

FIRST ARTICLE INSPECTION REPORT

(CUSTOMER APPROVAL)

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Revision: 1
Date: 05 October 2005

TITLE: INSPECTION REPORT FOR KN3855, KN3856, KN3857 & KN3858 –
SCORE ENERGY MANUFACTURED AVON TRIPLE DISH FLAME TUBES, POSITIONS 1 TO 8

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0	05/10/2005	First Issue	Sam O'Leary	IAW FAIR-KN3855-58	Andrew Bailey
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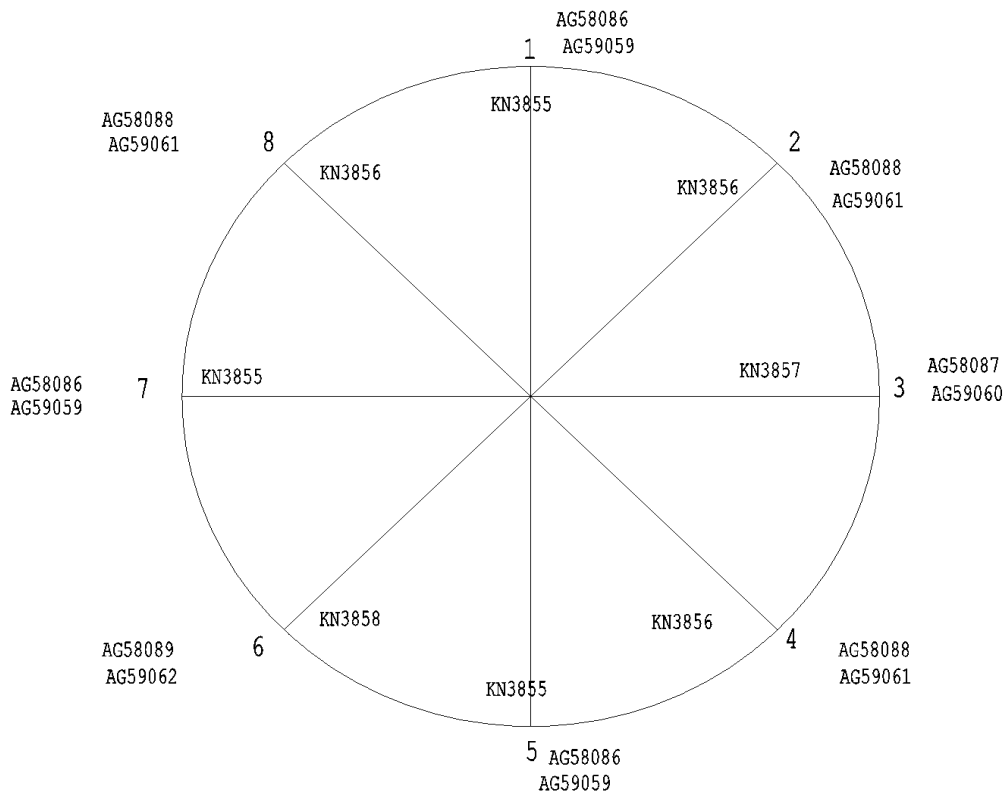
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1. Relationship to OEM Component

The Score Energy manufactured Avon triple dish flame tubes are equivalent to OEM manufactured Avon triple dish flame tubes at modification standard 4575.

Figure 1.1. Drawing showing relationship / equivalent modification standard between Score Energy manufactured triple dish flame tubes and OEM triple dish flame tubes.



