QUARTZ COATING PROCESS

CONFIDENTIAL

1.0 PURPOSE AND SCOPE

This document describes the simplified steps necessary to ensure that all quartz is processed through a chemical coating to allow resistively to high humidity.

2.0 AFFECTED DEPARTMENTS

PROPRIETARY 10/19/16

Manufacturing

3.0 REFERENCE DOCUMENTS

- Operation Manual for Large Blue M oven
- MSDS sheets for the chemicals and /or gases
- D0001.8196 Quartz Solution Process

4.0 RESPONSIBILITIES & AUTHORITY

The technician has the following responsibilities and authority:

- Verify compliance of the product to specifications.
- Communicate concerns to Supervisor or Quality Assurance.
- Request management review of product concerns.

5.0 DEFINITIONS

The mixture of coating chemicals is referred to as the quartz solution.

6.0 SAFETY PRECAUTIONS

- Chemical safety training is required before handling any chemical or gas.
- Wear safety glasses.
- Some chemicals are highly flammable, caution should be taken when handling.
- Oven temperatures will reach 300 degrees Celsius, caution should be taken when working around the oven to prevent burns.

7.0 EQUIPMENT & MATERIALS

Quartz
1000mL glass beaker
Quartz solution
Nitrogen
Deionized Water
Baxter all purpose liquid cleaner
Quartz oven vessel and holder
Ultrasonic cleaner

8.0 INSTRUCTIONS

8.1 Load quartz onto vessel hanger.

a. If doing 1" quartz only 10 can be loaded
b. If doing ½" or ¼ " quartz 110 can be loaded
c. If doing a mixture of sizes, care needs to be taken so that the quartz does not touch one another or parts of the vessel hanger.

8.2 If needed make a solution of coating chemicals. Once this solution is made it can be stored for future applications. This dilution does not need to occur each time that you coat the quartz. See D0001.8196 for solution details.

8.3 Clean quartz and prepare for coating process

1. Rinse out the 1000mL beaker with hot deionized water.
2. Fill the beaker with hot deionized water and add 2mL of Baxter All-Purpose liquid cleaner. Run in ultrasonic cleaner for 5 minutes then rinse and empty.
3. Fill beaker with hot deionized water. Place hanger with quartz into beaker with a squirt of micro-clean and ultrasonically clean for 10 minutes.
4. Rinse with deionized water and repeat steps 1 to 4 for a second time.
5. Place quartz holder into oven vessel and fasten down the lid. Take care that all quartz is seating in the middle of the vessel without touching the sides or each other.
6. Place vessel into the oven and tighten lid with wrench. Hook up the nitrogen line to the vessel.
7. Supply a slight flow of nitrogen through the vessel. Turn on the gas until you see the gauge on top of the vessel pop up. Listen for small flow of gas.
8. Set oven to 250 degrees Celsius. After oven reaches desired temperature allow 2 hours for the quartz to dry.
9. Set oven to 40 degrees Celsius and allow oven and vessel to cool.
10. When oven and vessel have cooled to 40 degrees Celsius, turn off the nitrogen gas and remove the vessel from the oven.

8.4 Coat Quartz

1. Apply a drop of quartz solution to each piece of quartz while it is still hanging on the quartz hanger.
2. Replace the quartz into the vessel and turn the nitrogen back on as before.
3. Set the oven to 300 degrees Celsius.
4. When oven reaches temperature, cure the quartz for a minimum of 10 hours. Preferably overnight if possible.

8.5 Cool down the oven and remove quartz from holder. Carefully place in a soft cloth and store in a designated padded box.

9.0 INSPECTION

Check each piece of coated quartz for left over droplets or scratches. Reject pieces that appear to have uncoated areas or that have had the thickness of the quartz changed.

10.0 RECORDS

None are generated as part of this instruction.

11.0 DISTRIBUTION

Manufacturing
Engineering

12.0 ATTACHMENTS

None

13.0 REVISION HISTORY

DCO #	REV	DATE	INITIALS	CHANGES MADE
	A	7/16/01	SM	Initial Release

DOCUMENT CHANGE ORDER

No. 320 **rev** ___

Originator: Scott McIlrath **Date:** 7/16/2001

Title: Quartz Coating Process **DOC #:** D0001.8195

Current Revision: - **New Revision:** A

The originator is required to complete the blue section **The red sections are completed only by Document Control**

Reason for change and brief description of the change:

