Rush to Failure: The Tragic Story of the US Army Airship ROMA
Roma Structure

Air Balloonets

Gas envelope

Nose cap

Air Ballonets

Forward engines

Keel

Elevator-rudder assembly

Passenger cabin

Control cabin

Landing pontoons

Center and aft engines

Air scoops
Roma Timeline

• 1919. Italy builds 410-foot long, semi-rigid dirigible, the Roma. Six 450-hp Ansaldo engines, 1.2M cu ft hydrogen lifting gas. Designed and built after the Armistice for commercial use
• 1920. US Army purchases Roma from Italy for $185,000 ($2.2M 2016). Italians have flown Roma over 20 times.

Ansaldo Engine on Test Stand. (NMUSAF)

The Roma Showing Large Elevator-Rudder Structure at arrow. (NMUSAF)
Points to Ponder

1. What operational mission(s) did the Air Service have in mind for the Roma?
   - Long distance reconnaissance
   - Photographic missions
   - Coastal patrol
   - Carrying supplies (airlift)
   - Training

2. What was the appeal of an airship?
   - Range
   - Payload
   - Endurance

   Why the Roma?
   - Available—NDI
   - Cost—a bargain at $185K
## Aircraft Performance Comparison

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- 740 miles
- 1380 miles

[Map showing distances between Langley Air Force Base and Virginia Beach]
Roma Timeline

- Feb 1921. 3 Air Service officers, 5 NCOs travel to Italy to inspect, train, and take possession of Roma
- Mar—May 1921. Roma disassembled, crated, loaded onboard ship for US
Roma Timeline

- Nov 15, 1921. First US flight—Langley/Norfolk area.
  - Maj Thornel, airship commander, reports Ansaldo engines “much too cold during entire flight…impossible to warm them up to operating temperature”
  - Aluminum door breaks loose, damages propeller—fragments tear envelope, cause hydrogen leak, which is repaired in flight
Roma Timeline

- Dec 9, 1921. Flight from Langley Field to Bolling Field cancelled—problems with Ansaldo engines
- Dec 17, 1921. Flight to Bolling for christening ceremony with VIPs postponed 4 days—engine problems
• Dec 21, 1921. Roma arrives 3 hours late for christening ceremony at Bolling Field. Fought strong headwinds with 3 engines dead. VIPs kept waiting in bitter cold and wind
  • Gen Mitchell, Ass’t Chief of Air Service
  • Gen Patrick, Chief of Air Service
  • Secretary of War Weeks
  • Congressmen
  • Italian Ambassador Rolandi-Ricci
  • Lt Gen Vaccarri, Italian Army
  • Daughter of Ass’t Secretary of War
  • Secretary of the Navy Denby

• Roma limps back to Langley after ceremony with only one engine running
Roma Timeline

- Jan 7, 1922. Gen Patrick to Engineering Division, McCook Field: “ROMA will not make another trip until it is equipped with Liberty motors.”
- Jan 7, 1922. Power plant engineer departs McCook Field to supervise Liberty installation at Langley.
Historical Note—1918

Frank W. Caldwell (1889-1974)

• Chief Engineer, Propeller Dept., Air Service Airplane Engineering Division, McCook Field
  • Pioneer in developing controllable-pitch propellers
  • Designed the whirl-testing facilities at McCook Field
    • Long endurance runs at high speeds
    • Ensured potential designs were structurally sound
    • Instruments measured torque, thrust, blade deflection

McCook Field Propeller Whirl Testing Facility, 1918
Historical Note—1908

Lt Thomas Selfridge
Roma Timeline

• Dec 13-14, 1921. Air Service Engineering Division, McCook Field, Dayton conducts destructive whirling test on propeller for Roma’s Liberty engines

Concludes “it is considered safe to use this propeller on the ROMA airship.”

Controllable pitch propeller—designed and built at McCook Field—was to be tested for use with Roma’s Liberty engines
Roma Timeline

Ansaldo (Langley History Office)

Liberty 12A (NMUSAF)

- Jan-Feb 1922. All six Ansaldos are replaced with Liberty 12A engines
- Jan 31, 1922. Gen Patrick to Gen Mitchell: envelope “pretty rotten…have ordered a new one from Italy…”. But not available until July-August
# Engine Comparison

<table>
<thead>
<tr>
<th>Engine</th>
<th>Max rated power</th>
<th>Weight dry *</th>
<th>Weight: hp ratio</th>
<th>Propeller Diameter / Type</th>
<th>Roma max speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ansaldo</td>
<td>450 hp</td>
<td>1018 lbs</td>
<td>2.26</td>
<td>10’ 11” / Pusher</td>
<td>67 mph</td>
</tr>
<tr>
<td>Liberty 12A</td>
<td>410 hp</td>
<td>710 lbs</td>
<td>1.73</td>
<td>11’ 4” / Tractor</td>
<td>80 mph est.</td>
</tr>
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* Net weight savings with Liberty engines = 1200 lbs
### Engine Comparison

