Hi-Temp Insulation, Inc. provides the Aircraft, Missile and Space Industries with the most innovative designs and the very best products used to solve thermal and acoustical problems.

The leader in new material use and fabrication techniques; our products are designed to meet the challenge of today’s sophisticated requirements.

Our modern 134,000 sq. ft. facility includes a comprehensive range of equipment, storage space, test labs, and manufacturing capability.

Our equipment includes many special machines such as rigidizing rollers for strengthening metal foils; special heated platen press for bonding structural components; heat-sealing machines; seam and spot welders for light gage stainless steel and inconel; high temperature ovens for shaping resin impregnated fabrics; and sewing machines for quilting up to two inches thick.

Specialists in metal foil, soft goods and sewn insulation designs; we have gained considerable experience by providing solutions for a variety of demanding applications.

As a full service manufacturer, Hi-Temp Insulation provides its customers with...

**Customer Service**

- Our sales and support staff are prepared to meet with you throughout the United States and worldwide to discuss your technical requirements.

**Research and Development**

- We continue to pursue numerous research and development projects including the best available products for high temperature and fire stop applications.

**Engineering**

- We have a comprehensive engineering facility which undertakes the complete design and manufacture of products from basic performance requirements.

**Production**

- We are small enough to be flexible and responsive, and large enough to manufacture a quality product that will satisfy your high standards of production.

**Quality Control**

- Our strict quality control procedures, satisfying the requirements of DF-9000, ISO-9000 and FAR21.303, track the fabrication process from material selection through final packaging, assuring that critical specifications are met.
Sewn Insulation Blankets

Hi-Temp Insulation's broad range of abilities in the sewing segment is unmatched in the Aircraft, Missile, and Space industries.

Working closely with material manufacturers, we have developed fabrication techniques for a variety of materials; including carbon, graphite, ceramic, and nicalon. We continually provide sample insulation blankets to major contractors and government agencies for testing.

This experience has made us the primary supplier of sewn insulation blankets on such critical programs as the Trident Missile, Delta Launch Vehicle, and the Space Shuttle.

To protect and seal sewn insulation blankets, Hi-Temp Insulation uses a wide variety of facing materials including coated fabrics, mylars, and films. In addition, using stainless steel thread, foils up to .002 thick can be sewn to insulation blankets for liquid proof protection at high operating temperatures.

We also specialize in diamond quilted blankets as specified in MIL-I-7171 for thermal and acoustical applications. In addition, our custom designed sewing machines are able to quilt blankets up to 60" wide and 2" thick. We use an interlocking quilt pattern which secures the insulation between the inner and outer facing fabrics even if a thread breaks. This unique method was used to fabricate the white exterior panels for the Space Shuttle.

An additional advantage is the ability to fabricate sewn blankets without investing in expensive set-up or tooling charges. This also allows for flexibility in production where changes can be easily incorporated to provide custom fit insulation blankets.
Metal Foil Covered Insulation Blankets

For many applications, especially for protection from high operating temperatures, metal covered insulation blankets are preferred.

We are capable of rigidizing, forming, and welding various metals from .002 to .010 thick. These metals typically include aluminum, stainless steel, inconel, titanium and nichrome.

Hi-Temp Insulation’s metal foil rigidizing method provides advantages over other methods. When fed into the rigidizer, the two rollers impart grooves into the foil which gathers the material rather than embossing it. Our method provides additional material which, during the forming process, prevents the foil from thinning or tearing and produces a stronger finished part.

Listed below are some of the advantages metal foil covered insulation blankets offer:

- Durable construction provides continuous use and long term service; even in high vibration or service areas.
- Creative attachment methods allow rapid removal and replacement for in-service inspection of protected equipment.
- Insulating materials, from glass to ceramic, provides thermal protection from sub-zero temperatures to 4000° degrees F.
- Liquid resistant construction protects the insulation from contaminants including fuels, oils, fungus, and cleaning agents.

Soft Goods Insulation Blankets—Fire Barriers

Hi-Temp Insulation is the leader in designing and fabricating insulation blankets for applications requiring thermal protection with fire stop capabilities.

As a fire stop, in accordance with FAA requirements for aircraft protection in an emergency situation, these blankets are able to stop a 2000° F flame for 15 minutes with no burn-through. Meeting this requirement allows our blankets to replace the existing brittle, short-lived coating now used on many commercial aircraft jet engines.

