FR-20710-2

# SSME ALTERNATE TURBOPUMP DEVELOPMENT PROGRAM (HPFTP)

## VERIFICATION COMPLETE REPORT FIRST TURBINE BLADE AERODYNAMIC DESIGN DVS DR NO. 3.1.2.2.4.1, VM NO. 4.1.2.4 A

## JUNE 1989


Prepared under
NASA Contract NAS8-36801
DRL Sequence No. SE12
WBS No. 1.5.1.2


Prepared for
George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Marshall Space Flight Center, Al 35812


Prepared by
Pratt & Whitney
P. O. Box 109600
West Palm Beach, FL 33410-9600


Approved by:

John Price for
W. C. Shubert
ATD Project Manager


(NASA-CR-183751) SSME ALTERNATE TURBOPUMP DEVELOPMENT PROGRAM (HPFTP). VERIFICATION COMPLETE REPORT. FIRST TURBINE BLADE AERODYNAMIC DESIGN DVS DR NO. 3.1.2.2.4.1, VM NO. 4.1.2.4 A (Pratt and Whitney

N89-71482

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Printed in the United States of America

## HPFTP Turbine Aerodynamic Design

The High Pressure Fuel Turbopump (HPFTP) turbine aerodynamic design is based on the requirements defined by the Interface Control Document (ICD) and by the Power Balance Model, Table 387B. Performance Table 387B was used for the turbine aerodynamic design because its turbine flow capacities are consistent with the baseline turbine nozzle flow test results conducted on Pratt & Whitney's test stand, E-6, in December, 1986.

A conventional pressure-compounded, 2-stage turbine was chosen because of its inherent high efficiency over a wide range of steady-state operating conditions. No exit guide vane is required for the small (18 degrees) exit swirl angle. The high airfoil gas bending loads in the HPFTP turbine required thin wall, hollow airfoil sections, with larger moments of inertia, in order to reduce the airfoil bending stresses. The HPFTP turbine design has a mean diameter wheel speed of 1482 ft/sec which is compatible with allowable disk and root attachment stress criteria. This wheel speed also provides a high design point wheel speed to gas velocity ratio, assuring that there will not be a significant efficiency loss at minimum power level (MPL) operation. The design point velocity ratio, (0.55) is conservative, ensuring minimal aerodynamic risk. The design speed of approximately 36,500 rpm selected for the HPFTP was primarily set by the pump hydrodynamics. The height of the turbine annulus was selected to limit the last stage blade root centrifugal stress to 46,000 psi. This annulus size yielded a favorable exit Mach number of 0.18 and a low exit swirl angle of 18 degrees, therefore, this rpm was satisfactory to the performance, stress, and exit Mach number requirements of the turbine.

The methodology associated with the design of the HPFTP starts with the meanline design analysis. This analysis is based on the assumption that the flow through the turbine can be represented by the flow at the center of the flow passage. This simplified approach permits selection of the number of stages required, the mean diameter of the flow passage, and the annulus area. Included in the analysis is an estimate of the aerodynamic efficiency. This prediction system uses the physical laws of aerodynamics and correlations from rig and engine data to estimate profile loss, secondary loss, blade tip leakage, and shock and incidence losses based on the geometry and aerodynamic parameters of the turbine. An interactive graphic flowpath design system is used, in conjunction with the optimum meanline design, to generate candidate flowpath configurations.

The streamline design analysis is used to optimize the radial variation in the velocity triangles, once the average conditions are selected from the meanline analysis. This analysis calculates the flow characteristics at numerous radial locations and at the inlet and exit of each airfoil row. Once the meanline and streamline analyses have been used to optimize the velocity triangles throughout the turbine, 2 dimensional (2-D) airfoil sections are designed. These airfoil sections are designed to achieve contours that provide the desired amount of flow turning without permitting the flow to separate from

the airfoil surface. This process involves determining the static pressure distributions and boundary layer parameters along the airfoil surfaces and endwalls. An interactive graphics airfoil design system is used to identify adverse static pressure gradients such that the airfoil contour can be modified appropriately. After the 2-D airfoils are estimated at several spanwise locations, they are radially faired and combined with a preliminary endwall definition. An inviscid multi-stage 3-D flow analysis is then used to refine and optimize the entire flowpath configuration.

All turbine airfoil, endwall, inlet, and exit flow passage surfaces are contoured and refined as a system. The multi-stage feature enables a complete evaluation of potential changes to an individual surface contour during the design process. This assessment includes, not only flow property changes around the component being modified, but also around all upstream and downstream components in the complete turbine system. Improved performance and reduced risk result from this global optimization capability.

This report contains:

- Hot elevation diagrams for each airfoil
- 3-D airfoil plots
- 2-D airfoil section plots
- Tabulated airfoil section coordinates
- A plot of hot gaging dimensions versus radius
- A plot of percent change in flow area versus airfoil rotation
- A plot of stress versus span
- 3-D airfoil static pressure distributions
- Airfoil Ps/PT and Mach number contours
- A plot of suction surface boundary layer friction coefficient versus surface distance

# COVER SHEET

S.S.M.E.

ENGINE Alternate Turbo-Pump Development

AIRFOIL 1st Stage Blade

ENGINEER R.J. Rowey EXT 5962 DATE 8/24/87

AERODYNAMIC DESIGN POINT 109% Power - Design Table 0387.B dated 4/10/87

**F.T.D. LIST:**

ELEVATION _____

AIRFOIL SECTIONS _____

AIRFOIL COORDINATES _____

**DF LIST:**

GAGING VS. RADIUS _____

FLOW AREA VS. ROTATION _____

STRESS VS. % SPAN _____

PRESSURE DIST. _____

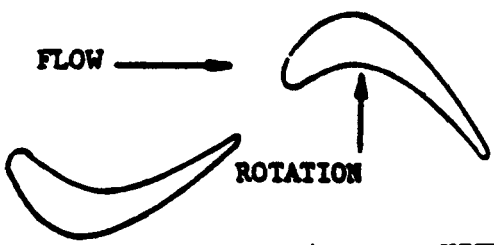
BOUNDARY LAYER _____

---

**CHECK ONE**

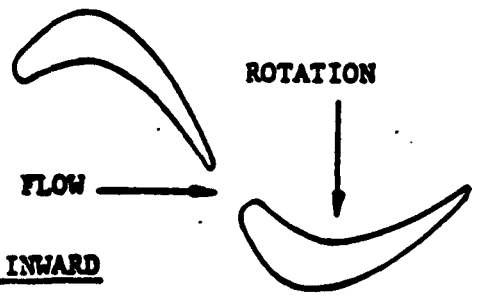
**P&WA CONVENTIONAL ROTATION**

VANE _____ BLADE ✓



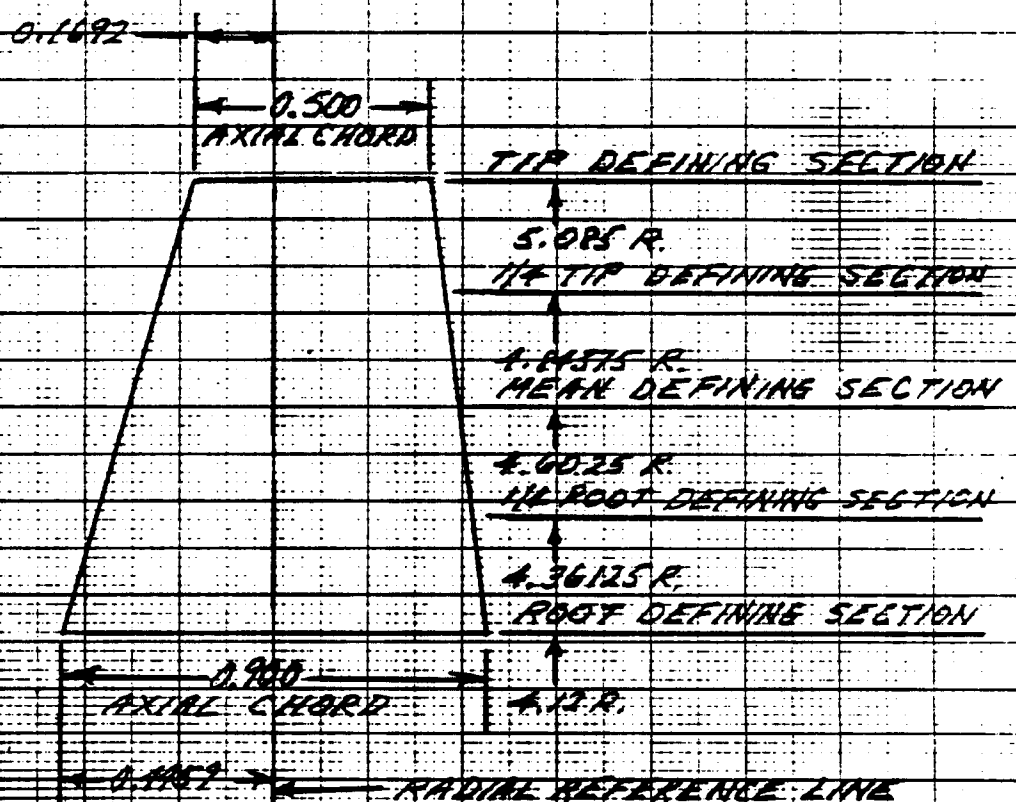

**P&WA COUNTER ROTATION**

VANE _____ BLADE _____




**VIEW LOOKING RADIALLY INWARD**

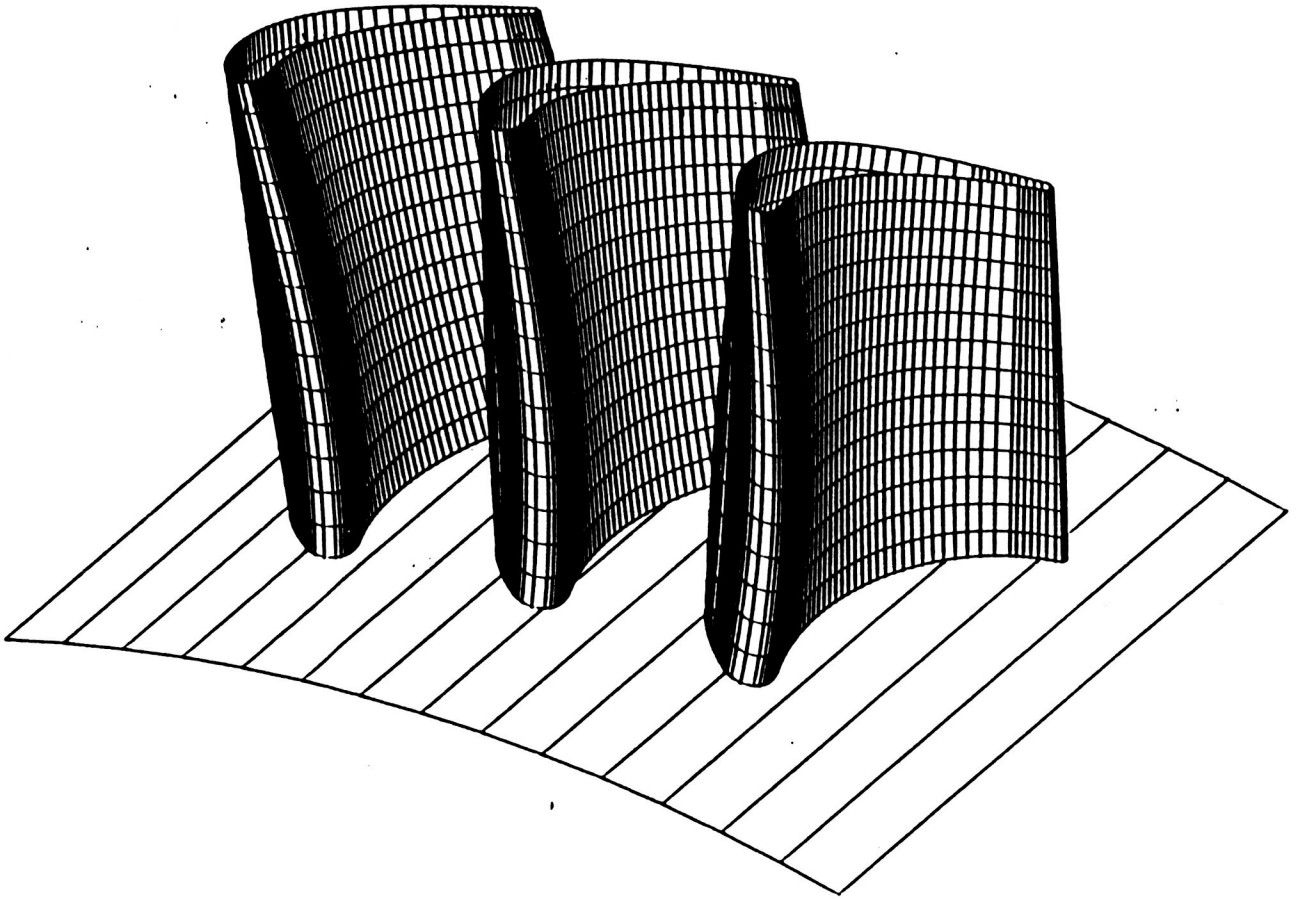
# SSME HPFTP FIRST STAGE BLADE HOT ELEVATION




NOTES:
1. BLADE IS CURVED LINE FAIRED IN P824.
2. NUMBER OF BLADES IS 50.
3. ALL DIMENSIONS ARE HOT.
4. MATERIAL IS PWA 1480. DENSITY = 0.312 #/IN.$^3$
5. NET WEIGHT IS 0.02168 #/FOIL.
6. PULL IS 3698. #/FOIL AT 36421. RPM.
7. AIRFOIL COORDINATES RESIDE IN P824 FILE RJRP824 BIFINAL.

R.J.R. 8/20/87

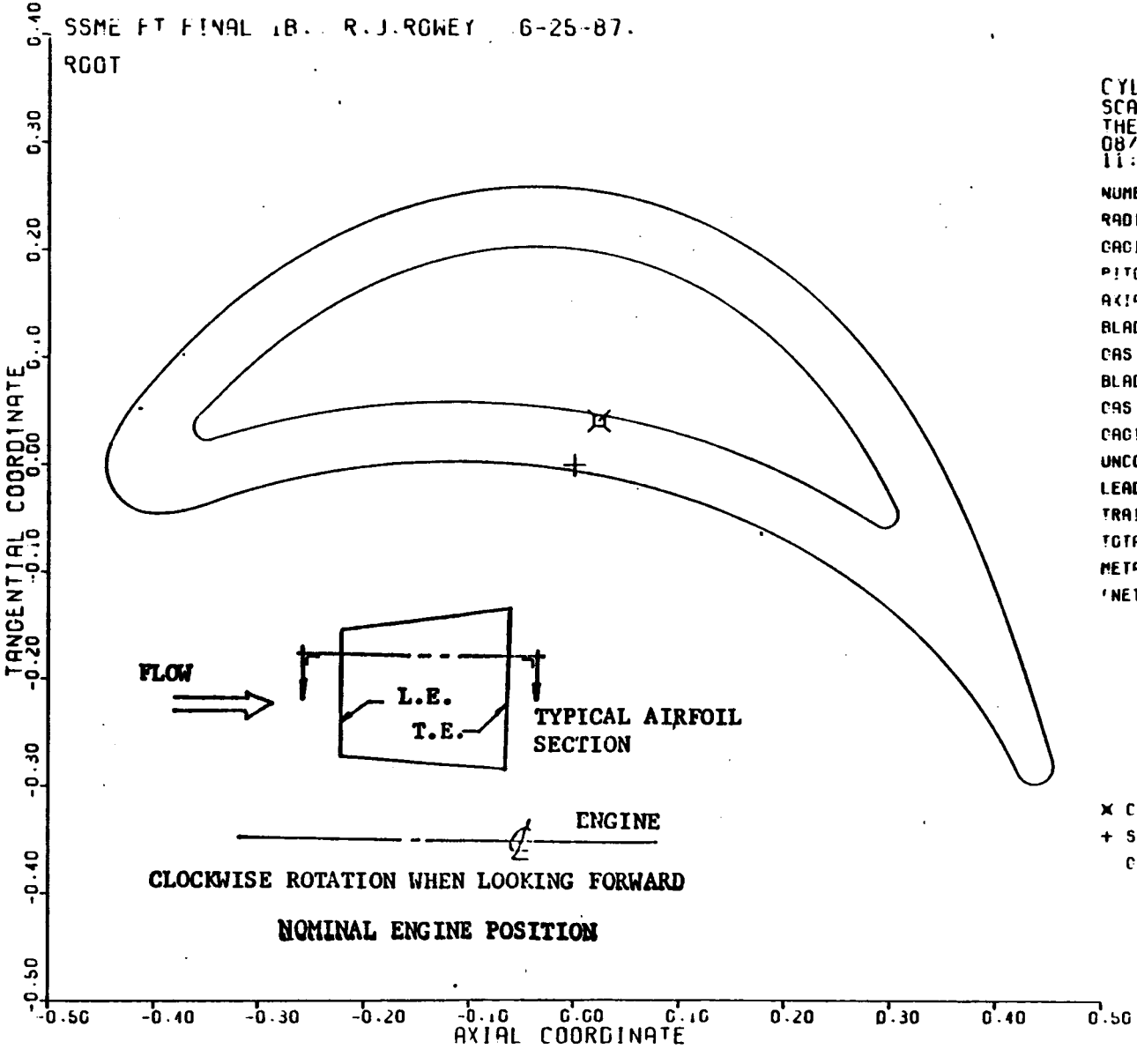
# 3DPLOT



05/22/8714:22:31

SSME FT FINAL 1B.. R.J.ROWEY.. 5-14-87.. 40.89 48.59 40.89

SSME FT FINAL 1B. R.J.ROWEY 6-25-87.
ROOT



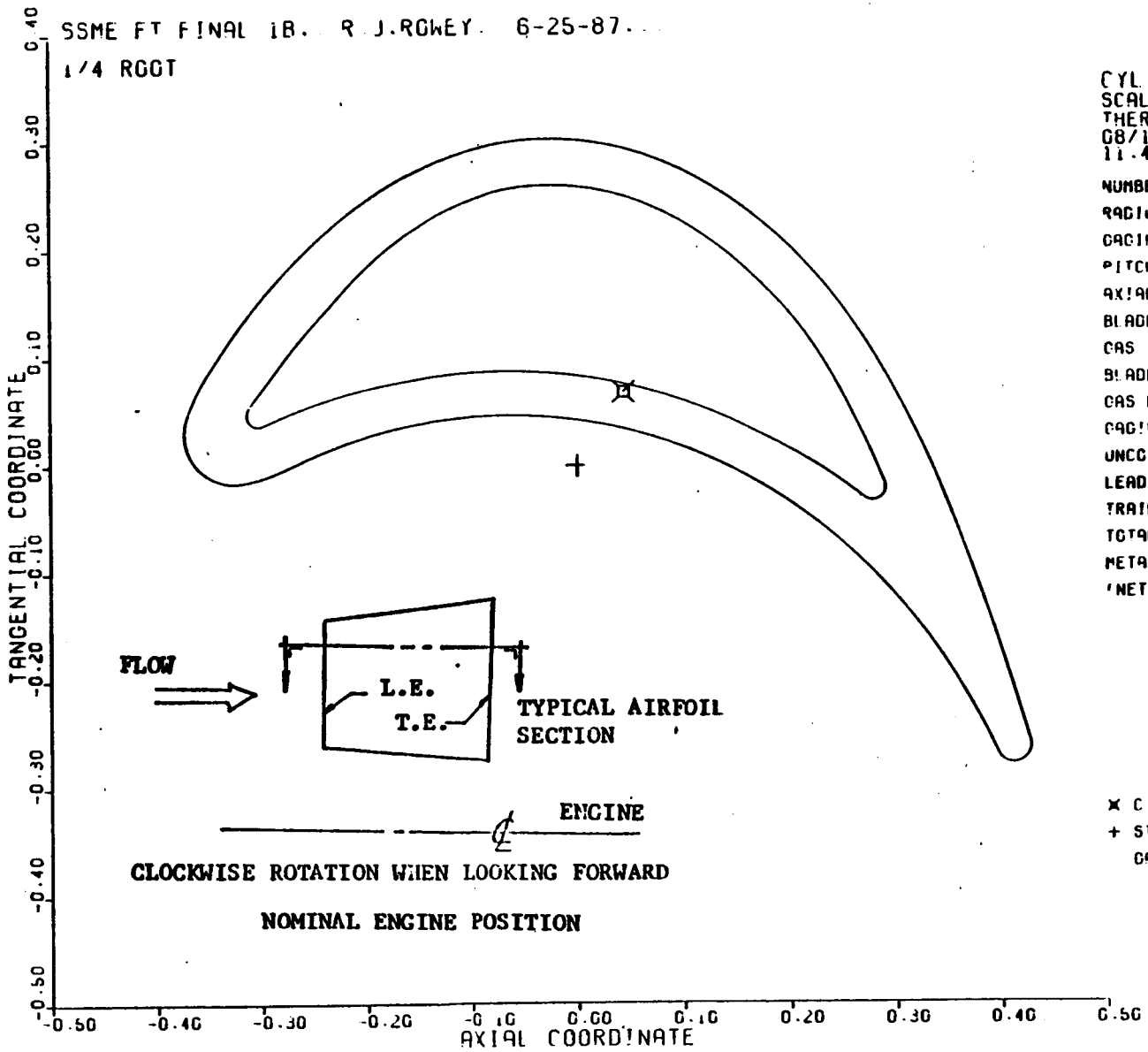

CYLINDRICAL
SCALE 10.0
THERMAL SHRINK FACTOR 1.000000
08/19/87
11:42:38

| | | |
|---|---|---|
| NUMBER OF BLADES | 50. | |
| RADIUS (HOT) | 4.120 | INCHES |
| GAGING (HOT) | 0.1892 | INCHES |
| PITCH (HOT) | 0.5177 | INCHES |
| AXIAL WIDTH | 0.9000 | INCHES |
| BLADE INLET ANGLE | 60.565 | DEGREES |
| GAS INLET ANGLE | 44.718 | DEGREES |
| BLADE EXIT ANGLE | 21.129 | DEGREES |
| GAS EXIT ANGLE | 21.062 | DEGREES |
| GAGING ANGLE | 21.431 | DEGREES |
| UNCOVERED TURNING | 22.892 | DEGREES |
| LEADING EDGE RADIUS | 0.0454 | INCHES |
| TRAILING EDGE RADIUS | 0.0175 | INCHES |
| TOTAL AREA (SOLID) | 0.1889 | SQ. IN. |
| METAL AREA (NET, UNCOATED) | 0.1137 | SQ. IN. |

| | X | Y |
|---|---|---|
| X C.G. | 0.0230 | 0.0000 |
| + STACKING LINE | 0.0000 | 0.0000 |
| GAGE | 0.2780 | 0.0000 |

SSME FT FINAL 1B. R.J.ROWEY. 6-25-87.