Initial Release

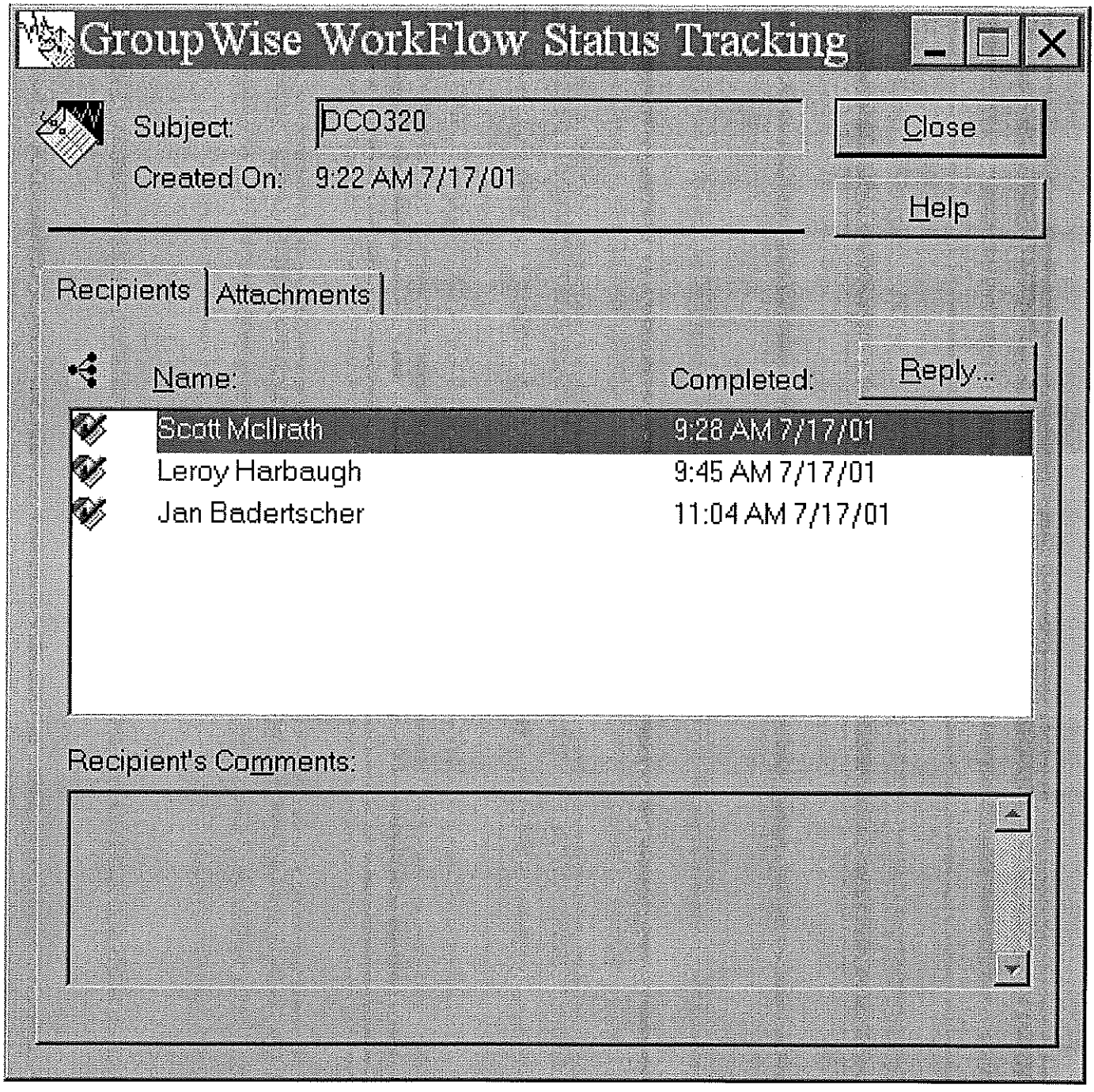
Approvals: (Select all departments affected by the document)

		Name	Date
☒	Document Owner:	Scott McIlrath	
☒	Quality Assurance:	Jan Badertscher	
☐	Director of Mfg:		
☐	Marketing:		
☐	Administration:		
☐	Finance:		
☒	Engineering:	Leroy Harbaugh	
☐	President:		
☐	_____:		

Distribution: ☒ Managers ☐ Company Wide

Status:
Clerk: [signature] Received: 7-17-01

☐ Approved
☐ Notification Sent
☒ Completed and filed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Scott McIlrath 9:28 AM 7/17/01
Leroy Harbaugh 9:45 AM 7/17/01
Jan Badertscher 11:04 AM 7/17/01
Recipient's Comments:

Drawing #3507.XXXX
Rev. A

"FAX" TRANSMITTAL SHEET

10/19/16 2R

~~PROPRIETARY~~

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Hamilton Precision Metals

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COMPANY: Larson Davis DATE: 1-23-89

ATTN: LeRoy Harbaugh PAGE: 1 OF 3

FROM: Mike Staab

SUBJECT:

MESSAGE: Hawar Data Sheet

1 of 3

WO/1477

Hamilton Precision Metals
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PRODUCT DESIGNATION: HAVAR®

DESCRIPTION:

HAVAR is a non-magnetic, corrosion resistant, cobalt-base alloy which exhibits high strength and a high fatigue endurance limit.

NOMINAL COMPOSITION:

Cobalt	42.5%	Beryllium	.04%
Nickel	13.0%	Manganese	1.60%
Chromium	20.0%	Tungsten	2.80%
Molybdenum	2.0%	Iron	Bal.
Carbon	.20%		

TYPICAL MECHANICAL PROPERTIES: (for strip cold reduced 75%)

	As Rolled	Age Hardened
Ultimate Tensile Strength	260,000 – 290,000 psi	320,000 – 350,000 psi
Yield Strength (at .2% offset)	235,000 – 265,000 psi	300,000 – 330,000 psi
Hardness (Rockwell C)	44 – 50	56 – 60

See Figures 1 and 2 for mechanical properties as a function of cold reduction.

PHYSICAL CONSTANTS:

Density	8.3 gm./cc.	.300 lb./cu. in.
Linear Coefficient of Thermal Expansion		12.5 x 10^6 in/in/°C (0–50°C)
Electrical Resistivity		91.4 microhm cm.
Modulus of Elasticity (Tension)		29.5 – 30.2 x 10^6 psi

12.5×10^{-6} in/in · °C
6.944×10^{-6} in/in °F

PRODUCT CHARACTERISTICS:

The outstanding mechanical properties of HAVAR are developed through a combination of cold working and heat treatment. HAVAR work hardens readily, and for many applications the as-rolled properties are adequate. A simple heat treatment will bring about a substantial increase in the strength and hardness of the as-rolled material, however, solution annealed HAVAR will not respond to the age hardening treatment. HAVAR can be utilized at elevated temperatures, especially in spring applications, with highly satisfactory results. A maximum service temperature of 750°F is recommended. Although maximum strengthening is achieved by heat treating for 3 hours at 950°F to 1000°F, the time can be varied from 3 to 5 hours, depending upon the required properties. In all cases, the treatment should be carried out in vacuum or a dry hydrogen atmosphere.

Bradley
M. Martin

For applications requiring high fatigue life, HAVAR has demonstrated excellent characteristics when rolled to 75% to 80% cold work and heat treated for 3 hours at 1000°F.

With a magnetic permeability on the order of 1.00004 at room temperature, HAVAR is sufficiently non-magnetic for most applications requiring this characteristic. After exposing a HAVAR specimen to a field of 5000 Oersteds, no residual magnetism could be detected with a search coil of 50 Gauss sensitivity.

Conventional machining of HAVAR can be accomplished, however, not without some difficulty since it work hardens rapidly in front of the cutting tool. Carbide cutting tools used with a cutting fluid of soluble oil in water are generally recommended. Machining operations should be performed on material in the cold worked condition, prior to the final heat treatment.

HAVAR is produced in the form of vacuum melted rod (1" dia. max), wire, strip, and foil in accordance with the standard tolerances.

