Acoustic Measurements for Small Solid Rocket Motors

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Agenda

- Overview and Scope
- Small Solid Rocket Motor Parameters
- Test Setup and Microphone Layout
- Instrumentation
- Procedures
- Data Analysis
- Time Histories
- 1/3 Octave bands
- Summary and conclusions
Overview and scope

- Models have been developed to predict large solid rocket motor acoustic loads based on the scaling of small solid rocket motors
- MSFC has measured several small solid rocket motors in horizontal and launch configurations to anchor these models
- Solid Rocket Test Motor (SRTM) has ballistics similar to the Reusable Solid Rocket Motor (RSRM) therefore a good choice for acoustic scaling
- Acoustic measurements were collected during the test firing of the Insulation Configuration Extended Length (ICXL) 7, 6, and 8 (in firing order) in order to compare to RSRM horizontal firing data
- The scope of this presentation includes:
  - Acoustic test procedures and instrumentation implemented during the three SRTM firings
  - Data analysis method and general trends observed in the data
## Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ICXL</th>
<th>RSRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrust</td>
<td>50,000 lbf</td>
<td>300,000 lbf</td>
</tr>
<tr>
<td>Exit Diameter</td>
<td>0.97 ft</td>
<td>12 ft</td>
</tr>
</tbody>
</table>

![Diagram showing test time vs. measured axial mean thrust (lb)](image)

- **Average**
- **Log - Thrust**

Test Time (sec)

![Image of nozzle with exhaust gases](image)
Test Setup

- Microphone layout based on nozzle diameters for scaling
- Sensors installed on uni-strut stands and leveled with the nozzle exit plane
- Uni-struts placed on 80 and 120 ND from the nozzle centerline
Instrumentation

- PCB 106B50, 5 psi, 10 kHz, quartz microphone
- Several DAQs were used for the tests due to availability
  - VXI 1432 ICXL7 and 6
  - VXI 1436 ICXL8
- IRIG-B was provided by the test area
- Weather information was collected by the test area
- Microphone location determined using an infrared GPS
Procedures

• Pre and Post-test calibration measured using a B&K pistonphone, 124 dB at 250 Hz
• System triggered remotely via ethernet using PCAnywhere software
• The system is started approximately 1 second before T-0, IRIG-B can be used to adjust the data to T-0
Data Analysis

• Data analysis performed using PCSignal
• Sample rate varied from test to test due to different DAQ and channel numbers
• Time: 8 second interval with 80% overlap
• Frequency: 5 second interval, 1.3 Hz bandwidth with 80% overlap
  – The processing block size was selected according to the sample rate to best match the parameters
  – The time interval was selected to encompass the maximum thrust time period
Time Histories

- Time histories show positively skewed data
- Similar behavior has been observed in RSRM data

17 Nozzle Diameters @ 90°

78 Nozzle Diameters @ 90°
**Overall Sound Pressure Level**

- **ICXL-7**
- **ICXL-8**
- **ICXL-6**

- Acoustic data follows the thrust max
- 3 dB reduction with 50% distance increase
• 1/3 Octaves shows repeatability of the measurements from test to test
Summary and future work

• Measured acoustic data shows repeatability and trend similar to the ones shown in previous static firings
• One more SRTM will be measured in May
• Data will be collected to make the required corrections