As a thermal barrier, when exposed to temperatures up to 2000° F for fifteen minutes, backside temperatures can be reduced to 380° F. Because of this unique ability, lighter weight aluminum or composite structures may be used, even near a fire wall!

Under normal operating conditions, there is no essential thermal property loss when blankets are exposed to gravitational stress, intense engine vibration, or repeated heating and cooling cycles.

Flexible, lightweight, and durable; many of our blankets have been in service since 1983 requiring minimal repair or replacement.

Designed to custom fit practically any contour, numerous attachment methods are available, including: capstans, grommets, and stainless steel velcro.
**Reflective Insulation Blankets**

Due to an increasing demand for fabricated insulation blankets for space applications, Hi-Temp Insulation installed a 3000 sq. ft. certified clean room which satisfies all the requirements set forth in Federal Standard 209B pertaining to Class 100,000.

Our clean room facility is used to manufacture multilayer (MLI) blankets of metal deposited films and dacron mesh. The reflective blankets act as heat shields to protect the Space Shuttle structure in the Payload area as well as various satellites.

**Product Testing**

Working at the design level on many new programs, Hi-Temp Insulation often performs physical tests on our products, including; fire, thermal, exposure and durability tests. To reduce cost and lead time, we frequently provide similarity or computer analysis in place of physical testing.

Shown is a fire test determining the ability of this insulation blanket design to perform as a fireproof barrier in accordance with FAR 25.1191. Testing is being conducted in accordance with the requirements set forth in Federal Aviation Administration Advisory Circular, AC 20-135. This test demonstrated that the insulation blanket prevented burn through and/or backside ignition for a period of fifteen minutes.

**Hi-Temp Insulation Inc.**

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METAL FOIL INSULATION BLANKETS
◇ For Protection in Demanding Environments ◇

When the blanket must be durable and operate in a high temperature environment, metal foil covered insulation is especially effective. Depending on the environment, various types of insulation, metal foil covers, and attachments are available. Hi-Temp Insulation fabricates metal foil blankets using a variety of insulation including glass fiber, micro fiber, or refractory fiber. The insulation is encapsulated in metal foil and will withstand operating temperatures up to 2400°F.

The type of foil that covers the insulation core is usually determined by examining two factors: temperature and environment. Depending on the temperature, Hi-Temp Insulation most often uses stainless steel or inconel for the covering material. Examining the type of environment the blanket will operate in helps determine the thickness of the foil. When the blanket is located near sharp objects, exposed to high vibration, or in a high service area; a thicker foil is recommended. If weight is the most critical requirement then a thinner foil is used.

When fabricating a metal foil insulation blanket, a number of steps are followed to provide a custom fit, quality blanket. The metal foil is cut to size then texturized to the HT-1025 pattern. Texturizing the foil creates a material surplus that prevents excess thinning or tearing of the foil during forming.

To create the necessary shape, the foil shells are formed in a hydraulic press using an epoxy punch and die. A breather hole is punched into the outer foil covering. To prevent fluid from entering the blanket, a hood is welded over the breather hole. The hood is used as the identification plate or an additional nameplate can be welded to the foil. If attachment hardware is required it is installed in the skins prior to assembly.

The insulation is then placed between the inner and outer skins. The blanket is seam welded or spot welded to achieve a liquid tight assembly. After the blanket is assembled, the edges are trimmed and folded to eliminate the burrs and sharp edges.

Hi-Temp Insulation manufactures parts using quality material and workmanship. Hi-Temp warrants its products to meet the requirements of applicable prints and/or specifications.

Hi-Temp Insulation Inc.
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FIGURE 1. THERMAL PROTECTION FROM THE ANTI-ICE DUCTS ON THE CF6-56 ENGINE.

MATERIAL: The ¼" thick, 16pcf Min-K insulation is encapsulated in .002 thick inside and .003 thick outside, stainless steel.

DUCT TEMPERATURE: 1020° F
SURFACE TEMPERATURE: 350° F
AMBIENT TEMPERATURE: -65° F to 250° F

Operating in a high vibration environment, this insulation blanket protects the fan compartment and inlet from the thermal Anti-Ice Ducts. The insulation assembly is resistant to typical aircraft contaminants. Since the insulation will not shift or settle, even in this high vibration environment, thermal efficiency is consistent throughout the assembly.

FIGURE 2. THERMAL PROTECTION FROM THE ANTI-ICE DUCTS ON THE CF6-56 ENGINE.