APPLICATIONS:

Mainsprings
Powersprings
Flat Springs
Drive Bands
Torsion Bars
Flexures
Orthodontic Wire
Pressure Diaphragms
Gap Spacers for Magnetic Recording Heads
Gas Target Foils for Nuclear Physics

Fig. 1
Effect of % Cold Reduction on Strength Properties of .005 Strip "as rolled" and "heat treated at 1000°F"

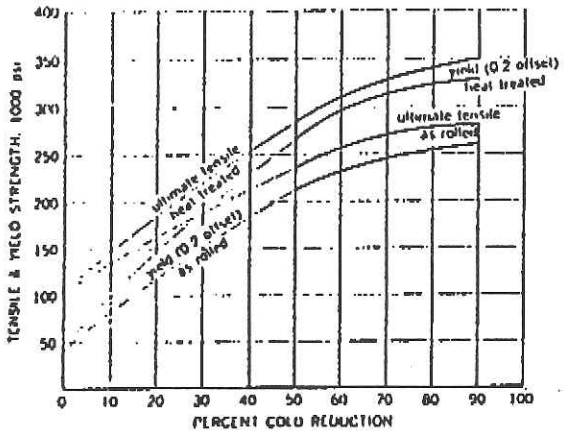
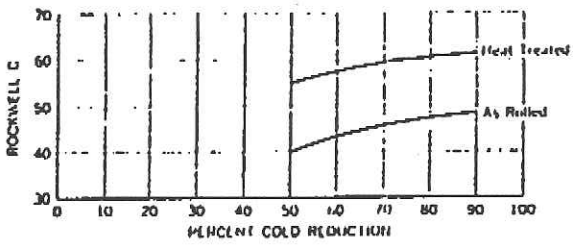


Fig. 2
Effect of % Cold Reduction on Hardness of .005 Strip "as rolled" and "heat treated at 1000°F"



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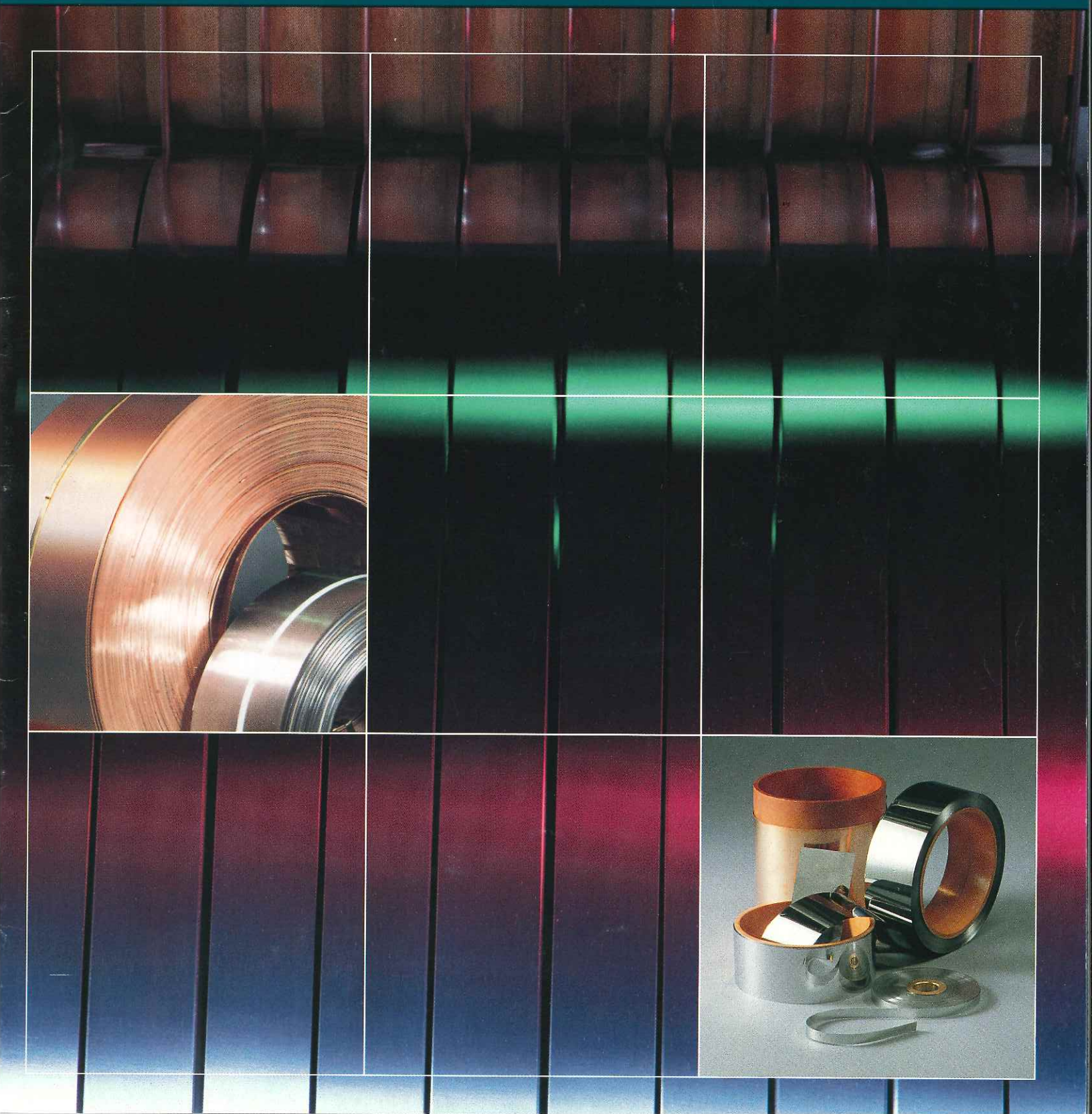
Hamilton Precision Metals

A CONTINUING TRADITION OF QUALITY



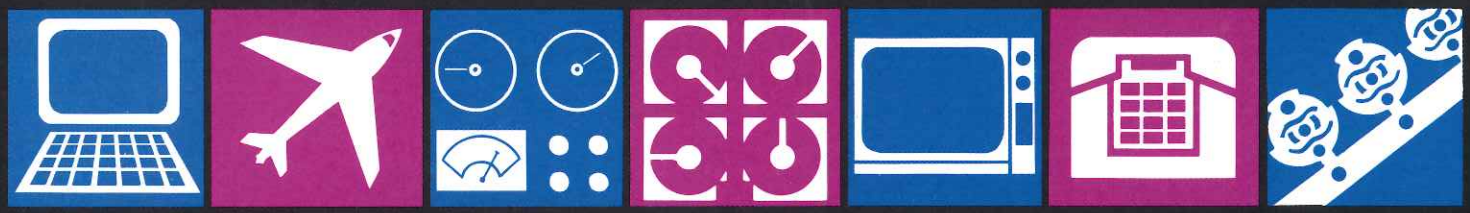
A CONTINUING TRADITION OF QUALITY

As American technology advances, our key industries face a strange and growing paradox.