1/4 ROOT



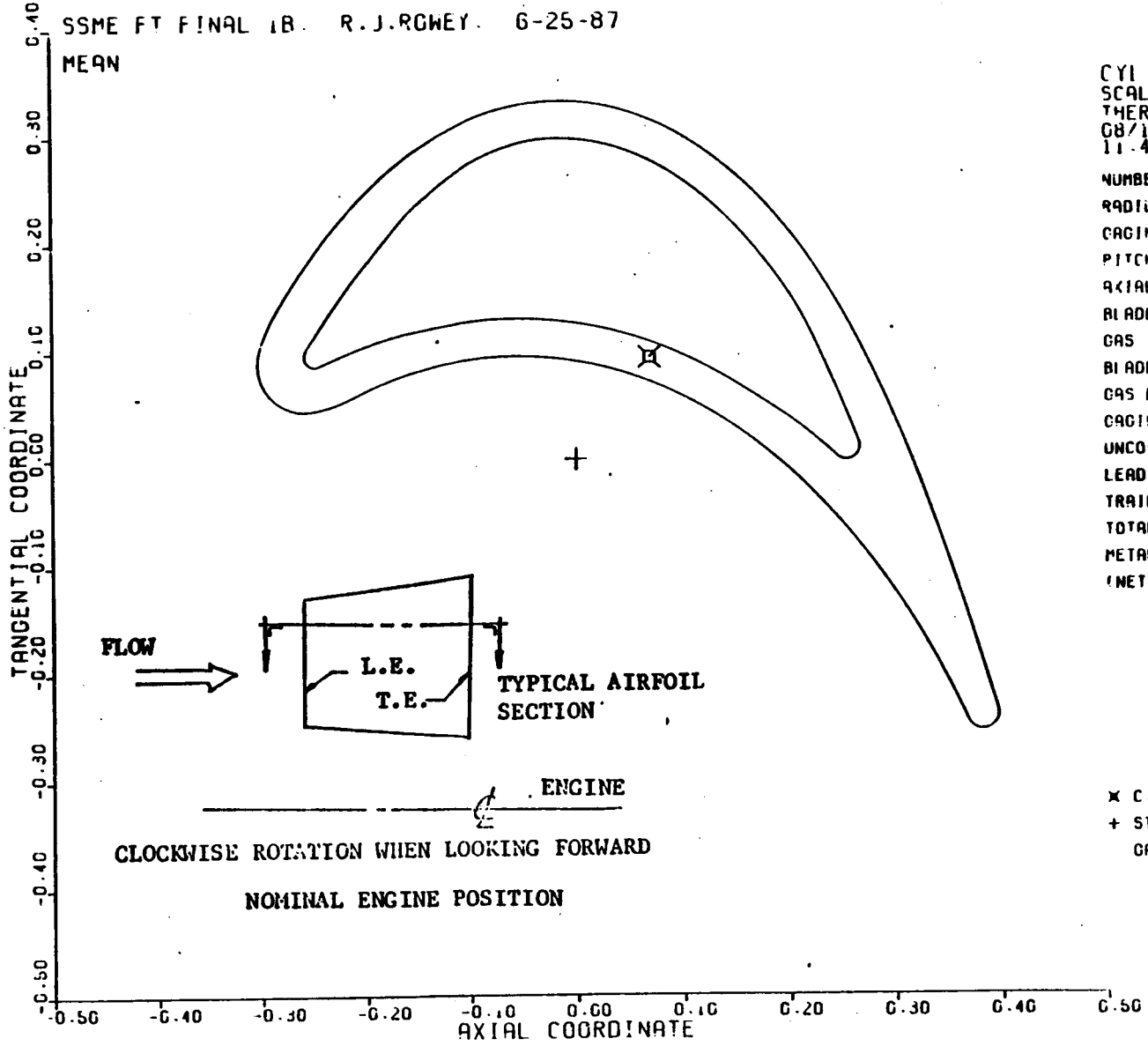

CYLINDRICAL
SCALE 10.0
THERMAL SHRINK FACTOR 1.000000
08/19/87
11.42:38

| | | |
|---|---|---|
| NUMBER OF BLADES | 50. | |
| RADIUS (HOT) | 4.361 | INCHES |
| CASING (HOT) | 0.1970 | INCHES |
| PITCH (HOT) | 0.5481 | INCHES |
| AXIAL WIDTH | 0.8000 | INCHES |
| BLADE INLET ANGLE | 53.331 | DEGREES |
| GAS INLET ANGLE | 38.220 | DEGREES |
| BLADE EXIT ANGLE | 21.126 | DEGREES |
| GAS EXIT ANGLE | 21.062 | DEGREES |
| CASING ANGLE | 21.062 | DEGREES |
| UNCOVERED TURNING | 21.153 | DEGREES |
| LEADING EDGE RADIUS | 0.0467 | INCHES |
| TRAILING EDGE RADIUS | 0.0163 | INCHES |
| TOTAL AREA (SOLID) | 0.1655 | SQ. IN. |
| METAL AREA (NET, UNCOATED) | 0.0875 | SQ. IN. |

| | X | Y |
|---|---|---|
| × C.G. | 0.0433 | 0.0000 |
| + STACKING LINE | 0.0000 | 0.0000 |
| CASE | 0.2430 | 0.0000 |

SSME FT FINAL 1B. R.J.ROWEY. 6-25-87

MEAN



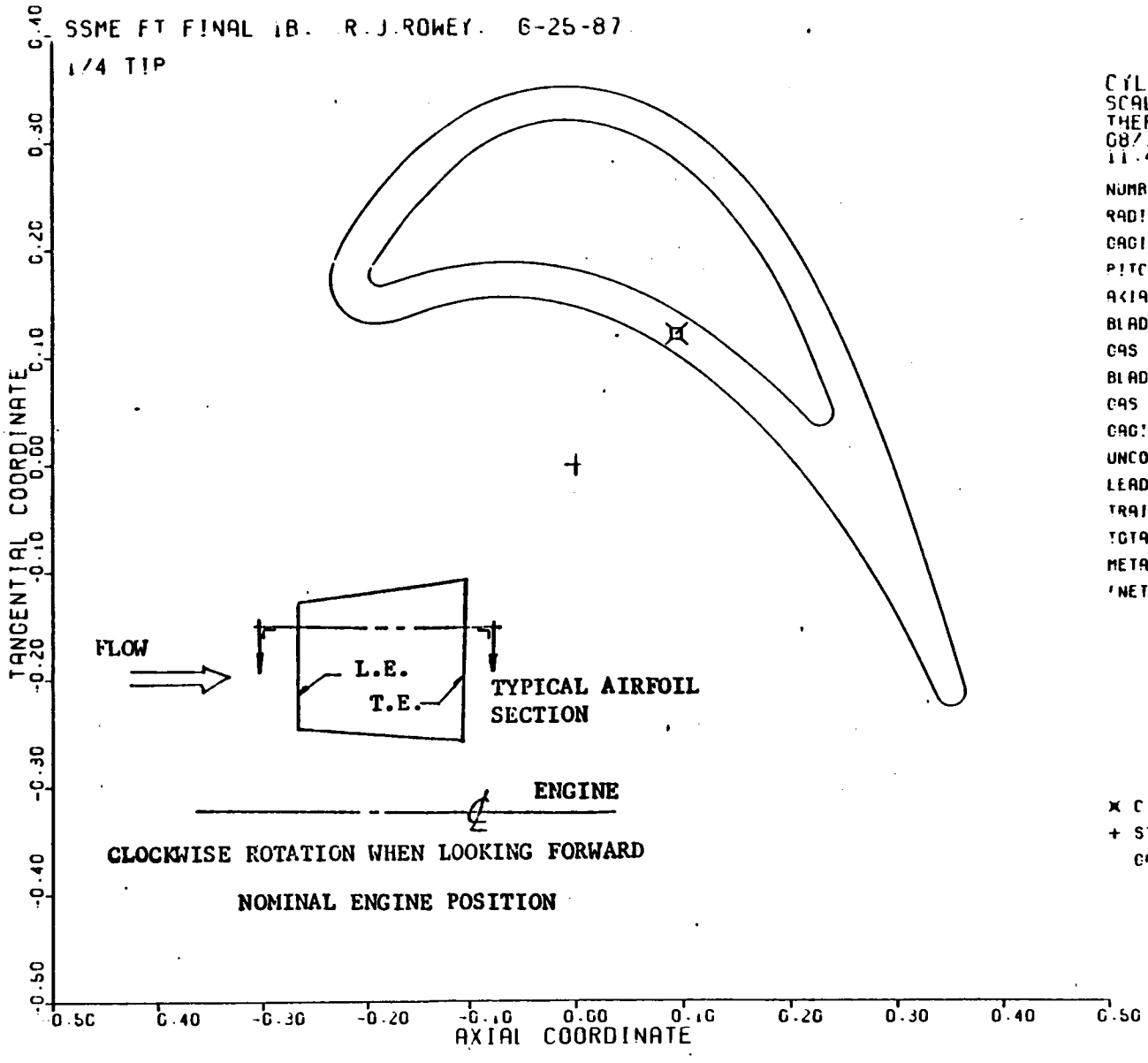

CYLINDRICAL
SCALE 10.0
THERMAL SHRINK FACTOR 1.000000
08/19/87
11:42:38

| | | |
|---|---|---|
| NUMBER OF BLADES | 50. | |
| RADIUS (HOT) | 4.002 | INCHES |
| GAGING (HOT) | 0.2065 | INCHES |
| PITCH (HOT) | 0.5784 | INCHES |
| AXIAL WIDTH | 0.7000 | INCHES |
| BLADE INLET ANGLE | 51.693 | DEGREES |
| GAS INLET ANGLE | 38.710 | DEGREES |
| BLADE EXIT ANGLE | 21.063 | DEGREES |
| GAS EXIT ANGLE | 21.062 | DEGREES |
| GAGING ANGLE | 20.914 | DEGREES |
| UNCOVERED TURNING | 20.619 | DEGREES |
| LEADING EDGE RADIUS | 0.0448 | INCHES |
| TRAILING EDGE RADIUS | 0.0150 | INCHES |
| TOTAL AREA (SOLID) | 0.1353 | SQ. IN. |
| METAL AREA (NET. UNCOATED) | 0.0685 | SQ. IN. |

| | X | Y |
|---|---|---|
| ✖ C.C. | 0.0690 | 0.0000 |
| + STACKING LINE | 0.0000 | 0.0000 |
| GAGE | 0.2065 | 0.0000 |

SSME FT FINAL 1B. R.J.ROWEY. 6-25-87

1/4 TIP



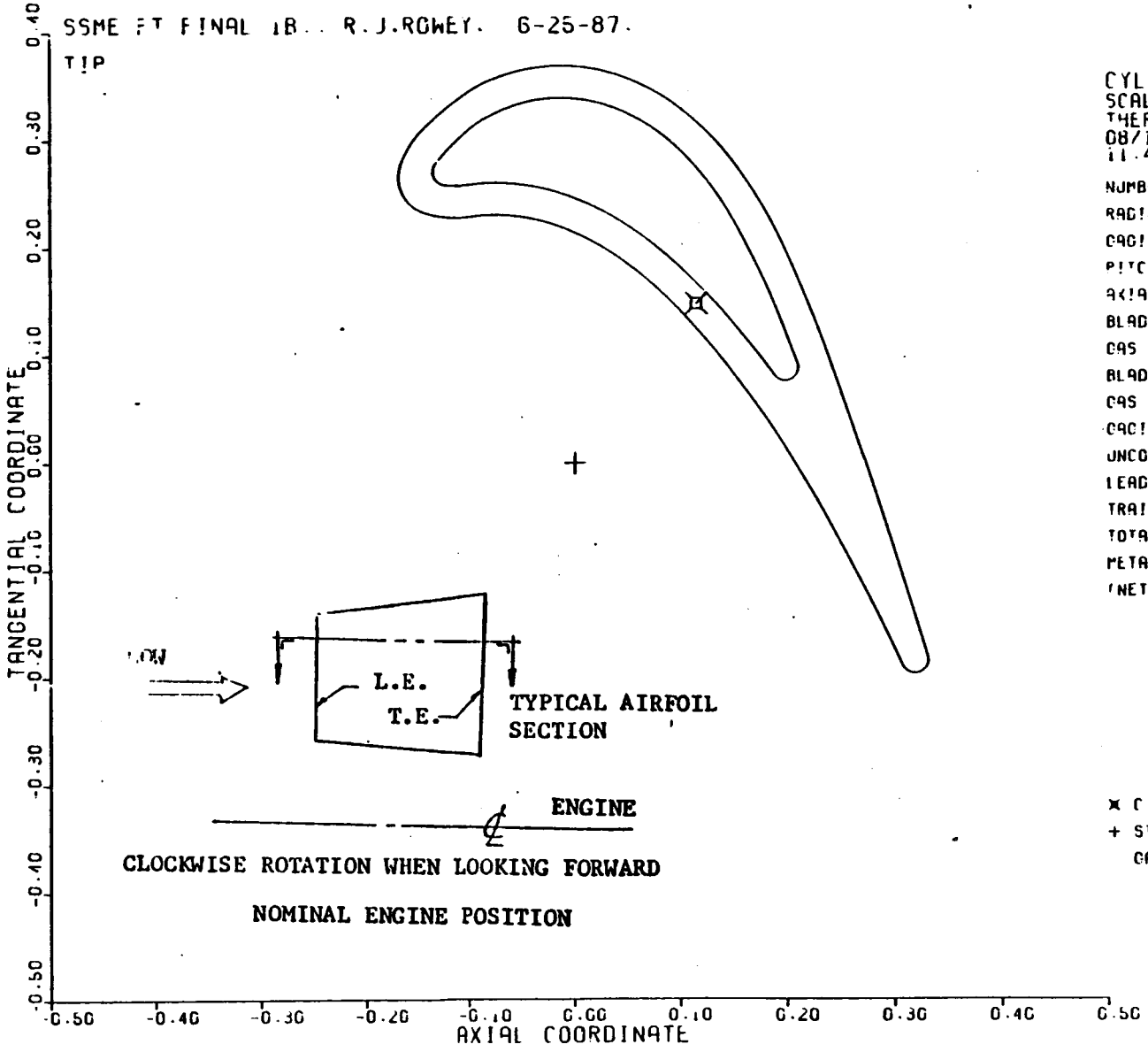

CYLINDRICAL
SCALE 10.0
THERMAL SHRINK FACTOR 1.000000
08/19/87
11.42:38

| | | |
|---|---|---|
| NUMBER OF BLADES | 50. | |
| RADIUS (HOT) | 4.844 | INCHES |
| GAGING (HOT) | 0.2180 | INCHES |
| PITCH (HOT) | 0.6087 | INCHES |
| AXIAL WIDTH | 0.6000 | INCHES |
| BLADE INLET ANGLE | 56.998 | DEGREES |
| GAS INLET ANGLE | 47.910 | DEGREES |
| BLADE EXIT ANGLE | 21.085 | DEGREES |
| GAS EXIT ANGLE | 21.062 | DEGREES |
| GAGING ANGLE | 20.985 | DEGREES |
| UNCOVERED TURNING | 21.498 | DEGREES |
| LEADING EDGE RADIUS | 0.0408 | INCHES |
| TRAILING EDGE RADIUS | 0.0137 | INCHES |
| TOTAL AREA (SOLID) | 0.1023 | SQ. IN. |
| METAL AREA (NET, UNCOATED) | 0.0550 | SQ. IN. |

| | X | Y |
|---|---|---|
| * C.C. | 0.0938 | 0.0000 |
| + STACKING LINE | 0.0000 | 0.0000 |
| GAGE | 0.1694 | 0.0000 |

SSME FT FINAL 1B.. R.J.ROWEY. 6-25-87.

TIP




CYLINDRICAL
SCALE 10.0
THERMAL SHRINK FACTOR 1.000000
08/19/87
11.42.38

| | | |
|---|---|---|
| NUMBER OF BLADES | 50. | |
| RADIUS (HOT) | 5.085 | INCHES |
| GAGING (HOT) | 0.2292 | INCHES |
| PITCH (HOT) | 0.0390 | INCHES |
| AXIAL WIDTH | 0.5000 | INCHES |
| BLADE INLET ANGLE | 70.889 | DEGREES |
| GAS INLET ANGLE | 70.889 | DEGREES |
| BLADE EXIT ANGLE | 21.048 | DEGREES |
| GAS EXIT ANGLE | 21.062 | DEGREES |
| GAGING ANGLE | 21.017 | DEGREES |
| UNCOVERED TURNING | 24.590 | DEGREES |
| LEADING EDGE RADIUS | 0.0346 | INCHES |
| TRAILING EDGE RADIUS | 0.0125 | INCHES |
| TOTAL AREA (SOLID) | 0.0718 | SQ. IN. |
| METAL AREA (NET. UNCOATED) | 0.0436 | SQ. IN. |

