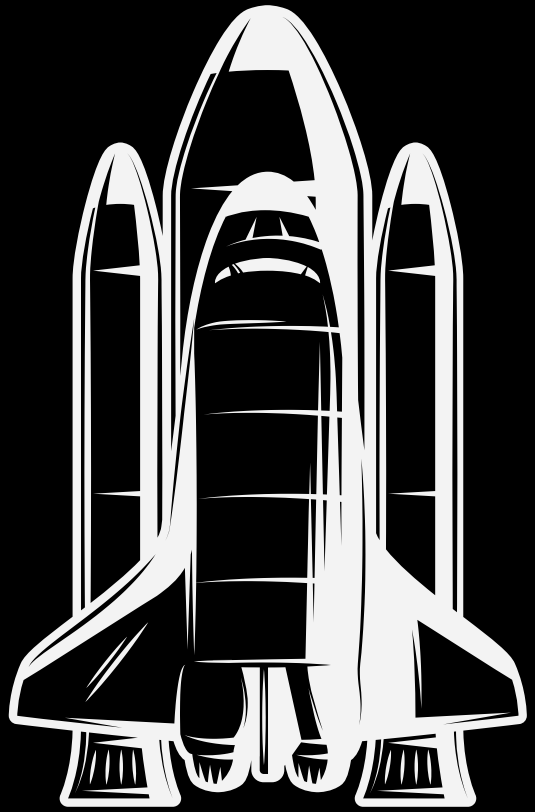
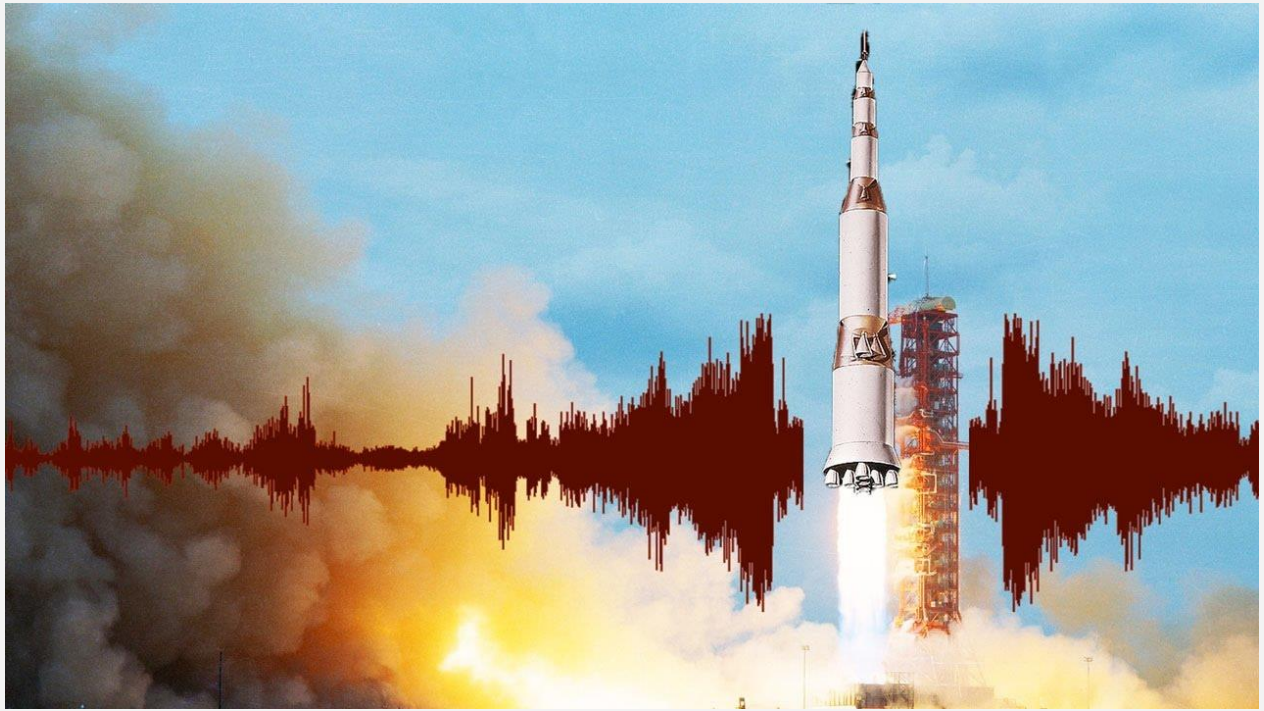


