THERMAL CONTROL SYSTEMS

Description

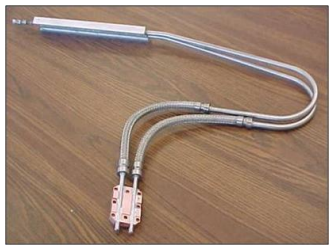
ATK's thermal control systems are two-phase heat pipes, or transfer devices circulating a working fluid, such as ammonia, that evaporates and condenses to transport waste heat. The heat pipes provide an energy efficient means to transport hundreds of watts of heat across several meters. Our extensive range of heat pipes includes:

- Aluminum extrusions varying from 0.15" thick elliptical to 1.3" round. ATK has over 100 standard extrusion designs that may accommodate your applications or can custom make a profile for you.
- Operating ranges from cryogenic to 120°C
- Flexible heat pipes that ease integration and deployment and provide vibration isolation
- Variable conductance heat pipes for temperature control
- Diode heat pipes for heat transfer in one direction only
- Heat pipes that can be embedded within a honeycomb panel and bonded to the interior side of facesheets
- Surface-mounting heat pipes with flanges that attach to heat pipe panels to transfer heat from internal equipment panels to external radiator panels

Our heat pipe experience—combined with our extensive structural experience and system design and analysis—provides for complete thermal control systems integrated with the spacecraft structure.

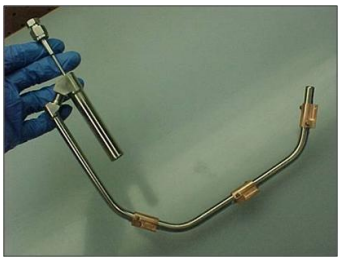
Heritage

Over 75,000 heat pipes delivered to the aerospace community with no operational failures

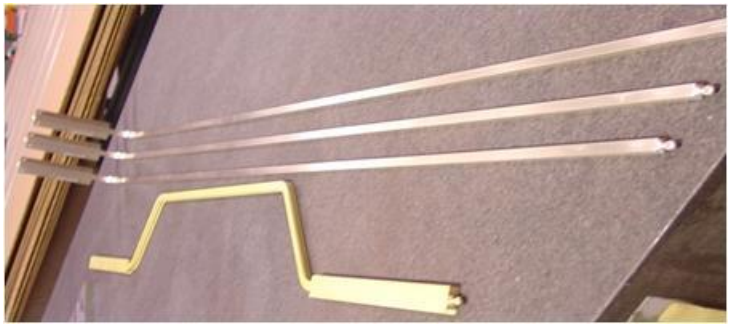


Flexible Heat Pipes

Variable Conductance Heat Pipes



Diode Heat Pipe



LOOP HEAT PIPES

Description

Loop Heat Pipes (LHPs) solve difficult thermal challenges for heat acquisition, transport, and rejection. With several meters of pressure head and small diameter tubing, the LHP can provide unique zero gravity thermal management and normal gravity testability with greater orientation independence.

