שיפור יעילות של מנועי סילון
וטורבינות תעשייתיות
בעזרת ציפוי חלק על חלקי המדחס

תהליך צביעה SermeTel 5380 DP

הגרר האווירודינמי במדחס גורם ל:

- עליה בצריכת דלק
- עליה בטמפ' גזי פליטה

הגרר עולה עם עליה בחספוס פני שטח במסלול זרימת גזים

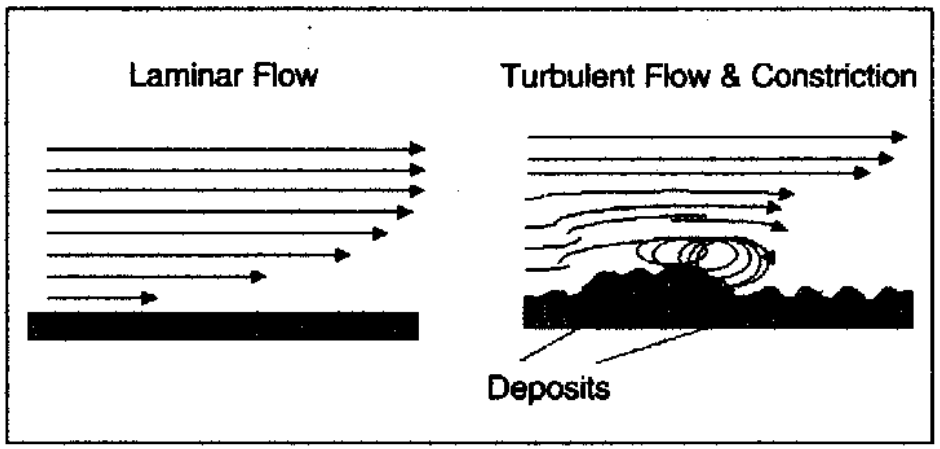


Figure 1: Effect of Fouling

הגורמים לחספוס:

- לכלוך מצטבר על פני שטח הלהבים בזמן השרות
- תוצרי השיתוך (חמצון או סולפידציה)

במדחס צירי 15-דרגות ההפסד יכול להגיע ל- 3%

Example # 1

- A Southeastern U.S. utility verified that SermeTel protective coatings could increase efficiency and power output when applied to the compressor section of an IGT. The utility completed hot gas path inspections on two of its Siemens-Westinghouse W501F units. During the outages, the utility performed identical maintenance on both units with one exception–Sermatech coated one of the compressor sections with SermeTel 5380 DP.

Example # 1 (cont.)

- Comparison results showed the following performance improvements for the turbine with the coated rotor:

  0.64 % compressor efficiency increase

  0.58 % heat rate decrease

  1.26 % maximum output increase.

Benefits of Sermatech's 5380DP™ Compressor Coating

on Siemens-Westinghouse 501F

Side-by-Side Test	
Nominal Rating	160,000 kW
Nominal Heat Rate	9.080 Btu/kWh
Improvements Attributable to Coating	
Output	1.26%
Heat Rate Reduction	0.58%

Benefits of Sermatech's 5380DP™ Compressor Coating on Siemens-Westinghouse 501F

Marginal Revenue Gains Expected	
Electric Sale ($0.035/kWh)	Approx. $ 600,000/ann.
Fuel Savings ($3/$10^{6)}$ Btu	Approx. $ 175,000/ann.
	Total $ 775,000/ann.

הקטנת חספוס/שיתוך

- שטיפת המנוע
- בחירת חומרים עמידים יותר לשיתוך
- ליטוש פני שטח החלקים
- צביעה/ציפוי