EFFECTIVENESS OF THE SOUND SUPPRESSION SYSTEM DURING A SPACE LAUNCH

PARAMVIR SINGH

BACKGROUND



THE SOUND OF A ROCKET LAUNCH

- During a launch, the engine exhausts fire hot gas along with the heat energy and a sound energy
- Sounds over 170dB are lethal
- Saturn V produced a sound level of around 220 dB, SLS produces about 180dB, space shuttle produced about 190dB

Vehicle	Space shuttle	Saturn V	SLS
Thrust	6.8 million pounds	7.6 million pounds	8.8 million pounds
Sound level	~190dB	~220dB	~180dB

WATER

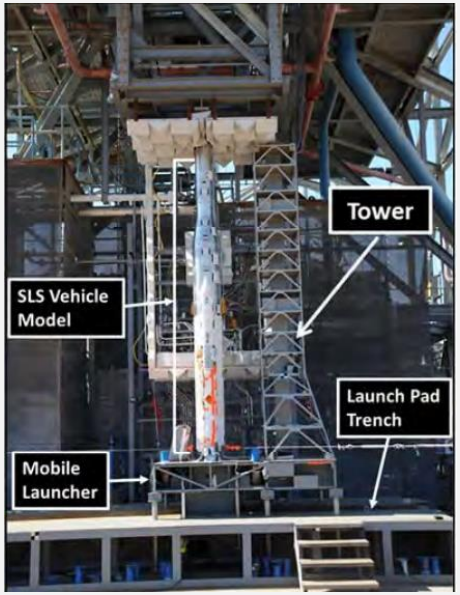
- Dumps over half a million gallons of water onto the launch pad in 60secs
- Protects ground from the rocket engine
- But also prevents the sounds waves from bouncing off the ground

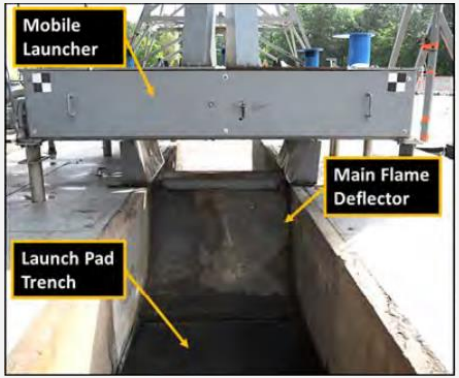
HOW DOES WATER SUPPRESSES THE SOUND?

- Sound waves are absorbed by water droplets
- Sound energy turns into heat energy

SCALE MODEL ACOUSTIC TEST CONFIGURATION

- Conducted at Marshall space flight center
- 5% scale model of the SLS vehicle
- Consists of the mobile launcher, launch pad trench, and main flame deflector
- 250 instruments measured acoustic and pressure data
- Total 17 hot fire tests over a 9-month period