On the one hand, new and exciting products are being born that demand precise and ofttimes unique characteristics in the sophisticated metals required to produce them. On the other hand, many of our larger metals producing companies are developing inflexible standards in their specialty metals processing methods; standards that do not allow for the subtle variations in characteristics, so vitally needed to give substance to our advancing technology.

It is in this paradoxical climate where Hamilton Precision Metals has carved a unique niche as a custom specialty producer of almost every alloy that is made today. It is here where our ability to respond rapidly to the most critical, highly specialized needs of the marketplace sets us apart. It is here where we perpetuate the continuing tradition of leadership for which Hamilton Precision Metals is recognized.

Our multi-million dollar 100,000 sq. ft. plant houses six cold mills, seven slitters, four atmosphere controlled strand annealing furnaces and associated equipment. Included in this equipment is a computerized cold rolling mill and a high speed annealing furnace that enhances Hamilton Precision Metals' rolling capacity. This offers strong evidence of our continuing effort to meet the growing demand for optimum quality, highly specialized strip and foil.



SPECIALTY FOIL AND STRIP... With absolute integrity of physical and mechanical properties.

Hamilton Precision Metals foil and strip are used selectively across a broad spectrum of high technology industries: Computers and Peripheral Equipment, Telecommunications, Surveillance, Electric and Electronic Appliances, Business Machines, Automotive, Machinery and Metalworking, Instruments and Control Systems, Aircraft, Land, Surface and Subsea Vessels and Spacecraft.

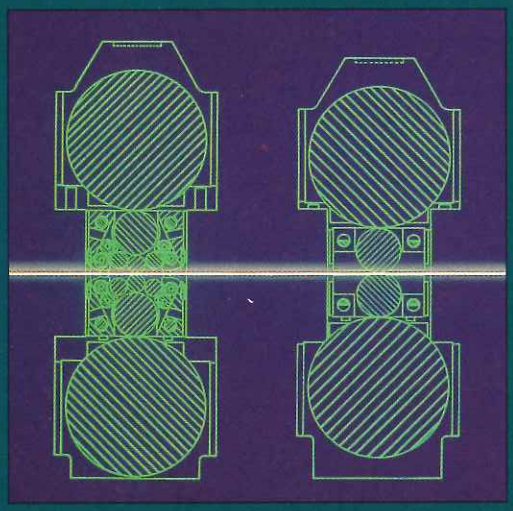
We have planned our growth toward meeting the highly critical requirements of these industries carefully, precisely, yet with a single philosophy: "Give the customer what he needs." As a result, 75% of the orders we receive require special properties, unobtainable from other sources.

These orders for custom-rolled specialty strip and foil have found their way into a host of highly sophisticated end use applications, including: Magnetic heads, CRT's, Honeycomb panels, Keyboard springs, Diaphragms, Electronic connectors, Springs, Flexures and Drive bands, along with many other precision components. From design board to production line, products made from high quality Hamilton Precision Metals strip and foil are constantly superior.

STRIP ROLLING CAPABILITY

Our Z-High mill is perhaps the greatest single advancement in contemporary strip rolling operations.

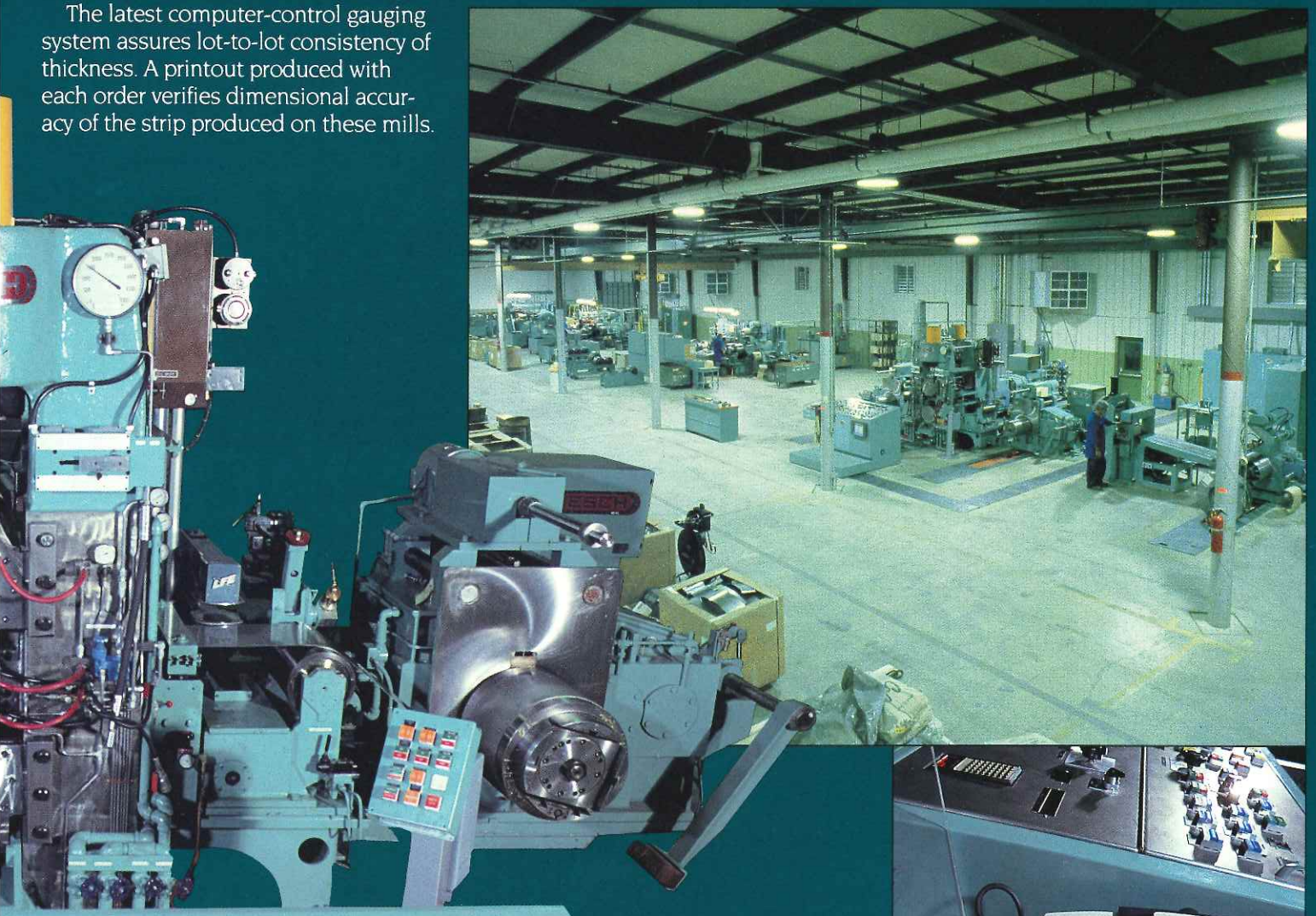
The first of its kind in the world, the Z-High has the distinctive capability of performing both as a Sendzimir mill and as a 4-High mill. The Z-High captures the best of both types of mills, allowing Hamilton Precision Metals to roll strip in certain alloys and thicknesses to closer than 50% of ASTM standard tolerances.