תוצאות שטיפת המנוע

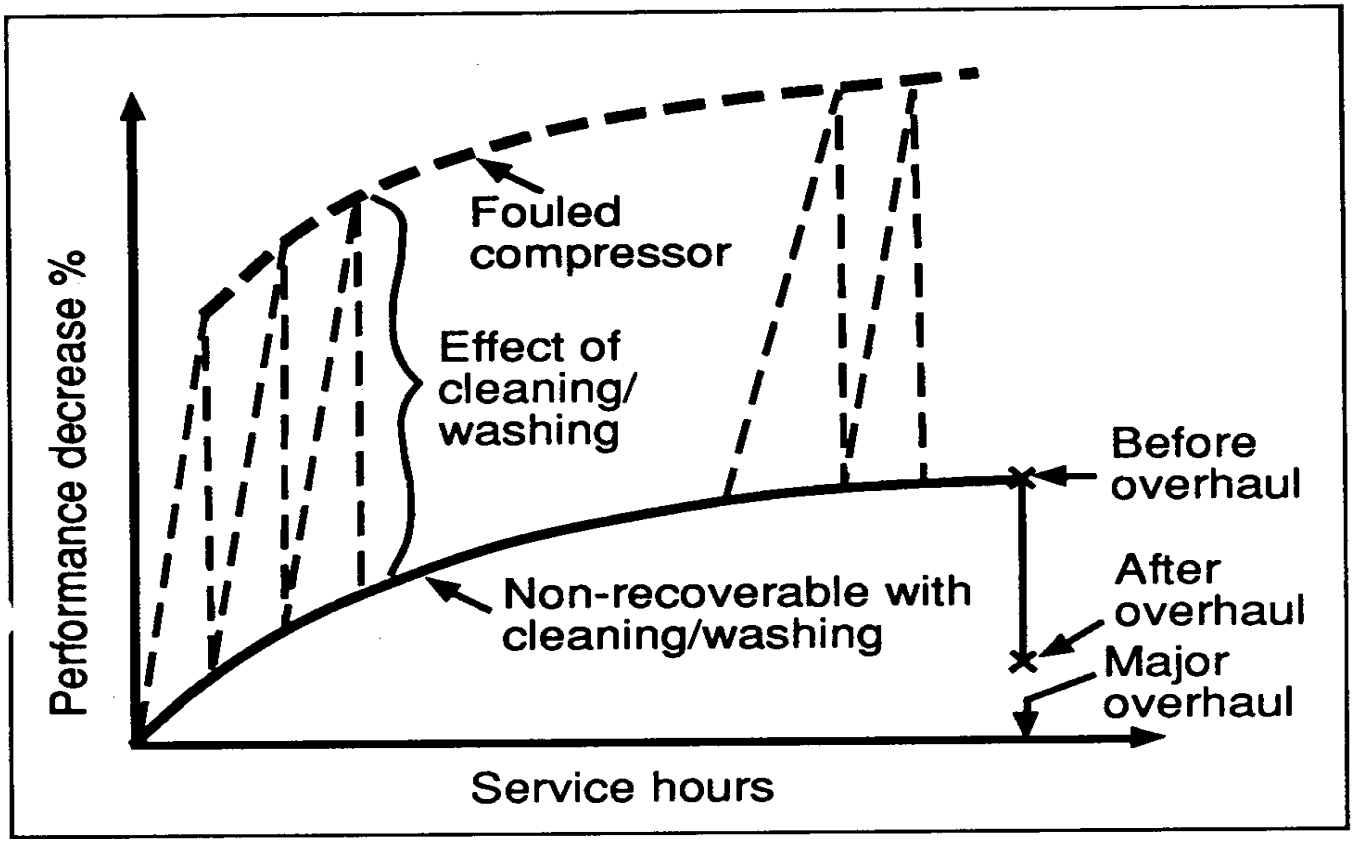
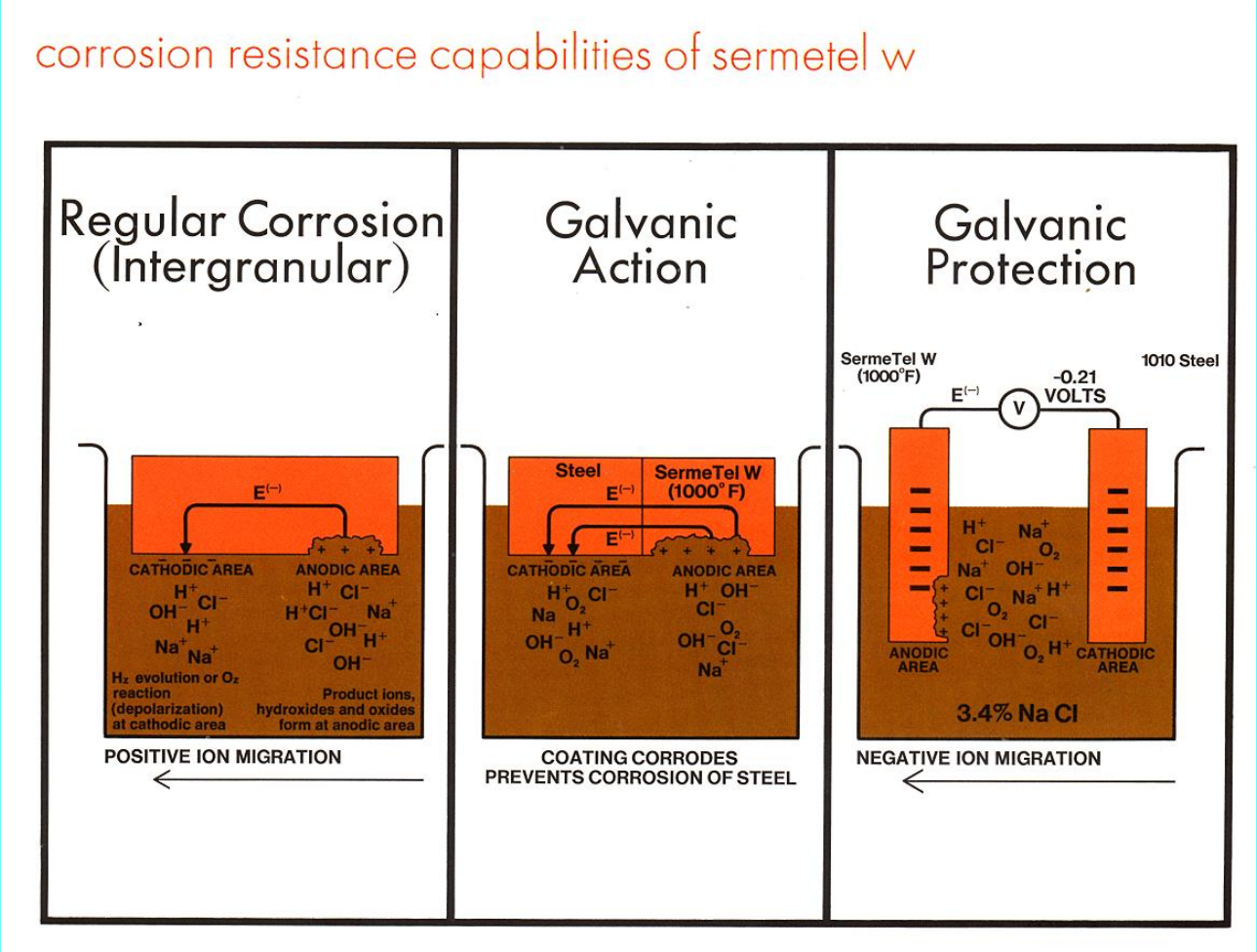


Figure1; typical performance deterioration behaviour as a function of time. Note the scale of improvement that can be achieved by effective cleaning or washing.

תכונות צבעי SermeTel

- צבע על בסיס מים, ללא ממס אורגני
- "מקריב את עצמו" לכל הפלדות
- עמיד בחום עד 870 מעלות C
- עמיד למכת חום/קור (מ- 635 מעלות לתוך מים)
- עמיד למים, שמן, גריז, נוזל הידראולי וממסים אורג'
- עמיד לארוזיה
- חלק במיוחד

הגנה אלקטרוכימית ("הקרבה עצמית")



Galvanic series

Material	**Millivolts (-)**
Zinc plating	975 - 990
Cadmium plating	760 - 765
SermeTel W Class 4 coating	730 - 760
AA3003 Aluminium	720 - 745
AA2024 T3 Aluminium	590
1010 Steel	565
410 Steel	235

Potentials were measured at 20^0 C in aerated 3.4 % NaCl against a saturated calomel electrode

תוצאות תא מלח

SEM photomicrographs (1000X)

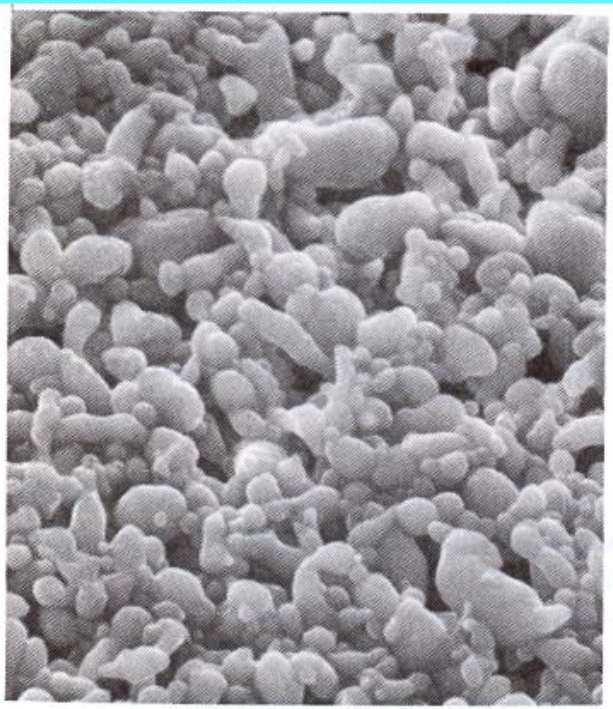


Fig. 1: SEM Photomicrograph of a SermeTel W coating, unburnished (1000X, 45° angle)

