5 August, 1999

c.c. J. Mead
M. Keeney
J. Swanson

To: Jim Rabbia
From. Glen Sietsema

RE: Trip Report, Welduction Corp. - Novi, MI.

I traveled to Welduction Corp. in Novi Michigan on July 29 – 30 to finalize the development of hardening the breech end of the M/710 barrels. Eighteen barrels were hardened and returned to Remington – Ilion for assembly to receivers. This is the second lot of barrels to be hardened at Welduction under P.O. 1000102977.

Objective and Samples:
This trip was to finalize the cycle requirements needed to locally harden the lugs in the M/710 barrel. Twenty finished barrels and sixteen set up blanks were provided for the heat treat development. The barrel is made of Remington Material Specification 155 and the heat treat zone is to be a minimum of 0.899" from the breech and a maximum of 1.30" form the breech The aim for hardness in the heat treat zone is HRc 37 – 42.

Process Development:
Bill Hutchinson, Welduction Metallurgy Lab. Manager, and I developed the process to harden the prototype M/710 barrel lugs. This work was performed in Welduction's development lab utilizing experimental equipment and coils. The process parameters that were used will also be used in any production equipment that is purchased. Eighteen test barrels were hardened and two barrels were destroyed in hardness testing.

The most critical parameter in this induction hardening process was determined to be the quenchant. Houghton AquaQuench 3600 was used at a concentration of ≅ 15% and temperature of 120°F. If a lower percentage or lower temperature quenchant were used the barrels were prone to quench cracking. An auxiliary quench internal to the breech of the barrel was also used to provide a uniform hardness from the I.D. to the O.D. Attached is a complete description of the process cycle.

I also had a meeting with Tim Boussie, Welduction's Engineering Director, regarding fixturing in a dedicated barrel hardening machine. There are still some issues in regards to the best way to fixture the barrel in the hardening equipment. These issues will be resolved at the time of purchasing the equipment.

Summary:
Eighteen barrels have been hardened and returned to Remington – Ilion. These barrels are ready for assembly to receivers. A process is developed that can be applied to any induction equipment that is purchased to harden the M/710 barrels. It was determined that quench concentration, temperature and location are critical to a uniform heat treat.

Attachment 1
Process Parameters

Program	
Step	**Time (Seconds)**
Harden	10.0
Delay	3.0
Quench (Rinse / Cool Down)	8.0
Delay	1.5
Temper	3.1
Delay	6.0
Quench (Rinse / Cool Down)	15.0

Process Set Point		
	Harden	**Temper**
Machine Specification	200kW – 10 kHz	200 kW – 10 kHz
Top of Coil to Top of Part	0.180 in.	0.110 in
POT Setting	000	000
Power %	15	15
Frequency %	100	100
Quench Temperature	120°F	
Quench Concentration	16.5%	
Quench Type	Houghton AquaQuench 3600	
Quench Pressure	8 psi	

The Barrels were heat treated from the O.D. using a single turn induction heating coil. Quenching was accomplished with an integral quench in the coil and for the O.D. and an Auxiliary quench for the ID of the barrels.