| | X | Y |
|---|---|---|
| * C.G. | 0.1150 | 0.0000 |
| + STACKING LINE | 0.0000 | 0.0000 |
| GAGE | 0.1376 | 0.0000 |

EXTERNAL CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 4.12000 COLD RADIUS = 4.10981 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.46063 | 0.02512 | 0.01533 | -0.46063 | -0.00504 | 0.01533 | | | | |
| 0.010 | -0.45163 | 0.04414 | | -0.45163 | -0.01564 | -0.01181 | | | | |
| 0.020 | -0.44263 | 0.05988 | | -0.44263 | -0.02296 | -0.02088 | | | | |
| 0.030 | -0.43363 | 0.07234 | | -0.43363 | -0.02988 | -0.02619 | | | | |
| 0.040 | -0.42463 | 0.08321 | | -0.42463 | -0.02921 | -0.02911 | | | | |
| 0.050 | -0.41563 | 0.09359 | | -0.41563 | -0.03018 | | | | | |
| 0.060 | -0.40663 | 0.10355 | | -0.40663 | -0.03020 | | | | | |
| 0.070 | -0.39763 | 0.11310 | | -0.39763 | -0.02945 | | L.E. CIRCLE (X,Y,R) | -0.41520 | 0.01533 | 0.04543 |
| 0.080 | -0.38863 | 0.12228 | | -0.38863 | -0.02804 | | T.E. CIRCLE (X,Y,R) | 0.42188 | -0.26424 | 0.01749 |
| 0.090 | -0.37963 | 0.13109 | | -0.37963 | -0.02604 | | | | | |
| 0.100 | -0.37063 | 0.13955 | | -0.37063 | -0.02351 | | L.E. TOP TANG. PT. (X,Y) | -0.45627 | 0.03475 | |
| 0.125 | -0.34813 | 0.15927 | | -0.34813 | -0.01591 | | L.E. BOTTOM TANG. PT. (X,Y) | -0.41991 | -0.02996 | |
| 0.150 | -0.32563 | 0.17768 | | -0.32563 | -0.00898 | | T.E. TOP TANG. PT. (X,Y) | 0.43660 | -0.25412 | |
| 0.175 | -0.30313 | 0.19313 | | -0.30313 | -0.00290 | | T.E. BOTTOM TANG. PT. (X,Y) | 0.40606 | -0.27170 | |
| 0.200 | -0.28063 | 0.20754 | | -0.28063 | 0.00238 | | | | | |
| 0.225 | -0.25813 | 0.22040 | | -0.25813 | 0.00688 | | NOSE POINT (X,Y) | -0.45477 | -0.00700 | |
| 0.250 | -0.23563 | 0.23174 | | -0.23563 | 0.01064 | | TAIL POINT (X,Y) | 0.42818 | -0.28056 | |
| 0.275 | -0.21313 | 0.24176 | | -0.21313 | 0.01366 | | | | | |
| 0.300 | -0.19063 | 0.25027 | | -0.19063 | 0.01597 | | NET CROSS-SECT. AREA (EXCL. COATING) | 0.11370 | | |
| 0.325 | -0.16813 | 0.25766 | | -0.16813 | 0.01757 | | | | | |
| 0.350 | -0.14563 | 0.26386 | | -0.14563 | 0.01847 | | GAGING (X,Y,CAMBER) | 0.26250 | 0.12098 | 0.18917 |
| 0.375 | -0.12313 | 0.26836 | | -0.12313 | 0.01868 | | GAGING ANGLE (DEG.) | 21.431 | | |
| 0.400 | -0.10063 | 0.27178 | | -0.10063 | 0.01819 | | | | | |
| 0.425 | -0.07813 | 0.27395 | | -0.07813 | 0.01701 | | CTR. OF GRAV. (INCL. COATING) (X,Y) | 0.00827 | 0.05667 | |
| 0.450 | -0.05563 | 0.27485 | | -0.05563 | 0.01512 | | RAD. REF. PT. (X,Y) | 0.0 | 0.0 | |
| 0.475 | -0.03313 | 0.27446 | | -0.03313 | 0.01254 | | INLET ANGLE (DEG.) | 60.565 | | |
| 0.500 | -0.01063 | 0.27278 | | -0.01063 | 0.00923 | | INLET WEDGE ANGLE (DEG.) | 70.517 | | |
| 0.525 | 0.01187 | 0.26976 | | 0.01187 | 0.00518 | | EXIT ANGLE (DEG.) | 21.129 | | |
| 0.550 | 0.03437 | 0.26528 | | 0.03437 | 0.00036 | | EXIT WEDGE ANGLE (DEG.) | 8.249 | | |
| 0.575 | 0.05687 | 0.25958 | | 0.05687 | -0.00523 | | UNCOVERED TURNING ANGLE (DEG.) | 22.892 | | |
| 0.600 | 0.07937 | 0.25229 | | 0.07937 | -0.01165 | | AXIAL CHORD | 0.90000 | | |
| 0.625 | 0.10187 | 0.24345 | | 0.10187 | -0.01893 | | ACTUAL CHORD | 0.94545 | | |
| 0.650 | 0.12437 | 0.23295 | | 0.12437 | -0.02711 | | PITCH | 0.51775 | | |
| 0.675 | 0.14687 | 0.22068 | | 0.14687 | -0.03625 | | NO. OF FOILS | 60 | | |
| 0.700 | 0.16937 | 0.20648 | | 0.16937 | -0.04643 | | | | | |
| 0.725 | 0.19187 | 0.19017 | | 0.19187 | -0.05773 | | | | | |
| 0.750 | 0.21437 | 0.17149 | | 0.21437 | -0.07026 | | | | | |
| 0.775 | 0.23687 | 0.15012 | | 0.23687 | -0.08415 | | | | | |
| 0.800 | 0.25937 | 0.12562 | | 0.25937 | -0.09958 | | | | | |
| 0.825 | 0.28187 | 0.09738 | | 0.28187 | -0.11679 | | | | | |
| 0.850 | 0.30437 | 0.06482 | | 0.30437 | -0.13609 | | | | | |
| 0.875 | 0.32687 | 0.02649 | | 0.32687 | -0.15794 | | | | | |
| 0.900 | 0.34937 | -0.01775 | | 0.34937 | -0.18305 | | | | | |
| 0.910 | 0.35837 | -0.03730 | | 0.35837 | -0.19424 | | | | | |
| 0.920 | 0.36737 | -0.05794 | | 0.36737 | -0.20625 | | | | | |
| 0.930 | 0.37637 | -0.07968 | | 0.37637 | -0.21917 | | | | | |
| 0.940 | 0.38537 | -0.10253 | | 0.38537 | -0.23325 | | | | | |
| 0.950 | 0.39437 | -0.12647 | | 0.39437 | -0.24876 | | | | | |
| 0.960 | 0.40337 | -0.15149 | | 0.40337 | -0.26611 | | | | | |
| 0.970 | 0.41237 | -0.17755 | | 0.41237 | -0.28600 | -0.27892 | | | | |
| 0.980 | 0.42137 | -0.20463 | | 0.42137 | -0.30979 | -0.28172 | | | | |
| 0.990 | 0.43037 | -0.23267 | | 0.43037 | -0.34082 | -0.27953 | | | | |
| 1.000 | 0.43937 | -0.26162 | -0.26424 | 0.43937 | -0.39978 | -0.26424 | | | | |

NO. 1 CORE CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 4.12000 COLD RADIUS = 4.10981 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.37755 | 0.05611 | 0.05075 | -0.37755 | 0.05424 | 0.05075 | | | | |
| 0.010 | -0.37083 | 0.06251 | | -0.37083 | 0.03612 | 0.03967 | | | | |
| 0.020 | -0.36414 | 0.06893 | | -0.36414 | 0.03799 | 0.03826 | | | | |
| 0.030 | -0.35744 | 0.07535 | | -0.35744 | 0.03987 | | | | | |
| 0.040 | -0.35075 | 0.08177 | | -0.35075 | 0.04174 | | | | | |
| 0.050 | -0.34405 | 0.08817 | | -0.34405 | 0.04362 | | | | | |
| 0.060 | -0.33736 | 0.09450 | | -0.33736 | 0.04549 | | | | | |
| 0.070 | -0.33066 | 0.10071 | | -0.33066 | 0.04734 | | L.E. CIRCLE (X,Y,R) | -0.36501 | 0.05075 | 0.01252 |
| 0.080 | -0.32397 | 0.10674 | | -0.32397 | 0.04914 | | T.E. CIRCLE (X,Y,R) | 0.27948 | -0.02982 | 0.01249 |
| 0.090 | -0.31727 | 0.11255 | | -0.31727 | 0.05087 | | | | | |
| 0.100 | -0.31058 | 0.11817 | | -0.31058 | 0.05253 | | L.E. TOP TANG. PT. (X,Y) | -0.37366 | 0.05980 | |
| 0.125 | -0.29384 | 0.13142 | | -0.29384 | 0.05641 | | L.E. BOTTOM TANG. PT. (X,Y) | -0.36163 | 0.03869 | |
| 0.150 | -0.27711 | 0.14357 | | -0.27711 | 0.05988 | | T.E. TOP TANG. PT. (X,Y) | 0.29062 | -0.02417 | |
| 0.175 | -0.26037 | 0.15468 | | -0.26037 | 0.06296 | | T.E. BOTTOM TANG. PT. (X,Y) | 0.27308 | -0.04055 | |
| 0.200 | -0.24363 | 0.16483 | | -0.24363 | 0.06566 | | | | | |
| 0.225 | -0.22689 | 0.17404 | | -0.22689 | 0.06798 | | NOSE POINT (X,Y) | -0.37589 | 0.04455 | |
| 0.250 | -0.21016 | 0.18235 | | -0.21016 | 0.06994 | | TAIL POINT (X,Y) | 0.28800 | -0.05895 | |
| 0.275 | -0.19342 | 0.18974 | | -0.19342 | 0.07153 | | | | | |
| 0.300 | -0.17668 | 0.19627 | | -0.17668 | 0.07276 | | | | | |
| 0.325 | -0.15994 | 0.20197 | | -0.15994 | 0.07363 | | | | | |
| 0.350 | -0.14321 | 0.20686 | | -0.14321 | 0.07414 | | | | | |
| 0.375 | -0.12647 | 0.21093 | | -0.12647 | 0.07429 | | | | | |
| 0.400 | -0.10973 | 0.21420 | | -0.10973 | 0.07409 | | | | | |
| 0.425 | -0.09299 | 0.21665 | | -0.09299 | 0.07353 | | | | | |
| 0.450 | -0.07626 | 0.21828 | | -0.07626 | 0.07261 | | | | | |
| 0.475 | -0.05952 | 0.21912 | | -0.05952 | 0.07133 | | | | | |
| 0.500 | -0.04278 | 0.21912 | | -0.04278 | 0.06969 | | | | | |
| 0.525 | -0.02604 | 0.21829 | | -0.02604 | 0.06769 | | | | | |
| 0.550 | -0.00931 | 0.21661 | | -0.00931 | 0.06531 | | | | | |
| 0.575 | 0.00743 | 0.21406 | | 0.00743 | 0.06256 | | | | | |
| 0.600 | 0.02417 | 0.21062 | | 0.02417 | 0.05942 | | | | | |
| 0.625 | 0.04091 | 0.20627 | | 0.04091 | 0.05589 | | | | | |
| 0.650 | 0.05764 | 0.20095 | | 0.05764 | 0.05196 | | | | | |
| 0.675 | 0.07438 | 0.19463 | | 0.07438 | 0.04763 | | | | | |
| 0.700 | 0.09112 | 0.18727 | | 0.09112 | 0.04288 | | | | | |
| 0.725 | 0.10786 | 0.17880 | | 0.10786 | 0.03768 | | | | | |
| 0.750 | 0.12459 | 0.16919 | | 0.12459 | 0.03204 | | | | | |
| 0.775 | 0.14133 | 0.15824 | | 0.14133 | 0.02593 | | | | | |
| 0.800 | 0.15807 | 0.14596 | | 0.15807 | 0.01933 | | | | | |
| 0.825 | 0.17481 | 0.13218 | | 0.17481 | 0.01223 | | | | | |
| 0.850 | 0.19154 | 0.11671 | | 0.19154 | 0.00463 | | | | | |
| 0.875 | 0.20828 | 0.09939 | | 0.20828 | -0.00361 | | | | | |
| 0.900 | 0.22502 | 0.07993 | | 0.22502 | -0.01243 | | | | | |
| 0.910 | 0.23171 | 0.07148 | | 0.23171 | -0.01613 | | | | | |
| 0.920 | 0.23841 | 0.06259 | | 0.23841 | -0.01994 | | | | | |
| 0.930 | 0.24510 | 0.05323 | | 0.24510 | -0.02384 | | | | | |
| 0.940 | 0.25180 | 0.04338 | | 0.25180 | -0.02782 | | | | | |
| 0.950 | 0.25849 | 0.03300 | | 0.25849 | -0.03183 | | | | | |
| 0.960 | 0.26519 | 0.02204 | | 0.26519 | -0.03584 | | | | | |
| 0.970 | 0.27188 | 0.01045 | | 0.27188 | -0.03985 | | | | | |
| 0.980 | 0.27858 | -0.00132 | | 0.27858 | -0.04383 | -0.04228 | | | | |
| 0.990 | 0.28527 | -0.01381 | | 0.28527 | -0.04782 | -0.04088 | | | | |
| 1.000 | 0.29197 | -0.02684 | -0.02982 | 0.29197 | -0.05182 | -0.02982 | | | | |

EXTERNAL CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87... CYLINDRICAL
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51
SUBTITLE HOT RADIUS = 4.36125 COLD RADIUS = 4.34810 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.38783 | 0.05502 | 0.04616 | -0.38783 | 0.02425 | 0.04616 | | | | |
| 0.010 | -0.37983 | 0.07444 | | -0.37983 | 0.01362 | 0.02001 | | | | |
| 0.020 | -0.37183 | 0.09067 | | -0.37183 | 0.00632 | 0.01095 | | | | |
| 0.030 | -0.36383 | 0.10369 | | -0.36383 | 0.00235 | 0.00532 | | | | |
| 0.040 | -0.35583 | 0.11571 | | -0.35583 | 0.00021 | 0.00180 | | | | |
| 0.050 | -0.34783 | 0.12726 | | -0.34783 | -0.00068 | -0.00009 | | | | |
| 0.060 | -0.33983 | 0.13835 | | -0.33983 | -0.00062 | -0.00057 | | | | |
| 0.070 | -0.33183 | 0.14899 | | -0.33183 | 0.00022 | | L.E. CIRCLE (X-Y-R) | -0.34108 | 0.04616 | 0.04675 |
| 0.080 | -0.32383 | 0.15918 | | -0.32383 | 0.00171 | | T.E. CIRCLE (X-Y-R) | 0.39902 | -0.24600 | 0.01625 |
| 0.090 | -0.31583 | 0.16896 | | -0.31583 | 0.00378 | | | | | |
| 0.100 | -0.30783 | 0.17833 | | -0.30783 | 0.00638 | | L.E. TOP TANG. PT. (X-Y) | -0.38436 | 0.06383 | |
| 0.125 | -0.28783 | 0.20007 | | -0.28783 | 0.01468 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.37656 | -0.00006 | |
| 0.150 | -0.26783 | 0.21955 | | -0.26783 | 0.02364 | | T.E. TOP TANG. PT. (X-Y) | 0.41146 | -0.12125 | |
| 0.175 | -0.24783 | 0.23704 | | -0.24783 | 0.03159 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.38122 | -0.25293 | |
| 0.200 | -0.22783 | 0.25258 | | -0.22783 | 0.03856 | | | | | |
| 0.225 | -0.20783 | 0.26621 | | -0.20783 | 0.04461 | | NOSE POINT (X-Y) | -0.37858 | 0.01825 | |
| 0.250 | -0.18783 | 0.27851 | | -0.18783 | 0.04976 | | TAIL POINT (X-Y) | 0.40178 | -0.26116 | |
| 0.275 | -0.16783 | 0.28867 | | -0.16783 | 0.05402 | | | | | |
| 0.300 | -0.14783 | 0.29744 | | -0.14783 | 0.05740 | | NET CROSS-SECT. AREA (EXCL. COATING) | 0.08747 | | |
| 0.325 | -0.12783 | 0.30466 | | -0.12783 | 0.05993 | | | | | |
| 0.350 | -0.10783 | 0.31037 | | -0.10783 | 0.06159 | | GAGING (X-Y-LAMBDA) | 0.22826 | 0.17021 | 0.19646 |
| 0.375 | -0.08783 | 0.31459 | | -0.08783 | 0.06240 | | GAGING ANGLE (DEG.) | 21.062 | | |
| 0.400 | -0.06783 | 0.31735 | | -0.06783 | 0.06236 | | | | | |
| 0.425 | -0.04783 | 0.31865 | | -0.04783 | 0.06146 | | CTR. OF GRAV. (INCL. COATING) (X-Y) | 0.02861 | 0.08399 | |
| 0.450 | -0.02783 | 0.31848 | | -0.02783 | 0.05969 | | RAD. REF. PT. (X-Y) | 0.0 | 0.0 | |
| 0.475 | -0.00783 | 0.31685 | | -0.00783 | 0.05704 | | INLET ANGLE (DEG.) | 53.331 | | |
| 0.500 | 0.01217 | 0.31372 | | 0.01217 | 0.05350 | | INLET WEDGE ANGLE (DEG.) | 62.239 | | |
| 0.525 | 0.03217 | 0.30908 | | 0.03217 | 0.04905 | | EXIT ANGLE (DEG.) | 21.126 | | |
| 0.550 | 0.05217 | 0.30291 | | 0.05217 | 0.04383 | | EXIT WEDGE ANGLE (DEG.) | 8.251 | | |
| 0.575 | 0.07217 | 0.29515 | | 0.07217 | 0.03726 | | UNCOVERED TURNING ANGLE (DEG.) | 21.152 | | |
| 0.600 | 0.09217 | 0.28575 | | 0.09217 | 0.02987 | | AXIAL CHORD | 0.80000 | | |
| 0.625 | 0.11217 | 0.27466 | | 0.11217 | 0.02142 | | ACTUAL CHORD | 0.85580 | | |
| 0.650 | 0.13217 | 0.26180 | | 0.13217 | 0.01188 | | PITCH | 0.54305 | | |
| 0.675 | 0.15217 | 0.24708 | | 0.15217 | 0.00116 | | NO. OF FOILS | 60 | | |
| 0.700 | 0.17217 | 0.23032 | | 0.17217 | -0.01080 | | | | | |
| 0.725 | 0.19217 | 0.21133 | | 0.19217 | -0.02409 | | | | | |
| 0.750 | 0.21217 | 0.18978 | | 0.21217 | -0.03881 | | | | | |
| 0.775 | 0.23217 | 0.16529 | | 0.23217 | -0.05509 | | | | | |
| 0.800 | 0.25217 | 0.13744 | | 0.25217 | -0.07309 | | | | | |
| 0.825 | 0.27217 | 0.10579 | | 0.27217 | -0.09301 | | | | | |
| 0.850 | 0.29217 | 0.06992 | | 0.29217 | -0.11509 | | | | | |
| 0.875 | 0.31217 | 0.02948 | | 0.31217 | -0.13967 | | | | | |
| 0.900 | 0.33217 | -0.01577 | | 0.33217 | -0.16723 | | | | | |
| 0.910 | 0.34017 | -0.03524 | | 0.34017 | -0.17922 | | | | | |
| 0.920 | 0.34817 | -0.05548 | | 0.34817 | -0.19186 | | | | | |
| 0.930 | 0.35617 | -0.07649 | | 0.35617 | -0.20522 | | | | | |
| 0.940 | 0.36417 | -0.09826 | | 0.36417 | -0.21938 | | | | | |
| 0.950 | 0.37217 | -0.12078 | | 0.37217 | -0.23449 | | | | | |
| 0.960 | 0.38017 | -0.14401 | | 0.38017 | -0.25072 | | | | | |
| 0.970 | 0.38817 | -0.16793 | | 0.38817 | -0.26836 | -0.26029 | | | | |
| 0.980 | 0.39617 | -0.19252 | | 0.39617 | -0.28792 | -0.26225 | | | | |
| 0.990 | 0.40417 | -0.21775 | | 0.40417 | -0.31061 | -0.26001 | | | | |
| 1.000 | 0.41217 | -0.24357 | -0.24600 | 0.41217 | -0.34057 | -0.24600 | | | | |

NO. 1 CORE CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87... CYLINDRICAL
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51
SUBTITLE HOT RADIUS = 4.36125 COLD RADIUS = 4.34810 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.32860 | 0.06880 | 0.06310 | -0.32860 | 0.04879 | 0.06310 | | | | |
| 0.010 | -0.32256 | 0.07464 | | -0.32256 | 0.04934 | 0.05341 | | | | |
| 0.020 | -0.31653 | 0.08254 | | -0.31653 | 0.05190 | 0.05238 | | | | |
| 0.030 | -0.31050 | 0.09048 | | -0.31050 | 0.05448 | | | | | |
| 0.040 | -0.30446 | 0.09844 | | -0.30446 | 0.05705 | | | | | |
| 0.050 | -0.29843 | 0.10636 | | -0.29843 | 0.05959 | | | | | |
| 0.060 | -0.29240 | 0.11416 | | -0.29240 | 0.06210 | | | | | |
| 0.070 | -0.28637 | 0.12179 | | -0.28637 | 0.06453 | | L.E. CIRCLE (X-Y-R) | -0.31780 | 0.06310 | 0.01080 |
| 0.080 | -0.28033 | 0.12917 | | -0.28033 | 0.06687 | | T.E. CIRCLE (X-Y-R) | 0.26240 | -0.03335 | 0.01220 |
| 0.090 | -0.27430 | 0.13630 | | -0.27430 | 0.06911 | | | | | |
| 0.100 | -0.26827 | 0.14319 | | -0.26827 | 0.07125 | | L.E. TOP TANG. PT. (X-Y) | -0.32635 | 0.06970 | |
| 0.125 | -0.25318 | 0.15968 | | -0.25318 | 0.07625 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.31356 | 0.05317 | |
| 0.150 | -0.23810 | 0.17584 | | -0.23810 | 0.08076 | | T.E. TOP TANG. PT. (X-Y) | 0.27570 | -0.00051 | |
| 0.175 | -0.22302 | 0.19164 | | -0.22302 | 0.08474 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.25502 | -0.01519 | |
| 0.200 | -0.20794 | 0.20568 | | -0.20794 | 0.08816 | | | | | |
| 0.225 | -0.19286 | 0.21795 | | -0.19286 | 0.09101 | | NOSE POINT (X-Y) | -0.32634 | 0.05650 | |
| 0.250 | -0.17777 | 0.22901 | | -0.17777 | 0.09410 | | TAIL POINT (X-Y) | 0.27000 | -0.01502 | |
| 0.275 | -0.16269 | 0.23903 | | -0.16269 | 0.09683 | | | | | |
| 0.300 | -0.14761 | 0.24775 | | -0.14761 | 0.09913 | | | | | |
| 0.325 | -0.13253 | 0.25506 | | -0.13253 | 0.10090 | | | | | |
| 0.350 | -0.11744 | 0.26122 | | -0.11744 | 0.10221 | | | | | |
| 0.375 | -0.10236 | 0.26647 | | -0.10236 | 0.10308 | | | | | |
| 0.400 | -0.08728 | 0.27066 | | -0.08728 | 0.10350 | | | | | |
| 0.425 | -0.07220 | 0.27357 | | -0.07220 | 0.10348 | | | | | |
| 0.450 | -0.05712 | 0.27522 | | -0.05712 | 0.10300 | | | | | |
| 0.475 | -0.04203 | 0.27584 | | -0.04203 | 0.10208 | | | | | |
| 0.500 | -0.02695 | 0.27554 | | -0.02695 | 0.10070 | | | | | |
| 0.525 | -0.01187 | 0.27428 | | -0.01187 | 0.09887 | | | | | |
| 0.550 | 0.00321 | 0.27198 | | 0.00321 | 0.09656 | | | | | |
| 0.575 | 0.01830 | 0.26867 | | 0.01830 | 0.09378 | | | | | |
| 0.600 | 0.03338 | 0.26431 | | 0.03338 | 0.09053 | | | | | |
| 0.625 | 0.04846 | 0.25892 | | 0.04846 | 0.08681 | | | | | |
| 0.650 | 0.06354 | 0.25244 | | 0.06354 | 0.08259 | | | | | |
| 0.675 | 0.07862 | 0.24484 | | 0.07862 | 0.07784 | | | | | |
| 0.700 | 0.09371 | 0.23612 | | 0.09371 | 0.07260 | | | | | |
| 0.725 | 0.10879 | 0.22624 | | 0.10879 | 0.06684 | | | | | |
| 0.750 | 0.12387 | 0.21502 | | 0.12387 | 0.06050 | | | | | |
| 0.775 | 0.13895 | 0.20256 | | 0.13895 | 0.05352 | | | | | |
| 0.800 | 0.15404 | 0.18863 | | 0.15404 | 0.04614 | | | | | |
| 0.825 | 0.16912 | 0.17341 | | 0.16912 | 0.03855 | | | | | |
| 0.850 | 0.18420 | 0.15722 | | 0.18420 | 0.03263 | | | | | |
| 0.875 | 0.19928 | 0.13809 | | 0.19928 | 0.02222 | | | | | |
| 0.900 | 0.21436 | 0.11619 | | 0.21436 | 0.01310 | | | | | |
| 0.910 | 0.22040 | 0.10643 | | 0.22040 | 0.00923 | | | | | |
| 0.920 | 0.22643 | 0.09612 | | 0.22643 | 0.00524 | | | | | |
| 0.930 | 0.23246 | 0.08531 | | 0.23246 | 0.00112 | | | | | |
| 0.940 | 0.23850 | 0.07404 | | 0.23850 | -0.00310 | | | | | |
| 0.950 | 0.24453 | 0.06232 | | 0.24453 | -0.00743 | | | | | |
| 0.960 | 0.25056 | 0.05016 | | 0.25056 | -0.01187 | | | | | |
| 0.970 | 0.25659 | 0.03755 | | 0.25659 | -0.01637 | -0.01620 | | | | |
| 0.980 | 0.26263 | 0.02452 | | 0.26263 | -0.02091 | -0.01765 | | | | |
| 0.990 | 0.26866 | 0.01106 | | 0.26866 | -0.02545 | -0.01594 | | | | |
| 1.000 | 0.27469 | -0.00293 | -0.00525 | 0.27469 | -0.02999 | -0.00525 | | | | |