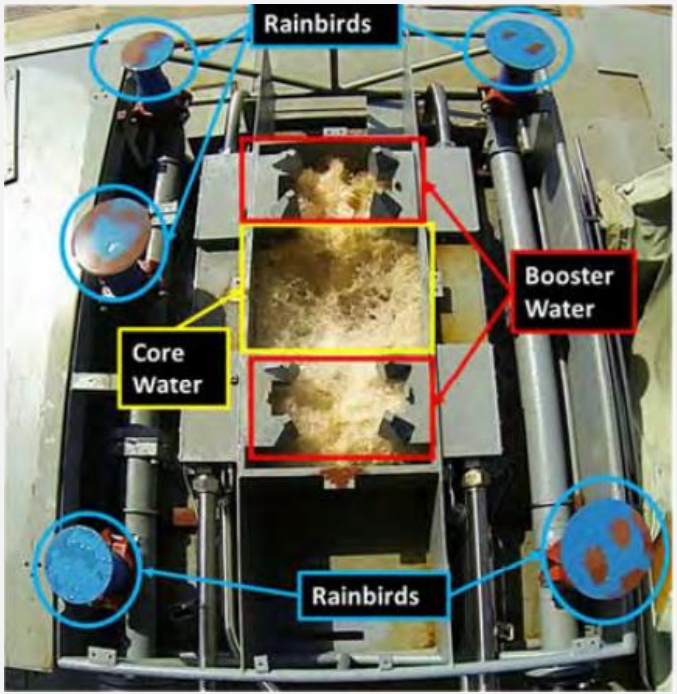




SOUND SUPPRESSION SYSTEM

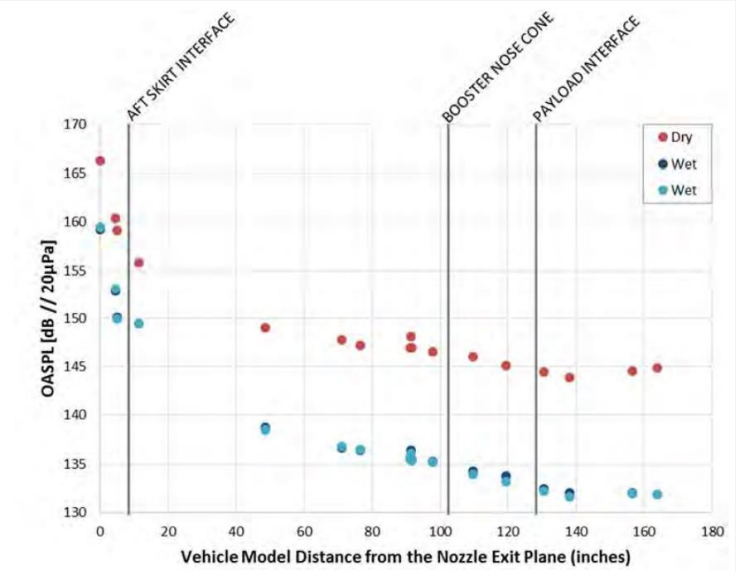
Two main types of water sound suppression system

1. Below the main deck
2. Above the deck (rain birds)



EFFECTIVENESS OF BELOW THE DECK SYSTEM

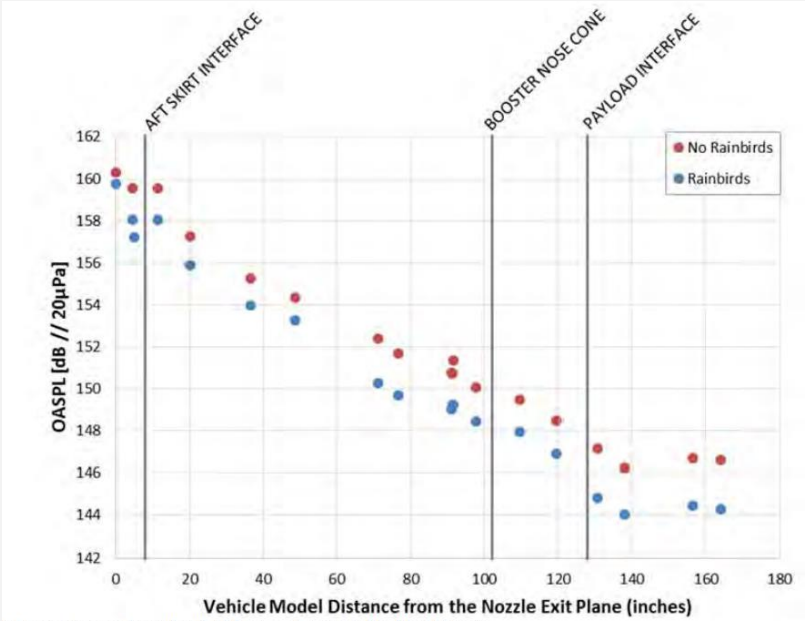
- System is effective at suppressing noise during the hold-down period
- Tested with and without the water
- Dry test is 6dB higher at the AFT skirt and 10dB higher over the rest



Comparison of dry (red) and wet (blue, turquoise) tests for the hold down tests.