2. Materials of Construction

Note: Image sizes are for representation only and are not to scale

Figure 2.1. – KN3855 – KN3858 Triple Dish Flame Tube Assembly – sectional image

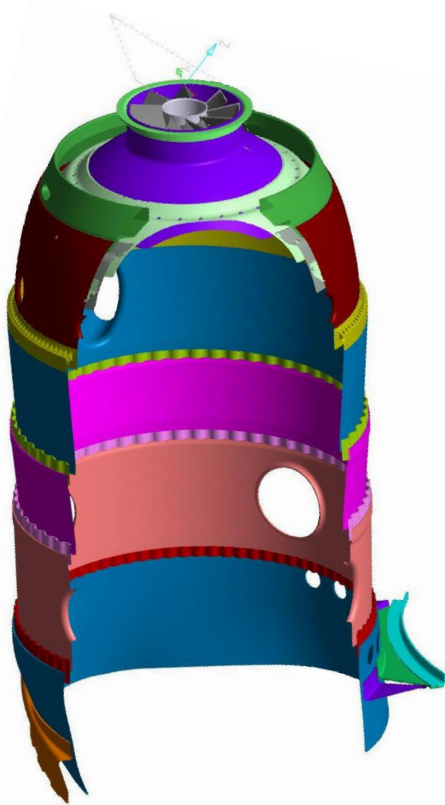
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Triple Dish Flame Tubes KN3855 – KN3858 are assembled from the detail components as listed in the following table (table 2.1)

Please note: The colours on the assembly drawing (figure 2.1) opposite relate directly to the colour of the detail components as shown in table 2.1

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Table 2.1. - Component detail, material specifications.

Item Number	Description	Image	Quantity	Material Specification	Material Form
KND001	Centre Fitting		1	18/8 Cr – Ni Stainless Steel	Bar
KND002	Spacer Bracket		9	Nimonic 75	Sheet 18 SWG
KND013	Corrugated Baffle		2	Nimonic 75	Sheet 20 SWG

Item Number	Description	Image	Quantity	Material Specification	Material Form
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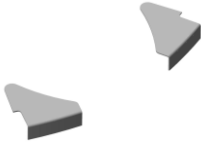
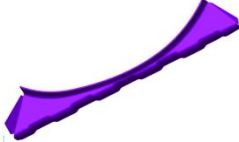

KND014	Skin		1	Nimonic 75	Sheet 20 SWG
KND018	Stiffener		1	Nimonic 75	Sheet 18 SWG
KND019	Stiffener		1	18/8 Cr – Ni Stainless Steel	Sheet 18 SWG
KND020	Stiffener		1	Nimonic 75	Sheet 18 SWG

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Item Number	Description	Image	Quantity	Material Specification	Material Form
KND021	Stiffening Bracket		2	Nimonic 75	Sheet 18 SWG
KND022 KND023	Stiffening Bracket Stiffening Bracket		1 1	Nimonic 75 Nimonic 75	Sheet 18 SWG
KND027	Corrugated Stiffener		1	Nimonic 75	Sheet 18 SWG
KND028	Corrugated Stiffener		1	Nimonic 75	Sheet 18 SWG

Item Number	Description	Image	Quantity	Material Specification	Material Form
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KND029	Stiffening Bracket		2	Nimonic 75	Sheet 18 SWG
KND030 KND031	Corner Plate Left Corner Plate Right		1 1	Nimonic 75 Nimonic 75	Sheet 18 SWG
KND034	Skin		1	Nimonic 263	Sheet 18 SWG
KND035	Inner Skin		1	Nimonic 263	Sheet 20 SWG

Item Number	Description	Image	Quantity	Material Specification	Material Form
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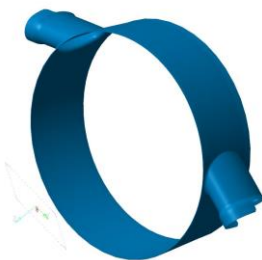



KND036	Inner Skin		1	Nimonic 263	Sheet 20 SWG
KND037	Skin		1	Nimonic 263	Sheet 20 SWG
KND038	Skin		1	Nimonic 263	Sheet 20 SWG
KND039	Flange		1	Nimonic 263	BAR

