professional engineer who is competent and current in aircraft ground power unit design.

**Comment on 5.5 Detailed Technical Requirements**

Refer 5.5.1(a) 400 Hz diesel GPUs normally have the output 400 Hz neutral connected to the chassis of the unit. The chassis is not deliberately earthed but can be close to earth during wet weather.

Refer 5.5.1(a) Add another clause (vi) Output cable multiboxes shall not be allowed. (Multiboxes allow 1 output cable to be split and feed 2 output cable extensions.)

Refer 5.5.1(b) Note Change *recommended* to *compulsory* and add *personnel protection between system and RCD*.

Refer 5.5.1(b)(iii) Last sentence states *shall not exceed 50 V*. Does this mean the standard touch voltage of 50 VAC or 110V ripple free DC? (AS/NZS3000:2000 1.7.4.3.2)

Refer 5.5.1(b)(vi) Earth can be high integrity but would be very costly to implement continuity monitoring in 28.5 V DC GPUs. A detailed cost benefit analysis should be carried out before this is implemented.

Refer 5.5.1(c)(i) 400 Hz diesel GPUs normally have the neutral connected to the chassis but should have lost neutral sensing fitted to disconnect output if the neutral goes open circuit.

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|   | <p>Refer 5.5.1(c)(i) Comment 11 sixth paragraph. Do not agree that <i>phase loads are reasonably well balanced</i> the phase loads vary a lot depending what is being done on-board the aircraft.</p>   |
| 5 | <p>XX considers that the most appropriate form for implementing this document is by way of a Code of Practice. It is important for the industry to have clarity as to a means of compliance and to have confidence in this – however, it is also important to retain some flexibility to respond to changes in technology and practice. A Code of Practice best suits these requirements.</p> <p>There are some technical details in the Document that could be problematic in practice and we would welcome the opportunity to work through these issues with the Ministry.</p> <p>Issues include:</p> <ul style="list-style-type: none"> <li>▪ Appropriate refuelling distances;</li> <li>▪ Incorporation of manufacturers’ requirements for current equipment where those requirements are different from document proposals;</li> <li>▪ Taking into account different requirements of DC Ground Power Units;</li> <li>▪ Maintenance requirements – understanding what’s appropriate in terms of maintenance requirements (e.g. monthly or 3 monthly as referred to in the Document);</li> <li>▪ Practicality of engineering qualifications required – e.g. is “Chartered Professional Electrical Engineer” a realistic requirement; and</li> <li>▪ Practicality of proposals for diesel trailer units.</li> </ul> |