Fig. 2: SEM Photomicrograph of a SermeTel W coating, Class 4 - burnished with Al_2O_3 (1000X, 45° angle)

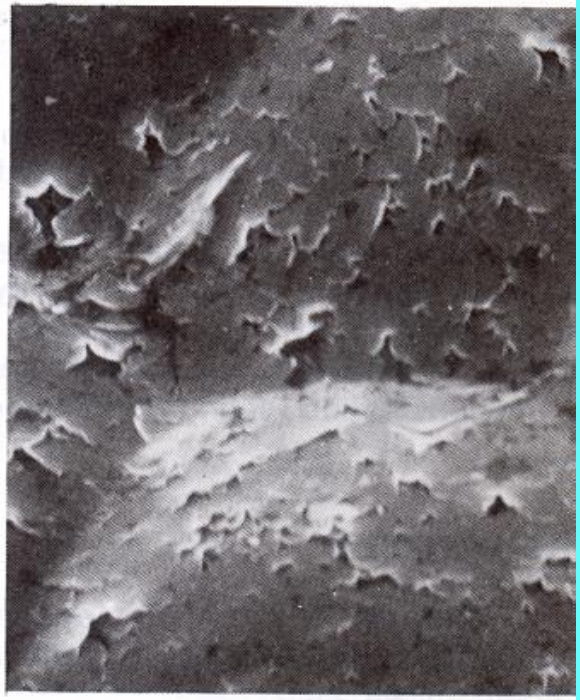


Fig. 3: SEM Photomicrograph of a SermeTel W coating, Class 4, burnished with glass beads (1000X, 45° angle)

Optical photomicrograph (500X)

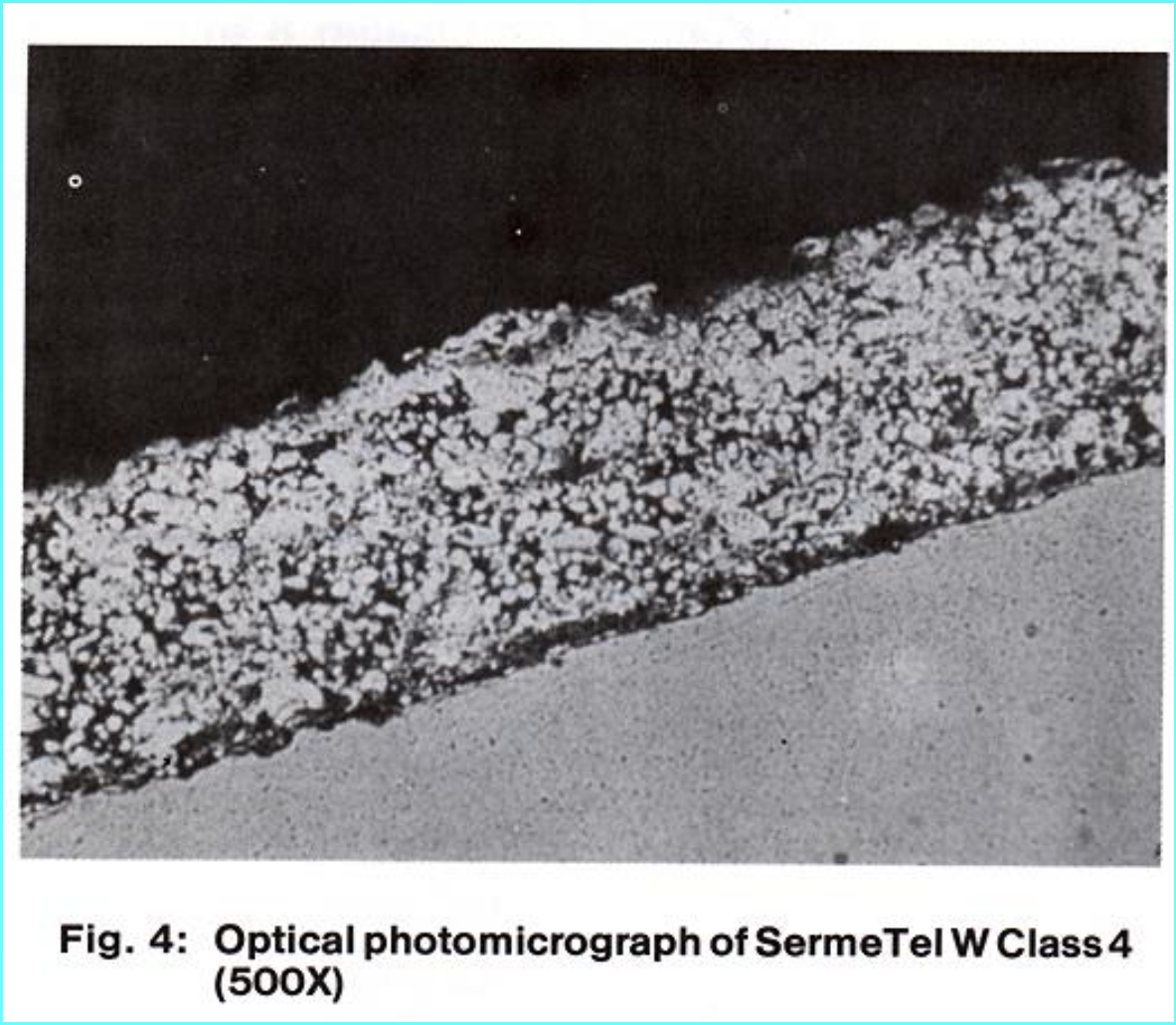


Fig. 4: Optical photomicrograph of SermeTel W Class 4 (500X)

תכונות צבעי DP

- קלייה קצרה בטמפ' נמוכה (190 או 163 מעלות C)
- עובי הצבע 10-100 מיקרון
- "מקריב את עצמו" לפלדות
- ניתן לצביעה בצבעי אפוקסי/פוליאורטן
- עמיד בשמן, דלק, גריז, נוזל הידראולי
- עמיד בטמפ' עד 538 מעלות C
- ניתן לאיטום על-ידי לכה

שיפורים בצבעי DP - dense pack

- קלייה קצרה בטמפ' נמוכה (190 או 163 מעלות C)
- שיפור באדהזיה ב- 20%
- פורוזיות נמוכה ב- 14%
- שיפור בעמידות בתא מלח
- שיפור בעמידות בארוזיה

Optical photomicrograph (500X)