This blanket insulates the same Anti-Ice Duct system as the part described under “figure 1” and is designed to meet the same requirements. In addition, to absorb the cooler ambient temperatures and keep the surface temperature lower, a high temperature black coating is applied to the outside surface.

FIGURE 3. COVERS THE ENGINE EXHAUST DUCT ON THE T-38.

MATERIAL: The ¼" thick, 8pcf Refractory Fiber Felt insulation is encapsulated in .006 thick Inconel.

EXHAUST TEMPERATURE: 1200° F
SURFACE TEMPERATURE: 800° F
AMBIENT TEMPERATURE: 80° F

Durability is the primary design requirement for the blanket insulating the Exhaust Duct on the T-38. This blanket operates in a high service area, subject to frequent handling, and is exposed to sharp objects and aircraft contaminants. A thick metal covering protects the insulation so that the blanket will endure this demanding environment.

FIGURE 4. COVERS THE APU EXHAUST DUCT ON THE F-18.

MATERIAL: The ¼" thick, 16pcf Min-K insulation is encapsulated in .003 thick stainless steel.

DUCT TEMPERATURE: 1300° F
SURFACE TEMPERATURE: 400° F
AMBIENT TEMPERATURE: 120° F

A unique method is used to attach this blanket, which protects the APU Exhaust Duct on the F-18. Straps provide an alternative to the more typical method of capstans and lockwire. Velcro is used to secure the attachment straps preventing any movement of the blanket once installed.

FIGURE 5. COVERS THE HEAT EXCHANGER ON THE F-18.

MATERIAL: The ¼" thick, 16pcf Min-K insulation is encapsulated in .003 thick stainless steel.

HEAT EXCHANGER TEMPERATURE: 900° F
SURFACE TEMPERATURE: 450° F
AMBIENT TEMPERATURE: 180° F

The blanket covering the Heat Exchanger on the F-18 uses a light gage stainless steel foil to protect the Min-K insulation. Min-K is the most efficient insulation available in this temperature range, and is ideal for high temperature applications where weight and thickness restrictions exist.

FIGURE 6. PROTECTS THE ALUMINUM STRUCTURES ALONG THE FIRE WALL ON THE B-1 BOMBER.

MATERIAL: The ¼" thick, 8pcf Refractory Fiber Felt insulation is encapsulated in .002 thick stainless steel.

Since a large number of insulation blankets are required to provide thermal protection for the aluminum structures on the B-1 Bomber, weight is critical. Texturizing adds strength to the metal foil and prevents additional thinning of the foil during the forming process. This method of fabrication enables us to provide very durable insulation blankets using foil as thin as .002" thick.

FIGURE 7. COVERS FOR TWO BLEED AIR VALVES ON THE F-18.

MATERIAL: "Figure 7A - The ¼" thick, 16pcf Min-K insulation is encapsulated in .003 thick stainless steel.

VALVE TEMPERATURE: 950° F to 1060° F
SURFACE TEMPERATURE: 400° F
AMBIENT TEMPERATURE: 250° F

Figure 7B - The ¼" thick, 8pcf Refractory Fiber Felt is encapsulated in .003 thick stainless steel.

These two insulation assemblies cover bleed air valves on the F-18. The blankets prevent gas fumes from igniting due to the high operational temperature of the valves. The assemblies are formed to custom fit the complex configuration of the valves. The individual blankets are attached with capstans and lockwire for easy installation and removal.

FIGURE 8. COVERS THE SECONDARY EJECTOR ON THE MD EXPLORER HELICOPTER.

MATERIAL: The ¼" thick, 6pcf Micro Fiberglass insulation is encapsulated in .002 thick inside and .003 thick outside, stainless steel.

DUCT TEMPERATURE: 1000° F
SURFACE TEMPERATURE: 450° F
AMBIENT TEMPERATURE: 250° F

This blanket, which covers the Secondary Ejector on the MD Explorer Helicopter, was developed from a software package. The customer supplied the necessary information on a Unigraphics II data tape which was used to machine a model out of Remboard. The model was then used to develop the form dies, and later, as an inspection fixture.
HIGH TEMPERATURE INSULATION BLANKETS

For Use as Fire Barriers

Figure 1
Insulation blanket acts as a fire stop while protecting the composite pre-cooler inlet duct on the Boeing 757.

