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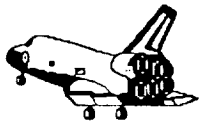
-REENTRY SYSTEMS-
MATERIAL TECHNOLOGY NEEDS



Rockwell International
Space Systems Division

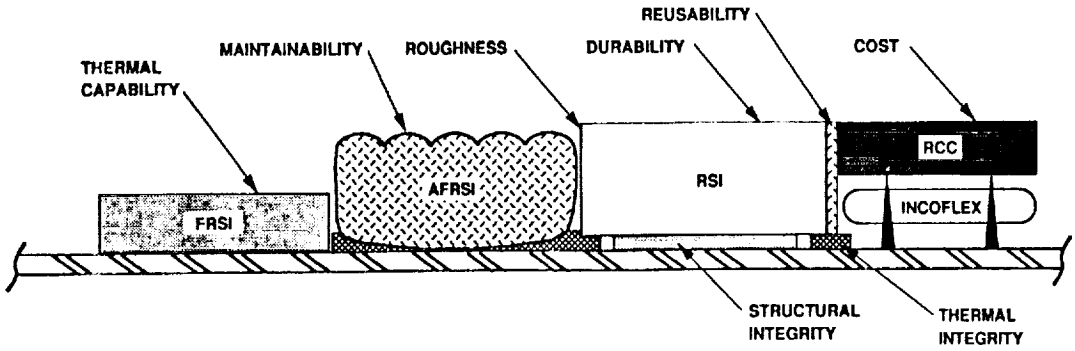
R. M. (MIKE) EHRET
M&P ENGINEERING & LABS
SPACE SYSTEMS DIVISION
9/24/91

BACKGROUND IN ENTRY SYSTEMS

- MIKE EHRET - MATERIALS ENGINEER
- 23 YEARS ROCKWELL SPACE DIVISION
  - SATURN S-II
  - SPACE SHUTTLE ORBITER
- MANAGER: MATERIALS & PROCESSES
  - ENGINEERING & LABORATORIES
- ENTRY SYSTEMS BACKGROUND
  - STRAIN ISOLATION
  - TILE DENSIFICATION
  - FRCI TILE CERTIFICATION
  - AFRSI DEVELOPMENT
  - WATER PROOFING
- PERSONAL PERSPECTIVES:
  - DESIGN (PERFORMANCE)
  - BUILD
  - OPERATIONS
  - MAINTAINABILITY

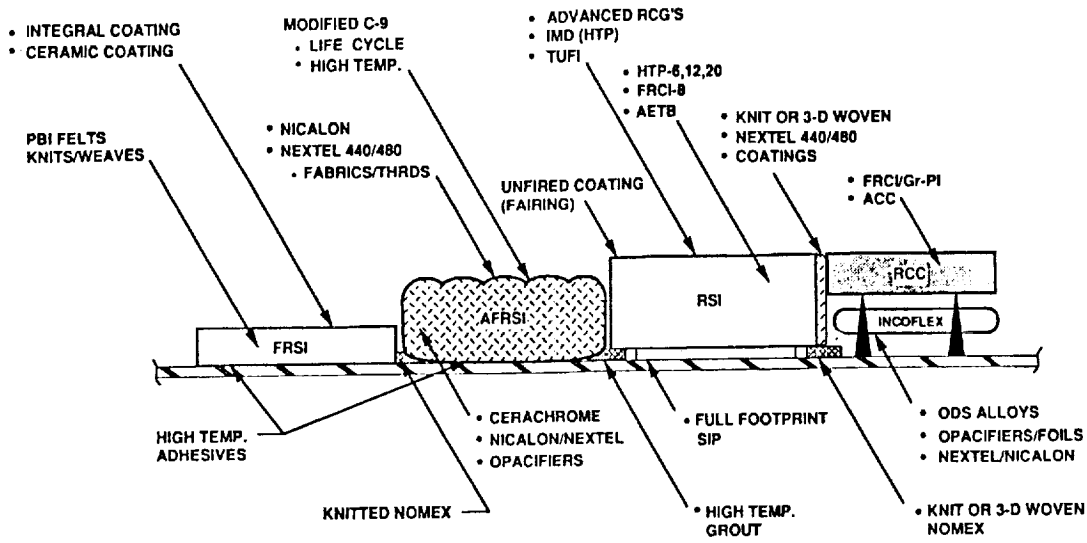
POTENTIAL IMPROVEMENTS EXIST WITHIN CURRENT ORBITER TPS SYSTEM