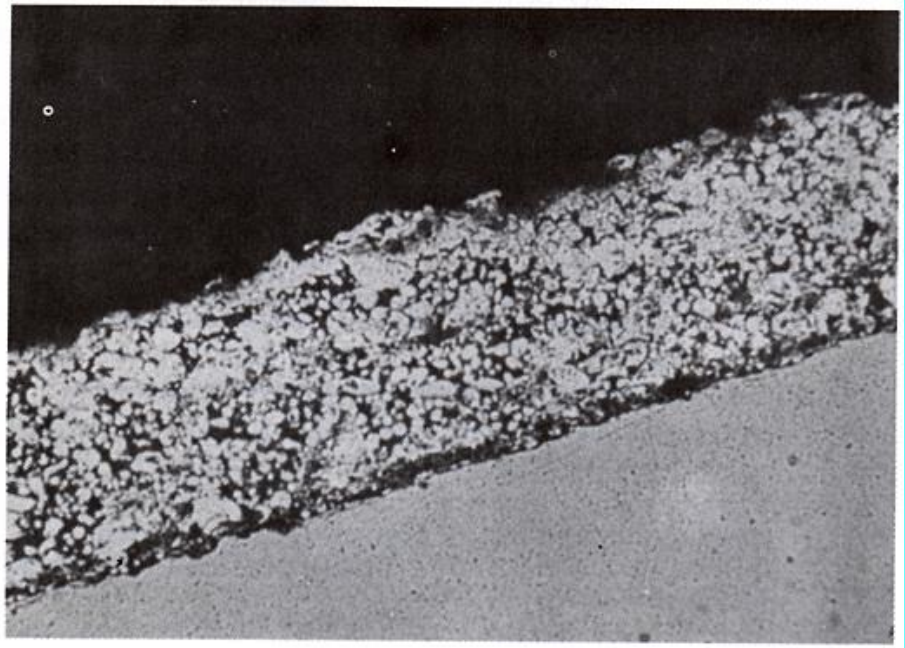


Fig. 4: Optical photomicrograph of SermeTel W Class 4 (500X)

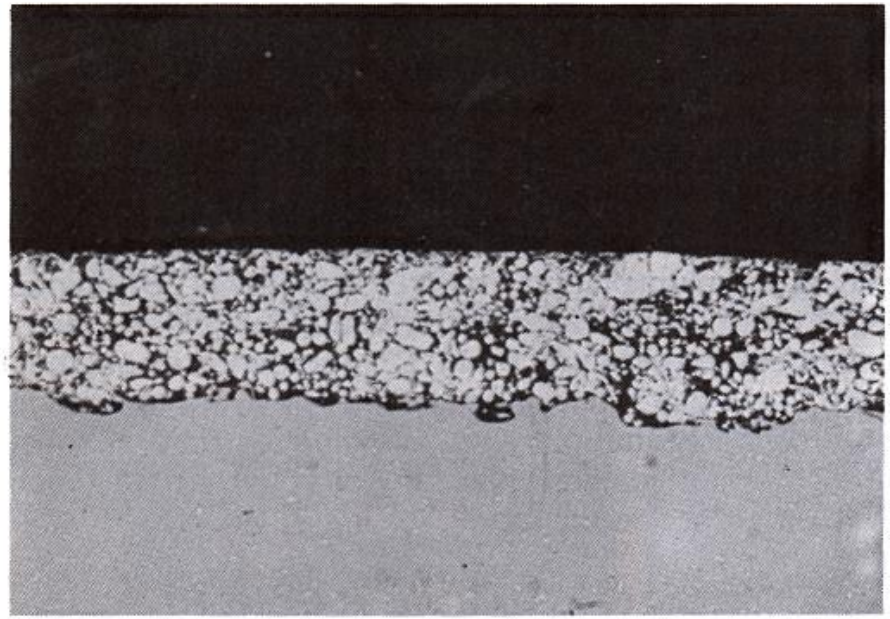


Fig. 6: Optical Photomicrograph of a Process 5380 coating (500X)