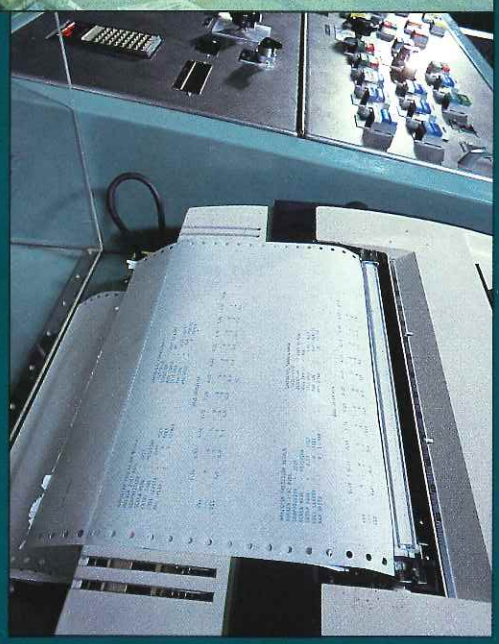


With the Z-High and five other Sendzimir mills, Hamilton Precision Metals has the capability to produce strip from 0.0005" to 0.080" thick, in widths up to 15". This bank of mills gives us the flexibility to produce strip to customers' exacting requirements — flexibility that is not obtainable elsewhere.

