

Drop Towers as a Research Platform

David Urban, Low-Gravity Exploration Technology Branch Chief
NASA Glenn Research Center

March 26, 2026
Meeting of the Committee on Biological and Physical Sciences in Space
The National Academies for Science, Engineering, and Medicine



Drop Towers offer inexpensive, repeatable access to reduced gravity

Cadence varies with facility, but drops are available year round

Cadence varies with the facility. Typically, short duration facilities (< 1s) are very high throughput (10-20 test/day)
Longer duration facilities can do 1 to 2 / day
Don't need to wait for a flight/launch

Tests are reproducible

Systems are well established and disturbances are limited or consistent

Costs

Lab scale tests are virtually free
NASA 2.2 s tower ~ \$12K / week (up to 20 drops/day)
NASA 5.2 s facility ~\$10K/drop

Limitation is test duration (seconds)

Mitigations include improved diagnostics and transient models

World Drop Tower Comparison (t > 1s)

(An Incomplete List)

Facility	Location	g-level	micro-g duration	Throughput	Notes
ZGRF – NASA GRC *VGDT(Atwood) (potential capability)	USA	10 ⁻⁵ 0.4 g to 10 ⁻⁵	5.2 s 5.7 lunar 6.6 Martian	2/day	Partial -g with centrifuge Full payload partial-g
ZARM – University of Bremen	Germany	10 ⁻⁵	4.7 s (9 s w/catapult)	~3/day	
Einstein Elevator – Leibniz University	Germany	10 ⁻⁴ and partial	~4 s	30+/day	Electromagnetic partial-g in work
Chinese Academy of Sciences	China	10 ⁻⁴ and partial	4 s	30+/day	copy of Einstein Elevator
National Microgravity Laboratory	China	10 ⁻⁵	3.5 s		
Hokkaido University	Japan	10 ⁻³	3 s		
Gravitower GTB-Pro Bremen	Germany	10 ⁻⁴ and partial	2.5 s	100+/day	Hydraulic winch Partial-g in work
IIT Madras	India		2.5 s	10/day	New
IRPI (private company)	Oregon	10 ⁻³	1.4 s	100+/day	
2.2s Tower – NASA GRC	USA	10 ⁻³	2.2 s	15/day	
Queensland University	Australia	10 ⁻⁴	2.1s	15/day	
Portland State University	USA	10 ⁻³	2.1 s	20+/day	
Purdue University	USA		2 s		
West Virginia University	USA	10 ⁻²	1.3 s		
University of Texas	USA	10 ⁻³	1.1 s		
Colorado State University	USA		1.1 s		

*If constructed

Red = Partial-g operational

Green= Partial-g – in development

Zero Gravity Research Facility (ZGRF) Overview



History

The Zero Gravity Research Facility is a **National Historic Landmark** and has been in operation since 1966. With more than **50 years of operation**, over 5,100 drop tests have been conducted. Tests conducted in the facility have included technology development for cryogenic propellant management, the Apollo 13 accident investigation, basic scientific studies of combustion and fluid physics, and the development and testing of spaceflight experiment hardware and experiment concepts.



About the Facility

The Zero Gravity Research Facility is the **largest microgravity research drop tower in the world** and has the **lowest gravity level of any of NASA's ground-based reduced-gravity facilities**.



Services



The Zero Gravity Research Facility allows access to a microgravity test environment at a **fraction of the cost of conducting an experiment in space** and can accommodate NASA, government, private industry, and university research programs.



Convenience

Choose from one of **seven drop vehicles**, which support payloads, and work with experienced technical staff to consult on payload design and integration with drop vehicles.

Capabilities

-  Microgravity duration: 5.18 s
-  Free-fall distance: 432 ft (132 m)
-  Gravitational acceleration: <math><0.00001\text{ g}</math>
-  Mean deceleration: 35 g
Peak deceleration: 65 g
-  Vacuum level: 0.05 torr

2.2 S Drop Tower Overview







History
The NASA Glenn 2.2 Second drop tower is likely to oldest operating drop facility. NASA's with over 28,000 drops. Drops started before 1965.

About the Facility
The 2.2 Second drop tower is an 8 story structure where the drop payload is enclosed in a drag shield and drops in air.