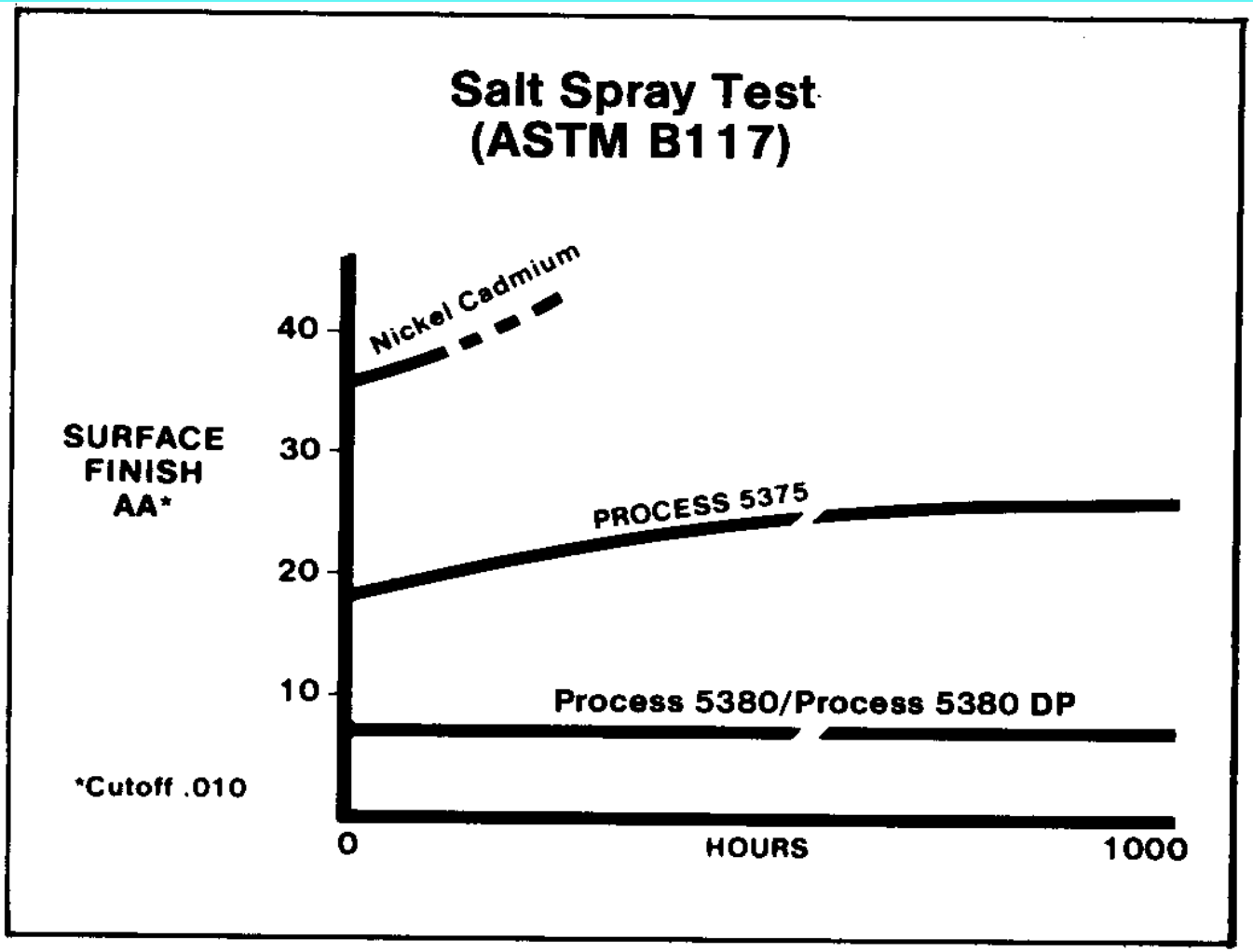


Fig. 7: Salt spray test comparison on nickel cadmium, Process 5375, Process 5380 and Process 5380DP coatings

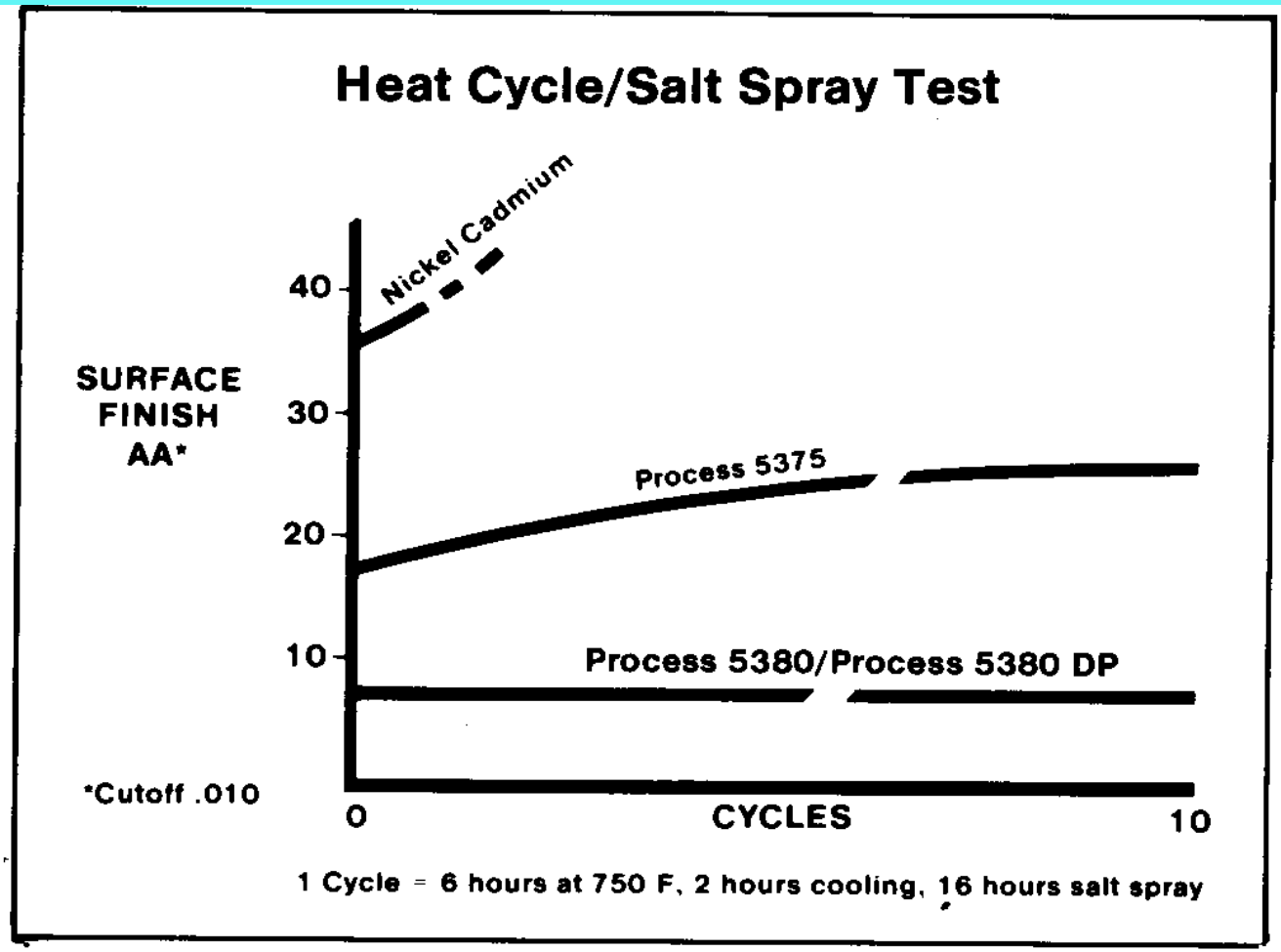
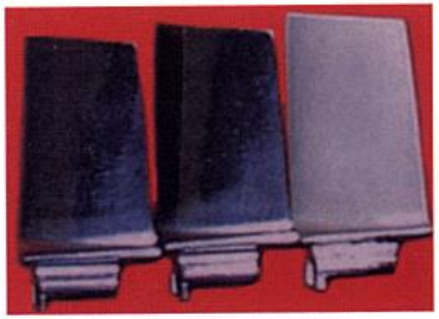


Fig. 8: Heat cycle/salt spray comparison on nickel cadmium, Process 5375, Process 5380 and Process 5380DP coatings

תוצאות בדיקות תא מלח/חום/לחות

Polished and S4000 @ 250C initially

Polished and S4000@ 250C after 10 cycles



Polished and S4000 @ 400C initially

Polished and S4000 @ 400C after 10 cycles

Stainless steel blades before and after salt/heat/humidity cycling

צביעה על פלב"מ (Cr 12%)

- Cyclic salt fog/heat/humidity test:
  5% salt fog for 1 hour,
  Heating to 450^{o} C for 2 hours
  Cooling to RT for 30 minutes
  100% humidity for 20 hours
  RT dry for 30 minutes