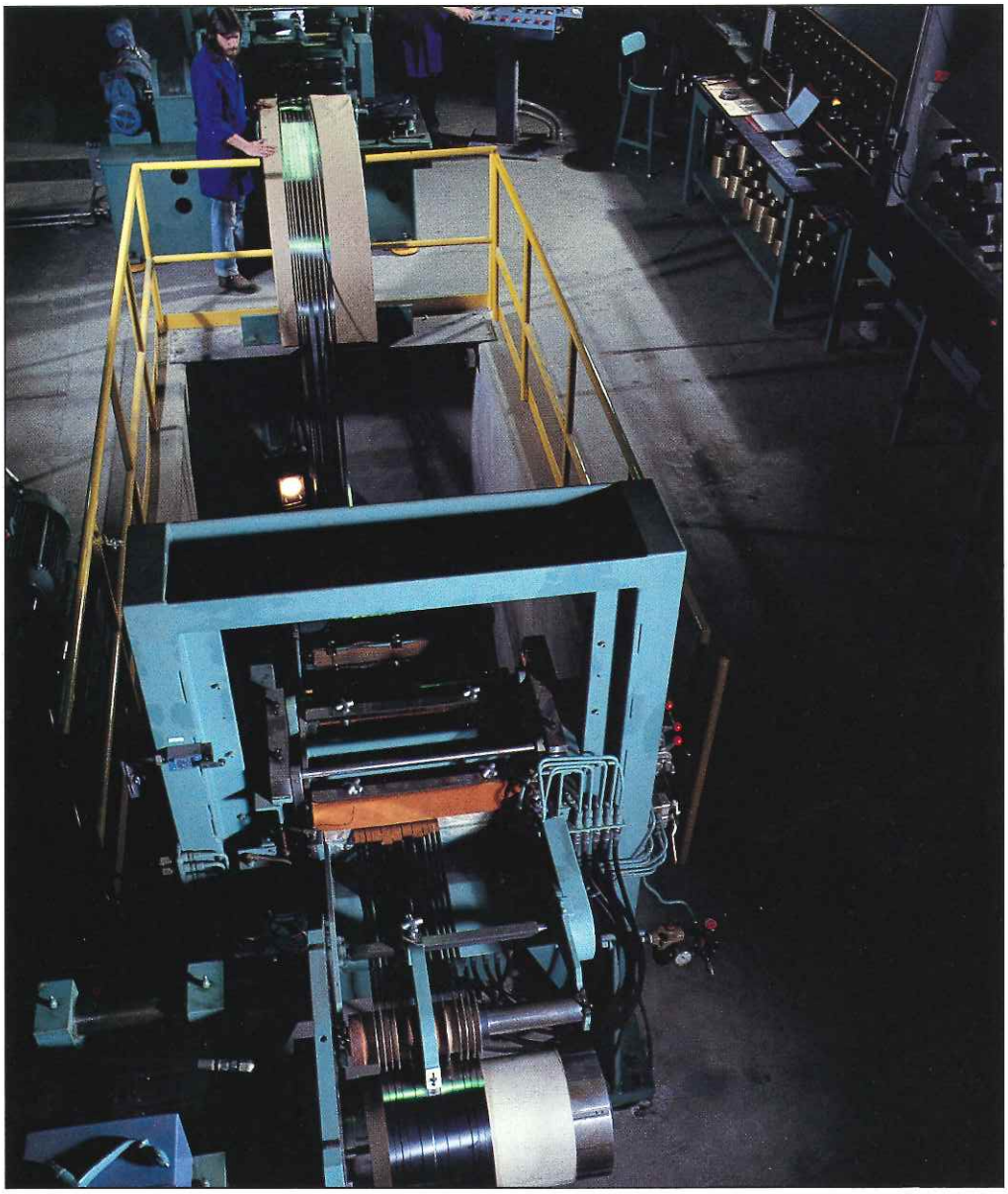
STRIP ROLLING CAPABILITY

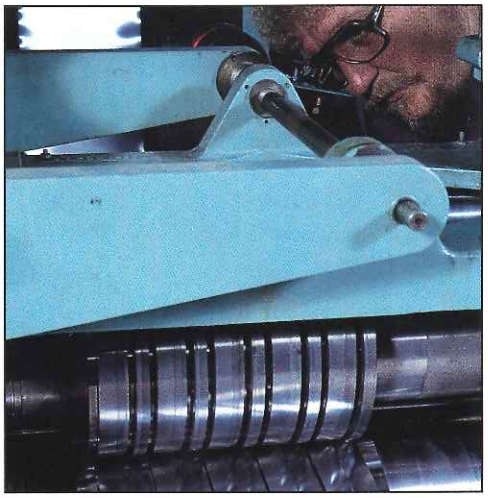
The latest computer-control gauging system assures lot-to-lot consistency of thickness. A printout produced with each order verifies dimensional accuracy of the strip produced on these mills.

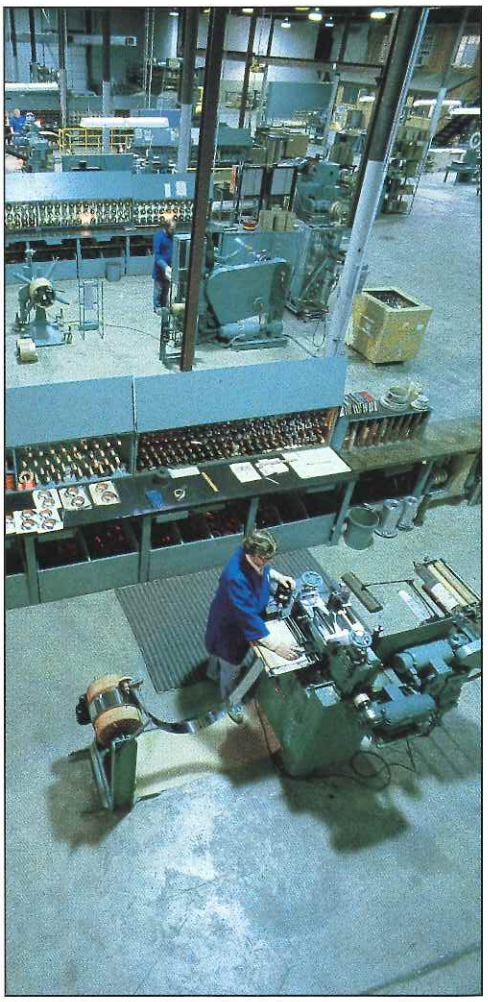




STRIP SLITTING CAPABILITY







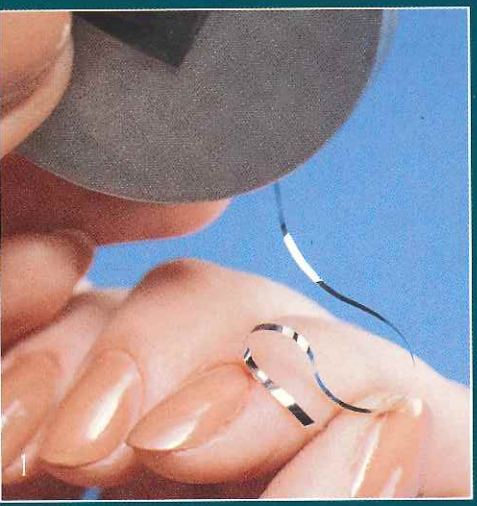
Precision slitting is required to produce high quality strip. Innovative techniques allow Hamilton Precision Metals to hold closer tolerances on slitting than industry norms.

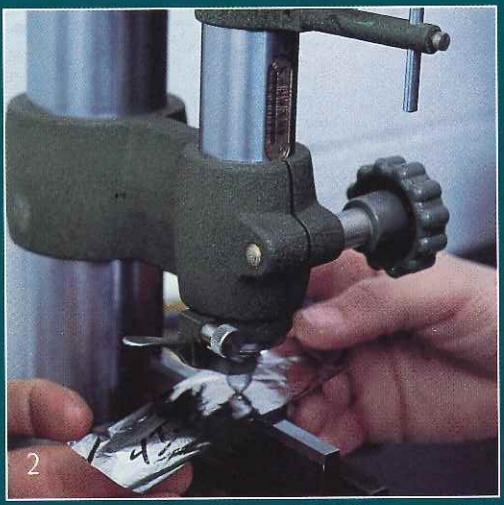
Five precision strip slitters, with a thickness range of 0.0004" to 0.080" slit to a minimum width of 0.029" with excellent control of camber and burr.