Item Number	Description	Image	Quantity	Material Specification	Material Form
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KND040 and KND046 KND048 or KND044 KND045	Skin Elliptical Port Elliptical Port Elliptical Port Elliptical Port		1 and 1 1 or 1 1	Nimonic 263 Nimonic 263 Nimonic 263 Nimonic 263 Nimonic 263	Sheet 20 SWG
Notes: KND046 & KND048 are female locations and are used only on assemblies KN3855 & KN3857 KND044 & KND045 are male locations and are used only on assemblies KN3856 & KN3858					
KND041	Flange		1	Nimonic 263	BAR
KND042	Corrugated Baffle		1	Nimonic 75	Sheet 18 SWG
KND043	End Skin		1	Nimonic 75	Sheet 18 SWG

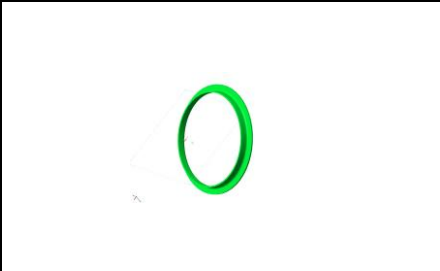

Item Number	Description	Image	Quantity	Material Specification	Material Form
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KND047	Front Flange		1	Nimonic 263	Bar
KND054	Skin		1	Nimonic 75	Sheet 20 SWG

Please turn over.....

3. Chemical Composition

3.1. Items manufactured from Nimonic 75 (Refer to table 2.1).
Conforming to OEM specification MSRR 7104 or approved equivalent.

Constituent	Value (wt %) unless otherwise stated
C	0.08 to 0.15
Si	≤1.0

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Mn	≤1.0
S	≤200 ppm
Co	≤5.0
Cr	18.0 to 21.0
Cu	≤0.5
Fe	≤5.0
Pb	≤50 ppm
Ti	0.20 to 0.60
Ni	REMAINDER

3.2. Items manufactured from 18/8 Cr – Ni Stainless Steel Bar (Refer to table 2.1).
Conforming to OEM specification MSRR 6522 or approved equivalent.

Constituent	Value (wt %) unless otherwise stated
C	≤0.08
Si	0.20 to 1.0
Mn	0.5 to 2.0
P	≤0.035
S	≤0.025
Al	≤0.05
Cr	17.0 to 19.0
Cu	≤0.5
Mo	≤1.0
Ni	7.0 to 11.0
Nb	≤1.1 (minimum value = 10 x C content)
Fe	REMAINDER

3.3. Items manufactured from 18/8 Cr – Ni Stainless Steel Sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 6523 or approved equivalent.

Constituent	Value (wt %) unless otherwise stated
C	≤0.08
Si	0.20 to 1.0
Mn	0.5 to 2.0
P	≤0.035
S	≤0.025
Al	≤0.05
Cr	17.0 to 19.0
Mo	≤1.0
Ni	7.0 to 11.0
Nb	≤1.0 (minimum value = 10 x C content)

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Fe	REMAINDER
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Please turn over.....

3.4. Items manufactured from Nimonic 263 sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 7036 or approved equivalent.

Constituent	Value (wt %) unless otherwise stated
C	0.04 to 0.08
S	≤70ppm
Si	≤0.4
Mn	≤0.6
Al	0.30 to 0.60
Co	18.5 to 21.0
Cr	19.0 to 21.0
Mo	5.6 to 6.1
Ti	1.9 to 2.4
Ti+Al	2.4 to 2.8
Cu	≤0.2
Fe	≤0.7
B	≤50 ppm
Ag	≤5 ppm
Bi	≤1 ppm
Pb	≤20ppm
Ni	REMAINDER

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3.5. Items manufactured from Nimonic 263 bar (Refer to table 2.1).
Conforming to OEM specification MSRR 7035 or approved equivalent.

Constituent	Value (wt %) unless otherwise stated
C	0.04 to 0.08
S	≤0.007
Si	≤0.4
Mn	≤0.6
Al	0.30 to 0.60
Co	18.5 to 21.0
Cr	19.0 to 21.0
Mo	5.6 to 6.1
Ti	1.9 to 2.4
Ti+Al	2.4 to 2.9
Cu	≤0.2
Fe	≤0.8
B	≤0.005
Ag	≤5 ppm
Bi	≤1 ppm
Pb	≤20ppm
Zr	≤0.04
Ni	REMAINDER

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4. Heat Treatment (as supplied)

4.1. Items manufactured from Nimonic 75 Sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 7104 or approved equivalent.