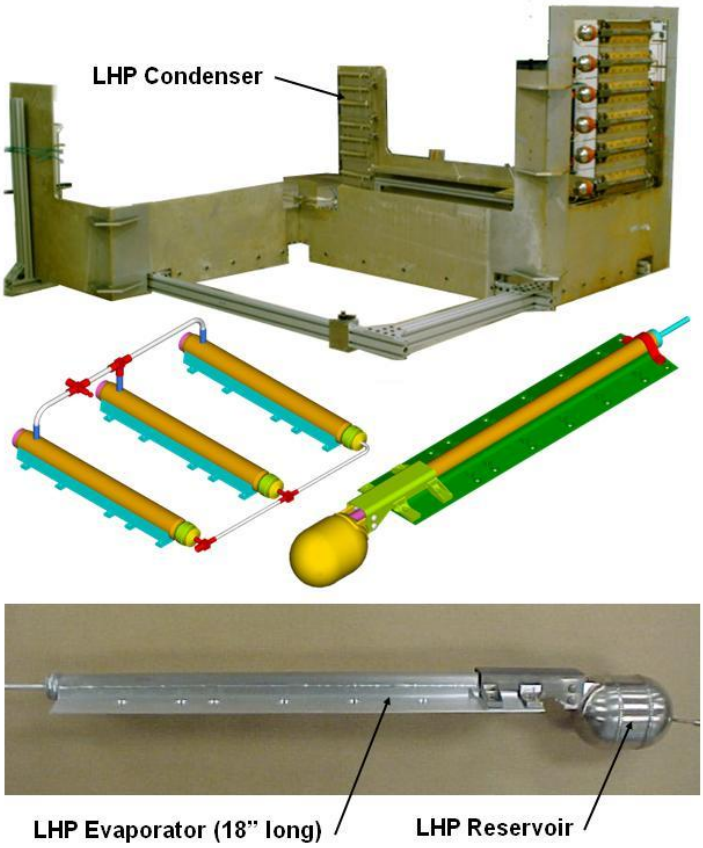
ATK Spacecraft Systems and Services provides LHPs with deployable radiators to significantly enhance heat rejection of high power spacecraft. Other large GEO spacecraft employ LHPs to cool specific high power components and transport heat to body-mounted heat pipe radiators.

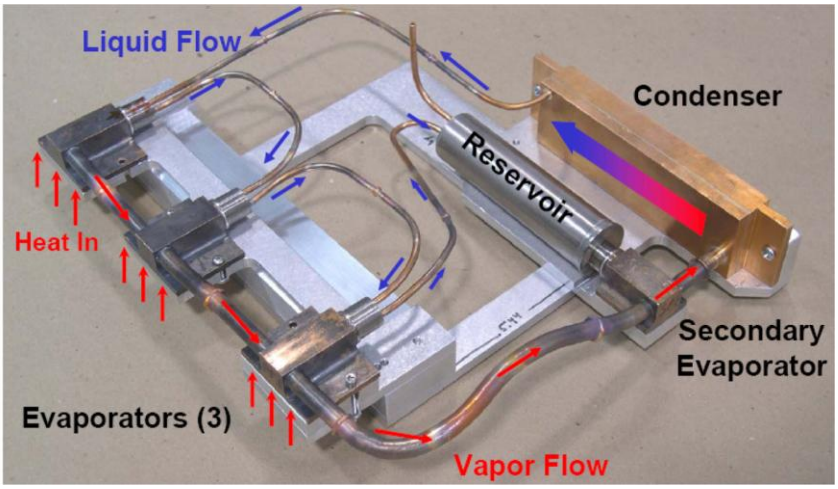
Unique payloads — such as phase arrays, lasers and CCDs — take advantage of LHPs for their heat transport capability, small diameters and flexible lines for routing, integration, mechanical isolation and variable conductance operation for temperature control.

LHPs provide high heat transport capability in zero gravity and at several meters of adverse elevation in normal gravity. They exhibit robust and reliable performance. Features include:

- Evaporator with fine wick providing high capillary pumping
- Co-located reservoir for fluid management, start-up and operating robustness
- Secondary wick to couple the reservoir and evaporator
- Small diameter, routable flexible transport lines
- Direct condensation or heat exchanger condensers
- High thermal transport and conductance
- Variable conductance
- Lightweight design
- A two-phase heat transport device for emerging spacecraft and terrestrial thermal control applications
- Flexible coupling to deployable radiators
- Thermal control of instruments, optical benches and small satellites
- Complex routing or configurations not amenable to integrated system level tests
- Cooling for densely packaged electronics

Loop Heat Pipe Images





HEAT PIPE RADIATORS AND EQUIPMENT PANELS

Heat pipe radiators and equipment panels contain embedded aluminum heat pipes consolidated with aluminum honeycomb core and facesheet. Depending upon the configuration, they contain multiple variations of inserts and thermal surface coatings such as conductive paint or optical solar reflectors.