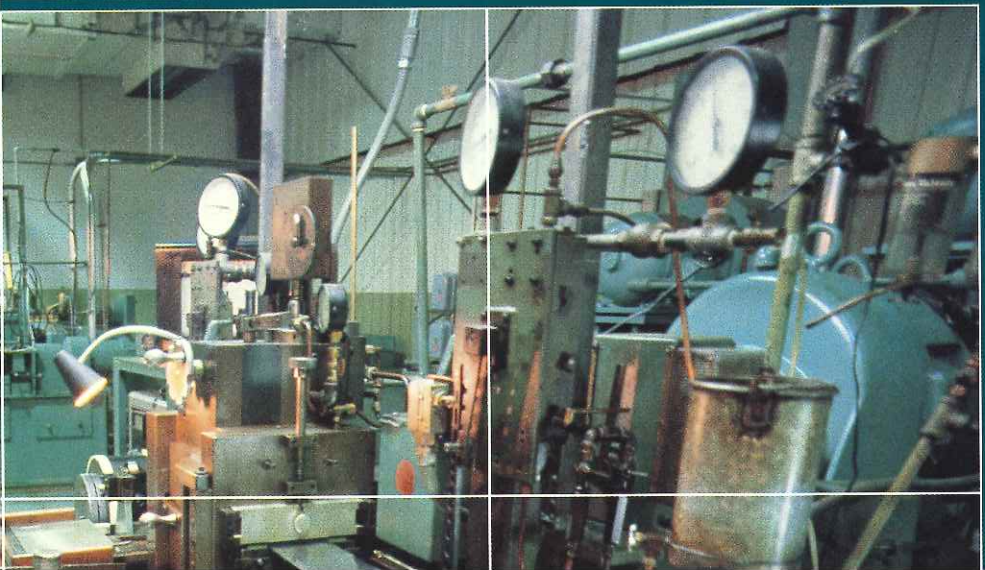
STRIP ANNEALING CAPABILITY

At Hamilton Precision Metals, superior control of mechanical properties are achieved by strand annealing. Our four strand annealing furnaces provide temperatures up to 2200° F with hydrogen, nitrogen or argon protective atmospheres.

The strand furnaces are used for in-process and final annealing to obtain optimum properties of the strip and foil.





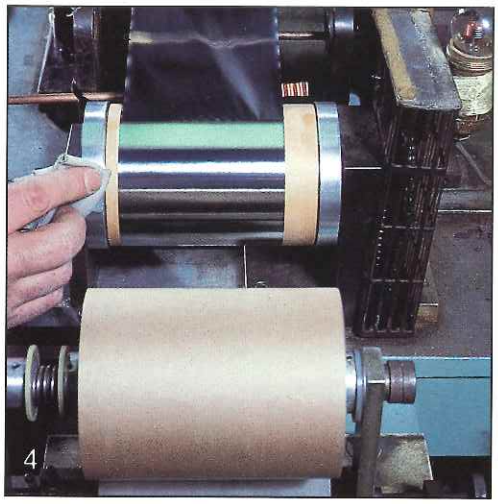


FOIL PRODUCTION

Cleaning and Slitting

After being rolled to a specified thickness, the foil goes through a cleaning line that was designed and built by Hamilton Precision Metals. A constantly distilled solvent completely removes all mill lubrication, assuring a perfectly clean surface.

Since equipment with adequate capability was not available on the market, precision slitters were also designed and built in-house, and are used to slit ultra thin foils. This equipment slits foil as thin as 0.00006" to widths as narrow as 0.010".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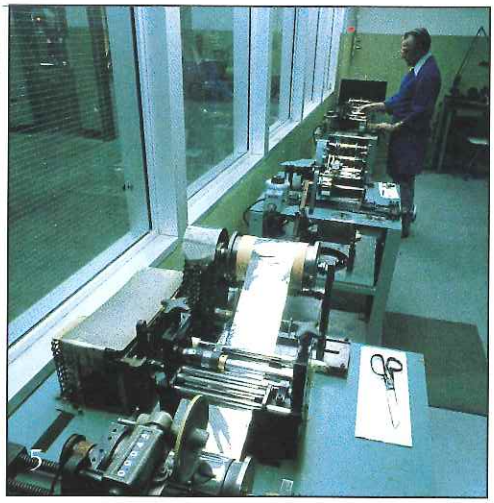
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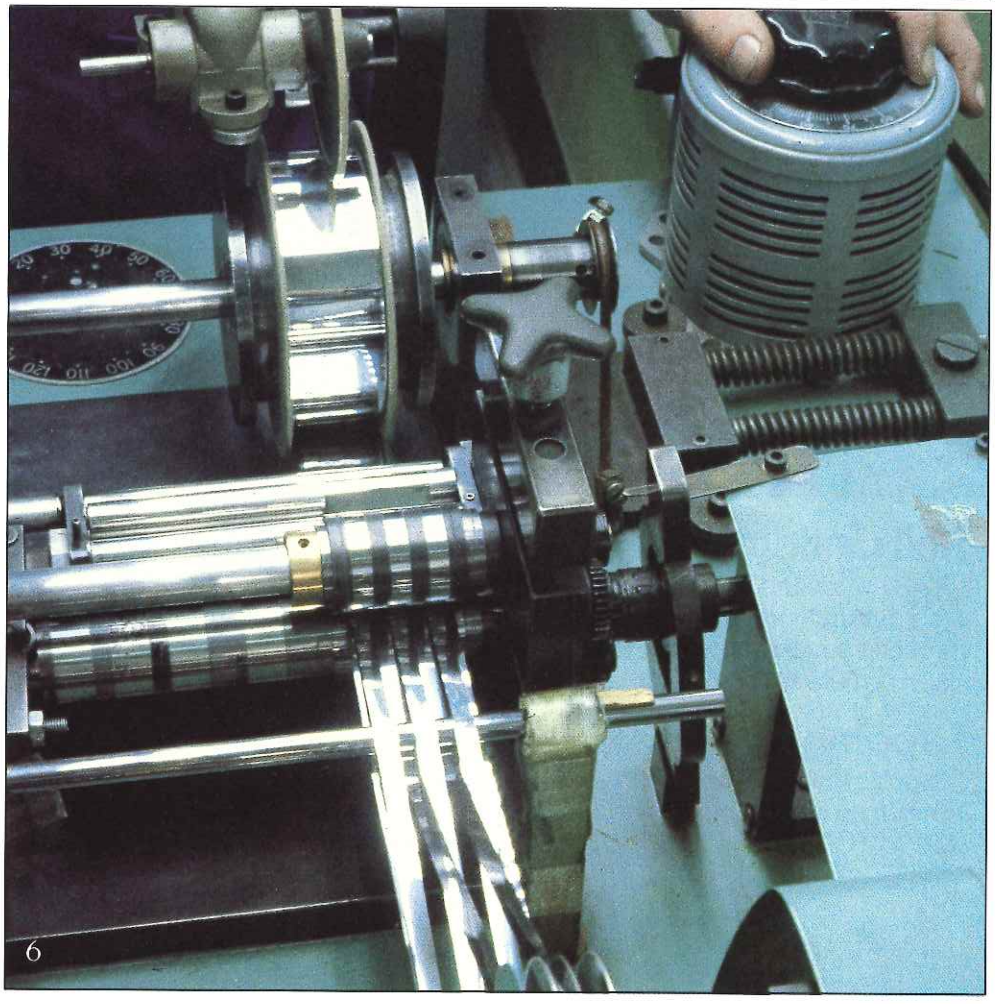
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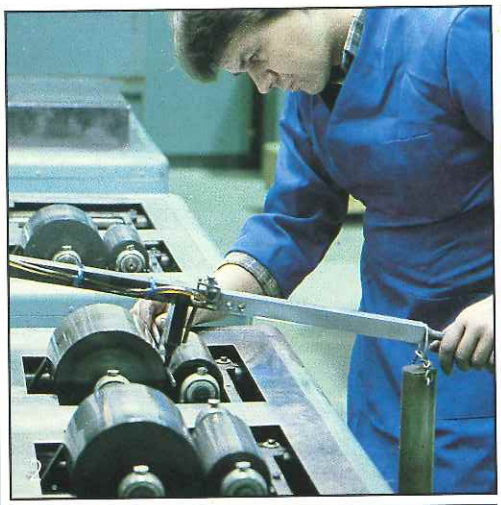
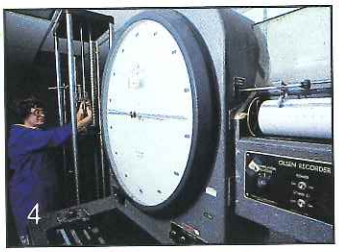
1 Havar material .000060" thick x .125" wide
2 Mikrokator measuring device used on thin gauge material
3 Overall foil mill area
4 Cleaning of .00050" thick x 4" wide Vicalloy foil
5 Overall foil slitting department
6 Slitting of .00050" thick x .250" wide Vicalloy aircraft flight recorder tape material