Annealed at 1000 to 1100°C followed by air cooling or other suitable medium.

4.2. Items manufactured from 18/8 Cr – Ni Stainless Steel Bar (Refer to table 2.1).
Conforming to OEM specification MSRR 6522 or approved equivalent.

Softened at 1050 to 1080°C followed by air cooling, oil quenching or water quenching.

4.3. Items manufactured from 18/8 Cr – Ni Stainless Steel Sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 6523 or approved equivalent.

Softened at 1000 to 1100°C followed by air cooling, oil quenching or water quenching.

4.4. Items manufactured from Nimonic 263 sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 7036 or approved equivalent.

Vacuum solution treated at 1150°C for 2 hours

4.5. Items manufactured from Nimonic 263 bar (Refer to table 2.1).
Conforming to OEM specification MSRR 7035 or approved equivalent.

Vacuum solution treated at 1150°C for 2 hours

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5. Mechanical Properties

5.1. Items manufactured from Nimonic 75 sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 7104 or approved equivalent.

0.2% Proof Stress (Tension)			UTS (Tension)			Ductility (% Elongation)		
Temp °C	Result	Unit	Temp °C	Result	Unit	Temp °C	Result (%)	Gauge Length (mm)
20	≥310	MPa	20	≥760	MPa	20	≥30	50

5.2. Items manufactured from 18/8 Cr – Ni Stainless Steel Bar (Refer to table 2.1).
Conforming to OEM specification MSRR 6522 or approved equivalent.

0.2% Proof Stress (Tension)			UTS (Tension)			Ductility (% Elongation)		
Temp °C	Result	Unit	Temp °C	Result	Unit	Temp °C	Result (%)	Gauge Length Root (A)
20	≥210	MPa	20	≥540	MPa	20	≥35	5.65

Hardness	
Test Type	Result
Brinell	140 to 220
Vickers	150 to 230

5.3. Items manufactured from 18/8 Cr – Ni Stainless Steel Sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 6523 or approved equivalent.

0.2% Proof Stress (Tension)			UTS (Tension)			Ductility (% Elongation)		
Temp °C	Result	Unit	Temp °C	Result	Unit	Temp °C	Result (%)	Gauge Length Root (A)
20	≥210	MPa	20	≥540	MPa	20	≥30	5.65

Hardness	
Test Type	Result
Vickers	≤220

5.4. Items manufactured from Nimonic 263 sheet (Refer to table 2.1).
Conforming to OEM specification MSRR 7036 or approved equivalent.
Note: Mechanical properties are subsequent to age hardening.

0.2% Proof Stress (Tension)			UTS (Tension)			Ductility (% Elongation)		
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Temp °C	Result	Unit	Temp °C	Result	Unit	Temp °C	Result (%)	Gauge Length (mm)
780	≥400	MPa	780	≥540	MPa	780	≥9	50

Hardness	
Test Type	Result
Rockwell C	≥22.5
Vickers	≥250

5.5. Items manufactured from Nimonic 263 bar (Refer to table 2.1).
 Conforming to OEM specification MSRR 7035 or approved equivalent.
 Note: Mechanical properties are subsequent to age hardening.