EXTERNAL CONTOUR TITLE - GSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 4.60250 COLD RADIUS = 4.58617 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.31784 | 0.11288 | 0.10481 | -0.31784 | 0.08421 | 0.10481 | | | | |
| 0.010 | -0.31084 | 0.13084 | | -0.31084 | 0.07414 | 0.09077 | | | | |
| 0.020 | -0.30284 | 0.14588 | | -0.30284 | 0.06714 | 0.07228 | | | | |
| 0.030 | -0.29684 | 0.15800 | | -0.29684 | 0.06323 | 0.06868 | | | | |
| 0.040 | -0.28984 | 0.16925 | | -0.28984 | 0.06100 | 0.06328 | | | | |
| 0.050 | -0.28284 | 0.18019 | | -0.28284 | 0.05992 | 0.06110 | | | | |
| 0.060 | -0.27584 | 0.19055 | | -0.27584 | 0.05970 | 0.06010 | | | | |
| 0.070 | -0.26884 | 0.20045 | | -0.26884 | 0.06019 | 0.06021 | L.E. CIRCLE (X-Y-R) | -0.27304 | 0.10481 | 0.04480 |
| 0.080 | -0.26184 | 0.20992 | | -0.26184 | 0.06127 | | T.E. CIRCLE (X-Y-R) | 0.36716 | -0.22327 | 0.01500 |
| 0.090 | -0.25484 | 0.21897 | | -0.25484 | 0.06287 | | | | | |
| 0.100 | -0.24784 | 0.22763 | | -0.24784 | 0.06494 | | L.E. TOP TANG. PT. (X-Y) | -0.31483 | 0.12095 | |
| 0.125 | -0.23034 | 0.24762 | | -0.23034 | 0.07197 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.26701 | 0.06042 | |
| 0.150 | -0.21284 | 0.26544 | | -0.21284 | 0.08020 | | T.E. TOP TANG. PT. (X-Y) | 0.36150 | -0.21568 | |
| 0.175 | -0.19534 | 0.28125 | | -0.19534 | 0.08767 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.35358 | -0.22964 | |
| 0.200 | -0.17784 | 0.29518 | | -0.17784 | 0.09401 | | | | | |
| 0.225 | -0.16034 | 0.30734 | | -0.16034 | 0.09936 | | NOSE POINT (X-Y) | -0.30819 | 0.07704 | |
| 0.250 | -0.14284 | 0.31786 | | -0.14284 | 0.10374 | | TAIL POINT (X-Y) | 0.37255 | -0.23127 | |
| 0.275 | -0.12534 | 0.32699 | | -0.12534 | 0.10716 | | | | | |
| 0.300 | -0.10784 | 0.33400 | | -0.10784 | 0.10963 | | NET CROSS-SECT. AREA (EXCL. COATING) | 0.06846 | | |
| 0.325 | -0.09034 | 0.33979 | | -0.09034 | 0.11116 | | | | | |
| 0.350 | -0.07284 | 0.34410 | | -0.07284 | 0.11175 | | GAGING (X-Y-LAMBDA) | 0.19172 | 0.21966 | 0.26646 |
| 0.375 | -0.05534 | 0.34694 | | -0.05534 | 0.11141 | | GAGING ANGLE (DEG.) | 20.914 | | |
| 0.400 | -0.03784 | 0.34834 | | -0.03784 | 0.11014 | | | | | |
| 0.425 | -0.02034 | 0.34830 | | -0.02034 | 0.10793 | | CTR. OF GRAV. (INCL. COATING) (X-Y) | 0.05426 | 0.11040 | |
| 0.450 | -0.00284 | 0.34680 | | -0.00284 | 0.10478 | | RAD. REF. PT. (X-Y) | 0.0 | 0.0 | |
| 0.475 | 0.01466 | 0.34385 | | 0.01466 | 0.10066 | | INLET ANGLE (DEG.) | 51.694 | | |
| 0.500 | 0.03216 | 0.33940 | | 0.03216 | 0.09558 | | INLET WEDGE ANGLE (DEG.) | 61.158 | | |
| 0.525 | 0.04966 | 0.33344 | | 0.04966 | 0.08951 | | EXIT ANGLE (DEG.) | 21.063 | | |
| 0.550 | 0.06716 | 0.32592 | | 0.06716 | 0.08245 | | EXIT WEDGE ANGLE (DEG.) | 8.069 | | |
| 0.575 | 0.08466 | 0.31679 | | 0.08466 | 0.07432 | | UNCOVERED TURNING ANGLE (DEG.) | 20.619 | | |
| 0.600 | 0.10216 | 0.30596 | | 0.10216 | 0.06514 | | AXIAL CHORD | 0.70000 | | |
| 0.625 | 0.11966 | 0.29337 | | 0.11966 | 0.05485 | | ACTUAL CHORD | 0.77917 | | |
| 0.650 | 0.13716 | 0.27888 | | 0.13716 | 0.04343 | | PITCH | 0.57827 | | |
| 0.675 | 0.15466 | 0.26239 | | 0.15466 | 0.03080 | | NO. OF FOILS | 50 | | |
| 0.700 | 0.17216 | 0.24370 | | 0.17216 | 0.01692 | | | | | |
| 0.725 | 0.18966 | 0.22261 | | 0.18966 | 0.00172 | | | | | |
| 0.750 | 0.20716 | 0.19884 | | 0.20716 | -0.01489 | | | | | |
| 0.775 | 0.22466 | 0.17210 | | 0.22466 | -0.03300 | | | | | |
| 0.800 | 0.24216 | 0.14210 | | 0.24216 | -0.05274 | | | | | |
| 0.825 | 0.25966 | 0.10863 | | 0.25966 | -0.07424 | | | | | |
| 0.850 | 0.27716 | 0.07157 | | 0.27716 | -0.09767 | | | | | |
| 0.875 | 0.29466 | 0.03088 | | 0.29466 | -0.12326 | | | | | |
| 0.900 | 0.31216 | -0.01334 | | 0.31216 | -0.15129 | | | | | |
| 0.910 | 0.31916 | -0.03198 | | 0.31916 | -0.16325 | | | | | |
| 0.920 | 0.32616 | -0.05114 | | 0.32616 | -0.17569 | | | | | |
| 0.930 | 0.33316 | -0.07081 | | 0.33316 | -0.18864 | | | | | |
| 0.940 | 0.34016 | -0.09096 | | 0.34016 | -0.20212 | | | | | |
| 0.950 | 0.34716 | -0.11159 | | 0.34716 | -0.21619 | | | | | |
| 0.960 | 0.35416 | -0.13266 | | 0.35416 | -0.23088 | -0.22075 | | | | |
| 0.970 | 0.36116 | -0.15416 | | 0.36116 | -0.24626 | -0.23702 | | | | |
| 0.980 | 0.36816 | -0.17606 | | 0.36816 | -0.26239 | -0.23824 | | | | |
| 0.990 | 0.37516 | -0.19836 | | 0.37516 | -0.27934 | -0.23596 | | | | |
| 1.000 | 0.38216 | -0.22102 | -0.22327 | 0.38216 | -0.29721 | -0.22327 | | | | |

NO. 1 CORE CONTOUR TITLE - GSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 4.60250 COLD RADIUS = 4.58617 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.27574 | 0.11475 | 0.11163 | -0.27574 | 0.09625 | 0.11163 | | | | |
| 0.010 | -0.26848 | 0.12248 | | -0.26848 | 0.09855 | 0.10280 | | | | |
| 0.020 | -0.26322 | 0.13023 | | -0.26322 | 0.10086 | 0.10160 | | | | |
| 0.030 | -0.25796 | 0.13801 | | -0.25796 | 0.10318 | | | | | |
| 0.040 | -0.25270 | 0.14578 | | -0.25270 | 0.10550 | | | | | |
| 0.050 | -0.24744 | 0.15347 | | -0.24744 | 0.10780 | | | | | |
| 0.060 | -0.24219 | 0.16102 | | -0.24219 | 0.11006 | | | | | |
| 0.070 | -0.23693 | 0.16836 | | -0.23693 | 0.11228 | | L.E. CIRCLE (X-Y-R) | -0.26364 | 0.11163 | 0.01005 |
| 0.080 | -0.23167 | 0.17545 | | -0.23167 | 0.11442 | | T.E. CIRCLE (X-Y-R) | 0.25963 | 0.02612 | 0.01255 |
| 0.090 | -0.22641 | 0.18228 | | -0.22641 | 0.11649 | | | | | |
| 0.100 | -0.22115 | 0.18887 | | -0.22115 | 0.11849 | | L.E. TOP TANG. PT. (X-Y) | -0.27199 | 0.11731 | |
| 0.125 | -0.20800 | 0.20465 | | -0.20800 | 0.12318 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.25963 | 0.10244 | |
| 0.150 | -0.19486 | 0.22040 | | -0.19486 | 0.12738 | | T.E. TOP TANG. PT. (X-Y) | 0.23158 | 0.03575 | |
| 0.175 | -0.18171 | 0.23592 | | -0.18171 | 0.13101 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.23122 | 0.01683 | |
| 0.200 | -0.16856 | 0.24961 | | -0.16856 | 0.13404 | | | | | |
| 0.225 | -0.15541 | 0.26140 | | -0.15541 | 0.13669 | | NOSE POINT (X-Y) | -0.27142 | 0.10521 | |
| 0.250 | -0.14227 | 0.27178 | | -0.14227 | 0.13924 | | TAIL POINT (X-Y) | 0.24877 | 0.01582 | |
| 0.275 | -0.12912 | 0.28155 | | -0.12912 | 0.14166 | | | | | |
| 0.300 | -0.11597 | 0.28978 | | -0.11597 | 0.14363 | | | | | |
| 0.325 | -0.10282 | 0.29653 | | -0.10282 | 0.14503 | | | | | |
| 0.350 | -0.08968 | 0.30210 | | -0.08968 | 0.14592 | | | | | |
| 0.375 | -0.07653 | 0.30679 | | -0.07653 | 0.14641 | | | | | |
| 0.400 | -0.06338 | 0.31043 | | -0.06338 | 0.14639 | | | | | |
| 0.425 | -0.05023 | 0.31273 | | -0.05023 | 0.14590 | | | | | |
| 0.450 | -0.03709 | 0.31372 | | -0.03709 | 0.14492 | | | | | |
| 0.475 | -0.02394 | 0.31369 | | -0.02394 | 0.14348 | | | | | |
| 0.500 | -0.01079 | 0.31277 | | -0.01079 | 0.14155 | | | | | |
| 0.525 | 0.00236 | 0.31091 | | 0.00236 | 0.13914 | | | | | |
| 0.550 | 0.01550 | 0.30802 | | 0.01550 | 0.13623 | | | | | |
| 0.575 | 0.02865 | 0.30413 | | 0.02865 | 0.13282 | | | | | |
| 0.600 | 0.04180 | 0.29922 | | 0.04180 | 0.12892 | | | | | |
| 0.625 | 0.05495 | 0.29329 | | 0.05495 | 0.12452 | | | | | |
| 0.650 | 0.06809 | 0.28627 | | 0.06809 | 0.11960 | | | | | |
| 0.675 | 0.08124 | 0.27819 | | 0.08124 | 0.11414 | | | | | |
| 0.700 | 0.09439 | 0.26898 | | 0.09439 | 0.10816 | | | | | |
| 0.725 | 0.10754 | 0.25863 | | 0.10754 | 0.10165 | | | | | |
| 0.750 | 0.12068 | 0.24702 | | 0.12068 | 0.09459 | | | | | |
| 0.775 | 0.13383 | 0.23402 | | 0.13383 | 0.08677 | | | | | |
| 0.800 | 0.14698 | 0.21963 | | 0.14698 | 0.07863 | | | | | |
| 0.825 | 0.16013 | 0.20400 | | 0.16013 | 0.07037 | | | | | |
| 0.850 | 0.17327 | 0.18742 | | 0.17327 | 0.06197 | | | | | |
| 0.875 | 0.18642 | 0.16813 | | 0.18642 | 0.05298 | | | | | |
| 0.900 | 0.19957 | 0.14589 | | 0.19957 | 0.04324 | | | | | |
| 0.910 | 0.20483 | 0.13597 | | 0.20483 | 0.03916 | | | | | |
| 0.920 | 0.21009 | 0.12552 | | 0.21009 | 0.03476 | | | | | |
| 0.930 | 0.21535 | 0.11462 | | 0.21535 | 0.03064 | | | | | |
| 0.940 | 0.22061 | 0.10333 | | 0.22061 | 0.02620 | | | | | |
| 0.950 | 0.22586 | 0.09166 | | 0.22586 | 0.02163 | | | | | |
| 0.960 | 0.23112 | 0.07965 | | 0.23112 | 0.01692 | | | | | |
| 0.970 | 0.23638 | 0.06731 | | 0.23638 | 0.01212 | 0.01402 | | | | |
| 0.980 | 0.24164 | 0.05467 | | 0.24164 | 0.00729 | 0.01275 | | | | |
| 0.990 | 0.24690 | 0.04173 | | 0.24690 | 0.00245 | 0.01592 | | | | |
| 1.000 | 0.25216 | 0.02850 | 0.02612 | 0.25216 | -0.00240 | 0.02612 | | | | |

EXTERNAL CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 4.84375 COLD RADIUS = 4.82433 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.25038 | 0.14575 | 0.18811 | -0.25038 | 0.17161 | 0.16811 | | | | |
| 0.010 | -0.24438 | 0.21058 | | -0.24438 | 0.16262 | 0.16681 | | | | |
| 0.020 | -0.23838 | 0.22295 | | -0.23838 | 0.15619 | 0.15921 | | | | |
| 0.030 | -0.23238 | 0.23284 | | -0.23238 | 0.15233 | 0.15427 | | | | |
| 0.040 | -0.22638 | 0.24189 | | -0.22638 | 0.14987 | 0.15092 | | | | |
| 0.050 | -0.22038 | 0.25035 | | -0.22038 | 0.14834 | 0.14876 | | | | |
| 0.060 | -0.21438 | 0.25831 | | -0.21438 | 0.14752 | 0.14758 | | | | |
| 0.070 | -0.20838 | 0.26584 | | -0.20838 | 0.14728 | | L.E. CIRCLE (X-Y-R) | -0.20956 | 0.18811 | 0.04082 |
| 0.080 | -0.20238 | 0.27301 | | -0.20236 | 0.14750 | | T.E. CIRCLE (X-Y-R) | 0.23588 | -0.19651 | 0.01375 |
| 0.090 | -0.19638 | 0.27983 | | -0.19638 | 0.14814 | | | | | |
| 0.100 | -0.19038 | 0.28633 | | -0.19038 | 0.14915 | | L.E. TOP TANG. PT. (X-Y) | -0.24739 | 0.20344 | |
| 0.125 | -0.17538 | 0.30121 | | -0.17538 | 0.15315 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.21094 | 0.14722 | |
| 0.150 | -0.16038 | 0.31429 | | -0.16038 | 0.15646 | | T.E. TOP TANG. PT. (X-Y) | 0.24902 | -0.19248 | |
| 0.175 | -0.14538 | 0.32572 | | -0.14538 | 0.16308 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.32343 | -0.20235 | |
| 0.200 | -0.13038 | 0.33560 | | -0.13038 | 0.16670 | | | | | |
| 0.225 | -0.11538 | 0.34402 | | -0.11538 | 0.16834 | | NOSE POINT (X-Y) | -0.24379 | 0.16588 | |
| 0.250 | -0.10038 | 0.35105 | | -0.10038 | 0.17102 | | TAIL POINT (X-Y) | 0.24082 | -0.20933 | |
| 0.275 | -0.08538 | 0.35675 | | -0.08538 | 0.17174 | | | | | |
| 0.300 | -0.07038 | 0.36115 | | -0.07038 | 0.17151 | | NET CROSS-SECT. AREA (EXCL. COATING) | 0.05499 | | |
| 0.325 | -0.05538 | 0.36429 | | -0.05538 | 0.17033 | | | | | |
| 0.350 | -0.04038 | 0.36619 | | -0.04038 | 0.16821 | | GAGING (X-Y-LAMBDA) | 0.15465 | 0.26778 | 0.21799 |
| 0.375 | -0.02538 | 0.36685 | | -0.02538 | 0.16516 | | GAGING ANGLE (DEG.) | 20.985 | | |
| 0.400 | -0.01038 | 0.36628 | | -0.01038 | 0.16115 | | | | | |
| 0.425 | 0.00462 | 0.36448 | | 0.00462 | 0.15622 | | CTR. OF GRAV. (INCL. COATING) (X-Y) | 0.07903 | 0.13740 | |
| 0.450 | 0.01962 | 0.36142 | | 0.01962 | 0.15033 | | RAD. REF. PT. (X-Y) | 0.0 | 0.0 | |
| 0.475 | 0.03462 | 0.35709 | | 0.03462 | 0.14350 | | INLET ANGLE (DEG.) | 56.998 | | |
| 0.500 | 0.04962 | 0.35143 | | 0.04962 | 0.13571 | | INLET WEDGE ANGLE (DEG.) | 69.874 | | |
| 0.525 | 0.06462 | 0.34441 | | 0.06462 | 0.12696 | | EXIT ANGLE (DEG.) | 21.085 | | |
| 0.550 | 0.07962 | 0.33596 | | 0.07962 | 0.11724 | | EXIT WEDGE ANGLE (DEG.) | 8.056 | | |
| 0.575 | 0.09462 | 0.32596 | | 0.09462 | 0.10653 | | UNCOVERED TURNING ANGLE (DEG.) | 21.497 | | |
| 0.600 | 0.10962 | 0.31432 | | 0.10962 | 0.09482 | | AXIAL CHORD | 0.60000 | | |
| 0.625 | 0.12462 | 0.30088 | | 0.12462 | 0.08209 | | ACTUAL CHORD | 0.72197 | | |
| 0.650 | 0.13962 | 0.28544 | | 0.13962 | 0.06833 | | PITCH | 0.06868 | | |
| 0.675 | 0.15462 | 0.26779 | | 0.15462 | 0.05349 | | NO. OF FOILS | 50 | | |
| 0.700 | 0.16962 | 0.24771 | | 0.16962 | 0.03757 | | | | | |
| 0.725 | 0.18462 | 0.22504 | | 0.18462 | 0.02051 | | | | | |
| 0.750 | 0.19962 | 0.19964 | | 0.19962 | 0.00224 | | | | | |
| 0.775 | 0.21462 | 0.17142 | | 0.21462 | -0.01715 | | | | | |
| 0.800 | 0.22962 | 0.14035 | | 0.22962 | -0.03788 | | | | | |
| 0.825 | 0.24462 | 0.10649 | | 0.24462 | -0.05996 | | | | | |
| 0.850 | 0.25962 | 0.06942 | | 0.25962 | -0.08346 | | | | | |
| 0.875 | 0.27462 | 0.03087 | | 0.27462 | -0.10852 | | | | | |
| 0.900 | 0.28962 | -0.01051 | | 0.28962 | -0.13523 | | | | | |
| 0.910 | 0.29562 | -0.02766 | | 0.29562 | -0.14642 | | | | | |
| 0.920 | 0.30162 | -0.04512 | | 0.30162 | -0.15790 | | | | | |
| 0.930 | 0.30762 | -0.06289 | | 0.30762 | -0.16970 | | | | | |
| 0.940 | 0.31362 | -0.08094 | | 0.31362 | -0.18182 | | | | | |
| 0.950 | 0.31962 | -0.09926 | | 0.31962 | -0.19427 | | | | | |
| 0.960 | 0.32562 | -0.11784 | | 0.32562 | -0.20705 | -0.20566 | | | | |
| 0.970 | 0.33162 | -0.13667 | | 0.33162 | -0.22018 | -0.20958 | | | | |
| 0.980 | 0.33762 | -0.15571 | | 0.33762 | -0.23358 | -0.21014 | | | | |
| 0.990 | 0.34362 | -0.17498 | | 0.34362 | -0.24712 | -0.20787 | | | | |
| 1.000 | 0.34962 | -0.19445 | -0.19651 | 0.34962 | -0.25966 | -0.19651 | | | | |

