Tower Drop Test (0.TST.3)
University of Colorado at Boulder
Aerospace Engineering Senior Projects
ARCTIC (Arctic Region Climate Tracking and Instrumentation Cargo) Project

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Test Description
This test consisted of two parts. The first part of the test was used to determine the streamer delay time. Four trials of five different delay streamer lengths were used. Dummy sondes with their drop streamer wrapped around them and then the delay streamer wrapped around the drop streamer were dropped from 50 meters and the streamer delay time was recorded. The four different trials for each delay streamer length were then averaged. From that information, a delay streamer length was able to be determined. The second part of the test was used to verify the drop rate of the sondes. Dummy sondes (two with a foam covering and three without a foam covering) were dropped from 295 meters and the time it took them to hit the ground was recorded. From those times, the drop rate of the dummy sondes were calculated and compared to ARA's quoted drop rate for verification.

Required Equipment
Table 1 gives a list of all the equipment pertinent to the Tower Drop Test. Items and their purposes are listed.

Table 1 – Required Equipment for Tower Drop Test

Equipment	Purpose
NOAA Tower	Provide necessary height for trial sonde drops
Dummy Sondes (five)	Test specimens to be dropped
Delay streamers (four each of five length cases)	Test specimens to test delay time
Stop Watches	Record time to drop a known distance and time for delay streamer to deploy sonde streamer
Binoculars	Provide a better view of sonde drop at high distances
Harnesses and Helmets	Safety when going up the NOAA tower
Video Camera	Record drop results
Walkie-Talkies	Communication between ground and tower personnel

Facilities and Resources

The Tower Drop Test did require an outside facility for its completion. The NOAA tower in Erie, Co. was used. Both Bruce Bartram and Daniel Wolfe of NOAA were the team's resources for this test.

Test Procedure

Table 2 outlines the steps taken in completing the Tower Drop Test. The procedure includes initial boxes for team personnel to keep track of what has been completed during a test trial.

Table 2 – Procedure for Tower Drop Test

Step	Description	Initial	Date
0.TST.3.1	Have two personnel travel to the appropriate height for the drop, depending on which part of the test is being performed (50 meters for delay streamer and 295 meters for the drop rate)		
0.TST.3.2	Have other personnel set up the video camera at designated location on the ground, as well as prepare the stop watch		
0.TST.3.3	Tower personnel should communicate to the ground when the sonde is to be released		
0.TST.3.4	Stop watch personnel should use the binoculars to view when the sonde has been dropped		
0.TST.3.5	Video camera personnel should tape the drop, capturing view of the sonde dropping		
0.TST.3.6	Use video and stop watch times to determine delay time and drop rate		

Results and Conclusions

Table 3 shows the average unravel and drop times using various delay streamer lengths. As mentioned above, these averages were calculated from four different trials for each of the five lengths. The times do not follow any specific pattern, however, the 12-inch delay streamer correlated to the longest unravel time. A long unravel time is desired because the team is dropping these sondes from a pusher prop plane. For this reason, a 12-inch delay streamer will be used and further tested in the prototyping process.

Table 3 – Average Times from 50 Meters for Various Streamer Lengths

Delay Streamer Length (in)	Unravel Time (s)	Time from Unravel to Ground (s)	Total Time (s)
12	3.19	1.90	5.09
13	2.43	1.96	4.39
14	2.21	1.47	3.68
15	2.20	1.80	4.01
16	2.85	2.00	4.85

Table 4 demonstrates the average sonde decent rates from 295 meters. As mentioned above, two sonde cases were tested; one case where foam casing was present and another

where it was not present. ARA's quoted descent rate is 14 m/s. A slow descent rate is desired to match the needed data collection rate. Therefore, the measured descent rates from this test were quite encouraging. It is also desired to minimize the volume of the sondes. Because the sonde without foam actually reported a slower descent rate, it should be no problem to remove the foam for further testing and prototyping.

Table 4 – Average Descent Rates

Overall Average Descent Rate (m/s)	Average Descent Rate with Foam (m/s)	Average Descent Rate without Foam (m/s)
11.991	12.623	11.569

With the help of NOAA and the use of their tower, the team was able to conclude that the 12-inch delay streamer was associated with the longest delay time. The team also found that the calculated descent rate was actually significantly lower than the quoted descent rate from the manufacturer and that the removal of the foam casing should not prove to be an issue in dropping these sondes.