#### Performance @ “Cruising Speed”

<table>
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<tr>
<th>Engine</th>
<th>Propeller speed</th>
<th>Engine power</th>
<th>Thrust</th>
<th>Airship speed</th>
</tr>
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<tbody>
<tr>
<td>Ansaldo</td>
<td>1400 rpm&lt;sup&gt;1&lt;/sup&gt;</td>
<td>340 hp&lt;sup&gt;1&lt;/sup&gt;</td>
<td>?</td>
<td>47 mph&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Liberty 12A</td>
<td>1100 rpm&lt;sup&gt;2&lt;/sup&gt; 1325 rpm&lt;sup&gt;3&lt;/sup&gt;</td>
<td>180 hp&lt;sup&gt;4&lt;/sup&gt; 360 hp&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1320 lbs&lt;sup&gt;4&lt;/sup&gt; 2000 lbs&lt;sup&gt;4&lt;/sup&gt;</td>
<td>75 mph&lt;sup&gt;5&lt;/sup&gt;</td>
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<sup>1</sup> *Report on the ROMA*, Air Service Engineering Division, McCook Field, April 1922

<sup>2</sup> *Ray Hurley’s Statement on the Roma Disaster* (civilian survivor), Feb 1922

<sup>3</sup> *The Semi-Rigid Airship “Roma,”* Col (ret) John Reardon, USAF (survivor), memo to AF University, March 1960


<sup>5</sup> *The Airship ROMA: Disaster in Hampton Roads*, Sheppard, N., June 2016

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“It is expected that the maximum air speed of the ROMA with the new Liberty engines will be nearly 75 miles an hour, which will, of course, enable her to fight any wind that she may encounter and arrive at her destination without mishap.” *Aerial Age Weekly*, Jan 30, 1922
3. What drove the Air Service to replace the Ansaldo engines? Do you agree with the reasons for doing so? Was there merit in selecting the Liberty 12A engine?

   Ansaldo
   o Poor reliability
   o Availability of spare engines (only 2), parts, and mechanics
   o Poor performance

   Liberty
   o Reliable
   o Availability of spare engines (hundreds at least)
   o Maintainability—access to spare parts, trained and experienced mechanics
   o Proven performance—greater airspeed
   o Lower weight = trade-off for more fuel onboard = longer range

4. Systems/aero/propulsion engineers—concerns about installing new engines?

5. Testers—concerns about the test strategy?
Engine Comparison
Weight and Balance

Net weight savings with 6 Liberty engines = 1200 lbs (200 lbs each)
Weight and Balance

Landing pontoons
Landing pontoons
Weight and Balance

Net weight savings with 6 Liberty engines = 1200 lbs (200 lbs each)

\[ \tau = r \times F \]
Weight and Balance

Net weight savings with 6 Liberty engines = 1200 lbs (200 lbs each)

\[ \Delta F = r \times F = 54,000 \text{ ft-lbs} \]
Flight Test With Liberty Engines
21 February 1922

• 1245. Preflight complete. On board: 45 officers, enlisted & civilians. (Operational crew size:18)
• 1345. Roma lifts off tail first, heads toward Chesapeake Bay at approximately 900 ft AGL. Capt Mabry orders “cruising speed”
• Crew member operating elevator control has trouble keeping nose up
• Observers near Ft. Monroe notice the nose looks “crinkled”
• Roma heads over water towards Willoughby Spit, crosses Willoughby Bay towards Naval Station
• Crew notices upper curve of nose is flattening

Approximate Flight Path of Roma. (Swift, Earl; Copyright (c) 2012, The Virginian-Pilot. Reprinted With Permission)
Flight Test With Liberty Engines
21 February 1922

- 1415. Less than 1000 ft AGL, Roma pitches 45 degrees down. Elevator unresponsive
- Capt Mabry orders engines cut. Center and aft stop, forward engines continue to run
- Keel buckles, elevator-rudder swings loose
- Crew attempts emergency landing at Norfolk Country Club Golf Course. Does not reach it
- Roma impacts ground, contacts high voltage lines

Approximate Flight Path of Roma. (Swift, Earl; Copyright (c) 2012, The Virginian-Pilot. Reprinted With Permission)
Tragic Crash

- Sparks ignite hydrogen, which ignites gasoline tanks
- Resulting inferno completely destroys Roma
- Fatalities: 34 of 45 on board
The Aftermath

- Investigating board: blocked forward air scoop
- Others: leaky gas envelope... juncture of nose stiffener and keel... Liberty engines too powerful... why hydrogen...?

- Of the 11 survivors, only 3 escape with no injuries
Lessons Learned

- One year after Roma mishap, Air Service abandoned H in favor of He
- Improved airship testing—RS-1 airship tests at Scott Field 1925-1926
  - Use of 1/33-scale water model testing
  - Extensive ground testing preceded first flight test
  - Flight test with experienced crew
  - Finding: semi-rigid airship envelope and keel are mutually dependent to maintain structural integrity
  - Recommendations for future airship testing and instrumentation

General Orvil Anderson, an experienced lighter-than-air pilot, believed that the speed of the Roma smashed the nose. He conducted tests in an American built semi-rigid dirigible, the RS-1. The nose of this airship caved in at 59 mph and General Anderson wrote that, "The weaker nose structure of the Roma and the lower internal pressure at which it was flown should have triggered a nose collapse at 55-56 mph." (The Army Airship ROMA, John B. Mitchell, Hampton Virginia 1973)
6. What was the “rush?”

7. What were the contributing causes to the mishap?
   - Leaky gas envelope
   - Weight and balance issues
   - Excess speed
   - Blocked air scoop
   - Minimal training
   - No direct method to control throttle or ballast from the control cabin

Were any caused by or exacerbated by a “rush?”

What might more time have changed?
   - New envelope
   - Tech data
   - Testing
   - Training
8. Were the Liberty 12A engines “too powerful” for the Roma?

*Air Force Test Center engineer: “They didn’t have to be.”*
Postscript
Capt Dale Mabry, 1891-1922
Thank You for Attending