Services
The 2.2 s Drop Tower Facility allows access to a microgravity test environment at very low cost and can accommodate NASA, government, private industry, and university research programs.

Convenience
Quick turnaround. Drop packages are small enough that they can be easily transported to and from home laboratory

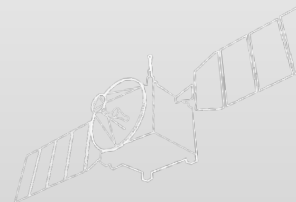
- Capabilities**
-  Microgravity duration: 52.2 s
 -  Free-fall distance: 79 ft (24 m)
 -  Gravitational acceleration: <0.001 g
 -  Mean deceleration: 15 g
Peak deceleration: 30 g
- 20 tests per day





Drop Towers are typically underutilized in the US

- **NASA utilization has focused on combustion and fire (> 95%) However that is unusual**
- **E.g. the IRPI (private company) drop tower is entirely used for fluid physics.**
- **Other disciplines can make good use of drop towers.**
- **ZARM (University of Bremen) reports that Combustion is only $\frac{1}{4}$ of testing with significant numbers of experiments in**
 - Fundamental physics
 - Fluid Dynamics
 - Astrophysics
 - Materials Science
 - Biology



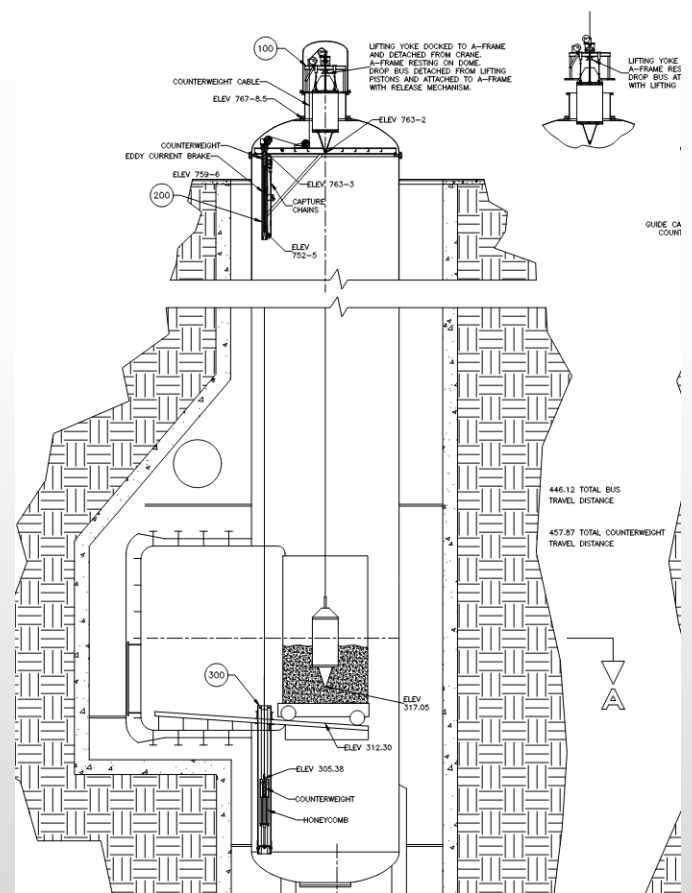


Future Challenge - Partial Gravity Capability

- **Exploration requirements and preparation for experiments on the lunar and Martian surface require access to lunar gravity**
- **Previously only offered by aircraft testing**
- **Current partial-g capabilities**
 - Centrifuge in 5.2 s drop tower
 - GTB-Pro (Bremen) (2.5 s)
 - Hannover Drop Tower (4 s)
- **Project in development to consider modifying the 5.2 s tower to provide partial – g (Atwood machine)**

How the Atwood Machine Works

- Payload and counterweight connected via high-strength cable
- Adjusting mass ratio produces **tunable effective gravity**
- System operates **inside the existing vacuum chamber**
- Payload still released from the top → **similar test duration** to current microgravity drops
- Existing bead deceleration system remains unchanged
- For lunar gravity, counterbalance approximately 91 kg for 1000 kg payload, and 231 kg for Martian gravity





Drop towers remain a cost and time effective choice

The combination of regular access, repeatability, gravity quality and cost makes drop towers a very effective test platform.