Figure 3
A high temperature blanket protects the composite bypass duct on the DC8 Quiet Nacelle by maintaining a cold side temperature of under 400°F when exposed to temperatures to 1200°F.

Figure 2
Used as a fire stop, this blanket keeps components at cooler temperatures. Here it protects the Junction Electric Box (Raceway) on the Boeing 747 and 767.

Figure 4
Through the use of a .020 metal shield, these blankets protect the struts on the Boeing 747 from possible leaks or ruptures in the bleed air lines.

Figure 5
On the Piaggio 180, this insulation system keeps the backside temperature below 380°F when the insulation is exposed to a 2000°F flame.

Hi-Temp Insulation manufactures parts using quality material and workmanship. Hi-Temp warrants its products to meet the requirements of applicable prints and/or specifications.

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LOW TEMPERATURE ENVIRONMENT

FIGURE 1. THERMAL AND FIRE PROTECTION FOR A PRE-COOLER INLET DUCT.

THICKNESS: \( \frac{1}{8}\)"  WEIGHT: \( .15 \text{ #/ft}^2 \)

The contoured insulation blanket, made with a single split line for easy installation, acts as a fire barrier for the pre-cooler inlet duct on the Boeing 757. A similar blanket insulates the pre-cooler duct, which has two outlets, on the Boeing 767. To insulate this duct with a one piece blanket, a unique "Y" type splitline is used. To save weight, depending on the temperature requirements at different areas of the duct, the blanket is fabricated using three different thicknesses of insulation.

FIGURE 2. THERMAL AND FIRE PROTECTION FOR A JUNCTION ELECTRIC BOX OR RACEWAY.

THICKNESS: \( \frac{1}{8}\)"  WEIGHT: \( .15 \text{ #/ft}^2 \)

To protect the Raceway on the Boeing 747 and 767, this lightweight blanket is designed to keep components at cooler temperatures. This type of blanket is heat cured under a vacuum which forms the insulation into the necessary shape. Since the finished product is still very flexible, components can be protected from heat with fewer individual blankets.

HIGH TEMPERATURE ENVIRONMENT

FIGURE 3. PROTECTION FOR THE COMPOSITE BYPASS DUCT ON THE DC8 QUIET NACELLE.

THICKNESS: \( \frac{1}{4}\)"  WEIGHT: \( .40 \text{ #/ft}^2 \)

This blanket, which provides fire protection for the composite bypass duct on the DC8Q, maintains a cold side temperature of under 400° F when exposed to temperatures up to 1200° F. This same design is also used to protect the reverser core of the V2500 International Engine, and the GE CF6-6 and CF6-50 Engines.

Hi-Temp Insulation uses a process which securely attaches a .002 stainless steel face sheet to the blanket. By bonding or sewing the face sheet to the insulation, this design offers many advantages over a typical metal foil blanket, including:
- The face sheet will not vibrate against the insulation core.
- The blanket will maintain its desired thickness, even in a high vibration environment.
- Regardless of atmospheric pressures or extreme temperatures, this design assures a proper air gap between the engine and the fan duct.

FIGURE 4. PROTECTS THE BOEING 747 STRUTS FROM HIGH TEMPERATURE AIR BLASTS CAUSED BY RUPTURES IN THE BLEED AIR LINES.

THICKNESS: \( \frac{1}{8}\)"  WEIGHT: \( .53 \text{ #/ft}^2 \)

For protecting the struts on the Boeing 747, Hi-Temp Insulation provides a blanket that maintains a cold side temperature under 380° F while operating in a steady state environment of 1200° F. On the hot side, this blanket has a .020 stainless steel shield. This face sheet allows the blanket to operate in a high temperature environment and act as a fire shield. The primary reason for a thicker than normal face sheet is to protect the struts against a high temperature, high pressure leak in the bleed air lines.

FIGURE 5. FIRE PREVENTION/RETENTION FOR THE PYLONS ON THE PIAGGIO 180 AND LOCKHEED C5.

THICKNESS: \( \frac{1}{8}\)"  WEIGHT: \( .55 \text{ #/ft}^2 \)

This type of insulation system prevents a 2000° F fire from penetrating the pylon and reaching the "wet wing" on the piaggio 180 (picture) and Lockheed C5.

Three types of blankets protect this area. The four side walls; these blankets are fire barriers. Between the pylon and engine; this blanket is a fire barrier that maintains a cold side temperature below 380° F when exposed to a 2000° F flame for 15 minutes. Between the pylon and the wing; this blanket meets the same requirements as the blanket above, and decreases fuel seepage into the pylon from the wing.