700 F	1,500 F	2,300 F	3,200 F
$650/FT^2	$2,000/FT^2	$10,000/FT^2	$30,000/FT^2
0.15 - 0.25 LB/FT^2	0.62 - 1.25 LB/FT^2	0.90 - 3.5 LB/FT^2	7.4 LB/FT^2
3,000 FT^2	3,000 FT^2	5,000 FT^2	400 FT^2



EXISTING SYSTEM IS FUNCTIONAL BUT MAY NOT BE MOST COST-EFFECTIVE

ADVANCED TPS OPPORTUNITIES



TPS MATERIAL ENHANCEMENTS ARE FEASIBLE

MATERIAL/CONCEPT	BENEFITS	TECHNOLOGY GAPS	TRENDS
RIGID TPS: (I.e., AETB, HTP, ACC-HARDSHELL, METALLIC STANDOFF, TUFI COATING, TITANIUM MULTIWALL, IMD, SOL-GEL RCG)	• HIGHER STRENGTH • HIGHER TEMPERATURE • IMPACT RESISTANT • LIGHTER WEIGHT • ADJUSTABLE DENSITY	• PRODUCTION SCALE-UP • AVAILABILITY • MAINTAINABILITY • COATINGS • COATINGS APPLICATION • INDUSTRY DATA BASE • MECHANICAL PROPERTIES • INSTALLATION PROCEDURES	• LIGHTER WEIGHT • DURABLE COATINGS • MATERIAL CONSISTENCY • HIGHER TEMPERATURE • TAILORED DENSITIES • STRONGER
FLEXIBLE TPS: (I.e., TABI, PBI)	• INCREASED TEMPERATURE • TAILORABLE PROPERTIES • PRODUCT FORMS • LOWER COST THAN RIGID • REDUCED VULNERABILITY	• PRODUCTION SCALE-UP • COATINGS • IN-SERVICE USE • INDUSTRY DATA BASE	• CONSTRUCTION METHODS • FIBER TREATMENT OPTIMIZATION • MIXING FIBER BLENDS • USED IN LIEU OF RIGID • HIGHER TEMPERATURE
FOAMS/ABLATORS: (I.e., SOFI, NCFI, SLA 561, POLYIMIDE, POLYMETHACYLIMIDE)	• LOWER COST vs TILE • FORMABLE • HIGH DIMENSIONAL STABILITY UNDER HEAT • FIRE RESISTANCE • EXCELLENT RADIATION TRANSMISSION	• IMPROVED MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE • LIGHTWEIGHT SANDWICH CONSTRUCTION • PRODUCTION SCALE-UP • AVAILABILITY • INDUSTRY DATA BASE	• NON-CFC BLOWN • LIGHTER WEIGHT • IMPROVED HEAT TRANSFER PROPERTIES • IMPROVED FABRICATION
REFRACTORY COMPOSITES: (I.e., ACC, C-C, SiC, SiC-SiC	• HIGH TEMPERATURE • LOAD CARRYING AT HIGH TEMPERATURE • WEIGHT SAVINGS • DIMENSIONALLY STABLE	• INSPECTION • COATING REPAIR • HIGH TEMP COATINGS • LOW COST • JOINING • COMPLEX STRUCTURES • IN-SERVICE	• OXIDATION RESISTANCE • THERMALLY STABLE FIBERS • IMPROVED MATRIX • AUTOMATED PROCESSING

SUMMARY OF TECHNOLOGY NEEDS AND DIRECTION

NEEDS

- LIGHTWEIGHT AND DURABLE RIGID INSULATION AND HIGHER TEMPERATURE FLEXIBLE MATERIALS
- INSPECTION, REPAIR, PRODUCIBILITY, AND MAINTAINABILITY OF REFRACTORY COMPOSITES

DIRECTION OF EFFORTS

- FUNDING BASE IS RELATIVELY SMALL FOR FUTURE YEARS
- TO MAXIMIZE RETURNS, COLLABORATIVE PROGRAMS APPEAR TO BE PRACTICAL
  - SSD'S APPROACH IS TO IMPLEMENT NASA DEVELOPED TECHNOLOGY

SPACE TRANSPORTATION STRUCTURES AND MATERIALS WORKSHOP

ENTRY SYSTEMS PANEL

- DON'T DESIGN A SPACECRAFT AS THOUGH IT WILL BE **TREATED** LIKE A SPACECRAFT
- DON'T BELIEVE PRELIMINARY LOADS
- DON'T ALLOW MATERIALS R&T HISTORY TO VANISH
- DON'T CERTIFY WITHOUT SYSTEM LEVEL TESTS
- DON'T BELIEVE THAT THE DESTROYER OF "GOOD" IS "BETTER"
- DON'T BUILD ANYTHING NEW WITH SOA MATERIALS TECHNOLOGY