Description

Standard Materials

- Aluminum 6063-T6 axially grooved heat pipes
- 2024-T81 or 5005-H34 aluminum facesheet (.008" to .062")
- BR 127 – corrosion resistant primer preparation for bonding
- Aluminum honeycomb core – 2.0 to 8.1 pcf 5056-H39 perforated
- Eccobond 56/C silver filled adhesive for thermal bond of pipes
- FM 73U film adhesive unsupported .01 to .03 weight – facesheet / heat pipe and facesheet / core
- FM 410 foaming adhesive .050" thick – core splices and shear tie to inserts
- 2024-T81 or 7075-T7351 aluminum bar – co-bonded panel inserts
- AF-1141 core fill adhesive – core fill and edge closeout material
- G-10 fiberglass and ULTEM thermal isolation
- EA 9394 two-part structural paste adhesive – structural bond of brackets

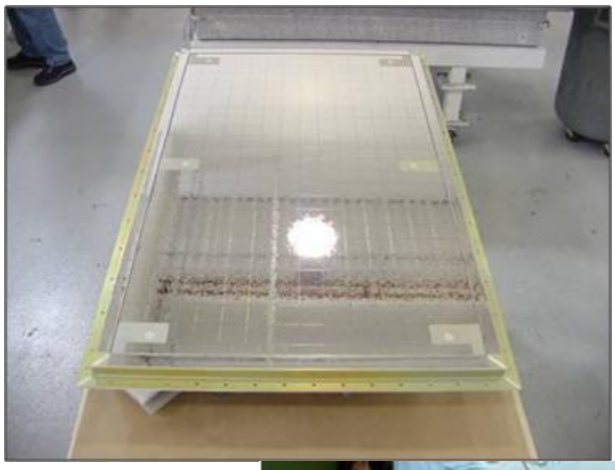
Radiator Inspections and Process Verifications

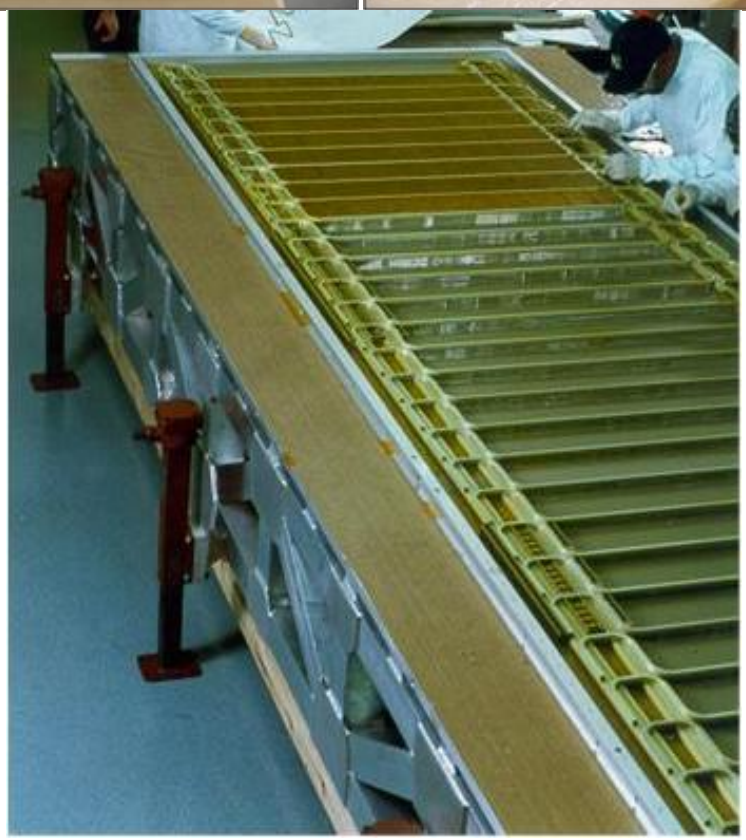
- Visual and dimensional inspection (including flatness measurements)
- Proprietary NDI inspection
- Cure cycle verification
- "T" peel testing – validates the inserts and facesheets / splice straps cleaning and priming operation
- Flatwise tension testing – validates the bonding / curing process
- Lap shear testing – validates the mixing / curing of all adhesives

