ADVANCED MAIN COMBUSTION CHAMBER PROGRAM

PROGRAM OVERVIEW

ADVANCE CURRENT MANUFACTURING TECHNOLOGY FOR SPACE HARDWARE

DESIGN A MAIN COMBUSTION CHAMBER

- INVESTMENT CASTINGS (LOW COST)
  - ROBUST WITH 100% INSPECTABLE WELDS
  - CAPABLE OF UTILIZING ALTERNATE LINERS
  - VACUUM PLASMA SPRAY MATERIALS
  - PLATELET
- USE SSME PROGRAM
  - LARGE DATA BASE - NONCONFORMITIES, ETC
  - AVAILABLE TEST FACILITY - TTB
- USE MSFC PERSONNEL FOR DESIGN EFFORT
  - DESIGN
  - ANALYSIS
  - QUALITY
- USE CONCURRENT ENGINEERING TECHNIQUES
**OBJECTIVES - DESIGN CRITERIA**

DESIGN WILL BE:

- INTERCHANGEABLE WITH SSME MAIN CHAMBER
- ROBUST DESIGN WITH 100% INSPECTABLE WELDS
  - HYDROGEN EMBRITTLEMENT RESISTANT MATERIAL
  - NO COPPER COATINGS OR WELD OVERLAYS
  - FMEA/CIF FAILURE MODES REDUCED
  - INCREASED LINER THERMAL MARGIN
- REDUCED FABRICATION COST ($1 MILLION -vs- $3.2 MILLION)
- REDUCED FABRICATION TIME (50 WEEKS -vs- 150 WEEKS)

**KEY ELEMENTS**

- **PLATELET (BACKUP)**
  - NAS8-37456
  - DESIGN & ANALYSIS
  - FABRICATION
    - JOINING PANEL TO PANEL
    - BONDING LINER TO JACKET
    - THERMAL CYCLES
      - NDE
    - CHANNEL ID SLOTTING & FILLER
  - VPS DEVELOPMENT
  - MATERIAL SELECTION
  - HANDLER DESIGN & FAB.
  - KEY PROCESS DEMONSTRATIONS
  - NDE

- **LINER (VPS)**
  - DESIGN & ANALYSIS
  - VPS DEVELOPMENT
  - MATERIAL CHARACTERIZATION

- **JACKET/COOLANT MANIFOLDS (CASTING)**
  - DESIGN & ANALYSIS
  - CASTING CONTRACT
  - MATERIAL SELECTION
  - IN-HOUSE PROCESSING & MACHINING
  - NDE

- **FABRICATION & TEST OF PROTOTYPE**

- **AMCC PROJECT**

- **SSME**

- **STME**

PR8-2
ADVANCED TECHNOLOGIES

1. METHODOLOGY (LOWER COST)
   HARDWARE PROGRAM

2. FABRICATION TECHNIQUE
   (OUTSIDE-IN)

3. CASTINGS
   NEAR-NET STRUCTURAL

4. ADVANCED MATERIALS
   (NASA-23)
   (GLIDCOP)

5 & 6. LINER DESIGNS
   VPS
   PLATELET

7. ADVANCED COOLING
   (HIGH ASPECT CHANNELS)
   • PLATELET
   • EDM CHANNELS

"NEW" APPROACH TO TECHNOLOGY / HARDWARE PROGRAMS

- INHOUSE - PROOF OF CONCEPT
  • TQM - DETERMINE PRIORITY, APPROACH, LAY OUT OF PROGRAM
  • DESIGN / ANALYSIS / MANUFACTURING - CONCURRENT ENGINEERING
  • FABRICATION - PRODUCIBILITY FACILITY
  • TEST
- CONTRACTOR - PRODUCTION
  • FABRICATION OF ADDITIONAL UNITS
  • DEVELOPMENT & CERTIFICATION
  • MAINTAINABILITY & REFURBISHMENT
- DEMONSTRATE "SOLUTION" IS VALID
  • QUALITY PRODUCT
  • COST SAVING IN TIMELY MANNER
  • TRAINING - CONFIDENCE THROUGH ACCOMPLISHMENT
  • TEAMWORK - DEVELOPMENT OF NECESSARY INTER-LABORATORIES COOPERATION
FABRICATION APPROACH

"OUTSIDE - IN"

SEQUENCE OF EVENTS

1. Cast Superalloy Jacket
2. VPS NARloy-Z Liner
3. Machine Cooling Channels in Inner Surface of Coldwall
4. VPS NARloy-Z Closeout
5. Remove Filler (HIPs & Heat Treatments Not Shown)

X-SECTION OF MCC WALL (NOT TO SCALE)

Cast Superalloy Jacket
Coolant channels
VPS NARloy-Z Closeout (NARloy-Z)

ADVANCED MCC

AMOC Conceptual Drawing.

PR8-4
ADVANCED MCC

ROOM TEMPERATURE DESIGN ALLOWABLE

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<th>ULT (ksi)</th>
<th>YIELD (ksi)</th>
<th>ELONG. (%)</th>
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<td>75</td>
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<td>110</td>
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ADVANCED MCC

FABRICATION SEQUENCE

BASELINE - VPS

1. CAST MANIFOLDS/JACKET
2. VACUUM PLASMA SPRAY ID (NARLOY-Z)
3. SLOT CHANNELS
4. FILL CHANNELS
5. VPS NARLOY LINER
6. CLEAN CHANNELS
7. INSPECT CHANNEL CLEANLINESS & WALL THICKNESS
8. FINISH WALL TO PRINT
9. PROOF

PLATELET

- CAST JACKET
- PLATELET LINER

ELIMINATE 2,3,4,5,6,7,8

- ADD LINER FITUP
- ADD JOINING SEGMENTS (LASER WELDS)
- ADD BONDING LINER / JAC.

PR8-5
Cast Structural Jacket And Platelet Liners
Simplify SSME MCC Fabrication

Fabricate Platelet Panels
Form Panels To Contour
Trim Panel Edges By Wire EDM
Prepare Structural Jacket Casting

Assemble Liners Within Casting
Laser Weld Panel Seams
Diffusion Bond Liners To Structural Jacket
Final Machine Chamber And Proof Test

ISSUE: THRUST CHAMBER LIFE IMPROVEMENT
THEORETICAL GAIN WITH HIGH ASPECT COOLANT CHANNELS
• LeRC IN-HOUSE PROGRAM
• THERMAL / STRUCTURAL ANALYSIS

PROBLEM: BEYOND CURRENT MANUFACTURING CAPABILITY

SOLUTION: MSFC DEVELOPMENT OF THIN HIGH ASPECT CHANNELS BY EDM
(DEMONSTRATED ON TEST SAMPLES)