

Application Guidance Notes: Technical Information from Cummins Generator Technologies

## AGN 065 – Air Inlet Filters

### **DESCRIPTION**

There are two types of Air Inlet Filter used on AvK and STAMFORD alternators. The type of filter design will be selected for specific environmental conditions. The two types are:

- Dry Dust Filter
- Moisture Filter

Both types of filters are manufactured by companies specialising in air filtration systems and each type of filter kit is a proprietary package from that company's standard range of appropriate products.

### **ENVIRONMENTAL CONDITIONS**

When considering a proposed operational site with a contaminated atmosphere, careful consideration must be given to the design and operational functionality of the Generating Set housing, with special attention to air inlet and air outlet apertures. The next area of concern must be the internal airflow management system in conjunction with the type of contamination that will inevitably enter the Generating Set housing. Finally, the type of supplementary filter required at point of entry to the alternator, the engine and its cooling system.

The decision making process regarding the need to consider an abnormal site and associated contaminated atmosphere must be a controlled function within the Generating Set manufacturer's commercial operation, where direct contact exists with the end user, their needs and required duty for any proposed Generating Set.

It is expected that this commercial team will have the necessary experience to identify troublesome applications at time of quotation and further expected that there will be Generating Set company technical documentation in place to help their commercial team work through a process of:

- Requirements
- Recommendations
- Application Checklist

Such a procedure will ensure the Generating Set supplier and installer are fully aware of the risk they place on the Generating Set company, if operational problems occur related to site conditions, when a correctly specified Generating Set equipment package has not been supplied or correctly installed and operationally managed.

Air inlet filters are constructed into a specially fitted filter framework at the factory. Each filter assembly is designed specifically for a particular alternator frame size and should be fitted at the factory during alternator manufacture. Retrofitting at the customer's site is complicated and is to be avoided.

It is strongly recommends that all alternators fitted with air inlet filters are specified to be factory fitted with stator winding temperature detection devices, thereby providing an automatic control system that can be employed to ensure that blocked air filters are detected before a winding overheats, with the risk of burn-out occurring.

## **FILTER TYPES**

### **Dry Dust Filters**

#### **STAMFORD Alternators**

The Dry Dust Filters used on STAMFORD alternators are made to a specific size to fit each of the frame size air inlet apertures. The type of filter medium used is known as P250 type.

The filter assembly is constructed from ferrous metals and is; therefore, liable to rust if the filter assembly is used in a damp/wet environment. Desert conditions or excessively dusty environments should be carefully considered by the designer of the Generating Set housing. Such conditions require the housing to have air inlet apertures with large areas, therefore very low air speed and incorporate a tortuous path that includes a 'sand-trap'. The 'sand-trap' must be regularly inspected and emptied and the access and method for doing this should be a design feature of the Generating Set housing.

**S0/S1 and P0/P1:** Air inlet filters are not available for these small alternators.

**UC 224 (S2) and UC 274 (S3):** A pair of dry dust filter assemblies are fitted, one at each side of the terminal box.

**S4, HC5 (S5) and S6:** A pair of dry dust filter assemblies are fitted, one at each side of the terminal box.

**P7 (S7):** A single dry dust filter assembly is located at the NDE of the terminal box. When the filter is fitted to the P7 (S7) alternator, a grommet is fitted to the slots at the DE of the frame.

### **AvK Alternators**

The Dry Dust Filters used on AvK alternators are made to a specific size to fit each of the frame size air inlet apertures. The type of filter medium used will be determined during negotiations on the complete alternator specification.

The filter assembly may be constructed from steel with zinc coated mesh wire or stainless steel with stainless steel mesh wire, depending on the application conditions.

### **Moisture Filters**

Dry dust filters do have some capability to take moisture from the cooling air stream, but their effectiveness is very limited. In damp/wet environments, moisture filters are recommended.

### **STAMFORD Alternators**

Moisture Filters may be fitted to the HC6 (S6) or P7 (S7) alternator as part of the IP44 upgrade package. This upgrade package is not available on other STAMFORD alternators. The moisture filter used in a Premaburg type and is made to a specific size to fit the HC6 (S6) or P7 (S7) frame size air inlet aperture. The Premaburg filter is designed for removing airborne water droplets from the cooling air stream.

This type of filter is designed to function by a fundamental principle known as a 'torturous path'. Here the cooling air stream is passed through a filter system providing large area therefore, relatively low air speed. The cooling air is then made to turn through many 90° changes of direction around multiple vertical aluminium vanes. At each directional change the heavier than air water droplet collides with a vane and is then held against a barb formed as part of the extruded aluminium vane. The water droplets then drain under gravity to a designed drain point and drip to atmosphere away from the cooling air flow path. The clearance between the vanes is typically 10mm, which is ideal for the filtration of water droplets, but renders these filters virtually useless for dry dust filtration.

When IP44 requirements are specified and the alternator is supplied with IP44 Premaburg air inlet filters, then the alternator will also be fitted with IP23 air outlet louvers at the alternator's air outlet apertures.