  5 cycles

תוצאות הבדיקה

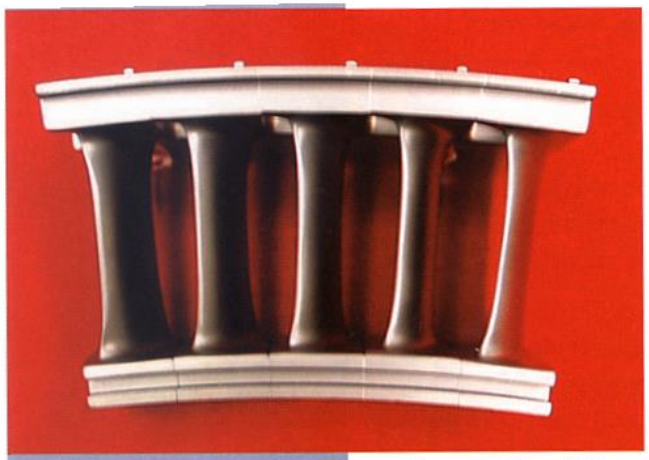
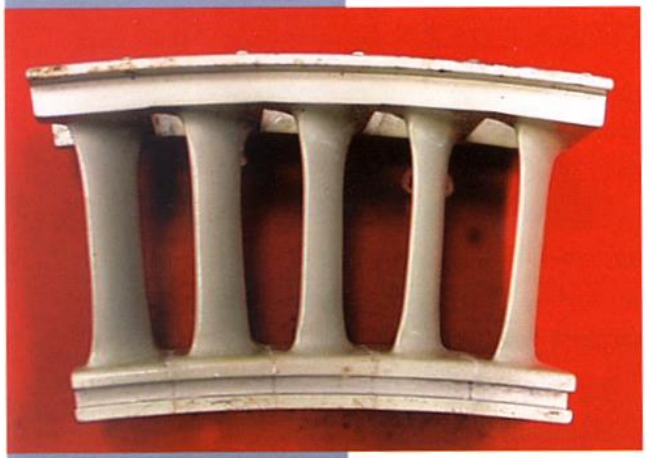


Figure 5: Bare HPC vanes made of 12% Cr steel before and after (right) five salt/heat/humidity cycles at 450°C (842°F).



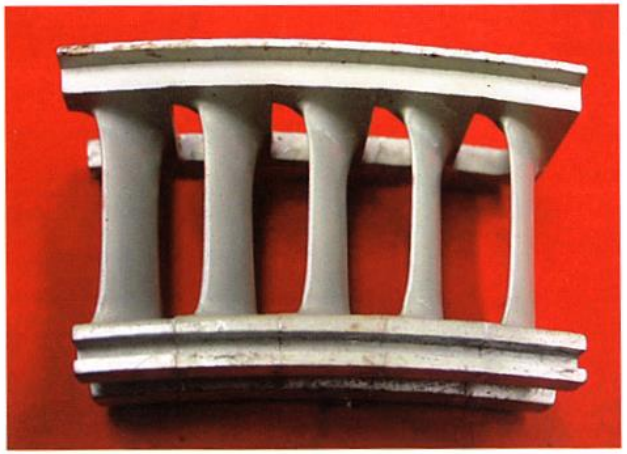
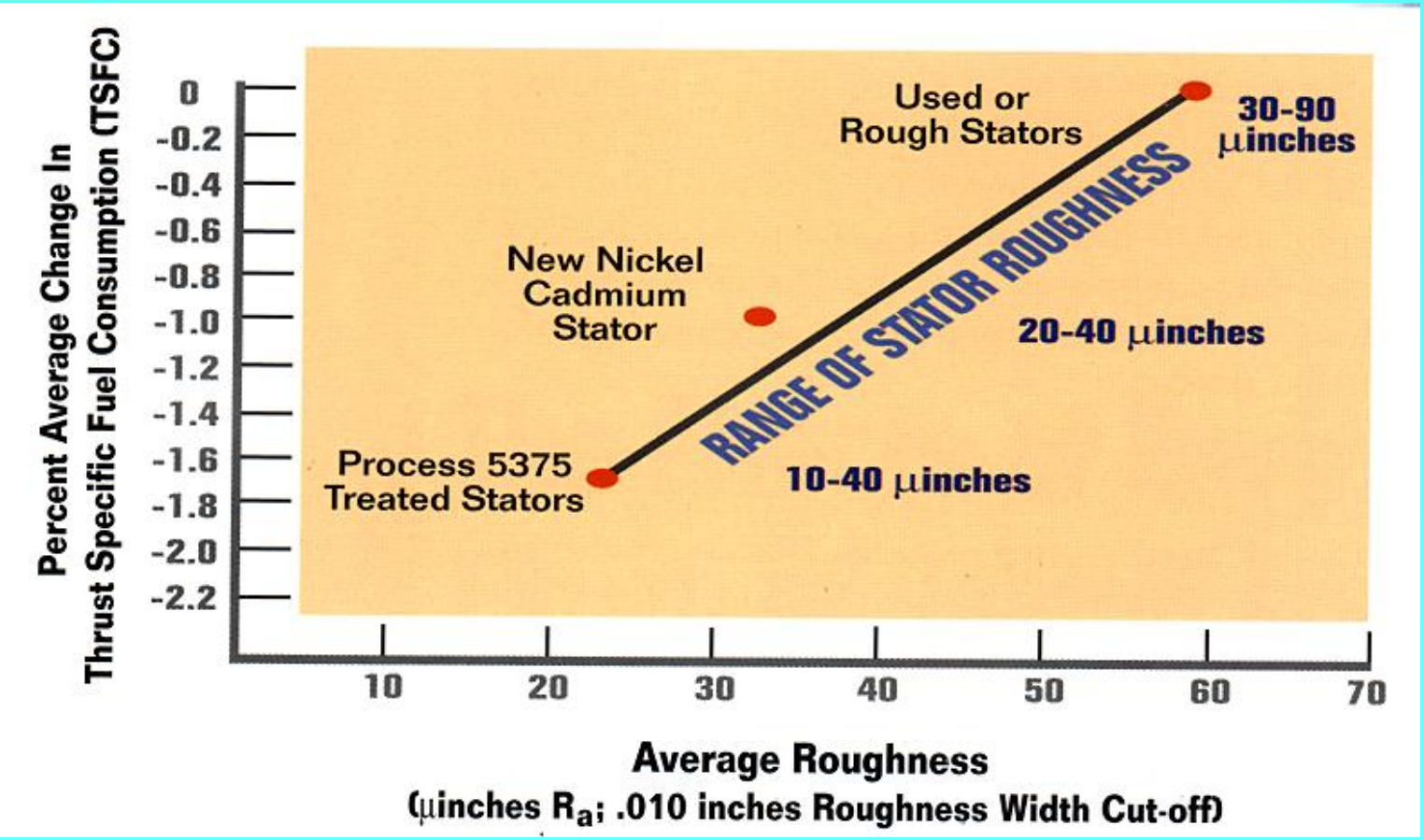


Figure 6: Steel HPC vanes coated with "ideally" smooth sealed aluminum/ceramic coating before and after (right) five salt/heat/humidity cycles at 450°C (842°F).