NO. 1 CORE CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 4.84375 COLD RADIUS = 4.82433 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.21259 | 0.19605 | 0.19267 | -0.21259 | 0.17874 | 0.19267 | | | | |
| 0.010 | -0.20920 | 0.20225 | | -0.20920 | 0.17996 | 0.18409 | | | | |
| 0.020 | -0.20482 | 0.20841 | | -0.20482 | 0.18117 | 0.18224 | | | | |
| 0.030 | -0.20043 | 0.21452 | | -0.20043 | 0.18239 | 0.18239 | | | | |
| 0.040 | -0.19605 | 0.22056 | | -0.19605 | 0.18361 | | | | | |
| 0.050 | -0.19166 | 0.22648 | | -0.19166 | 0.18484 | | | | | |
| 0.060 | -0.18728 | 0.23222 | | -0.18728 | 0.18610 | | | | | |
| 0.070 | -0.18289 | 0.23776 | | -0.18289 | 0.18738 | | L.E. CIRCLE (X-Y-R) | -0.20299 | 0.19267 | 0.01059 |
| 0.080 | -0.17851 | 0.24307 | | -0.17851 | 0.18867 | | T.E. CIRCLE (X-Y-R) | 0.21208 | 0.06296 | 0.01285 |
| 0.090 | -0.17412 | 0.24815 | | -0.17412 | 0.18996 | | | | | |
| 0.100 | -0.16973 | 0.25303 | | -0.16973 | 0.19125 | | L.E. TOP TANG. PT. (X-Y) | -0.21163 | 0.19880 | |
| 0.125 | -0.15877 | 0.26457 | | -0.15877 | 0.19434 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.20016 | 0.18246 | |
| 0.150 | -0.14781 | 0.27584 | | -0.14781 | 0.19704 | | T.E. TOP TANG. PT. (X-Y) | 0.22405 | 0.06561 | |
| 0.175 | -0.13685 | 0.28675 | | -0.13685 | 0.19919 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.20261 | 0.05527 | |
| 0.200 | -0.12588 | 0.29629 | | -0.12588 | 0.20082 | | | | | |
| 0.225 | -0.11492 | 0.30443 | | -0.11492 | 0.20208 | | NOSE POINT (X-Y) | -0.21166 | 0.18659 | |
| 0.250 | -0.10396 | 0.31164 | | -0.10396 | 0.20313 | | TAIL POINT (X-Y) | 0.21887 | 0.05305 | |
| 0.275 | -0.09300 | 0.31801 | | -0.09300 | 0.20397 | | | | | |
| 0.300 | -0.08203 | 0.32336 | | -0.08203 | 0.20436 | | | | | |
| 0.325 | -0.07107 | 0.32760 | | -0.07107 | 0.20426 | | | | | |
| 0.350 | -0.06011 | 0.33071 | | -0.06011 | 0.20372 | | | | | |
| 0.375 | -0.04914 | 0.33350 | | -0.04914 | 0.20275 | | | | | |
| 0.400 | -0.03818 | 0.33526 | | -0.03818 | 0.20133 | | | | | |
| 0.425 | -0.02722 | 0.33599 | | -0.02722 | 0.19947 | | | | | |
| 0.450 | -0.01626 | 0.33573 | | -0.01626 | 0.19719 | | | | | |
| 0.475 | -0.00529 | 0.33465 | | -0.00529 | 0.19440 | | | | | |
| 0.500 | 0.00567 | 0.33282 | | 0.00567 | 0.19120 | | | | | |
| 0.525 | 0.01663 | 0.33021 | | 0.01663 | 0.18755 | | | | | |
| 0.550 | 0.02759 | 0.32676 | | 0.02759 | 0.18345 | | | | | |
| 0.575 | 0.03856 | 0.32247 | | 0.03856 | 0.17885 | | | | | |
| 0.600 | 0.04952 | 0.31732 | | 0.04952 | 0.17381 | | | | | |
| 0.625 | 0.06048 | 0.31129 | | 0.06048 | 0.16831 | | | | | |
| 0.650 | 0.07144 | 0.30435 | | 0.07144 | 0.16234 | | | | | |
| 0.675 | 0.08241 | 0.29644 | | 0.08241 | 0.15588 | | | | | |
| 0.700 | 0.09337 | 0.28754 | | 0.09337 | 0.14894 | | | | | |
| 0.725 | 0.10433 | 0.27757 | | 0.10433 | 0.14153 | | | | | |
| 0.750 | 0.11530 | 0.26642 | | 0.11530 | 0.13359 | | | | | |
| 0.775 | 0.12626 | 0.25398 | | 0.12626 | 0.12509 | | | | | |
| 0.800 | 0.13722 | 0.24018 | | 0.13722 | 0.11621 | | | | | |
| 0.825 | 0.14818 | 0.22508 | | 0.14818 | 0.10710 | | | | | |
| 0.850 | 0.15915 | 0.20870 | | 0.15915 | 0.09771 | | | | | |
| 0.875 | 0.17011 | 0.19041 | | 0.17011 | 0.08789 | | | | | |
| 0.900 | 0.18107 | 0.16971 | | 0.18107 | 0.07751 | | | | | |
| 0.910 | 0.18546 | 0.16067 | | 0.18546 | 0.07318 | | | | | |
| 0.920 | 0.18984 | 0.15124 | | 0.18984 | 0.06875 | | | | | |
| 0.930 | 0.19423 | 0.14146 | | 0.19423 | 0.06422 | | | | | |
| 0.940 | 0.19861 | 0.13137 | | 0.19861 | 0.05959 | | | | | |
| 0.950 | 0.20300 | 0.12101 | | 0.20300 | 0.05485 | 0.05487 | | | | |
| 0.960 | 0.20738 | 0.11042 | | 0.20738 | 0.05000 | 0.05200 | | | | |
| 0.970 | 0.21177 | 0.09963 | | 0.21177 | 0.04513 | 0.05112 | | | | |
| 0.980 | 0.21615 | 0.08868 | | 0.21615 | 0.04021 | 0.05178 | | | | |
| 0.990 | 0.22054 | 0.07759 | | 0.22054 | 0.03529 | 0.05429 | | | | |
| 1.000 | 0.22492 | 0.06637 | 0.06639 | 0.22492 | 0.03037 | 0.06296 | | | | |

EXTERNAL CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 5.08500 COLD RADIUS = 5.06333 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.18395 | 0.28893 | 0.28166 | -0.18395 | 0.27031 | 0.25166 | | | | |
| 0.010 | -0.17895 | 0.29994 | | -0.17895 | 0.26261 | 0.26275 | | | | |
| 0.020 | -0.17395 | 0.30902 | | -0.17395 | 0.25686 | 0.25733 | | | | |
| 0.030 | -0.16895 | 0.31614 | | -0.16895 | 0.25305 | 0.25515 | | | | |
| 0.040 | -0.16395 | 0.32122 | | -0.16395 | 0.25029 | | | | | |
| 0.050 | -0.15895 | 0.32760 | | -0.15895 | 0.24822 | | | | | |
| 0.060 | -0.15395 | 0.33247 | | -0.15395 | 0.24667 | | | | | |
| 0.070 | -0.14895 | 0.33696 | | -0.14895 | 0.24553 | | L.E. CIRCLE (X-Y-R) | -0.14935 | 0.28166 | 0.07460 |
| 0.080 | -0.14395 | 0.34119 | | -0.14395 | 0.24472 | | T.E. CIRCLE (X-Y-R) | 0.20355 | -0.16809 | 0.01250 |
| 0.090 | -0.13895 | 0.34517 | | -0.13895 | 0.24419 | | | | | |
| 0.100 | -0.13395 | 0.34891 | | -0.13395 | 0.24392 | | L.E. TOP TANG. PT. (X-Y) | -0.18070 | 0.29631 | |
| 0.125 | -0.12145 | 0.35729 | | -0.12145 | 0.24416 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.16492 | 0.25076 | |
| 0.150 | -0.10895 | 0.36458 | | -0.10895 | 0.24548 | | T.E. TOP TANG. PT. (X-Y) | 0.31550 | -0.16444 | |
| 0.175 | -0.09645 | 0.37030 | | -0.09645 | 0.24645 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.29223 | -0.17339 | |
| 0.200 | -0.08395 | 0.37512 | | -0.08395 | 0.24648 | | | | | |
| 0.225 | -0.07145 | 0.37890 | | -0.07145 | 0.24559 | | NOSE POINT (X-Y) | -0.18204 | 0.27034 | |
| 0.250 | -0.05895 | 0.38169 | | -0.05895 | 0.24377 | | TAIL POINT (X-Y) | 0.20804 | -0.17976 | |
| 0.275 | -0.04645 | 0.38353 | | -0.04645 | 0.24103 | | | | | |
| 0.300 | -0.03395 | 0.38443 | | -0.03395 | 0.23737 | | NET CROSS-SECT. AREA (EXCL. COATING) | 0.04361 | | |
| 0.325 | -0.02145 | 0.38441 | | -0.02145 | 0.23278 | | | | | |
| 0.350 | -0.00895 | 0.38348 | | -0.00895 | 0.22727 | | GAGING (X-Y-LAMBDA) | 0.12281 | 0.31047 | 0.22918 |
| 0.375 | 0.00355 | 0.38163 | | 0.00355 | 0.22085 | | GAGING ANGLE (DEG.) | 21.017 | | |
| 0.400 | 0.01605 | 0.37885 | | 0.01605 | 0.21350 | | | | | |
| 0.425 | 0.02855 | 0.37512 | | 0.02855 | 0.20525 | | CTR. OF GRAV. (INCL. COATING) (X-Y) | 0.10021 | 0.16403 | |
| 0.450 | 0.04105 | 0.37041 | | 0.04105 | 0.19608 | | RAD. REF. PT. (X-Y) | 0.0 | 0.0 | |
| 0.475 | 0.05355 | 0.36467 | | 0.05355 | 0.18601 | | INLET ANGLE (DEG.) | 70.889 | | |
| 0.500 | 0.06605 | 0.35784 | | 0.06605 | 0.17504 | | INLET WEDGE ANGLE (DEG.) | 91.696 | | |
| 0.525 | 0.07855 | 0.34986 | | 0.07855 | 0.16317 | | EXIT ANGLE (DEG.) | 21.048 | | |
| 0.550 | 0.09105 | 0.34062 | | 0.09105 | 0.15040 | | EXIT WEDGE ANGLE (DEG.) | 8.070 | | |
| 0.575 | 0.10355 | 0.32999 | | 0.10355 | 0.13674 | | UNCOVERED TURNING ANGLE (DEG.) | 24.590 | | |
| 0.600 | 0.11605 | 0.31780 | | 0.11605 | 0.12220 | | AXIAL CHORD | 0.50000 | | |
| 0.625 | 0.12855 | 0.30379 | | 0.12855 | 0.10678 | | ACTUAL CHORD | 0.68538 | | |
| 0.650 | 0.14105 | 0.28766 | | 0.14105 | 0.09049 | | PITCH | 0.63900 | | |
| 0.675 | 0.15355 | 0.26910 | | 0.15355 | 0.07332 | | NO. OF FOILS | 50 | | |
| 0.700 | 0.16605 | 0.24786 | | 0.16605 | 0.05530 | | | | | |
| 0.725 | 0.17855 | 0.22382 | | 0.17855 | 0.03642 | | | | | |
| 0.750 | 0.19105 | 0.19702 | | 0.19105 | 0.01669 | | | | | |
| 0.775 | 0.20355 | 0.16765 | | 0.20355 | -0.00388 | | | | | |
| 0.800 | 0.21605 | 0.13596 | | 0.21605 | -0.02529 | | | | | |
| 0.825 | 0.22855 | -0.10229 | | 0.22855 | -0.04753 | | | | | |
| 0.850 | 0.24105 | 0.06697 | | 0.24105 | -0.07058 | | | | | |
| 0.875 | 0.25355 | 0.03028 | | 0.25355 | -0.09446 | | | | | |
| 0.900 | 0.26605 | -0.00752 | | 0.26605 | -0.11913 | | | | | |
| 0.910 | 0.27105 | -0.02290 | | 0.27105 | -0.12923 | | | | | |
| 0.920 | 0.27605 | -0.03841 | | 0.27605 | -0.13964 | | | | | |
| 0.930 | 0.28105 | -0.05405 | | 0.28105 | -0.14979 | | | | | |
| 0.940 | 0.28605 | -0.06980 | | 0.28605 | -0.16027 | | | | | |
| 0.950 | 0.29105 | -0.08565 | | 0.29105 | -0.17087 | | | | | |
| 0.960 | 0.29605 | -0.10160 | | 0.29605 | -0.18159 | -0.17809 | | | | |
| 0.970 | 0.30105 | -0.11764 | | 0.30105 | -0.19245 | -0.18034 | | | | |
| 0.980 | 0.30605 | -0.13376 | | 0.30605 | -0.20342 | -0.18034 | | | | |
| 0.990 | 0.31105 | -0.14995 | | 0.31105 | -0.21451 | -0.17809 | | | | |
| 1.000 | 0.31605 | -0.16622 | -0.16809 | 0.31605 | -0.22574 | -0.16809 | | | | |

NO. 1 CORE CONTOUR TITLE - SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
TD 0 TD REV. 0 PART NO. EMD NO. DATE 06/22/89 TIME 15:27:51 CYLINDRICAL
SUBTITLE HOT RADIUS = 5.08500 COLD RADIUS = 5.06333 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

| PCT X | X TOP | Y TOP | (CIRCLE) | X BOT | Y BOT | (CIRCLE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | -0.15125 | 0.29107 | 0.28651 | -0.15125 | 0.27484 | 0.28651 | | | | |
| 0.010 | -0.14778 | 0.29517 | | -0.14778 | 0.27463 | 0.27788 | | | | |
| 0.020 | -0.14431 | 0.29914 | | -0.14431 | 0.27440 | 0.27534 | | | | |
| 0.030 | -0.14084 | 0.30296 | | -0.14084 | 0.27416 | 0.27422 | | | | |
| 0.040 | -0.13737 | 0.30664 | | -0.13737 | 0.27393 | | | | | |
| 0.050 | -0.13390 | 0.31014 | | -0.13390 | 0.27376 | | | | | |
| 0.060 | -0.13043 | 0.31344 | | -0.13043 | 0.27369 | | | | | |
| 0.070 | -0.12696 | 0.31655 | | -0.12696 | 0.27373 | | L.E. CIRCLE (X-Y-R) | -0.13878 | 0.28651 | 0.01247 |
| 0.080 | -0.12349 | 0.31947 | | -0.12349 | 0.27390 | | T.E. CIRCLE (X-Y-R) | 0.18324 | 0.10452 | 0.01251 |
| 0.090 | -0.12002 | 0.32221 | | -0.12002 | 0.27416 | | | | | |
| 0.100 | -0.11655 | 0.32479 | | -0.11655 | 0.27451 | | L.E. TOP TANG. PT. (X-Y) | -0.14825 | 0.29462 | |
| 0.125 | -0.10787 | 0.33064 | | -0.10787 | 0.27549 | | L.E. BOTTOM TANG. PT. (X-Y) | -0.13983 | 0.27407 | |
| 0.150 | -0.09920 | 0.33578 | | -0.09920 | 0.27619 | | T.E. TOP TANG. PT. (X-Y) | 0.19486 | 0.10915 | |
| 0.175 | -0.09053 | 0.34027 | | -0.09053 | 0.27640 | | T.E. BOTTOM TANG. PT. (X-Y) | 0.17310 | 0.09720 | |
| 0.200 | -0.08185 | 0.34410 | | -0.08185 | 0.27622 | | | | | |
| 0.225 | -0.07318 | 0.34730 | | -0.07318 | 0.27568 | | NOSE POINT (X-Y) | -0.15028 | 0.28169 | |
| 0.250 | -0.06450 | 0.34982 | | -0.06450 | 0.27478 | | TAIL POINT (X-Y) | 0.18927 | 0.09556 | |
| 0.275 | -0.05583 | 0.35197 | | -0.05583 | 0.27347 | | | | | |
| 0.300 | -0.04715 | 0.35346 | | -0.04715 | 0.27178 | | | | | |
| 0.325 | -0.03848 | 0.35438 | | -0.03848 | 0.26970 | | | | | |
| 0.350 | -0.02980 | 0.35476 | | -0.02980 | 0.26726 | | | | | |
| 0.375 | -0.02113 | 0.35461 | | -0.02113 | 0.26444 | | | | | |
| 0.400 | -0.01245 | 0.35393 | | -0.01245 | 0.26123 | | | | | |
| 0.425 | -0.00378 | 0.35271 | | -0.00378 | 0.25763 | | | | | |
| 0.450 | 0.00490 | 0.35095 | | 0.00490 | 0.25363 | | | | | |
| 0.475 | 0.01357 | 0.34865 | | 0.01357 | 0.24925 | | | | | |
| 0.500 | 0.02225 | 0.34580 | | 0.02225 | 0.24447 | | | | | |
| 0.525 | 0.03092 | 0.34238 | | 0.03092 | 0.23930 | | | | | |
| 0.550 | 0.03960 | 0.33837 | | 0.03960 | 0.23373 | | | | | |
| 0.575 | 0.04827 | 0.33375 | | 0.04827 | 0.22776 | | | | | |
| 0.600 | 0.05695 | 0.32849 | | 0.05695 | 0.22138 | | | | | |
| 0.625 | 0.06562 | 0.32256 | | 0.06562 | 0.21461 | | | | | |
| 0.650 | 0.07430 | 0.31591 | | 0.07430 | 0.20744 | | | | | |
| 0.675 | 0.08297 | 0.30848 | | 0.08297 | 0.19986 | | | | | |
| 0.700 | 0.09165 | 0.30020 | | 0.09165 | 0.19188 | | | | | |
| 0.725 | 0.10032 | 0.29097 | | 0.10032 | 0.18349 | | | | | |
| 0.750 | 0.10900 | 0.28067 | | 0.10900 | 0.17470 | | | | | |
| 0.775 | 0.11767 | 0.26920 | | 0.11767 | 0.16549 | | | | | |
| 0.800 | 0.12635 | 0.25642 | | 0.12635 | 0.15588 | | | | | |
| 0.825 | 0.13502 | 0.24224 | | 0.13502 | 0.14586 | | | | | |
| 0.850 | 0.14370 | 0.22658 | | 0.14370 | 0.13546 | | | | | |
| 0.875 | 0.15237 | 0.20951 | | 0.15237 | 0.12467 | | | | | |
| 0.900 | 0.16105 | 0.19111 | | 0.16105 | 0.11347 | | | | | |
| 0.910 | 0.16452 | 0.18339 | | 0.16452 | 0.10888 | | | | | |
| 0.920 | 0.16799 | 0.17545 | | 0.16799 | 0.10421 | | | | | |
| 0.930 | 0.17146 | 0.16728 | | 0.17146 | 0.09947 | | | | | |
| 0.940 | 0.17493 | 0.15891 | | 0.17493 | 0.09466 | 0.09518 | | | | |
| 0.950 | 0.17840 | 0.15037 | | 0.17840 | 0.08980 | 0.09299 | | | | |
| 0.960 | 0.18187 | 0.14172 | | 0.18187 | 0.08490 | 0.09200 | | | | |
| 0.970 | 0.18534 | 0.13301 | | 0.18534 | 0.07999 | 0.09219 | | | | |
| 0.980 | 0.18881 | 0.12429 | | 0.18881 | 0.07507 | 0.09322 | | | | |
| 0.990 | 0.19228 | 0.11560 | | 0.19228 | 0.07016 | 0.09587 | | | | |
| 1.000 | 0.19575 | 0.10693 | 0.10452 | 0.19575 | 0.06526 | 0.10452 | | | | |

