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Attention : the MANAGER

Subject : Precision Investment Casting Production
ATAR 9 C engine.

Dear Sir,

Enclosed herewith please find three copies of the following reports :

Report nº I : Precision Investment Casting Production - Visit to Microfusion.

Report nº 2 : Precision Investment Casting Production - Discussions with SNECMA.

Report nº 3 : Precision Investment Casting Production - Evaluation of Information to date.

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Yours faithfully,

C. Bellward

C. BELLWARD.

HAK/SG

R E P O R T Nº I.

Precision Investment Casting Production -

Visit to Microfusion.

This contact was arranged, at our request, by Mr. BENNET of S.N.E.C.M.A. Control Department at Kellermann, and a visit to the Microfusion Foundry agreed to for November 30th for the purpose of discussing, in general terms, the production of ATAR 9C precision investment castings.

The visiting party was as follows :

Mr. HEUT de la TOUR - Contr. Métallurgique - Kellermann.
Mr. BENNET - Contr. Dept. Kellermann.
Mr. KING - C.A.C.

At the head office of Microfusion, located at 20, rue Venier PARIS I7e, an introduction was made to Mr. ALLARD (Director). A short discussion then followed on investment castings in general and an inspection of a wide range of castings both in type and size, that had been produced by Microfusion. Mr. ALLARD did not speak in English, however Mr. BENNET very kindly offered his services as interpretor, between Mr. ALLARD and the writer, during this visit.

The party then proceeded to the foundry division of Microfusion located at Gennevilliers, an outer suburb of Paris.

The Microfusion foundry covered a fairly extensive area and was stated to have a labour strength of approximately 300. Castings are produced by either of two processes, namely the Austenal Process (Licence agreement now expired) and the Mono-shell Process (Licence agreement comparatively new and still current).

Mr. ALLARD conducted the tour of the foundry. With the language barrier, and the comparatively short time at our disposal, there was no real opportunity to concentrate on any particular detail of plant or process in operation. The overall impression gained was very favourable, particularly in relation to plant cleanliness, systematic approaches, and the variety of work being produced. The following points of interest were noted:

- No opportunity was given to see any of the shell building up or dewaxing process associated with the Monoshell Process. This was located in a separately enclosed area and obviously not for unauthorised persons to see. The moulds could be seen only after dewaxing and during casting.

- All metal melting was being carried out using the 10 lb Austenal indirect Arc type furnaces . Water cooling of the electrode holders of these furnaces was

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used. A 30 lb capacity induction furnace and a vacuum furnace were also installed, both operating off the same power unit. The vacuum furnace was not in use, although it was stated to be in use most of the time for the production of hollow nozzle guide vanes for a Rolls Royce engine. The alloy here employed was a nickel based one containing, among other elements, some aluminium and titanium. These nozzle guide vanes are cast in a Monoshell mould.

- Monoshell moulds, after firing for a few hours in a furnace at 1000ºC, are cast by clamping on top of the Austenal furnace and casting in the conventional way. It was surprising to note the strength of the shell moulds at this stage.

- All nozzle guide vanes for the ATAR 9C engine are cast using the Monoshell Process. The requirements are for 100% X Ray and 100% grain size checking on all castings produced. A brief inspection of several productions batches of these castings, in the etched condition, was carried out. A grain size variation was noted within one blade, and from blade to blade, but all grains were of the equiaxed type. It was stated by Mr. ALLARD that they still have a rejection rate on these castings of up to 30% for grain size. A reference was also made to the composition of the dipcoat being an important feature for good grain size control. This was stated to be partly tied up with the basic Monoshell process, however modifications had been introduced by Microfusion to improve this property. The current basic thought behind all this, from what could be understood, appeared to be the introduction of something into the dipcoat to give an improved "chilling effect" property to the dip coat that comes into initial contact with the molten metal.

At the conclusion of the tour of the foundry, a discussion took place, in the office at the foundry, on ATAR 9C investment cast parts currently in production at Microfusion. A list of all ATAR 9C precision investment castings had previously been prepared, for this discussion, from the official casting list supplied to us by SNECMA.The question of major importance, at this stage, being - could all the castings be produced by the Austenal Process, or was it necessary to use the Monoshell Process ? Also could photographs of running systems be supplied for the production of castings to be produced by the Austenal Process.