RAIN BIRDS (above the deck)

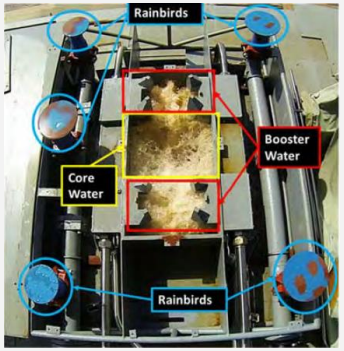
- Below deck water sound suppression system are operational during this test
- Water mass flow to the propellant mass flow ratio (W_w/W_p) of 1.9 was tested
- 2-3 dB of sound suppression for most of the vehicle

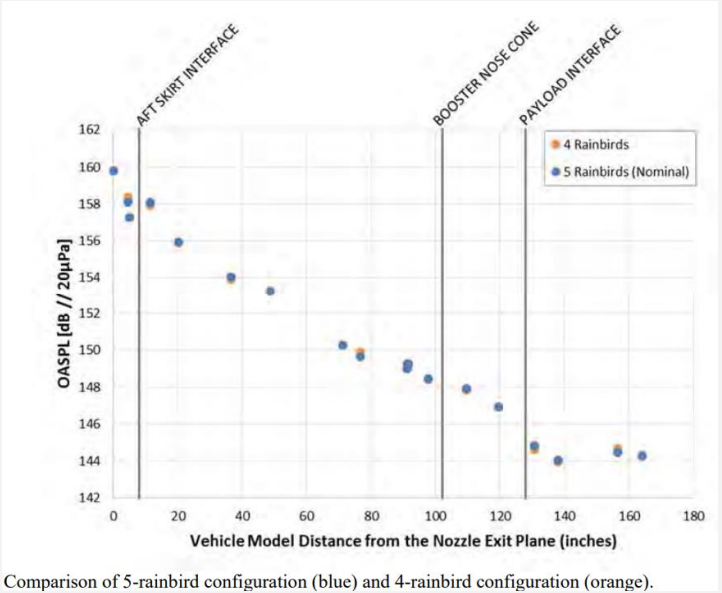


Comparison of rainbird (blue) and no rainbird (red) tests.

ALTERING THE NUMBER OF RAINBIRDS

- Initial setup includes 2 rainbirds positioned on the south side and 3 on the north side around the deck
- Modified to have 4 rainbirds
- Equal amount of water flow between both configurations
- Practically no effect on the sound pressure level

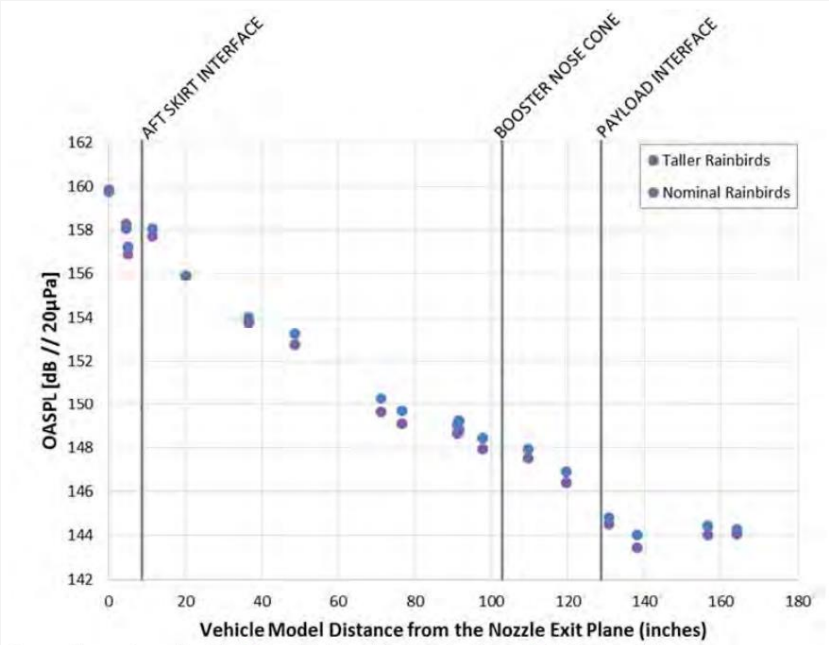




Comparison of 5-rainbird configuration (blue) and 4-rainbird configuration (orange).