The Lockheed C5 upper pylon insulation assembly features a Hi-Temp Insulation designed pressure release system which, when activated by a ruptured bleed air line, releases pressure from the pylon.
MOLDED FIBERGLASS INSULATION BLANKETS

◊ For Use as Thermal and Acoustical Insulation ◊

Molded Fiberglass Insulation Blankets are used for a wide range of applications requiring excellent thermal and/or acoustical protection. Molded blankets are available in three resin or binder types: Phenolic and Phenolic with a water repellent additive are used for temperatures to 450° F (232° C); Silicone is used for temperatures to 700° F (371° C). The uncured resin in the fiberglass is cured in a heated press to the required thickness and density.

Each of the three variations is very well suited for applications in which space and weight are critical. Blankets are molded to close tolerances in various sizes and thicknesses to fit numerous configurations. Material densities range from .6 pcf to 30 pcf; high densities provide rigidity and structural strength while lower densities are excellent for acoustical and/or applications that require a flexible insulation.

To ensure that the correct material is used when manufacturing an insulation panel, and that the panel is to the proper dimensions, it is important that all required information be provided when the order is placed. Insulation panels may be ordered to various specifications, applicable certifications will be provided. When inquiring about molded insulation, please provide the following information:

- **SPECIFICATION OR FIBER TYPE:** As applicable.
- **DENSITY (Lbs/Cu. Ft.):** .6 pcf to 30 pcf, except when limited by the specification.
- **DIMENSIONS:** Up to 48" by 72" for phenolic and water repellent, and up to 36" by 72" for silicone.
- **THICKNESS:** Normal - ¼" to 4".

Hi-Temp Insulation manufactures parts using quality material and workmanship. Hi-Temp warrants its products to meet the requirements of applicable prints and/or specifications.

Hi-Temp Insulation Inc.

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Figure 1 — LAMINATED MATERIALS
Molded insulation panels are limited in thickness, width and length by the dimension of the uncured material and the heated press. Cured fiberglass insulation in densities of 42 pcf, 6 pcf, 1.0 pcf and 1.5 pcf may be laminated into thicknesses over 1.5'. The width and length are restricted by the size of the raw material; width may not exceed 72' and length is typically less than 50'.

Figure 2 — COVERS AND FACINGS
Uses for molded and laminated insulation blankets are extended by either covering the insulation with various films (figure 2), or laminating fabrics directly to the insulation. Encapsulating the insulation in a heat sealable film is an easy way to provide a liquid resistant barrier. Sewing a cloth cover, or laminating a fabric directly to the exposed area of the insulation, increases the blankets’ durability and resistance to various environmental conditions and contaminants. In order to prevent shifting or creeping of the insulation, especially when installed in a vertical position, blankets require tufting at 18' intervals.

Figure 3 — PHENOLIC BINDER
Uncured fiberglass insulation, with a phenolic thermosetting resin binder, is used for hot side temperatures to 450° F (232° C). Since the material can be molded into a variety of special contours and shapes, it is excellent for applications where a precise custom fit is required. This material may be ordered to the following specification:

LAC-C-26-425 INSULATION, PREFORMED (THERMAL AND ACOUSTICAL) BONDED FIBROUS GLASS.
TYPE: AA Composed of glass fibers - 0.00004 +/- 0.00001 inch diameter.
       B Composed of glass fibers - 0.00013 +/- 0.00002 inch diameter.
WEIGHT: Nominal Density - [Lbs./Cu.Ft.]

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Figure 4 — PHENOLIC BINDER WITH A WATER REPELLENT ADDITIVE
This insulation has the same characteristics and capabilities as molded fiberglass with phenolic binder. The water repellent additive allows the material to be used for applications where water resistance is required. This material may be ordered to the following specifications:

HT-MS-1001 FIBROUS GLASS PHENOLIC BINDER, WATER REPELLENT INSULATION BLANKET
DMS-2087C INSULATION, COMPRRESSED, FIBROUS GLASS, PHENOLIC BINDER, WATER REPELLENT.
LAC-C26-1184C INSULATION, THERMAL, PREFORMED, BONDED FIBROUS GLASS ANTI-WETTING.
WEIGHT: Nominal Density - [Lbs./Cu.Ft.]