The following remarks by Mr. ALLARD, on these subjects and the Monoshell Process in general, as understood by the writer, are here recorded.

1 Microfusion would not attempt to make a number of the ATAR 9C castings using the Austenal Process, as it would not in their opinion, (in some cases based on actual experience with the part) be possible to meet all the requirements for casting soundness and grain size, as required by SNECMA.

2 Mr. ALLARD, in conjunction with his control Metallurgist, has indicated what ATAR 9C engine parts it should be possible to produce using the Austenal Process, and what parts would require the Monoshell Process - See list attached to this report for full details.

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3 Photos of running systems could be supplied for only the Austenal produced castings at Microfusion, and a request for this information should be made to Microfusion in writing. In regard to the running system for castings produced by the Monoshell process ; the Monoshell licence agreement would not allow this detail to be passed to C.A.C.

4 The Austenal Process is now virtually out of date. The Monoshell Process would do all the castings the Austenal Process was capable of producing, and a lot more besides.

5 The Monoshell Process was the original shell Process to be developed, and was considered to be the best of the shell Processes that were currently available.

6 Microfusion were very satisfied with the Monoshell Licence and Process.

7 No expensive items of equipment were required to set up the shell preparation and dewaxing section for the Monoshell process. The mould firing, melting, and casting equipment is common to the Austenal Process. In fact there were very few equipment changes required to convert the Austenal Process to Monoshell process.

8 One important feature of the Monoshell Process that should be noted is that the wax pattern dies are not interchangable between Austenal and Monoshell Processes. The contraction allowances from the wax pattern die to the casting are different for each process.

9 With the Monoshell Process it is possible to have, as a general rule, a greater number of parts per cluster of castings.

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Precision Investment Castings ATAR 9C Engine

Part Nº	Part Name	No off per engine	Material	Casting Process recommended by Microfusion
502.506.360.9		6	Z 20 CN W 22	Not currently known at Microfusion
50I.150.II6.9	Verrou	2	Z 15 CN S 20	Austenal Process
50I.150.II7.9	Verrou	2	" "	" "
50I.150.II8.9	Verrou	4	" "	" "
50I.204.002.9	Bossage	I	25 CD 4	" "
*50I.220.0II.9	Pivot	* 31		" "
50I.286.0I4.9	Moyeu	1		Not currently known at Microfusion
*50I.484.0I5.9	Bride	* 1		Austenal Process
50I.704.0I9.9	Coude	1	25 CD 4	" "
50I.702.I40.9	Chape	1	"	" "
502.500.464.9	Bossage	5	Z 20 CN W 22	" "
502.506.305.9	Bossage	I5		" "
502.500.391.9	Bossage	5	Z 20 CN W 22	" "
502.55I.421.9	Bossage	1	Z 20 CN W 22	" "
502.55I.0I7.9	Oeillet	4	Z 15 CN S 20	" "
*502.705.084.9	Chape double	* 9		Not currently known at Microfusion
*502.705.006.9	Embout	* 12		Austenal Process
502.705.257.9	Embout double	I8	Z 12 CN KD W 20	" "
502.705.323.9	Support	36	Z 20 CN W 22	" "
502.705.145.9	Bras de guidage	I8	Z 20 CN W 22	" "
502.705.146.9	Bras de guidage	I8	" "	" "
502.55I.0I8.9	Plaquette	21	35 CD 4	" "
502.506.444.9	Double arrivée carburant	1	KC 25 NW	" "
502.553.305.9	Anneau de levage	1	Z 20 CN W 22	" "
50I.652.30I.9	Aube redresseur	54	KC 25 NW	Monoshell Process
*502.705.008.9.	Chape A.R.	* 9		" "
502.705.0I5.9	Support de vérin	8	35 CD 4	" "
502.705.0I8.9	Support de vérin	1	25 CD 4	" "
502.705.3I5.9	Double chape	I8	Z 12 CN K DW 20	" "
502.705.0I6.9	Volet commandé	I8	KC 25 NW	" "

* = Hardcore items (not for production at C.A.C.)

Total non Hardcore Parts for production at C.A.C.	Total Different Parts.	Total castings per engine.
Austenal Process recommended :	2I parts.	154 castings
Monoshell " " :	5 parts.	99 "
	26 parts.	castings

R E P O R T Nº 2.