0.2% Proof Stress (Tension)			UTS (Tension)			Ductility (% Elongation)		
Temp °C	Result	Unit	Temp °C	Result	Unit	Temp °C	Result (%)	Gauge Length (mm)
780	≥400	MPa	780	≥540	MPa	780	≥12	5.65

Hardness	
Test Type	Result
Brinell	≥235
Vickers	≥250

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6. Tungsten Inert Gas Welding Details

6.1 Welding Rod:

Welding wire used for joining of:

- Nimonic 263 to Nimonic 263
- Nimonic 263 to Nimonic 75

Nimonic 263 conforming to OEM specification MSRR 9500/16

Constituent	Value (wt %) unless otherwise stated
C	0.04 to 0.08
S	≤0.007
Si	≤0.4
Mn	≤0.6
Al	0.30 to 0.60
Co	18.5 to 21.0
Cr	19.0 to 21.0
Mo	5.6 to 6.1
Ti	1.9 to 2.4
Ti+Al	2.4 to 2.9
Cu	≤0.2
Fe	≤0.8
Ag	≤5 ppm
Bi	≤1 ppm
Pb	≤10ppm
Ni	REMAINDER

6.1 Welding Rod (continued):

Welding wire used for joining of:

- Nimonic 75 to Nimonic 75
- Nimonic 75 to 18/8 Cr – Ni Stainless Steel

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NC 80/20 conforming to OEM specification MSRR 9500/3

Constituent	Value (wt %) unless otherwise stated
C	0.26 max
Si	0.50 max
Mn	1.20 max
P	0.03 max
S	0.015 max
Cr	18.0 to 21.0
Cu	0.20 max
Fe	0.5 max
Ni	REMAINDER

6.2. Welder Approval:

Operator approved IAW OEM test schedule RPS 912 Issue 10.

7. Resistance Welding Details

7.1 Resistance Welding Integrity

Post resistance welding qualification is conducted for each batch IAW BS EN 15614-12: 2004

8. Assembled Heat Treatment

Age Heat Treatment

Temp: 800 °C ± 10 °C

Time: 8 hours ± 15 min

Cooling rate: No less than 6 °C / min to below 600 °C

9. Non Destructive Testing

Non Destructive Testing (NDT) is conducted at all stages of manufacture.

All detail components are subject to 100% penetrant flaw detection prior to assembly.

Assembled component is subject to further penetrant flaw detection.

10. Tungsten Carbide Coating

10.1 Reason for application:

The contact surfaces of the flame tube to snout location, and side / outer baffles are given a coating of tungsten carbide coating in order to extend overhaul life by improving resistance to wear of the contact / mating surfaces.

10.2. Areas to be coated:

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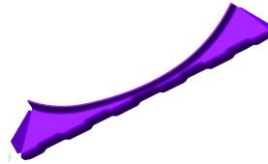
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Intake snout location flange bore



Baffle strips, inside & outside faces coated

10.3. Coating to be applied:

Praxair 1343 VM

Nominal composition:

Tungsten carbide: 83%
Cobalt: 17%

10.4. Coating Properties:

Bond Strength: 10,000 psi
Micro-Hardness: 1,125 HV₃₀₀
Microstructure: Porosity ~ 2%
Oxides ~ 2%

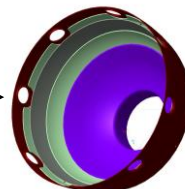
11. Thermal Barrier Coating

11.1 Reason for application:

Flame tube deterioration due to distortion and burning has been encountered on generators using high luminosity fuels, and in some instances the entire head section has become detached. A ceramic thermal barrier coating (TBC) is therefore introduced.

11.2. Areas to be coated:

Internal flares of the head section



11.3. Coating to be applied:

Bond coat: CoNiCrAlY, 0.003" to 0.005" thick
Top Coat (ceramic): 8Y₂O₃ / ZrO₂, 0.010" to 0.015" thick

10.5. Method of application:

Robot manipulated air plasma spray

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12. Dimensional Report

All components inspected by a combination of computer controlled & conventional measuring techniques to ensure compliance to manufacturing drawings KN3855, KN3856, KN3857, KN3858.

13. Functionality Testing

In order to verify the dimensional data recorded in section 12 of this report a trial engine build was conducted using a complete engine set of Score Energy manufactured triple dish flame tubes. The flame tubes were assembled fully IAW the RR assembly instructions and found to be satisfactory. All parts used in the trial engine build were (with the exception of the triple dish flame tubes) either; new, serviceable or overhauled OEM components.