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Figure 5 — SILICONE BINDER
Uncured fiberglass insulation, with a silicone organic base resin binder, is used for hot side temperatures to 700° F (371° C). This material may be ordered to the following specifications:

HT-MS-1005 FIBROUS GLASS SILICONE BINDER MOLDABLE INSULATION (-300 to 700° F).
DMS-1966A INSULATION, FIBROUS GLASS, SILICONE BINDER.

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MOLDED DUCT INSULATION

◊ For Use as Removable Insulation Covers ◊

The removable duct insulation covers are currently used on many military aircrafts including the F-4, F-16, and B-1 Bomber.

Insulation is molded in half sections to a desired density, thickness or shape; then covered with films, coated fabrics, or metal skins. By combining molded materials with various protective facings, Hi-Temp Insulation offers removable duct insulation for temperatures to 2600°F (1427°C). This process provides a very durable assembly that will stand up to continuous vibration and frequent handling.

A variety of attachment methods are used, depending on the insulation covering, to allow the duct insulation assemblies to be easily installed and removed. When covering the insulation with film, the assembly is fabricated allowing the covering to overlap the split line. The overlap is then adhered, or heat sealed, to the mating portion. For coated fabrics, pressure sensitive tapes provide a secure and easy attachment. When the insulation is protected with a metal covering, capstans can be installed allowing the half sections to be laced on.

Hi-Temp Insulation manufactures parts using quality material and workmanship. Hi-Temp warrants its products to meet the requirements of applicable prints and/or specifications.

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**INSULATION**

All the insulation being used is molded into a variety of sizes, shapes, thicknesses and densities. This versatility allows the insulation to protect odd-shaped parts, special configurations, and components that require a precise fit. The type of insulation that is used is dependent upon the environment and the temperature of the duct during operation.

**DUCT TEMPERATURE LIMIT: 400° F (204° C)**

A common insulation used at temperatures up to 400° F is moldable fiberglass with a Phenolic thermosetting resin binder (figure 1). This binder type can include a water repellent additive (figure 2) for applications where water resistance is required.

**DUCT TEMPERATURE LIMIT: 700° F (371° C)**

Fiberglass insulation is also available with a Silicone thermosetting resin binder (figure 3) for temperatures up to 700° F. There are many advantages to using moldable fiberglass insulation in this temperature range; it is lightweight, has excellent thermal efficiency, and is very cost effective.

**DUCT TEMPERATURE LIMIT: 2600° F (1427° C)**

For high temperature applications up to 2600° F, moldable Refractory fiber insulation is available. In addition to withstanding high temperatures, this insulation also has excellent thermal stability and will maintain its shape in a high vibration environment.

**COVER**

Molded duct insulation is available with a number of covering materials including films, coated fabrics, and metals. A cover adds stability to the insulation while providing various methods for attachment. Temperature and environment are the critical elements that determine if a cover is required and which type to use.

**DUCT TEMPERATURE LIMIT: 400° F (204° C)**

**SURFACE TEMPERATURE: *200° F (93° C)**

If moisture or liquids do not exist in the operating environment, no cover may be necessary (figure 1A). If a protective cover is required, lightweight films are available, adding stability and excellent physical properties to the moldable insulation. Various heat sealable and pressure sensitive films are available (figure 1B), and are inert to solvents, acids, petroleum products, and synthetic hydraulic fluids.

Illustrated in figure 2 is one method of completely encapsulating the insulation. To protect against typical aircraft contaminants, the insulation is sealed by bonding an aluminized coated cloth to the outside surface and coating the inside surface with liquid silicone.

**DUCT TEMPERATURE LIMIT: 700° F (371° C)**

**SURFACE TEMPERATURE: *400° F (204° C)**

Molded insulation in this temperature range is available without a cover (figure 3A). If a cover is required, coated fabrics provide a liquid resistant surface, and increase durability. A special design developed by Hi-Temp Insulation for use on the Space Shuttle’s Hydraulic System is shown in figure 3B. A pressure sensitive polyester film is used to cover the silicone insulation. If leaks develop in the Hydraulic lines the insulation will discolor; the problem area is then isolated and repaired.