Precision Investment Casting Production.

Discussions with SNECMA.

A discussion was arranged with Mr. BRUNETAUD, in order to gain advice on the subject of Precision Investment Casting production for ATAR 9C engine in general, the necessity for the Monoshell Process, and information relating to what shell type process licences were currently available.

SNECMA are not licenced to produce Precision Investment Castings. All their requirements are subcontracted to Microfusion - An investment Casting foundry Company producing a very wide range of castings and considered to be the foremost company in this field in France. They operate the Austenal Process in addition to the Monoshell Process.

ATAR 9C Castings have also been produced by FORGES & ATELIERS DU CREUSOT who operate the Austenal Process and a Trucast Shell Process. All ATAR 9C Investment Casting requirements are at present being supplied by Microfusion.

Mr. BRUNETAUD was not definite that Monoshell, or one of the other forms of Investment Shell Processes, were essential for the production of satisfactory ATAR 9C Castings. He stated that we could expect a lot of troubles and some high scrap rates, if we attempted to produce all parts by the Austenal Process. He doubted very much if the grain size standard required for the nozzle guide vane could be maintained.

On the subject of Shell Process Licences available, and relevant detail, the following information is recorded. Monoshell Process :

This is a licence agreement with MISCO in America. MISCO and AUSTENAL are both controlled by the same financial company, but there is no connection on the processing aspects.

In France, Microfusion are the only licences of the Monoshell Process. There are licences in both Germany and Switzerland. It would not be possible for SNECMA to obtain a Monoshell Licence and start up in opposition to Microfusion.

Shell Process - en Kolcast :

Kolcast is a division of Thompson Products (TASCO) in America, who will issue a licence for an Investment Shell Castings Process.

Shell Process - ex HAYNES STELLITE :

HAYNES STELLITE in America (a division of Union Carbide) also operate aShell casting process.

Licence agreements are not easily obtained for the process.

Shell Process - ex Trucast :

Very little detail was known about this type of shell process. Trucast have a good reputation in England and Rolls Royce are using their shell process.

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REPORT Nº 3

Precision Investment Casting Production.

Evaluation of Information obtained.

In view of the information obtained both from Microfusion and SNECMA (See reports nº 1 & 2), and on the subject of production of Precision Investment Castings for the ATAR 9C engine at C.A.C., it would appear that we have to decide on one of the following suggestions :

(1) Take a chance and proceed with production of all parts at C.A.C.
(2) Produce only those parts at C.A.C. listed by Microfusion as "Satisfactory for the Austenal Process". All remaining parts to be listed as "Hard core" items for action accordingly.
(3) Arrange for a Shell process licence and produce all listed castings at C.A.C.

Comments on (1)

Such an action is considered far too risky, and we would be very unwise to consider it any further. It is possible that we may be able to do what Microfusion have found difficult and impossible, by virtue of our smaller production quantities and operation on pilot plant basis control, but this could become expensive, and the uncertainty of being able to meet quality standards would not be acceptable to the production programme.

Comments on (2)

The main comment against this course of action is the loss of castings for production at C.A.C., not only on the initial order, but as replacements for overhaul. Included among these is the nozzle guide vane at 54 off per engine. Of the other parts, functional data and possible replacement rate at overhaul is not known, but as the parts are all mostly in the Canal section, it would be reasonable to expect that some of these would be high also.

Comments on (3)

This is the recommended action that, if possible, should be taken. It would provide C.A.C. with a up-to-date manufacturing potential for not only the present programme, but for future casting programmes. The ATAR 9K engine, if produced at C.A.C., could increase the list of castings that are "not recommended for Austenal Process production", and thus only further aggravate overall position.

For information purposes, the following summarised comments are offered on the Austenal Process, Shaw Process, and Shell Process ; based on observation made to date.

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- The Austenal Process is out of date.

- The Shaw Process has a fairly wide field of application where small production runs are concerned, where castings are required quickly, and where dimensional accuracy is not a major requirement. The pattern production costs are low, but mould materials are reported to be expensive.

- The Shell Investment Process will certainly do all castings that the Austenal Process will do, and also the majority of the Shaw process castings. Die production costs for wax pattern production can be expensive, but mould materials are cheap. For quantity production the Shell process can be cheaper than the Shaw.

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