QUALITY CONTROL & SERVICES





1 Roll Grinding

Rolls are ground in our roll shop by highly qualified personnel. Rolls are reground frequently to assure that they impart no defects to strip and foil.

2 Lapping

Lapping machines are used to further improve the finish of the foil rolls.

3 Grinding Slitter Knives

The slitter knives are reground frequently to assure minimum burr.

4 Tensile Testing

5 Hardness Testing

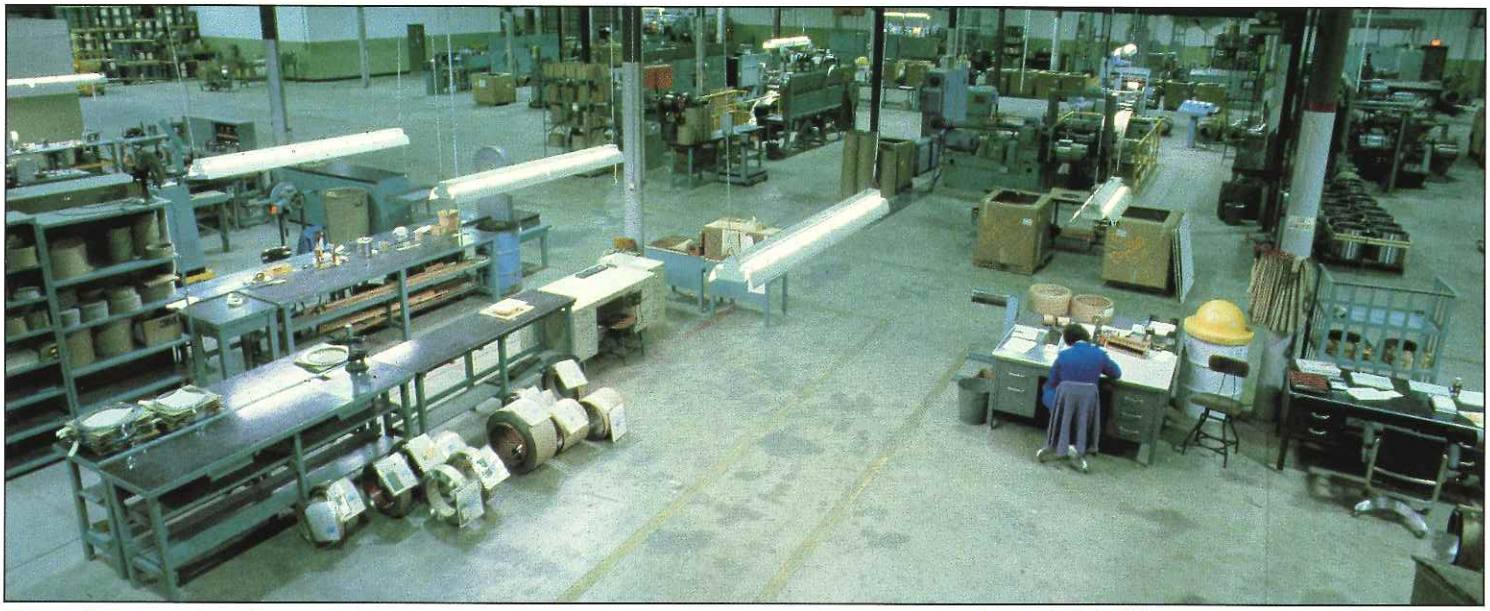
6 Pickling

Flash pickling operation is used to remove stains and tenacious oxides when required.

7 Hot Rolling

As a special service to customers and prospects, experimental and small lots of alloys can be processed using our 2-High hot breakdown mill. Materials as thick as 2" can be hot rolled down to .100" and conditioned for further cold rolling into strip or foil on our other mills.

Hamilton Precision Metals



Final Inspection

Because of the extreme precision required, quality and accuracy are maintained at every stage of production. Experienced qualified inspectors visually check surface quality and integrity to assure that all material meets customer specifications.

Our facilities can be reached easily from Route 283 by exiting at Route 741. Proceed north on 741 for ¼ mile. The plant is on the West side of Route 741.