Remington Arms Company, Inc. **CONFIDENTIAL** Research and Development Technology Center
Elizabethtown, Kentucky

June 7, 2000

To: Joe Zajk
From: Marlin Jiranek

Cc: D. Danner, M. Keeney

RE: MPIF FC 0508-60 MATERIAL AND HEAT TREATMENT

SUMMARY

A sample of five M/710 bolt stops was delivered to the Elizabethtown facility for microhardness analysis. The parts were manufactured by Sterling Sintered company from MPIF FC 0508-60. The heat treatment on the print calls out a Carburize at 0.7% carbon potential and a final part hardness of HR15n 88-92. The hardness readings which were obtained upon inspection at the Hickory manufacturing plant were HR15n 80-83. 83

The MPIF FC 0508-60 material (which corresponds to Remington P.M. 4058) is nominally 5% Cu, 0.75% C, and the balance Fe. This material is NOT intended to be case hardened. This particular material is intended to be used in the as-sintered condition and provide good wear resistance and moderate toughness. This material inherently contains a large amount of porosity (up to 15%) in it's sintered state, but can be quench and tempered to increase the sintered apparent hardness level to HRc mid-40's. Microhardness measurements are typically not achievable due to the large amount of porosity in the material.

RECOMMENDATION

This material is most likely acceptable to be used for this component. Alternatives can be provided if required. The print should have the heat treat and the hardness sections altered to reflect the actual processing and should read as follows:

Material:	P.M. 4058 or MPIF FC 0508-60
Heat Treat:	Oil Quench & Temper or Carburize (0.7% C.P.)
Hardness:	HRc 42-48 Apparent
Color:	Black Oxide

The heat treatment, based on the carbon content of the material, can be run in either of the two processes. The standard quench and temper treatment will provide the same part as the carburized part. The carburizing atmosphere would simply provide a protective atmosphere for the component at temperature, but is really unnecessary if its cost is greater than the standard quench and temper processing.

The last potential issue is the colorability of the Fe/Cu material. The material will have undissolved Cu in the matrix (see figures in procedure section) and may not color well with the black oxide. Some sample parts will have to be run on a trial basis to determine if the coloration is acceptable.

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PROCEDURE / RESULTS

To characterize the material specimens which were sent for evaluation, al five specimens were first measured for hardness using the HR15n scale. One of the specimens was then sectioned, mounted in bakelite, and polished to an 0.05mm finish for microstructural evaluation. Three of the remaining samples were measured for density per ASTM Specification 311-93. Additionally, all four of the specimens were measured for hardness using the HRc scale.

Hardness / Density Results

The hardness and density measurement results are presented in Table 1. Note that the specification hardness is for case hardening components and is not applicable for this material, as all of the parts are out of specification tolerance per the print.

MATERIAL DATA
M/710 BOLT STOP - MPIF FC-0508-60

	Hardness							Density (ASTM B311-93)			
		Parts					Test Block	Specification	Parts (g/cc)		
	Specification	1	2	3	4	5	89.2 +/- 1.0	(g/cc)	1	2	3
HR15n	88 - 92	86.0	84.3	85.1	83.0	85.8	89.4	6.8	6.70	6.76	6.75
HRc	---	46.6	46.5	48.3	43.9	---	---				

Table 1. Hardness and density results obtained from the samples provided for analysis.

The hardness of the material is actually in the mid-40's (HRc scale) which would most likely provide sufficient strength for the application. Other materials could be substituted for this material to provide equivalent or increased strength and toughness. These materials include some of the Fe/Cu (FC Series), Fe/Ni (FN Series), low alloy steels (FL Series), and the sinter hardened materials (FLC Series).

The density of the components was slightly lower than the print. However, the MPIF standard lists the 6.8 g/cc density value as a "typical" value. Individual supplier material may differ from this value to some degree. For this reason, these numbers are acceptable from a incoming inspection perspective.

Microstructure

As expected, the microstructure of the component contains approximately 16% porosity and regions of pure Cu in the steel matrix. This is expected of steel material with greater than about 2% Cu additions. Figures 1, 2, and 3 present images of the microstructure at 50, 200, and 500X magnification. These images illustrate the amount of porosity in the material and present the microstructure of the material. The microstructure is what is expected of a quench and tempered high carbon steel material.

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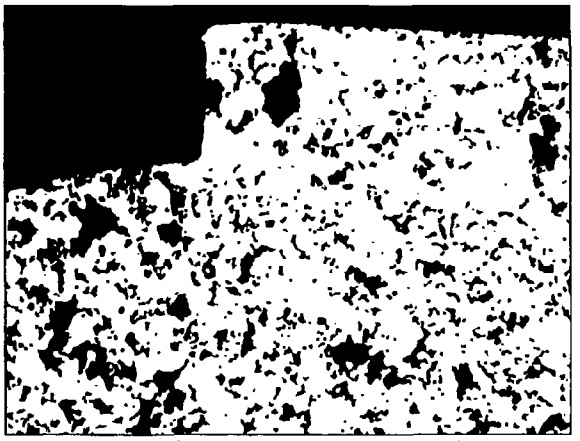

Figure 1. Unetched image of MPIF FC 0508-60 material, illustrating the amount of porosity in the part. Magnification approximately 50X.

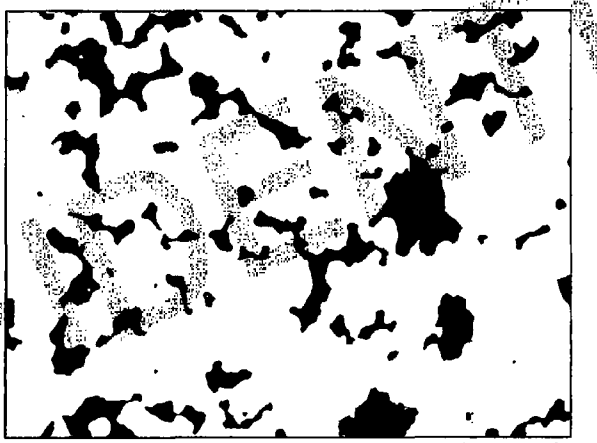

Figure 2. Unetched microstructure of the material showing the undissolved Cu present in the matrix. Magnification approximately 200X.

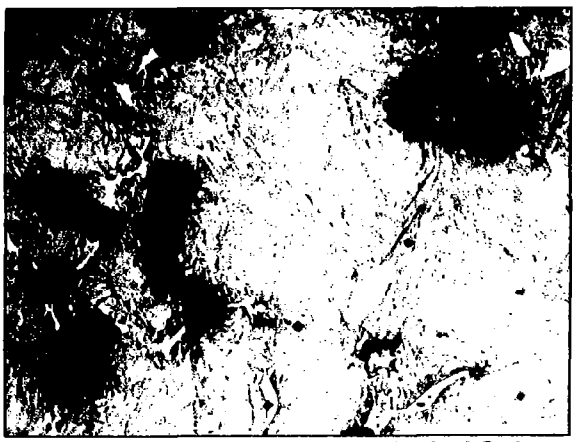

Figure 3. Etched (2% Nital) microstructure, showing undissolved Cu in a tempered martensite matrix. Magnification approximately 500X.

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