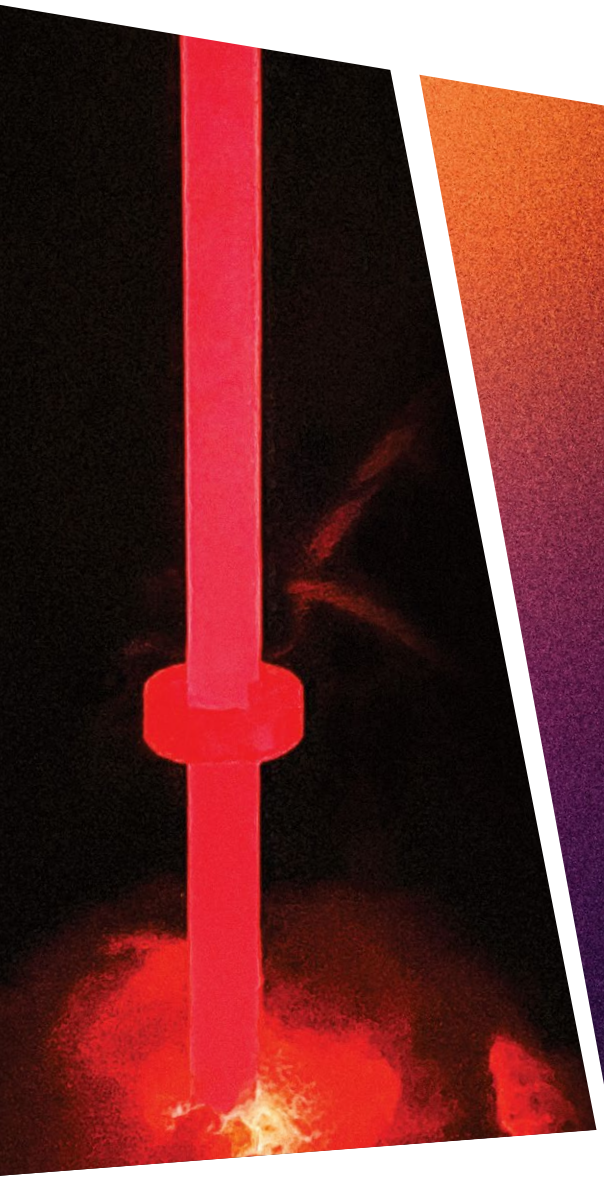
ADVANCED COOLING TECHNOLOGIES



HIGH-TEMPERATURE HEAT PIPES FOR NUCLEAR POWER & ENERGY APPLICATIONS

High-temperature heat pipes are specialized thermal management devices that operate in extreme environments, typically 400°C to 1100°C. They use alkali metals as working fluids, which have high latent heat and remain stable at operating temperatures. Common envelope materials include stainless steel and high-strength superalloys.

TYPES OF HIGH-TEMPERATURE HEAT PIPES

WORKING FLUIDS

- **Cesium** heat pipes operate from 380°C to 600°C.
- **Potassium** heat pipes operate from 400°C to 1000°C.
- **Sodium-Potassium** heat pipes operate from 500°C to 900°C.
- **Sodium** heat pipes operate from 500°C to 1100°C.
- **Lithium** heat pipes operate at greater than 1000°C.

DESIGN & STRUCTURE

Heat pipes can be designed several ways based on their internal structures.

- **Wicked heat pipes** rely on an internal wick for working fluid return.
- **Thermosyphons and loop thermosyphons** rely purely on gravity for working fluid return.
- **Pulsating heat pipes** rely on vapor/liquid plugs and are orientation-independent.

ENVELOPE

ACT has experience with a variety of envelope materials compatible with alkali metals and the challenging environments of high-temperature applications.

Common envelope materials include **stainless steel and nickel-based superalloys** (Inconel, Haynes). ACT's R&D team continuously explores the use of new material combinations (refractory metals, FeCrAl) for novel applications in the nuclear and energy fields.

APPLICATIONS FOR ALKALI METAL HEAT PIPES

Nuclear Power

Transport heat from advanced terrestrial reactors (SMRs, MMRs) and space-based fission power systems to energy conversion systems or other users.

Solar Thermal

Transport heat from solar receivers to thermal storage units or steam turbines.

Industrial Heat Recovery and Storage

Capture waste heat from industrial processes and furnaces to support secondary operations (e.g., material processing) and improve energy efficiency.