חסכון בצריכת דלק



Example # 2

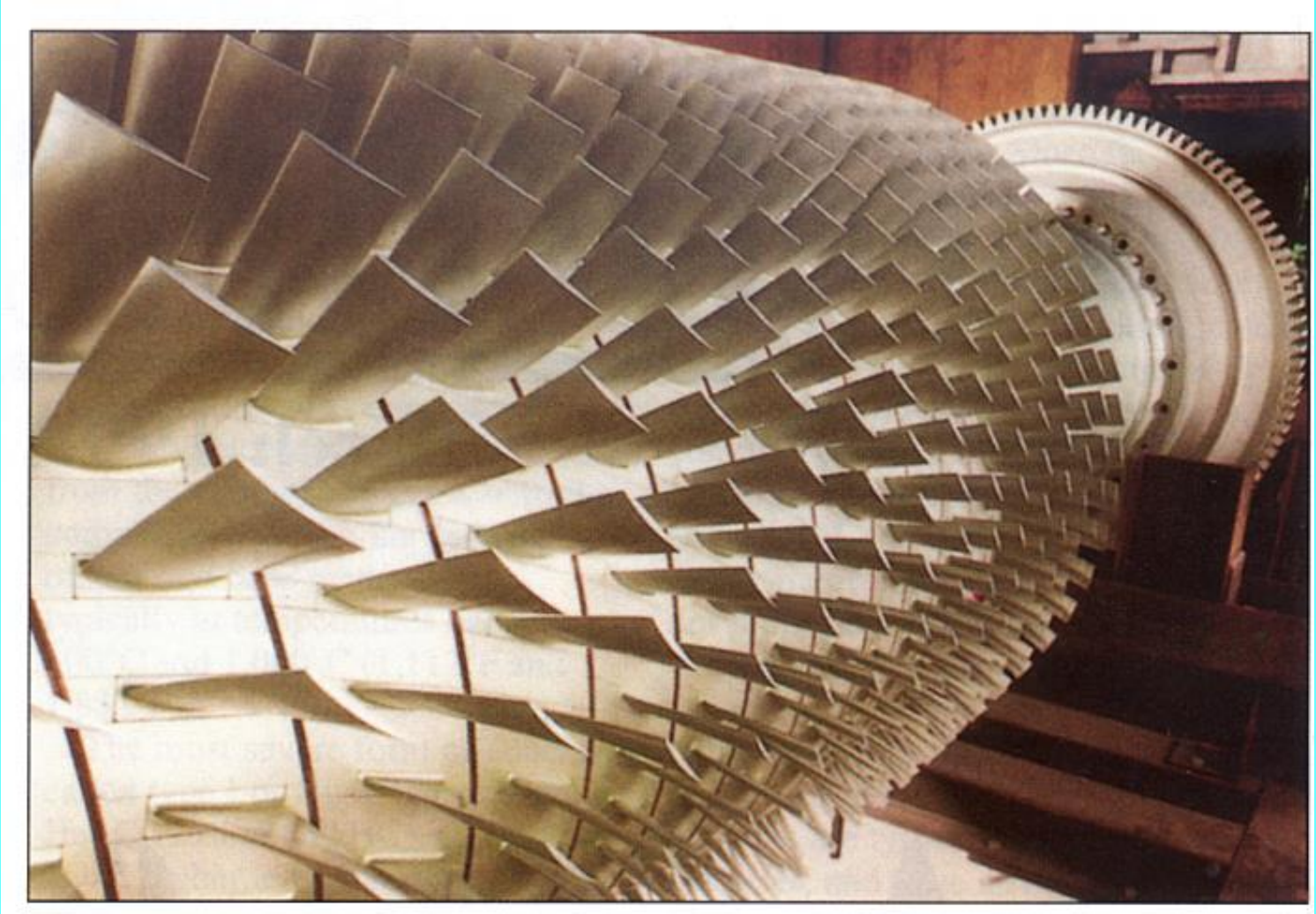
- The Electric Power Research Institute (EPRI) reported on the performance increase observed on a 70 MW Westinghouse 501 gas turbine when the compressor section was coated with SermeTel 5380 DP. The customer estimated that it would save $52,560 (USD) in fuel savings alone during the first year of combined cycle operation.

Example # 3

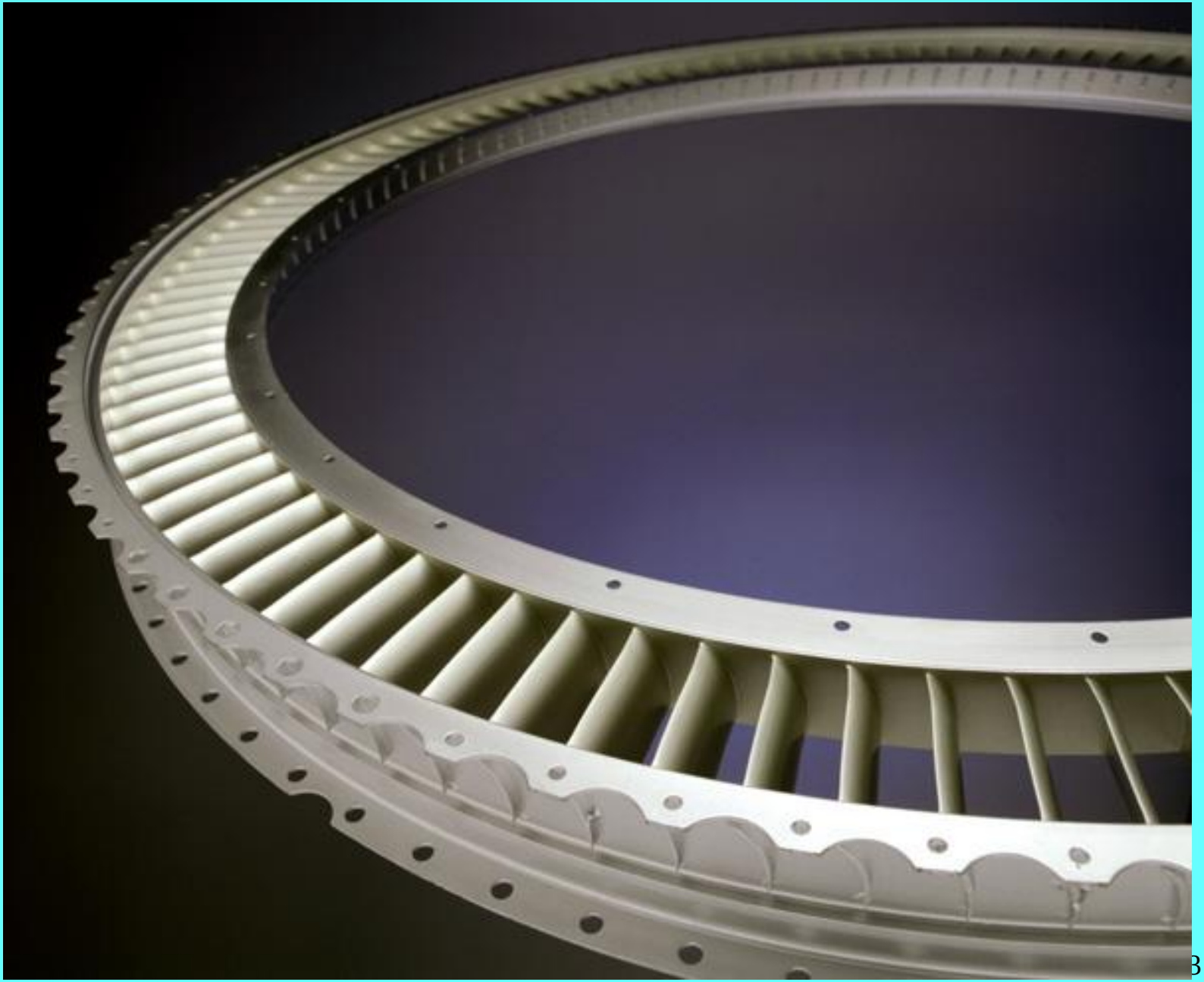
- A U.S. utility had the compressor section airfoils (blades and vanes) of a GE Frame 7 unit coated at overhaul with SermeTel 5380 DP. No other work was performed on the unit during the overhaul. The customer documented a recapture of lost power of 3 MW (4.7%) as compared to the clean condition operating performance immediately prior to shutdown.

