

7/1/93

#### Summary of Copper Bullet Development

The copper bullet development has been done during windows that opened on the CNC machine during the copper slug and sabot development. To date, four materials have been tried - C102, C110, C145, and C147. C102 & C110 basically have the same characteristics with a machineability rating of 20 while C145 & C147 basically have the same characteristics with a machineability rating of 85. C102 & C110 produce better mush than C145 & C147.

The drilled hole depth poses a major problem due to drill bit breakage using C102 & C110. Additional pecks are required which increases cycle time and still doesn't eliminate drill bit breakage.

The majority of testing has been done using bullets made from C110 material.

Several bullet designs have been tried and narrowed to a long driving band for easier manufacture and acceptable ballistics.

The following information describes the sample testing to date:

- 30 cal 150 gr. boattail with .100" driving band; v/p, accuracy, and mush looked okay. Material - C110, broke several drill bits drilling hole.
- 30 cal 150 gr. boattail with .100" driving band; v/p, accuracy okay but poor mush. Material - C145, drills better than C110.
- 30 cal 150 gr. terminated, started 165 gr. boattail with no driving band to increase weight and decrease overall bullet length; high pressure and low velocity
- 30 cal 165 gr. long driving band & two driving bands, C110 & C145 material, additional pecks to minimize drill bit breakage, lower pressure and higher velocity. C145 testing terminated due to poor mush. Long driving band selected as preferred design. Annealed bullets from C110 & C145 for mush testing. Mush was worse on annealed bullets.
- 30 cal 165 gr. long driving band C102 & C147 material. Basically same results as C110 & C145 respectively.
- 30 cal 190 gr. long driving band using C110 material. Ballistics testing acceptable.
- 270 cal 140 gr. long driving band using C110 material. Ballistics marginal. Additional testing needed to find an acceptable powder.
- 30 cal solid copper core annealed for forming cavity manually. Four die progression, piece extremely hard to remove from die and punch. Do not believe present equipment can form copper.

A sample of the copper bullet made from C110 & C145 along with a Barnes X-bullet was sent to Fred Schmidt for analysis. The only significant difference found was the X-bullet went through an annealing operation. His suggestion was to try various materials.

Product drawing was sent out to various vendors for quotes for the manufacture of this product. The vendors are listed below:

Apex Industries - only vendor to quote which gave unfavorable economics. Quote was based on C145 material. Supplied 18 feet of C110 for samples and got ~ 25 bullets. Sample was not made on production equipment such as Davenports but on Swiss type CNC machine and had several tool failures due to material. Vendor stated C110 could not be run on production equipment. See attachment.

Security Signals - could not run on present equipment (Davenports) and originally was looking at the feasibility of purchasing a CNC machine but decided against purchasing one. No quote. See attachment.

Anderson Screw Machine - after studying product drawing and viewing sample of bullets, decided their equipment (Davenports) could not produce bullets. No quote. See attachment.

Nippert Co. - possibly have process to form bullets but no quote or information to date.

A design that produces acceptable ballistics from C110 has been established but it appears the only way to manufacture is by machining on a Swiss type machine which is very costly with low output. The material itself is questionable for machining purposes.

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