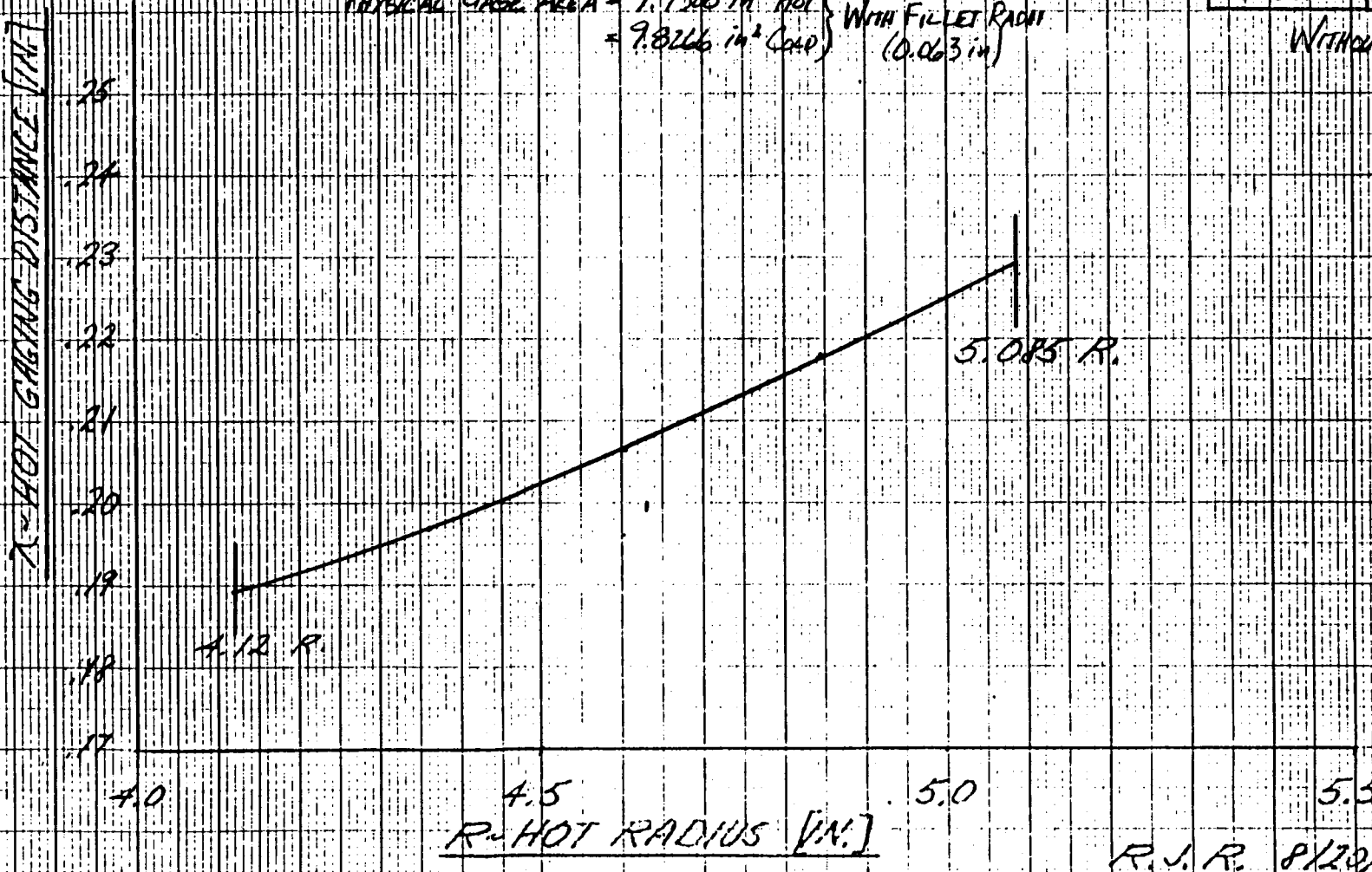
# SSME HPFTP FIRST STAGE BLADE
## HOT GAGING VS. RADIUS

| $A_\lambda$ | GAGE FLOW AREA, IN.² | |
|---|---|---|
| | HOT | COLD |
| REQUIRED | 10.0152 | 9.9148 |
| ACTUAL | 10.0152 | 9.9148 |

WITHOUT FILLET RADII

MEANLINE DESIGN EFFECTIVE GAGE AREA = 9.8136 in²

PHYSICAL GAGE AREA = 9.9300 in² HOT } WITH FILLET RADII (0.063 in)
= 9.8246 in² COLD }




R.J.R. 8/20/87

PR24 UTILITY PROGRAM - FLOW AREA CALCULATION

SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
HOT TO COLD CONVERSION RADII

| HOT | COLD |
|---|---|
| 4.12000 | 4.10981 |
| 4.21650 | 4.20520 |
| 4.31300 | 4.30046 |
| 4.40950 | 4.39574 |
| 4.50600 | 4.49094 |
| 4.60250 | 4.58617 |
| 4.69900 | 4.68142 |
| 4.79550 | 4.77670 |
| 4.89200 | 4.87201 |
| 4.98850 | 4.96765 |
| 5.08500 | 5.06332 |

RESTAGGER ANGLE DEGREES = 0.0 RADIANS = 0.0
PLATFORM RADII LE ID = 4.12000 LE OD = 5.10000
TE ID = 4.12000 TE OD = 5.10000
GAGING RADII INNER = 4.12000 OUTER = 5.08500
NUMBER OF BLADES FOR GAGING = 50
STAGGER IN DEGREES IS -3.00 TO 3.00 IN INCREMENTS OF 0.50
IN CLASS IS - 6 TO 6
TOLER = 0.0

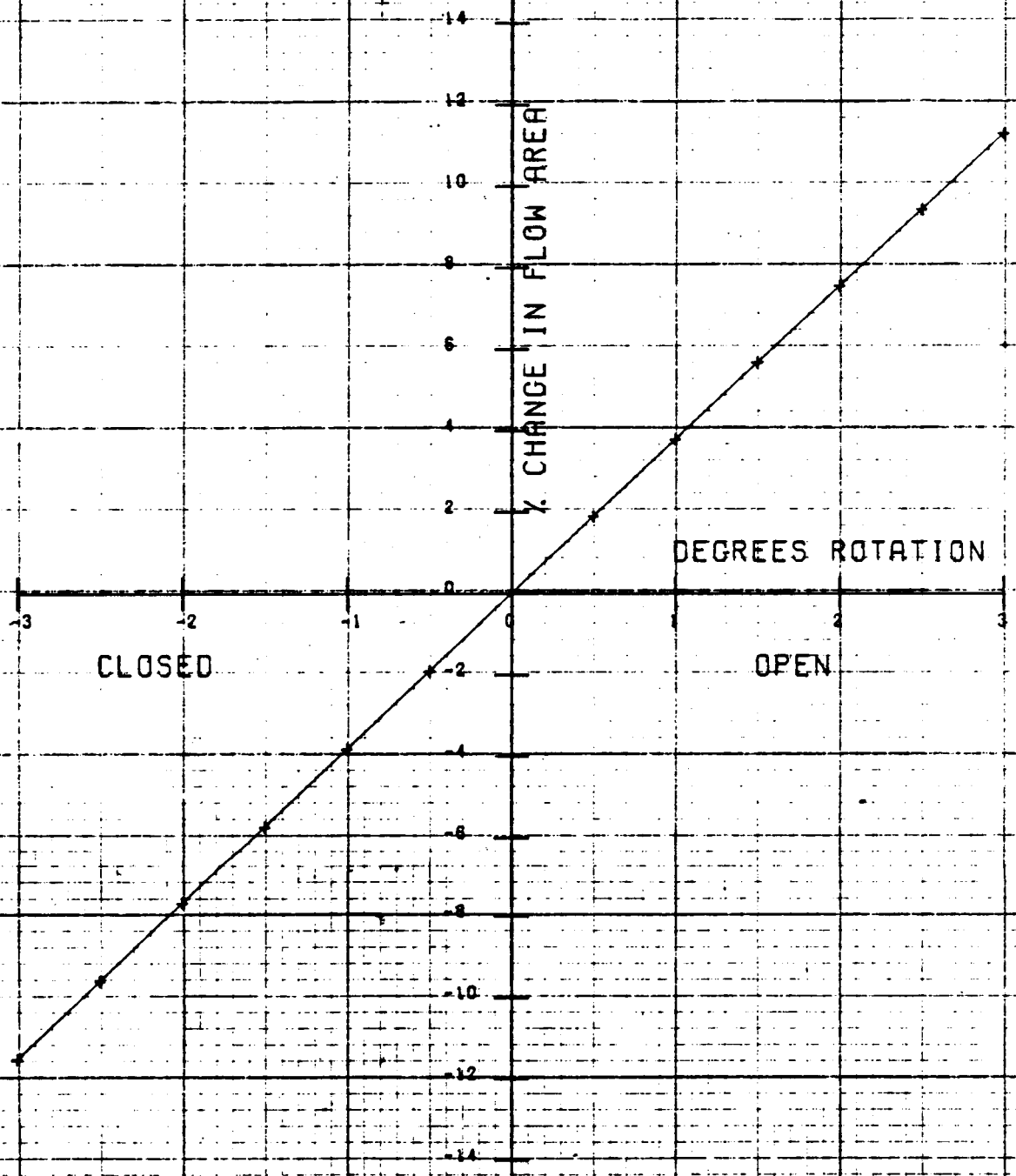
| STAGGER (DEGREES) | HOT FLOW (SQ IN) | ( CHANGE FLOW AREA | COLD FLOW (SQ IN) |
|---|---|---|---|
| -3.00000 | 8.86176 | -11.51731 | |
| -2.50000 | 9.05540 | -9.58358 | |
| -2.00000 | 9.24852 | -7.65567 | |
| -1.50000 | 9.44107 | -5.73306 | |
| -1.00000 | 9.63305 | -3.81615 | |
| -0.50000 | 9.82445 | -1.90507 | |
| 0.0 | 10.01525 | 0.0 | 9.91182 |
| 0.50000 | 10.20547 | 1.89922 | |
| 1.00000 | 10.39508 | 3.79252 | |
| 1.50000 | 10.58406 | 5.67941 | |
| 2.00000 | 10.77240 | 7.55993 | |
| 2.50000 | 10.96008 | 9.43396 | |
| 3.00000 | 11.14713 | 11.30156 | |

SSME FT FINAL 1B - R.J.ROWEY - 10-06-87

NOMINAL FLOW AREA - SQ. IN.

HOT - 10.015

COLD - 9.912



SSME FT FI... 1B...R.J.ROWEY..10-06-87...
OPERATING CONDITION 1 109 PCT...ADP...R.J.ROWEY...5-15-87...
WAE = 157.9 MXR = 153.2 MXM = 38.3 MXT = 0.0
RPM =36421. MYR = 147.2 MYM = 36.8 MYT = 0.0

NET BENDING

| %S | RADIUS | SIG P/A | SHRD P/A | LE | TE | CONV |
|---|---|---|---|---|---|---|
| 0 | 4.1200 | 32523. | 0. | -13. | -26. | 19. |
| 10 | 4.2165 | 31155. | 0. | 51. | 564. | -263. |
| 20 | 4.3130 | 29502. | 0. | 190. | 796. | -432. |
| 30 | 4.4095 | 27490. | 0. | 405. | 801. | -564. |
| 40 | 4.5060 | 25047. | 0. | 676. | 705. | -712. |
| 50 | 4.6025 | 22115. | 0. | 944. | 606. | -868. |
| 60 | 4.6990 | 18669. | 0. | 1120. | 549. | -978. |
| 70 | 4.7955 | 14732. | 0. | 1094. | 495. | -936. |
| 80 | 4.8920 | 10328. | 0. | 803. | 370. | -671. |
| 90 | 4.9885 | 5442. | 0. | 326. | 158. | -268. |
| 100 | 5.0850 | 0. | 0. | 0. | 0. | -0. |

GAS BENDING

| %S | RADIUS | XOFF | YOFF | LE | TE | CONV |
|---|---|---|---|---|---|---|
| 0 | 4.1200 | 0.0 | 0.0 | 32656. | 25680. | -29838. |
| 10 | 4.2165 | 0.0071 | 0.0112 | 29142. | 21526. | -26771. |
| 20 | 4.3130 | 0.0156 | 0.0220 | 25803. | 18127. | -23765. |
| 30 | 4.4095 | 0.0252 | 0.0326 | 22532. | 15235. | -20858. |
| 40 | 4.5060 | 0.0355 | 0.0431 | 19223. | 12653. | -17852. |
| 50 | 4.6025 | 0.0460 | 0.0537 | 15784. | 10225. | -14546. |
| 60 | 4.6990 | 0.0563 | 0.0645 | 12170. | 7830. | -11141. |
| 70 | 4.7955 | 0.0661 | 0.0753 | 8396. | 5393. | -7569. |
| 80 | 4.8920 | 0.0753 | 0.0862 | 4658. | 2989. | -4097. |
| 90 | 4.9885 | 0.0839 | 0.0969 | 1480. | 945. | -1265. |
| 100 | 5.0850 | 0.0920 | 0.1074 | 0. | 0. | -0. |

SHROUD MISALIGNMENT

| %S | RADIUS | AREA | PULL | LE | TE | CONV |
|---|---|---|---|---|---|---|
| 0 | 4.1200 | 0.1137 | 510.2 | 0. | 0. | 0. |
| 10 | 4.2165 | 0.1023 | 469.9 | 0. | 0. | 0. |
| 20 | 4.3130 | 0.0921 | 433.0 | 0. | 0. | 0. |
| 30 | 4.4095 | 0.0831 | 400.0 | 0. | 0. | 0. |
| 40 | 4.5060 | 0.0753 | 370.9 | 0. | 0. | 0. |
| 50 | 4.6025 | 0.0685 | 345.4 | 0. | 0. | 0. |
| 60 | 4.6990 | 0.0626 | 322.8 | 0. | 0. | 0. |
| 70 | 4.7955 | 0.0574 | 302.1 | 0. | 0. | 0. |
| 80 | 4.8920 | 0.0526 | 282.0 | 0. | 0. | 0. |
| 90 | 4.9885 | 0.0481 | 261.7 | 0. | 0. | 0. |
| 100 | 5.0850 | 0.0436 | 0.0 | 0. | 0. | 0. |

| %S | RADIUS | MXT | MYT | MXG | MYG | THETA N |
|---|---|---|---|---|---|---|
| 0 | 4.1200 | -153.3 | -147.1 | 153.2 | 147.2 | -66.03 |
| 10 | 4.2165 | -121.4 | -122.6 | 124.1 | 119.2 | -38.39 |
| 20 | 4.3130 | -94.3 | -97.6 | 98.0 | 94.2 | -47.53 |
| 30 | 4.4095 | -71.4 | -73.7 | 75.1 | 72.1 | -66.29 |
| 40 | 4.5060 | -52.1 | -52.4 | 55.1 | 53.0 | 78.35 |
| 50 | 4.6025 | -36.0 | -34.6 | 38.3 | 36.8 | 45.55 |
| 60 | 4.6990 | -22.9 | -20.8 | 24.5 | 23.5 | 30.52 |
| 70 | 4.7955 | -12.7 | -10.9 | 13.8 | 13.2 | 25.02 |
| 80 | 4.8920 | -5.5 | -4.5 | 6.1 | 5.9 | 23.69 |
| 90 | 4.9885 | -1.3 | -1.0 | 1.5 | 1.5 | 24.32 |
| 100 | 5.0850 | 0.0 | 0.0 | -0.0 | 0.0 | -8.13 |

SSME FT FINAL 1B...R.J.ROMEY..10-06-87...
DENSITY = 0.31200 WEIGHTING RADII INNER = 4.1200 OUTER = 5.0850
SHROUD VOLUME = 0.0 SHROUD THICKNESS = 0.0
SHROUD MISALIGNMENT = 0.0 RADIUS OF SHROUD = 0.0
WEIGHT OF AIRFOIL = 0.02168 WEIGHT OF SHROUD = 0.0
TOTAL WEIGHT = 1.08415 NUMBER OF BLADES = 50

SUMMARY OF SECTION PROPERTIES

| %S | RADIUS | AREA | IMIN | IMAX | THETA | XBAR | YBAR |
|---|---|---|---|---|---|---|---|
| 0 | 4.1200 | 0.1137 | 0.1299E-02 | 0.8096E-02 | -14.71 | 0.0083 | 0.0567 |
| 10 | 4.2165 | 0.1023 | 0.1233E-02 | 0.6963E-02 | -16.38 | 0.0154 | 0.0679 |
| 20 | 4.3130 | 0.0921 | 0.1130E-02 | 0.5948E-02 | -18.52 | 0.0239 | 0.0787 |
| 30 | 4.4095 | 0.0831 | 0.1000E-02 | 0.5057E-02 | -21.13 | 0.0335 | 0.0893 |
| 40 | 4.5060 | 0.0753 | 0.8548E-03 | 0.4289E-02 | -24.19 | 0.0438 | 0.0999 |
| 50 | 4.6025 | 0.0685 | 0.7038E-03 | 0.3637E-02 | -27.65 | 0.0543 | 0.1105 |
| 60 | 4.6990 | 0.0626 | 0.5573E-03 | 0.3090E-02 | -31.42 | 0.0645 | 0.1212 |
| 70 | 4.7955 | 0.0574 | 0.4251E-03 | 0.2633E-02 | -35.40 | 0.0743 | 0.1320 |
| 80 | 4.8920 | 0.0526 | 0.3128E-03 | 0.2247E-02 | -39.50 | 0.0835 | 0.1429 |
| 90 | 4.9885 | 0.0481 | 0.2227E-03 | 0.1920E-02 | -43.64 | 0.0921 | 0.1536 |
| 100 | 5.0850 | 0.0436 | 0.1535E-03 | 0.1640E-02 | -47.80 | 0.1002 | 0.1641 |

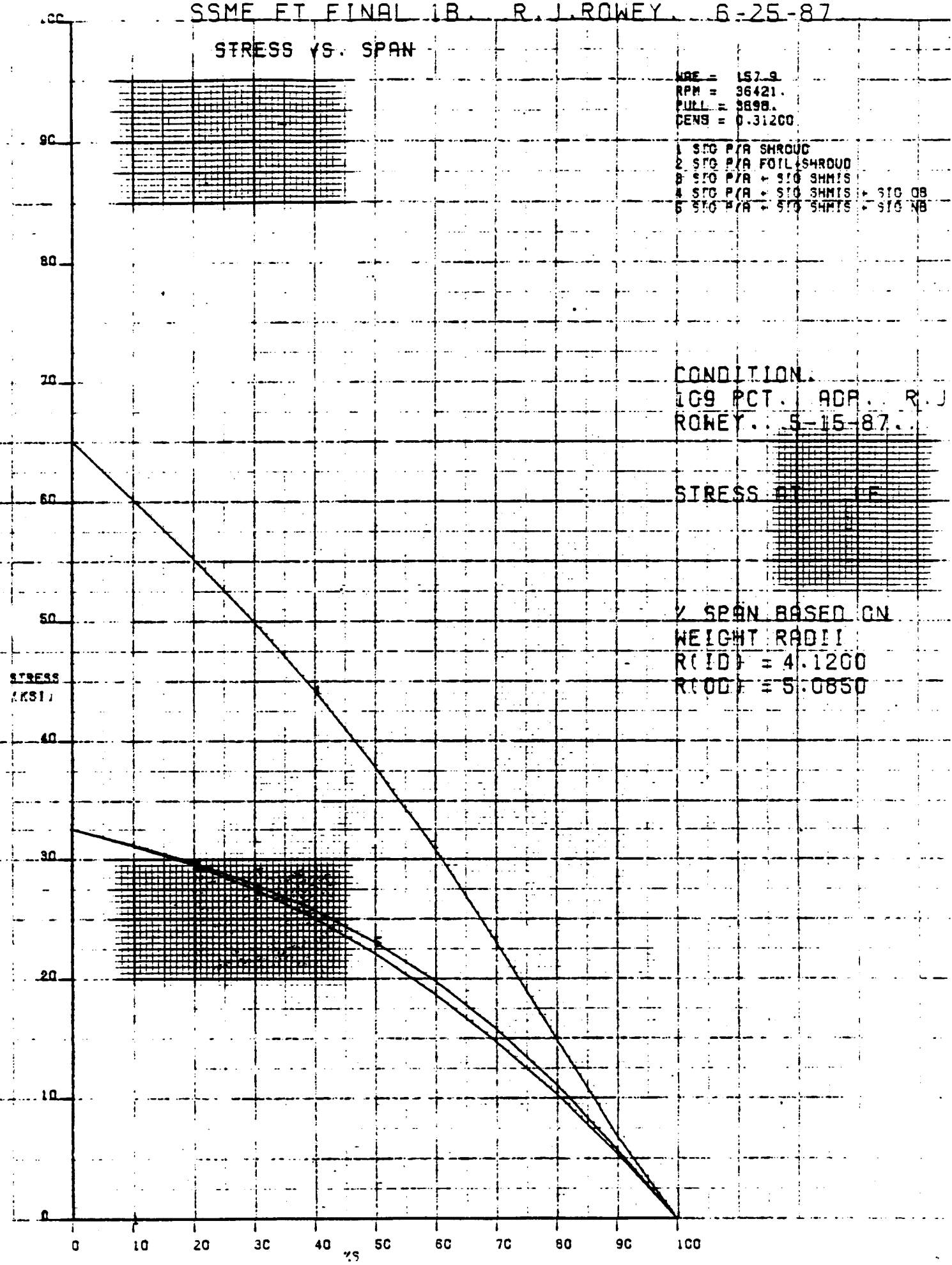
| %S | RADIUS | K | L | MAX T | AX.WIDTH | C1 | C2 |
|---|---|---|---|---|---|---|---|
| 0 | 4.1200 | 0.0 | 0.2783E-03 | 0.2746 | 0.9000 | 0.1930 | 0.2229 |
| 10 | 4.2165 | 0.0 | 0.2179E-03 | 0.2939 | 0.8600 | 0.2012 | 0.2173 |
| 20 | 4.3130 | 0.0 | 0.1725E-03 | 0.3109 | 0.8200 | 0.2061 | 0.2083 |
| 30 | 4.4095 | 0.0 | 0.1382E-03 | 0.3256 | 0.7800 | 0.2079 | 0.1962 |
| 40 | 4.5060 | 0.0 | 0.1125E-03 | 0.3379 | 0.7400 | 0.2065 | 0.1817 |
| 50 | 4.6025 | 0.0 | 0.9284E-04 | 0.3483 | 0.7000 | 0.2017 | 0.1654 |
| 60 | 4.6990 | 0.0 | 0.7738E-04 | 0.3563 | 0.6600 | 0.1935 | 0.1483 |
| 70 | 4.7955 | 0.0 | 0.6438E-04 | 0.3635 | 0.6200 | 0.1824 | 0.1311 |
| 80 | 4.8920 | 0.0 | 0.5318E-04 | 0.3698 | 0.5800 | 0.1693 | 0.1146 |
| 90 | 4.9885 | 0.0 | 0.4346E-04 | 0.3765 | 0.5400 | 0.1550 | 0.0992 |
| 100 | 5.0850 | 0.0 | 0.3506E-04 | 0.3844 | 0.5000 | 0.1405 | 0.0850 |

| %S | RADIUS | C3 | CLE | CTE | C4 | ALPHA B | B |
|---|---|---|---|---|---|---|---|
| 0 | 4.1200 | 0.2086 | 0.3991 | 0.4815 | 0.0045 | 72.79 | 0.9244 |
| 10 | 4.2165 | 0.2130 | 0.3715 | 0.4721 | 0.0351 | 72.07 | 0.8846 |
| 20 | 4.3130 | 0.2145 | 0.3466 | 0.4623 | 0.0456 | 70.99 | 0.8469 |
| 30 | 4.4095 | 0.2125 | 0.3242 | 0.4523 | 0.0586 | 69.51 | 0.8115 |
| 40 | 4.5060 | 0.2067 | 0.3043 | 0.4422 | 0.0734 | 67.59 | 0.7790 |
| 50 | 4.6025 | 0.1969 | 0.2873 | 0.4320 | 0.0688 | 65.22 | 0.7498 |
| 60 | 4.6990 | 0.1837 | 0.2736 | 0.4220 | 0.0837 | 62.37 | 0.7246 |
| 70 | 4.7955 | 0.1678 | 0.2636 | 0.4119 | 0.0967 | 59.09 | 0.7036 |
| 80 | 4.8920 | 0.1503 | 0.2572 | 0.4020 | 0.0884 | 55.45 | 0.6869 |
| 90 | 4.9885 | 0.1326 | 0.2544 | 0.3922 | 0.0969 | 51.53 | 0.6743 |
| 100 | 5.0850 | 0.1150 | 0.2547 | 0.3827 | 0.1032 | 47.44 | 0.6654 |

