

SIPES – System Weight Reduction

Material Substitution

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Basis of Analysis

Assumptions:

1. C7A2 parts and geometry remain unchanged.
2. Material is able to withstand thermal and mechanical loads.

New material set:

1. Titanium (monolithic metal)
2. Aluminum (monolithic metal)
3. Polyfoam (thermoplastic elastomer)
4. Torlon (engineered ultra polymer)
5. Graphite-aluminum (metal matrix composite)
6. Graphite-magnesium (metal matrix composite)
7. Graphite-epoxy overwrap (reinforced composite)

Material Densities

| Material | Density (g/cm ³) | Strength (MPa) |
|------------------------------------|------------------------------|----------------|
| aluminum | 2.70 | 231 |
| titanium | 4.65 | 1140 |
| steel | 7.85 | 675 |
| polyfoam | 0.74 | --- |
| Torlon | 1.65 | 168 |
| graphite-magnesium | 1.80 | 504 |
| graphite-aluminum | 2.40 | 522 |
| graphite-epoxy overwrapped barrel* | 3.14 | 1720 |

* Equivalent density of overwrapped steel barrel where there is no change in the outer diameter and a 70% overwrap thickness is assumed.

Weight Breakdown for C7A2

| PART TITLE | GENERIC MATERIAL | MEASURED MASS (g) | % Total |
|----------------------------------|------------------|-------------------|---------|
| BARREL, RIFLE, C7 | STEEL | 901.100 | 27.7 |
| CARRIER, BOLT | STEEL | 246.200 | 7.6 |
| RECEIVER, LOWER, MODEL C7 (715) | ALUMINUM | 228.200 | 7.0 |
| RECEIVER, UPPER | ALUMINUM | 213.200 | 6.6 |
| HANDGUARD, CAMOFLAGE (GREEN) | NYLON | 144.800 | 4.5 |
| SIGHT, FRONT, C7 | STEEL | 132.900 | 4.1 |
| EXTENSION, RECEIVER (4 POSITION) | ALUMINUM | 111.030 | 3.4 |
| BUTTSTOCK, SLIDING | NYLON | 102.400 | 3.1 |
| BOX, MAGAZINE, 30 ROUND | ALUMINUM | 84.400 | 2.6 |
| SHOULDER PAD, BUTTSTOCK (GREEN) | RUBBER | 75.180 | 2.3 |
| GRIP, PISTOL | NYLON | 68.750 | 2.1 |
| COMPENSATOR | STEEL | 61.460 | 1.9 |
| SPRING, ACTION | STEEL | 52.420 | 1.6 |
| BODY, TRIAD, LH | ALUMINUM | 50.000 | 1.5 |
| BODY, TRIAD, RH | ALUMINUM | 48.000 | 1.5 |
| EXTENSION, BARREL | STEEL | 47.330 | 1.5 |
| BOLT | STEEL | 37.800 | 1.2 |

- Total number of components is 125.
- Total weight of C7A2 is 3250 g with 17 components comprising 80% of the total weight or 2600 g.
- Barrel represents 28% of the total weight.

Reference



★ c.g.
● > 40 g

Sight not included in analysis

| Configuration | Weight (g) | Longitudinal c.g. (in.) |
|--------------------------------|------------|-------------------------|
| Steel, aluminum, nylon, rubber | 3250 | -15.74 |

- Barrel weighs 900 g or represents 28% of the total weight.

Lightest Weight



★ c.g.
● > 40 g

Sight not included in analysis

| Configuration | Weight (g) | Longitudinal c.g. (in.) |
|---------------|------------|-------------------------|
| 100% Torlon | 1275 | -20.34 |

Foreseeable



★ c.g.
● > 40 g

Sight not included in analysis

| Configuration | Weight (g) | Longitudinal c.g. (in.) |
|---|------------|-------------------------|
| overwrap barrel, Gr-Al, Gr-Mg, Torlon, polyfoam | 1650 | -17.78 |

Titanium and Torlon



★ c.g.
● > 40 g

Sight not included in analysis

| Configuration | Weight (g) | Longitudinal c.g. (in.) |
|---|------------|-------------------------|
| steel > titanium, remainder > Torlon | 2071 | -16.72 |

Overwrapped Barrel and Titanium



★ c.g.
● > 40 g

Sight not included in analysis

| Configuration | Weight (g) | Longitudinal c.g. (in.) |
|--|------------|-------------------------|
| overwrap barrel, steel > titanium, aluminum, nylon, rubber | 2249 | -18.46 |

Overwrapped Barrel



★ c.g.
● > 40 g

Sight not included in analysis

| Configuration | Weight (g) | Longitudinal c.g. (in.) |
|---|------------|-------------------------|
| overwrap barrel, steel, aluminum, nylon, rubber | 2670 | -18.50 |

Potential Weight Reduction

| Configuration | Material List | Weight (g) | c.g. (in.) | % change |
|---|--|------------|------------|-----------|
| Reference | steel, aluminum, nylon, rubber | 3250 | -15.74 | 0 / 0 |
| All plastic | Torlon only | 1320 | -20.34 | -59 / -29 |
| Forseeable | overwrap barrel, Gr-Al, Gr-Mg, Torlon, polyfoam | 1650 | -17.78 | -49 / -13 |
| <hr style="border-top: 1px dashed black;"/> | | | | |
| Titanium-Torlon | steel > titanium, remainder > Torlon | 2071 | -16.72 | -36 / -6 |
| Overwrap barrel – Titanium | overwrap barrel, steel > titanium, aluminum, nylon, rubber | 2249 | -18.46 | -31 / -17 |
| Overwrap barrel | overwrap barrel, steel, aluminum, nylon, rubber | 2670 | -18.50 | -18 / -17 |