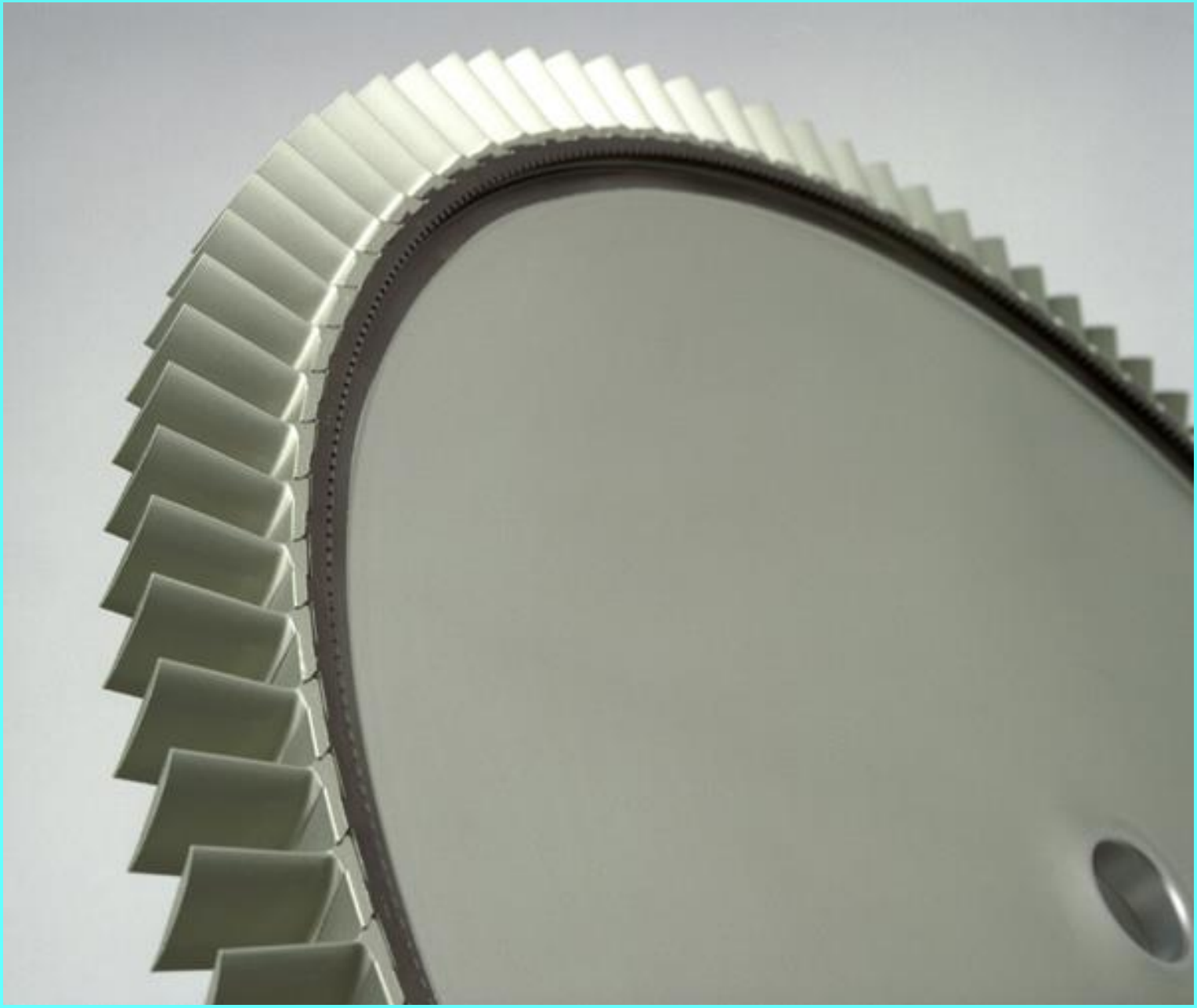
On-site spraying of compressor blades. The flexibility of the application process means that coating can take place in-situ.

GE Frame 5 turbine compressor in SermeTel 5380 DP




Sermatech





SERMATECH®
International

SermeTel® Coating Licensee

This certificate is issued to

Israel Aircraft Industries Ltd.

whose business address is:

IAI Engines Division
Bedek Aviation Group
Ben Gurion International Airport,
Israel 70100

Upon finding that its organization complies in all respects with the requirements relating to the establishment of a SermeTel coating application facility, Sermatech International Inc. hereby licenses and approves the above named licensee to apply the following coating products and processes:

SermeTel 5380DP, related products and processes

This certificate, unless canceled, suspended or revoked, shall continue in effect until

December 31, 2002

Date issued:

March 28, 2002

By direction of:

James McCabe
President, Sermatech International Inc.

This Certificate is not Transferable, and any major change in the basic facilities, or in the location hereof, shall be immediately reported to the corporate office of Sermatech International Inc. at 155 South Limerick Road, Limerick, PA 19468 U.S.A.

SERMATECH INTERNATIONAL INCORPORATED
A TELEFLEX COMPANY (NYSE: TFX)