Aerospace & Hypersonic Vehicles

Enable cooling of hypersonic vehicle leading edges (missiles/aircraft) exposed to extreme high temperatures.

Energy Conversion Systems

Provide a thermal link between the heat source and the hot end of energy conversion systems (Stirling, Brayton, Rankine, thermionics, thermo-photovoltaics).

Temperature Calibration & Control

Isothermalize furnace elements for temperature calibration applications.

Typical Performance Envelope

(Configuration-Dependent)

Operating Temperature Range: 500°C to 1100°C

Heat Transport Capacity: Up to tens of kW per pipe (design-dependent)

Heat Transport Length: Up to 5 m

Operating Environments: Vacuum, inert gas, controlled atmospheres, ambient

Radiation Compatibility: Neutron and gamma tolerant

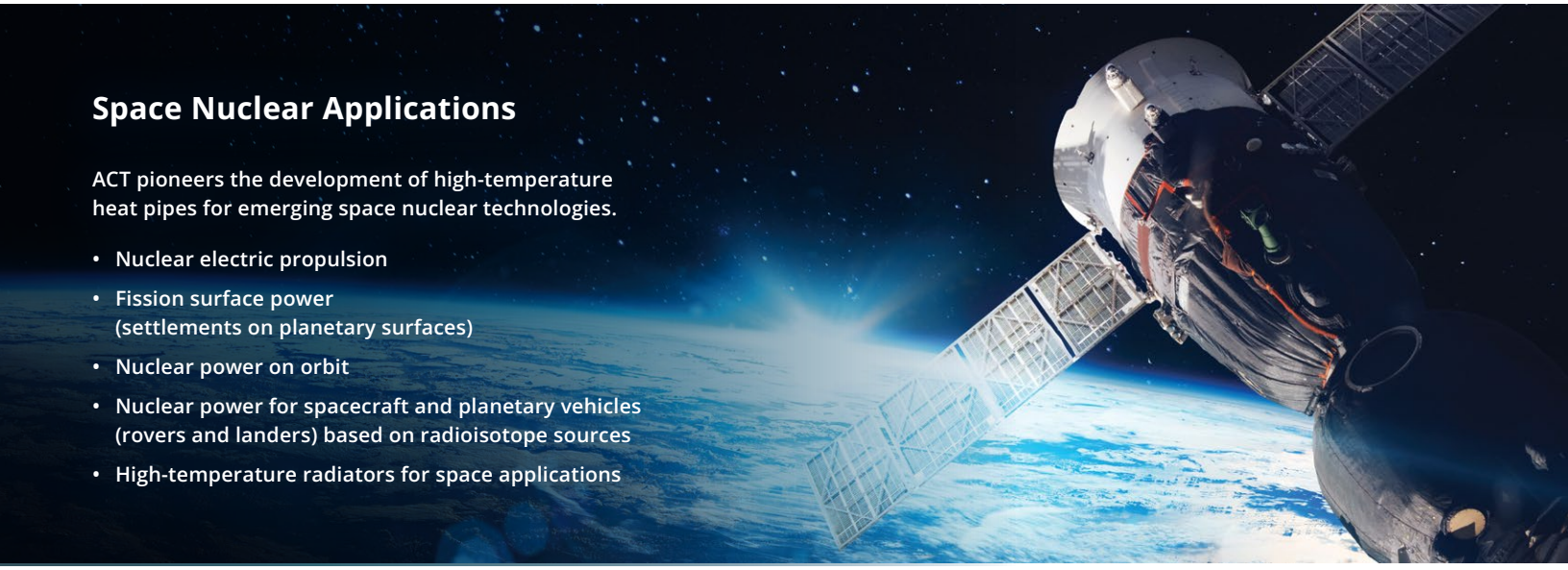
Orientation Sensitivity: Low (application-dependent)

Size: Typical diameter of 0.5" to 4–5"

Geometries: Straight, bent, or custom profiles

Final performance values are established through design trade studies and qualification testing.

Space Nuclear Applications



ACT pioneers the development of high-temperature heat pipes for emerging space nuclear technologies.

- Nuclear electric propulsion
- Fission surface power (settlements on planetary surfaces)
- Nuclear power on orbit
- Nuclear power for spacecraft and planetary vehicles (rovers and landers) based on radioisotope sources
- High-temperature radiators for space applications

Build with confidence.

ACT partners with you to deliver high-quality manufacturing for advanced energy and nuclear systems.

LEARN MORE AND

TALK TO AN EXPERT

Scan the QR code to visit our website or contact **solutions@1-act.com**

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