MODIFYING THE HEIGHT OF THE RAINBIRDS

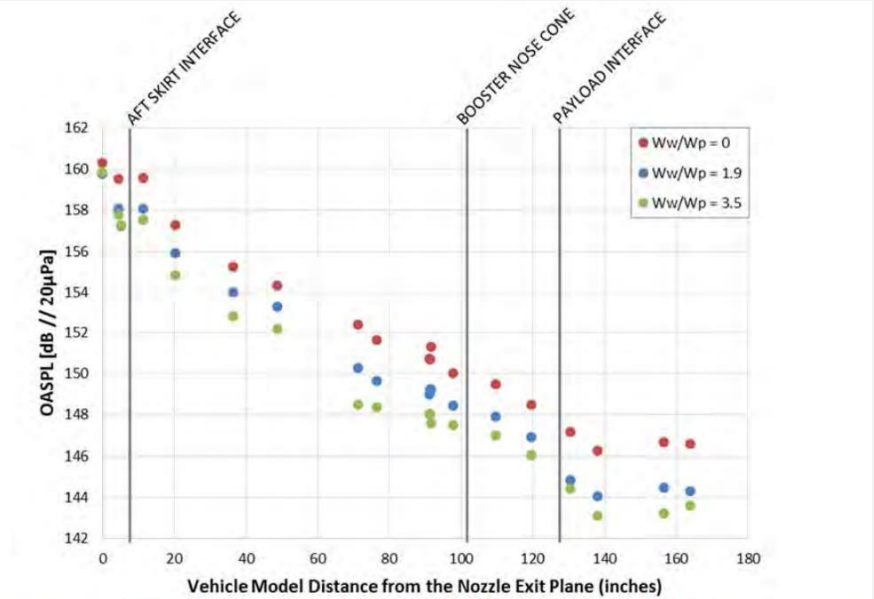
- Taller rainbirds encounter the flumes earlier
- Slightly better than the shorter rainbirds



Comparison of nominal height rainbirds (blue) and taller rainbirds (purple).

CHANGE IN WATER FLOW

- Higher suppression with increasing water flow
- 3.5 flow rate saw the most suppression in sound

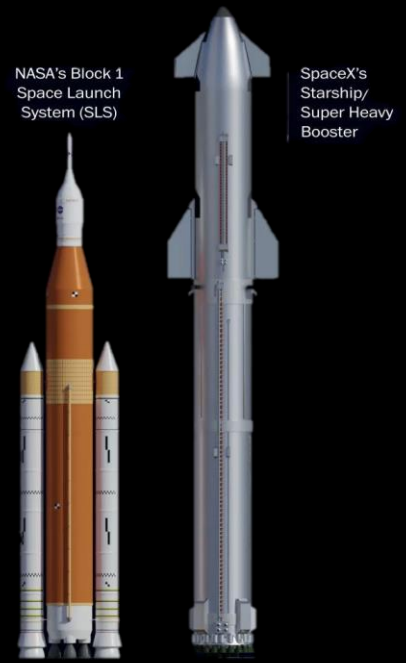


Comparison of different rainbird flow rates (no water – red, $W_w/W_p = 1.9$ – blue, $W_w/W_p = 3.5$ – green).

CONCLUSION

- Below deck water sound suppression system is very effective
- Increased ratio of 3.5, increased the reduction of the sound (2-5 dB)
- Installing taller rainbirds provided a slight decrease in sound at all locations on the vehicle
- Decreasing the number of rainbird nozzles did not have a significant effect

JUST A THOUGHT



8.8 million pounds of thrust
~180dB

12 million pounds of thrust
???

QUESTIONS?

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