P824 UTILITY PROGRAM - STRESS CALCULATION

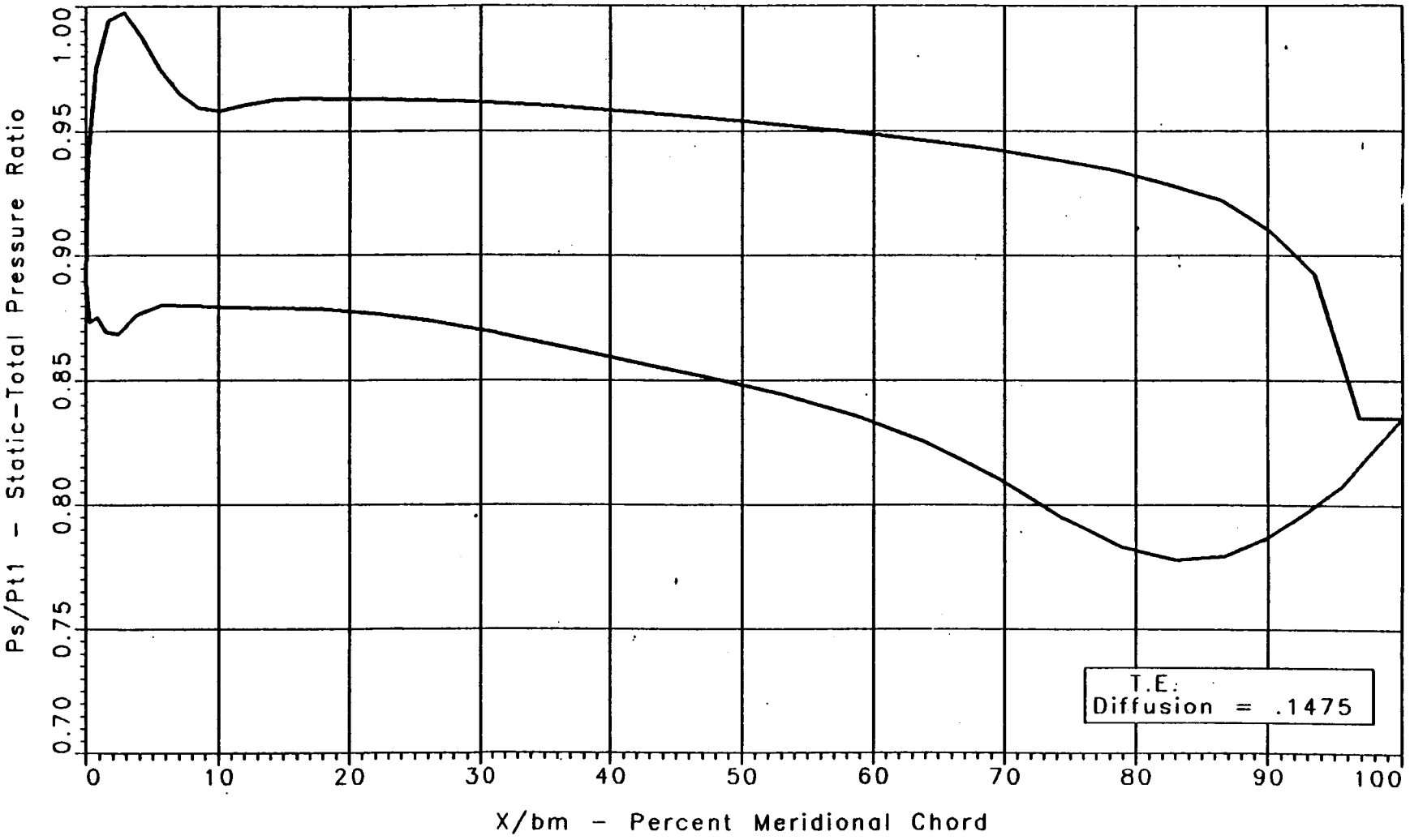
```
SSME FT FINAL 1B...R.J.ROWEY..10-06-87...
ENGINE OPERATING CONDITION
     MAE        RPM        TITLE
 1   157.9     36421.     109 PCT...ADP...R.J.ROWEY...5-15-87...
XGBR = 153.17601  XGBM =  38.29401  XGBT =   0.0
YGBR = 147.18486  YGBM =  36.79601  YGBT =   0.0
DENSITY =   0.31200 WEIGHTING RADII INNER =    4.1200 OUTER =    5.0850
SHROUD VOLUME        =   0.0      SHROUD THICKNESS =   0.0
SHROUD MISALIGNMENT =   0.0      RADIUS OF SHROUD =   0.0
```

SSME FT FINAL 1B. R.J.ROWEY. 6-25-87



PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution (V310)
Poisson Generated "C"-Mesh

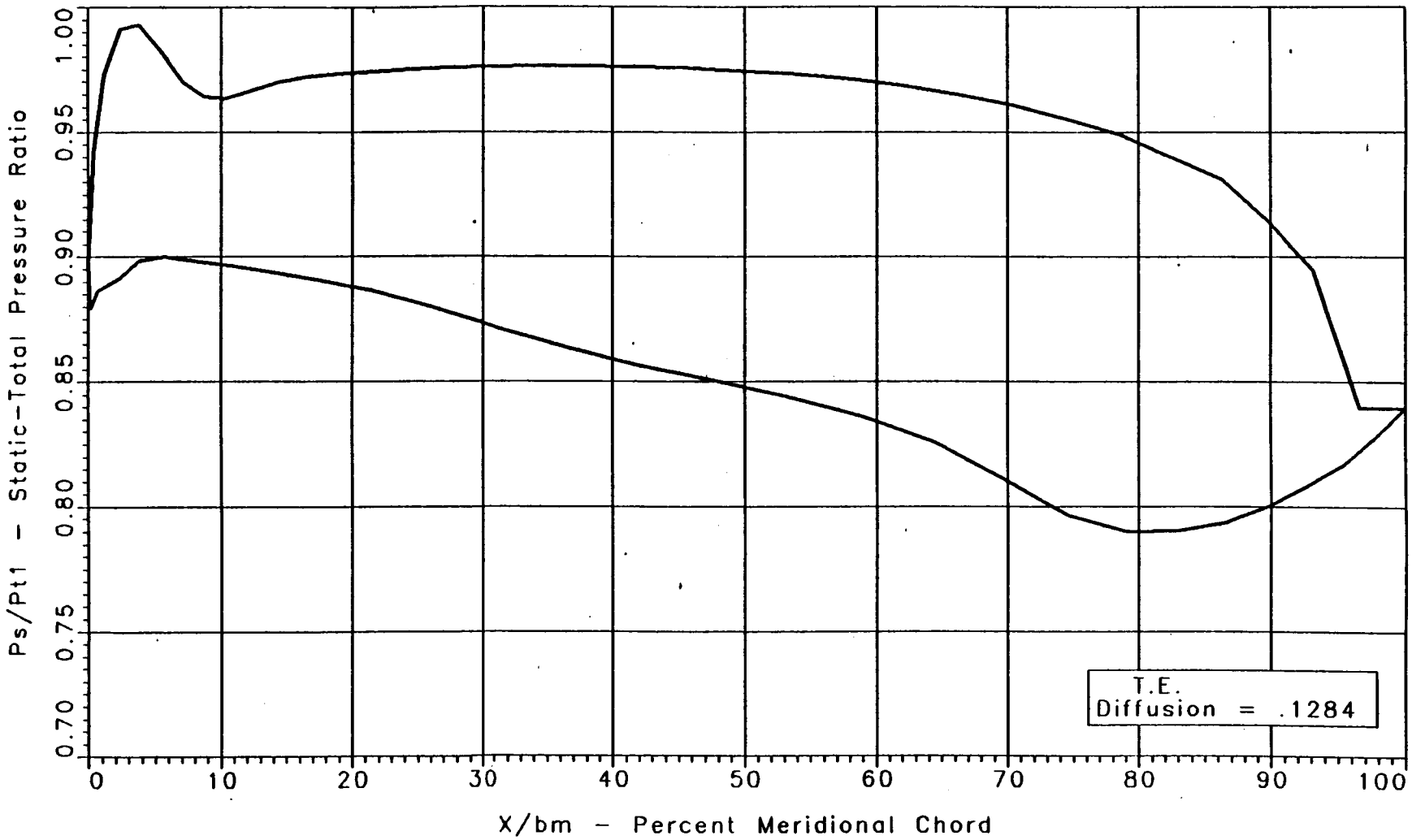
6 First Stage Blade: 0% Span




08/20/87
DLS

PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution (V310)
Poisson Generated "C"-Mesh

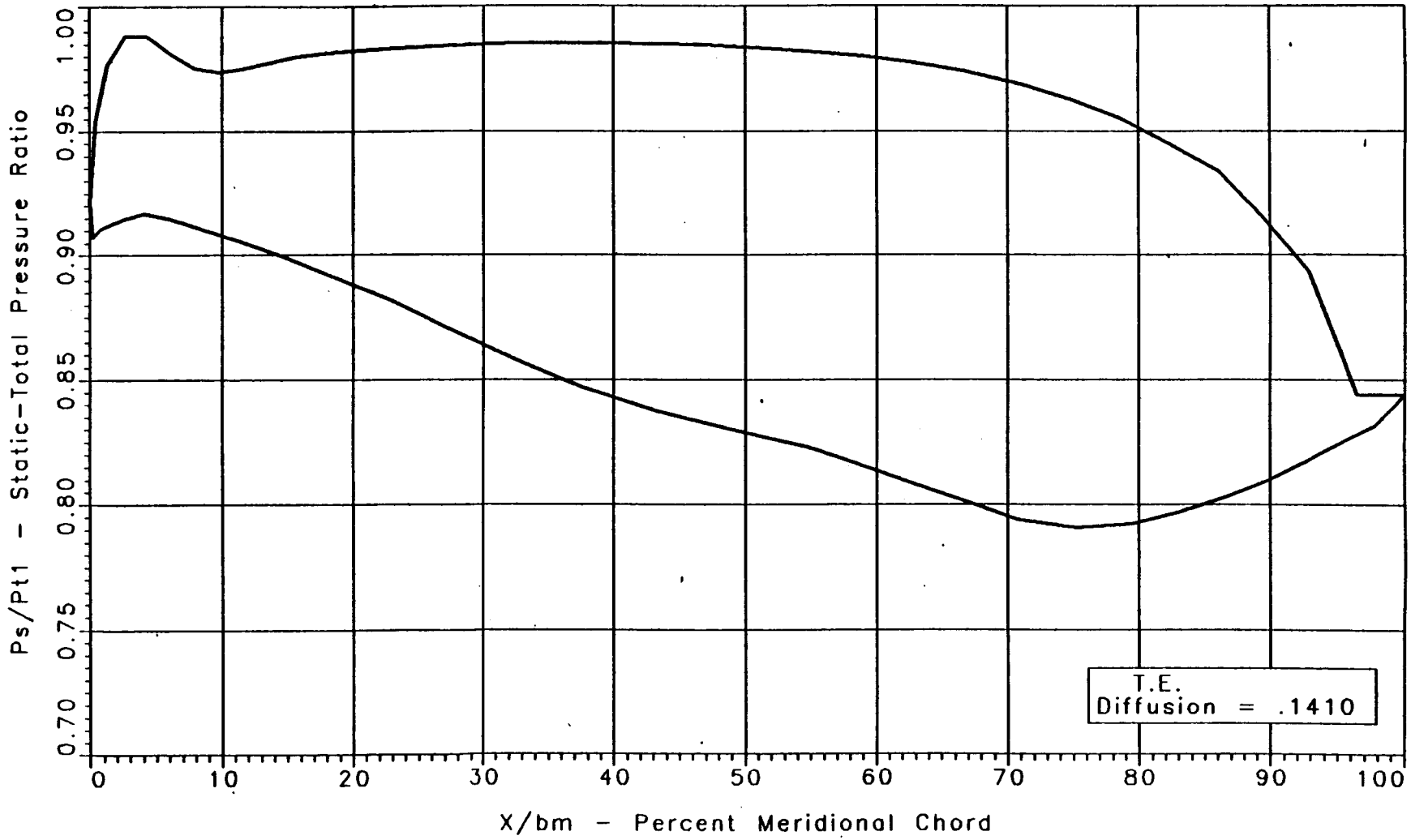
7 First Stage Blade: 25% Span




08/20/87
DLS

PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution (V310)
Poisson Generated "C"-Mesh

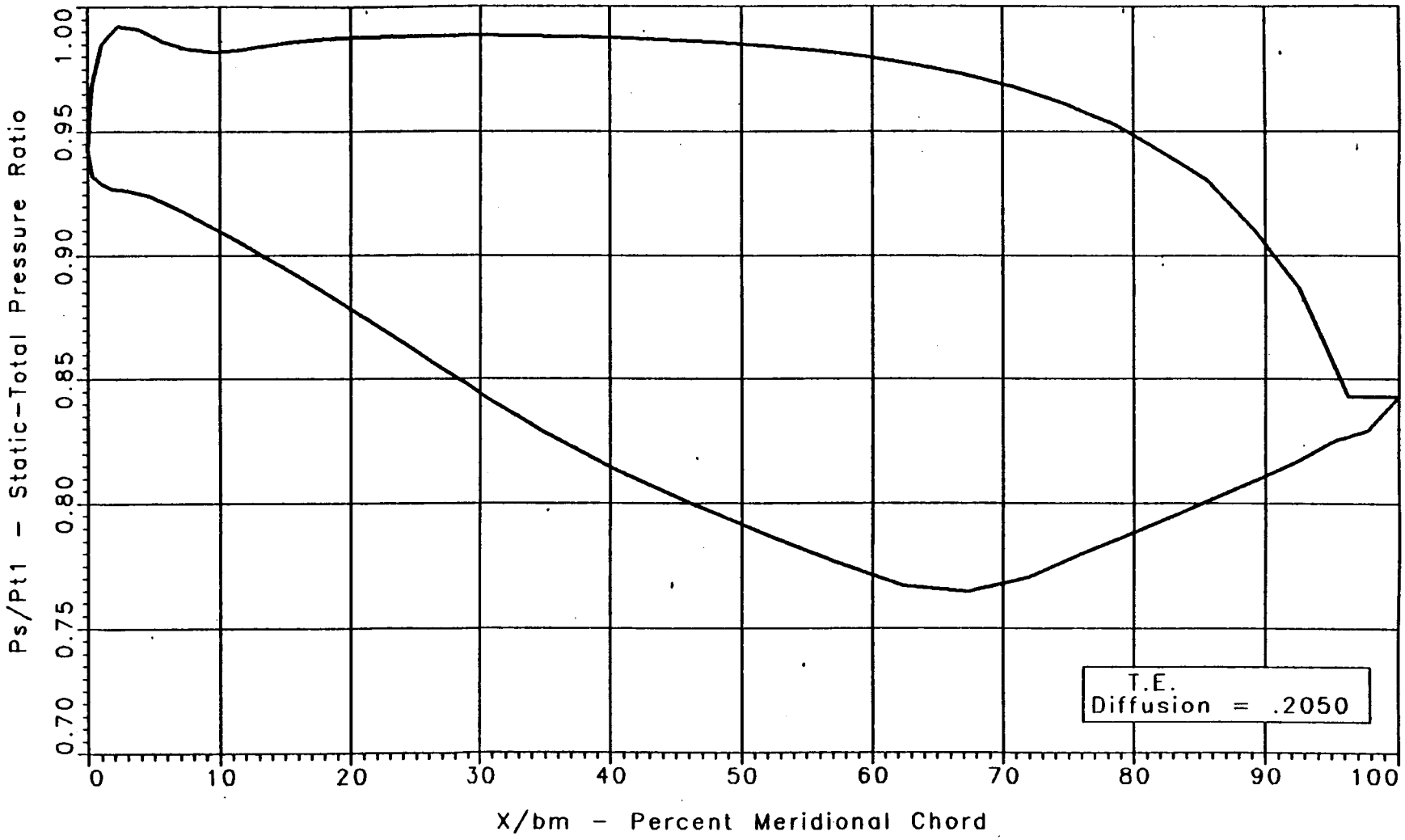
8 First Stage Blade: 50% Span




08/20/87
DLS

PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution (V310)
Poisson Generated "C"-Mesh