**DUCT TEMPERATURE LIMIT: 2600° F (1427° C)**

**SURFACE TEMPERATURE: *1400° F (760° C)**

In high temperature environments, moldable refractory fiber duct insulation is available without a cover. When necessary, to protect the insulation, a metal foil facing is used on the outer surface (figure 4A). To add a foil cover to a curved section of insulation, the metal is first texturized (figure 4B) which prevents excess thinning and tearing of the metal during the forming process. A welded metal foil assembly may be used to completely encapsulate the insulation. Figure 5 shows a unique process in which a metal shield is attached to the inside surface, allowing the outside surface to see temperatures low enough to use a coated fabric.

*Temperatures are estimated and will vary depending on insulation thickness and density.*
A VARIETY OF INSULATION

◊ For Use on the Space Shuttle ◊

Hi-Temp Insulation is proud of our participation in the success of the Space Shuttle. As a major designer and fabricator of insulation products, Hi-Temp developed many new technologies to meet the requirements of the Shuttle program. A combination of low weight and high thermal efficiency necessitated an examination of new materials and fabrication techniques; this knowledge has led to the introduction of many new products for the Aerospace and Commercial markets.

Low Temperature — Environmental Control — 180°F to 380°F

- **Hydraulic Lines and System Components** — The Hydraulic lines are wrapped with molded fiberglass insulation and covered with polyester film. Using a white insulation with a clear cover allows the lines to be easily monitored for fluid loss without removing the insulation. Hydraulic system components are also insulated with fiberglass; a stainless steel cover is formed over the insulation for additional durability.

- **Payload Bay** — The Payload Bay is protected from heat by using a two-blanket insulation system. The outer blankets are fabricated using molded fiberglass insulation encapsulated in reinforced polyimide film or beta cloth. The inner blankets are a multilayer insulation (MLI) design composed of numerous layers of metal deposited films and dacron mesh. The "two-blanket" design absorbs heat (outer blanket) to protect the payload, and reflects heat (inner blanket) to protect the aluminum shuttle frame.

High Temperature — External — 2000°F to 2600°F

- **Space Shuttle’s White Exterior Surface** — Flexible sewn blankets are made from layers of quartz felt and encapsulated in quartz and ceramic fabrics. Hi-Temp developed a process for quilting up to two inches thick without compressing the insulation; this is critical in maintaining consistent thermal protection throughout the blanket.

- **Wing Leading Edge** — Molded cerachrome insulation is encased in inconel foil producing a light rigid insulation assembly that provides protection from high re-entry temperatures.

- **Main Engine Nozzles** — Ceramic insulation is encapsulated in nichrome foil and nichrome screen. This construction withstands temperatures to 2600°F while operating in an environment that experiences extreme vibration.

The descriptions, as specified on the back, detail the majority of insulation assemblies manufactured by Hi-Temp for use on the Space Shuttle, however, a number of specialized items were also developed. For further discussion or information please contact the Hi-Temp Insulation sales department.

Hi-Temp Insulation manufactures parts using quality material and workmanship. Hi-Temp warrants its products to meet the requirements of applicable prints and/or specifications.

Hi-Temp Insulation Inc.
4700 Calle Alto, Camarillo, California 93012 • (805) 484-2774
Fax (805) 484-7551
A HIGH TECHNOLOGY BLANKET

◊ For Use as a Fire Barrier ◊

Figure 1.

PICTURED: HT 2000 is a flexible, highly thermal efficient insulation blanket, used here by Boeing Commercial Airplane Company, to protect the engine cowl on the Boeing 757 Aircraft.

As seen in AVIATION WEEK AND SPACE TECHNOLOGY, October 15, 1984.

Figure 2.

PICTURED: Insulquilt 2000 is a lightweight, flexible Refractory Fiber Insulation Blanket, used here by McDonnell Douglas Helicopter Company, to protect the Engine Cowls on the MD Explorer Helicopter.

The Insulquilt product is a proven insulation system developed to prevent flames from reaching the adjacent aluminum/composite airframe structure. There are many advantages to a removable insulation blanket; which is primarily used to meet FAA requirements, in accordance with Circular AC20-135 for aircraft protection in an emergency situation. Insulquilt insulation products also have the ability to withstand:

• REPEATED HEATING AND COOLING CYCLES.
• RAPID AND FLUCTUATING TEMPERATURE CHANGES.
• CONTINUOUS VIBRATION AND GRAVITATIONAL STRESS.
• CONTACT WITH TYPICAL AIRCRAFT ENGINE CONTAMINANTS.
• EXPOSURE TO A 2000° F FLAME FOR 15 MINUTES WITH NO BURN THROUGH.