Heritage

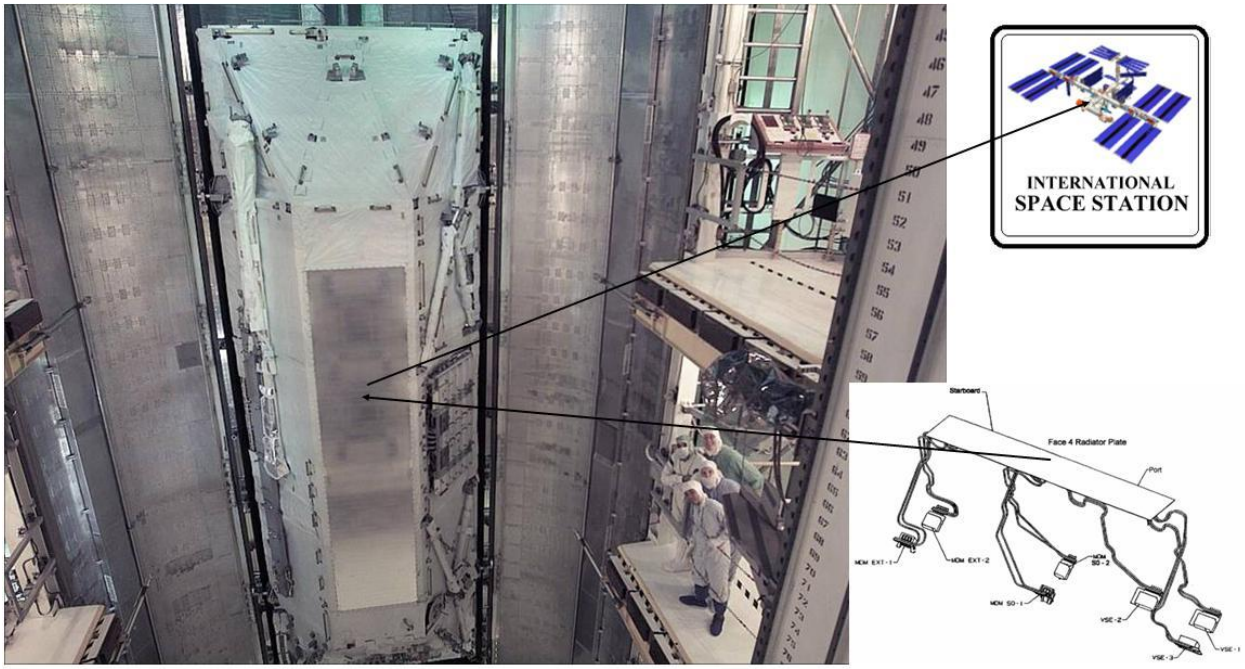
- ISS S0 heat pipe radiator system (5' x 21')
- ISS DDCU, RPC, BSP, Zenith and Nadir MDM heat pipe radiator systems
- Hubble Space Telescope thermal control systems
- SWIFT BAT detector panel
- Lunar Reconnaissance Orbiter
- GEOCOM transponder and bus radiator embedded heat pipe panels (Boeing, Lockheed Martin, Orbital, and Loral)
- High temperature OMUX panels

Example Heat Pipe Radiators and Equipment Panels





Space Station Example for Heat Pipe Radiators and Equipment Panels



- 21' x 6' Heat Pipe Radiator on the S0 Truss Structure for the International Space Station
- View is into Space Shuttle cargo bay with bay doors open
- Within S0 Segment, the Heat Pipe Radiator connects to network of 14 Heat Pipes (20' to 24' long) and 7 Heat Pipe Cold Plates