**S6:** A pair of Premaburg filter assemblies are fitted, one at each side of the terminal box base, as part of the IP44 protection upgrade.

**P7 (S7):** When the Premaburg type of filter is fitted to any type of P7 (S7) alternators, then a grommet will be fitted to the slots at the DE of the frame. A single Premaburg filter assembly is fitted to the terminal box side opposite to cable entry, as part of the IP44 protection upgrade.

## **AvK Alternators**

Moisture Filters are available for all AvK alternators. The type of filter will be determined by the application conditions and the IP protection afforded to the alternator. The Premaburg type filter, as used on STAMFORD HC6 (S6) and P7 (S7) alternators is regularly used on AvK alternators. Whichever moisture filter is used, it will be made to a specific size to fit the alternator frame size air inlet aperture. Refer to the information above, for details of the Premaburg filter design.

## **ALTERNATOR DE-RATES**

Any air inlet filtration system will restrict air flow, reducing the volume and so thermal heat transfer characteristic, of the cooling air as it passes through the alternator. For this reason the following guidance is offered;

### **Dry Dust Filters invoke a 5% de-rate**

This 5% 'rule' is applicable to all STAMFORD alternators and is based on an expectation of good on-site filter maintenance. With good maintenance, the pressure drop across the filter should never exceed 10% of the total pressure drop across the complete alternator. The necessary de-rate will be factored in to the size of AvK alternator nominated for a particular application.

### **Moisture Filters**

Moisture Filters may be fitted to STAMFORD HC6 (S6) or P7 (S7) alternators as part of the IP44 upgrade package. The IP44 upgrade package invokes a 10% de-rate. No further de-rate is necessary. The necessary de-rate will be factored in to the size of AvK alternator nominated for a particular application.

## **MAINTENANCE**

### **Dry Dust Filters**

The dry dust filter assemblies used on AvK and STAMFORD alternators were chosen after due discussions with reliable and reputable suppliers concerning technical aspects in terms of airspeed, air volume and choice of a media material. Also with due consideration for serviceability and worldwide supply structure.

It must be accepted that the major influence for continual in-service filter performance is filter maintenance, where the principle responsibility is with the Generating Set operator. However, the Generating Set manufacturer must supply appropriate Installation, Service and Maintenance Instructions to ensure that all operational requirements regarding the cooling

airflow system, for both the engines and alternators air filtration systems, are regularly checked and cleaned by an appropriate method. The dry dust filter is washable and the following procedure should be carried out to prevent damage to the high efficiency fine particle filtration media:

- Remove the filter assembly from the alternator.
- Immerse the filter in water containing a mild household detergent (washing up liquid or similar).
- Agitate the filter to remove dirt particles from the media.
- If necessary, use a soft brush and gently brush off any remaining dirt particles.
- Thoroughly rinse the filter using clean water.
- Reverse flush the filter – rinse the filter with clean water in the opposite direction to the airflow through the filter when in normal service. This will ensure that dirt particles are not collected on the clean air side of the filter.
- Ensure the filter is completely dry before refitting it to the alternator.

The chosen dry dust filter media must not be soaked in oil prior to use. This is an outdated requirement for older type filters. The dry dust filters used on AvK and STAMFORD alternators are not designed to operate under conditions of water saturated cooling air situations. The media becomes saturated and then large globules of water will enter the alternator with disastrous results. It should be noted that even when the Generating Set is not running, exposing the filter to prevailing wet weather conditions is not acceptable, as the filter media will absorb water and could become saturated. Subsequent natural convection of air through the alternator will encourage air flow through the filter and this could easily result in moist air entering the alternator. This will introduce the risk of reducing the alternator's Insulation Resistance (IR) values, thereby promoting the risk of winding failure occurring when the alternator is next started.

### **Moisture Filters**

Although the openings between the Premaburg filter's vanes is some 10mm, the filter still needs to be regularly checked for any obstruction, such as leaves or plastic bags etc. and clear silt from the water drain area along with ensuring the drain hole is not restricted.

A maintenance regime similar to that for the dry dust filters may be used for these moisture filters. The fitting of a water gauge is recommended to measure pressure drop through the filter.

With the appropriate de-rate applied, the alternator will have an allowance for the restriction to air flow when the filter is becoming clogged with dirt and operating with an air restriction pressure drop of 0.5 inch water gauge. When the pressure drop across the filter reaches this critical 0.5 inch pressure drop, the alternator should be taken out of service. The filter element should be removed and thoroughly washed clean, dried and then refitted.

If a situation occurs whereby the filter element pressure drop exceeds the 0.5 inch pressure drop, but it is not immediately possible to take the alternator out of service, then the Generating Set's output should be reduced below its nameplate rating by a factor that makes good

allowance for the reduction of air flow quantity and the prevailing site ambient temperature conditions, when compared with the alternator's nameplate data.