A variety of related insulation products are also available. Insulation cores or facing materials may be substituted based on customer requirements for low cost, reduced weight, or high thermal efficiency.
FIGURE 1. The Fan Cowl is protected with a removable firewall insulation blanket. Metal shields or intumescent coatings are often used for fire protection, however, due to its need for periodic replacement, these methods are expensive and time consuming. The core of the blanket is a high efficiency insulation quilted between a layer of glass cloth (cold side) and ceramic cloth (hot side). To protect the insulation from chemical damage and abrasion the blanket is encapsulated/sealed with silicone coated cloth. The silicone is heat cured under vacuum to provide a custom fit to the required configuration.

FIGURE 2. To protect the composite Cowl on the MD Explorer, an Insulquilt product is provided which meets the FAA 2000°F 15-minute flame penetration requirement. In addition, under normal operating conditions, the blanket temperature on the engine side of 500°F is reduced to 250°F against the cowl.

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FAA Test Requirements per Circular AC20-135 for Aircraft Protection in an Emergency Situation.

Test reports available upon request.

**THERMAL EFFICIENCY**

K=(BTU-IN)/Sqft-Hr-Deg F)

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THERMAL AND FIRE PROTECTION

FOR USE ON CF6 GE ENGINE THRUST REVERSERS

According to FAA fireproofing regulations, commercial engine cowlings must be capable of withstanding a fuel-fed flame of 2000°F for fifteen minutes without flame penetration. To meet this requirement, there are two approved spray-on coatings, MA-25 S and 64-C1-2. For some time, many in the industry have been aware of reverser core failures resulting in heat induced degradation going unnoticed under spray-on coatings.

Hi-Temp Insulation provides removable reverser insulation blankets for CF6-6, CF6-50 and CF6-80 engine series. Each insulation blanket performs as a fireproof barrier in accordance with FAR 25.1191. The blanket tests were conducted in compliance with the criteria and requirements set forth in Federal Aviation Administration Advisory Circular AC 20-135. The insulation blankets prevent a burn through and/or backside ignition for a minimum of fifteen minutes.

Following is a list of the advantages removable insulation blankets offer over spray-on coatings. Many of these advantages where detailed in an article written for Aerospace Engineering by Paul Romnes, Engine Technical Services Maintenance Operations, United Airlines, San Francisco, CA.

Environmental:

- Elimination of toxic emissions during the surface preparation and spray-on application of ablative insulation coatings.
- Elimination of disposal problems associated with the coatings when removed for inspection and with the chemicals used during removal of the coatings.
- Elimination of special training and handling.
- Elimination of special purpose spray containment facilities.

Fit:

- Blankets are manufactured to tool controlled tolerances.
- Blankets are configured to pan down in specific areas to improve fit and avoid interference problems.
- Blankets are designed around areas where insulation is not required, rather than applying a coating to the entire area, reducing overall weight.
- Mechanical fasteners are used to precisely position and positively retain the blankets in place.
Consistency:
- Blankets are not affected by high vibration levels of an in-flight environment that can cause fragile coatings to disintegrate.
- Blanket thickness is controlled by both quilting the insulation core and heat curing the final lay-up under vacuum.
- Blanket thermal efficiency is superior to coatings, and remains consistent due to controlled thickness and improved durability.

Durability:
- Blankets are not as easily damaged as coatings during maintenance.
- Blankets are more resistant to typical aircraft contaminants than coatings.
- Blankets do not require top coats like those used as a binder for coatings.

Maintainability:
- Blankets are easily repaired.
- Blanket repair can be done "on-wing."
- Blankets are easily removed and reinstalled for fan reverser inspections.

Inspections:
- Reverser bond lines, between the hot-side surface and the honeycomb core, can be inspected more frequently due to improved accessibility.
- With improved accessibility, a more reliable "tap test" and visual inspection can be performed.
- Reversers require less repair time since coatings are not being removed and re-applied.

Cost:
- Blankets last the life of the reverser under normal conditions.
- Maintenance costs are reduced compared to removing and re-applying coatings.
- Costly special handling, needed to use the highly toxic components of the coatings, is eliminated.
- Products related to the coatings, that have a limited shelf life and must be stored, are eliminated.
- Maintenance downtime for reverser removal and reinstallation, is reduced from ten days for coatings, to less than twelve hours for blankets.

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Lightweight Kapton film is typically used on the backside of the blanket.

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