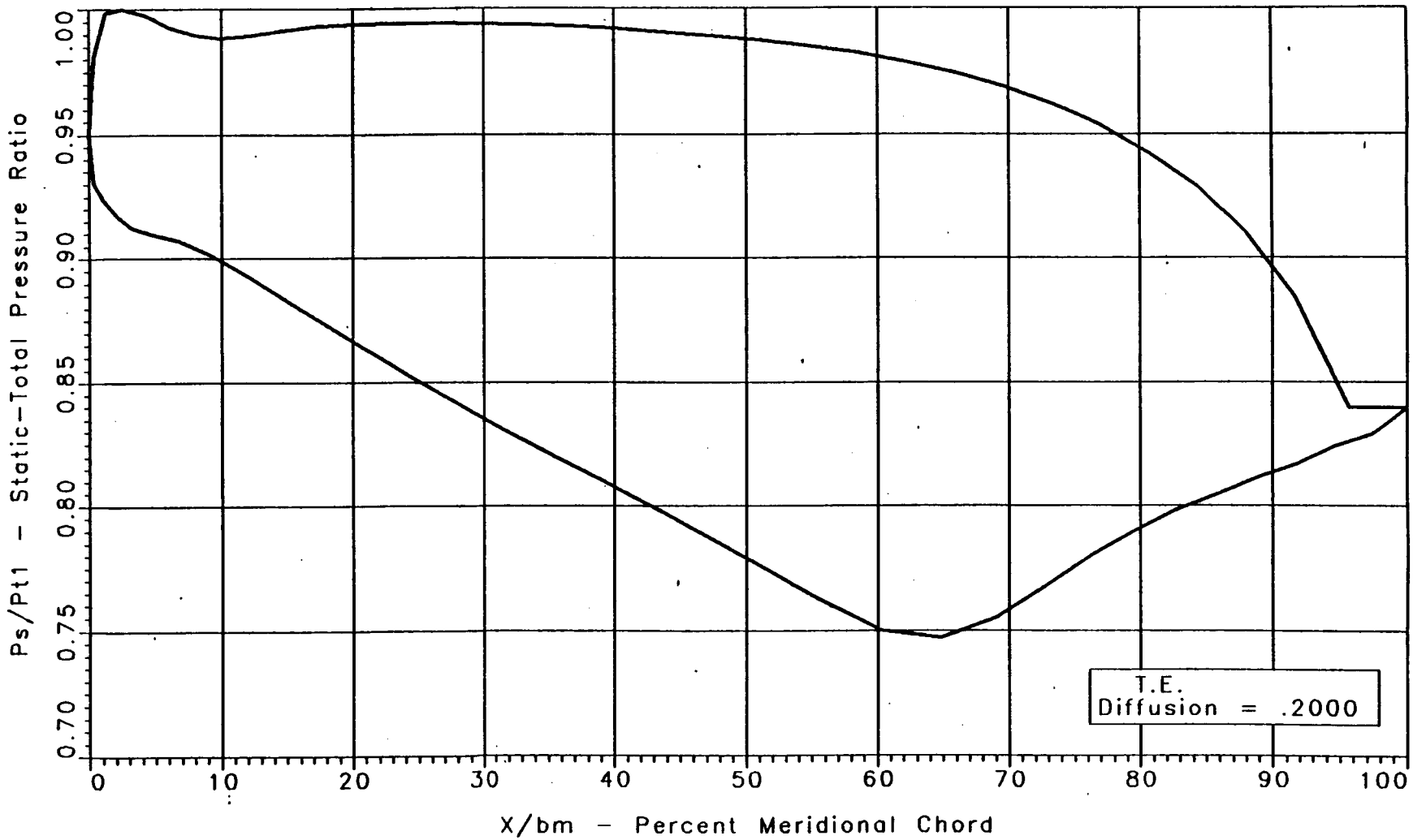
9 First Stage Blade: 75% Span




08/20/87
DLS

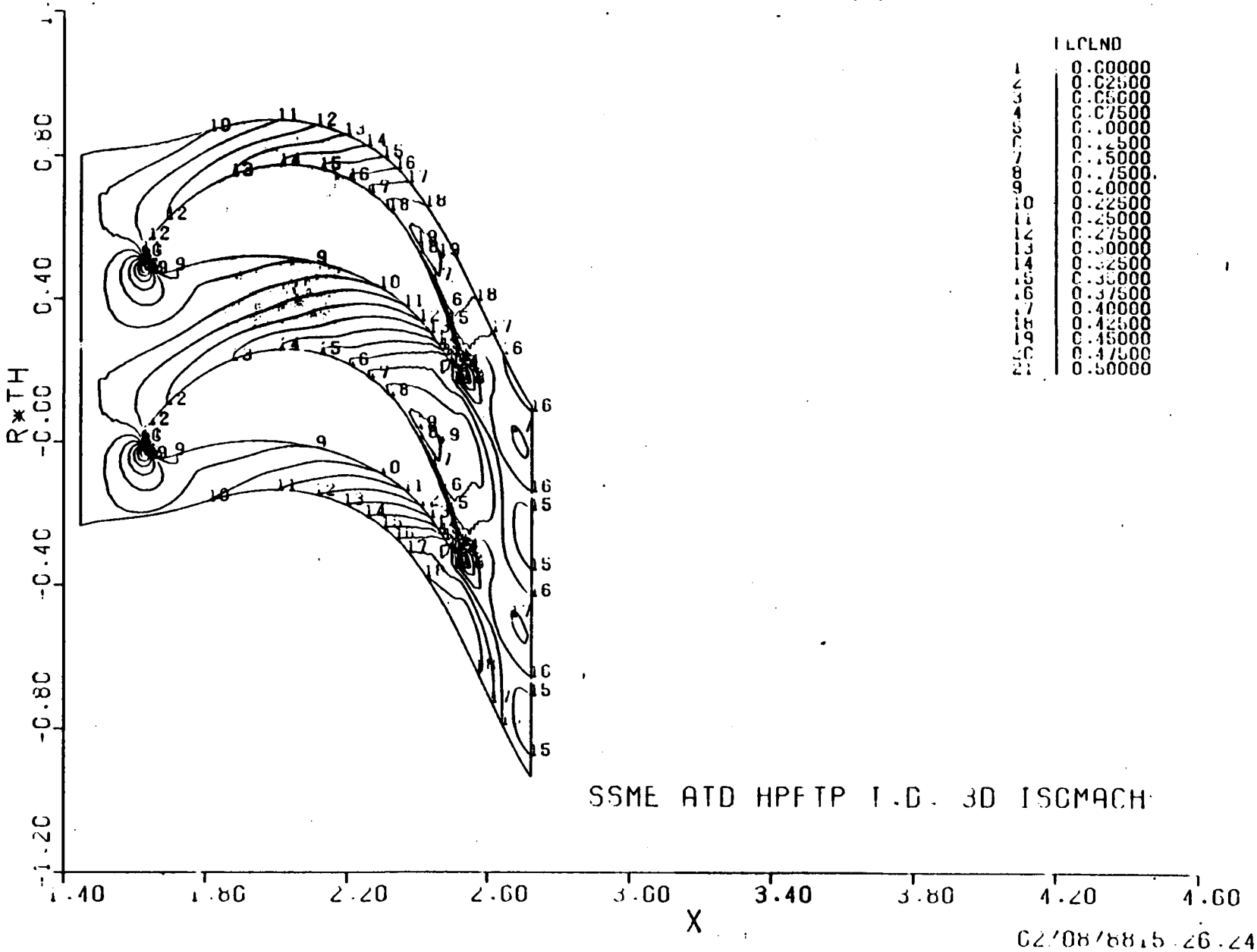
PRATT & WHITNEY
SSME ATD Fuel Pump Turbine
3-D Pressure Distribution (V310)
Poisson Generated "C"-Mesh

10 First Stage Blade: 100% Span




08/20/87
DLS

# MACH CONTOURS

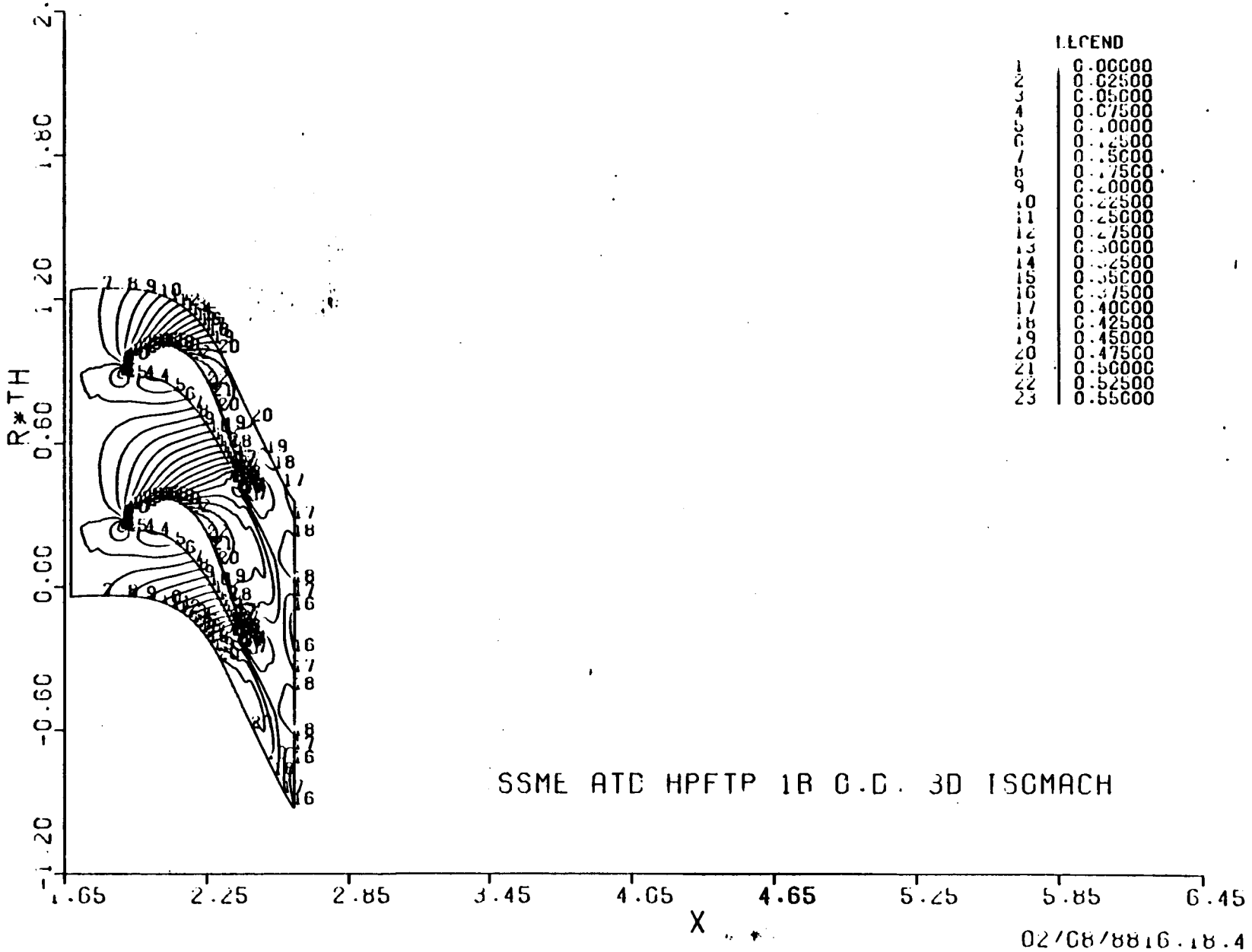



SSME ATD HPFTP I.D. 3D ISOMACH

02/08/88 15:26:24

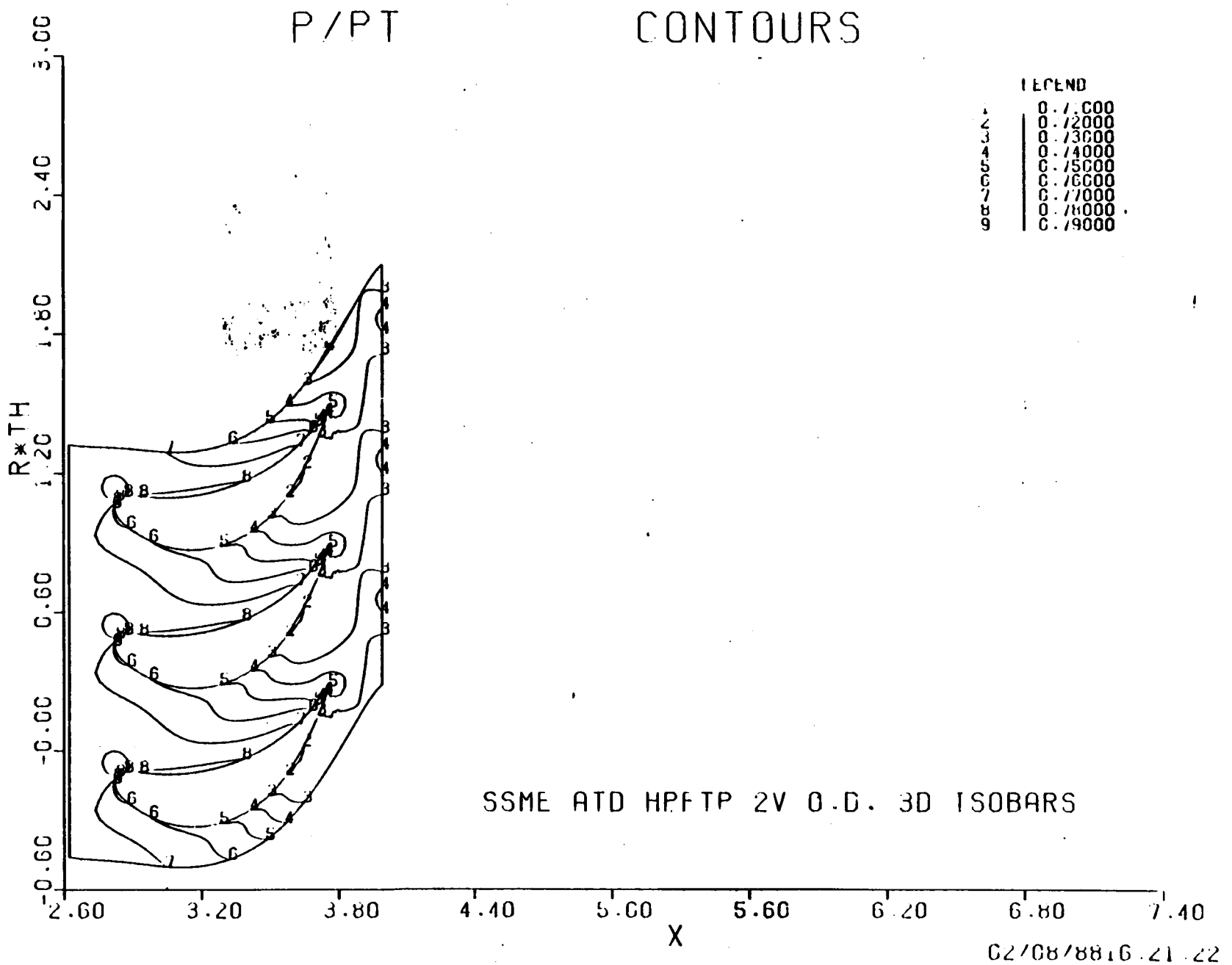
KSLICE= 1 NI 3D CYLINDRICAL C-GRID INLET STRUT. R.I. ROWEY 01-05-88 R

# MACH CONTOURS



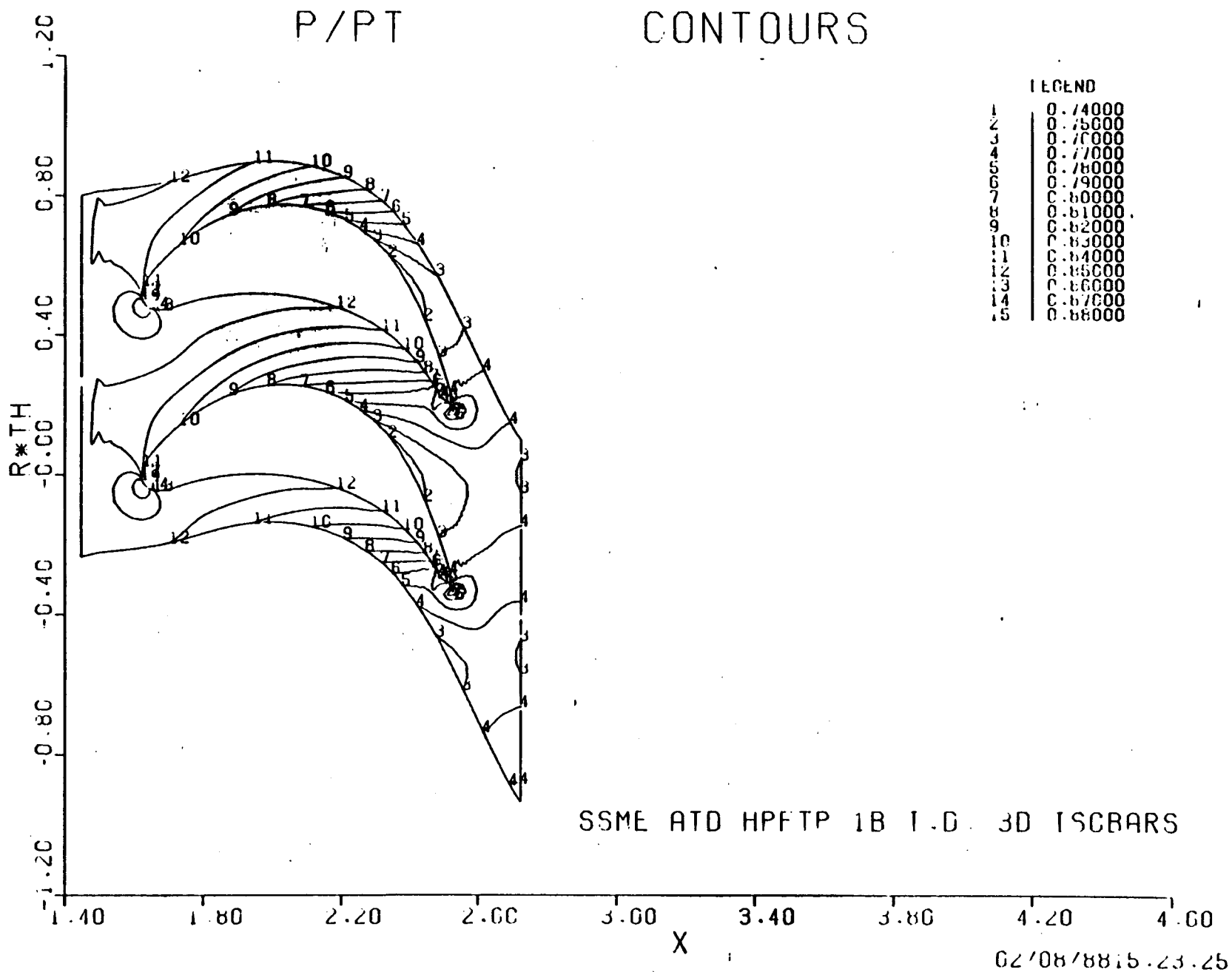

02/08/8816.18.41

KSLICE= 9 NI 3D CYLINDRICAL C-GRID INLET STRUT. R.T. ROWEY. 01-05-88. R




02/08/88 16.21.22

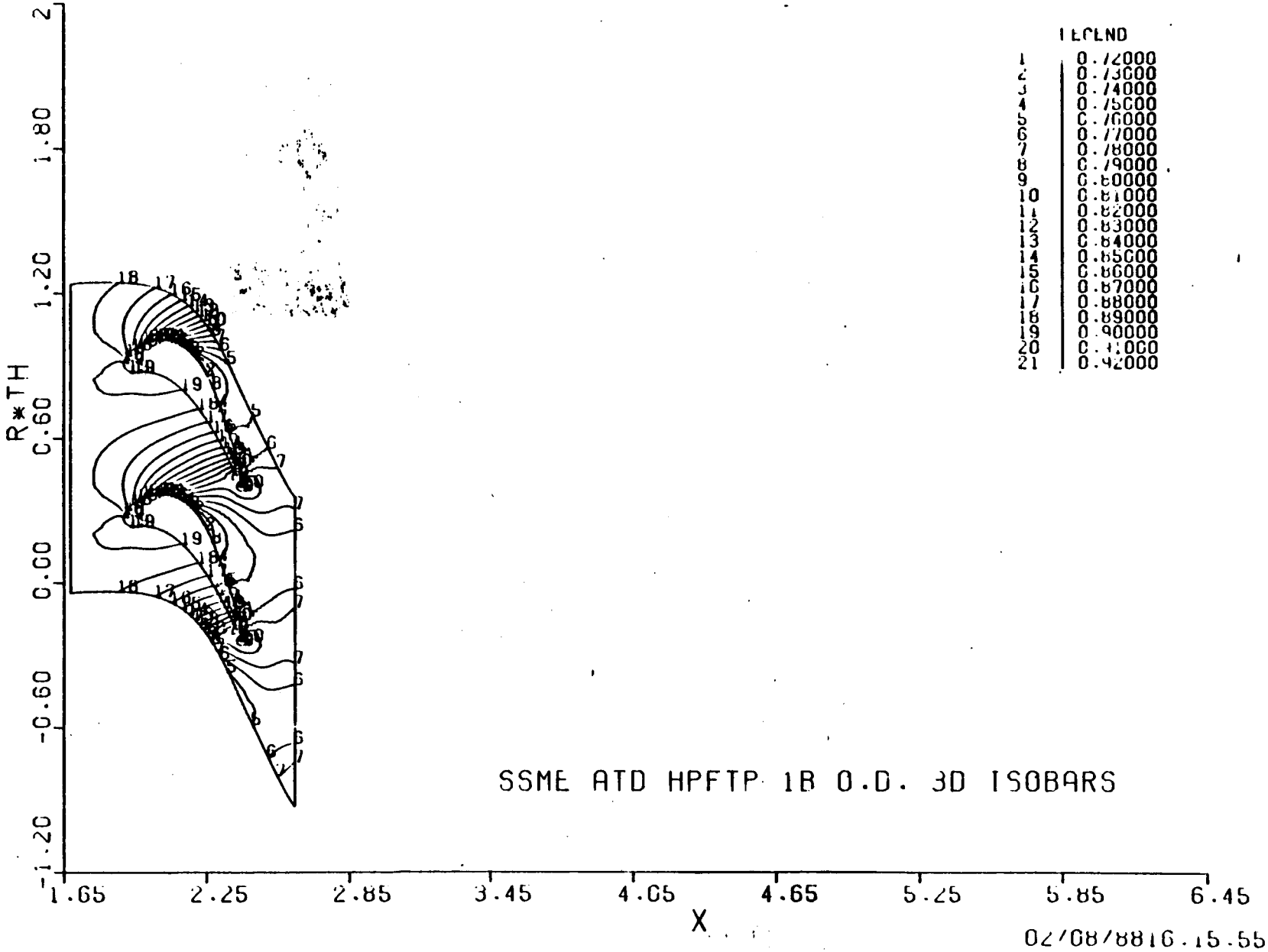
KSLICE= 9 NT 3D CYLINDRICAL C-GRID INLET STRUT.. R.J. ROWEY.. 01-05-88. R




02/08/88 15.23.25

KSLICE= 1 NI 3D CYLINDRICAL C-GRID INLET STRUT.. R. L. ROWEY. 01-05-88. R

# P/PT CONTOURS




SSME ATD HPFTP 1B O.D. 3D ISOBARS

02/08/8816.15.55

KSLICE= 9 NT 3D CYLINDRICAL C-GRID INLET STRUT... R J. ROWEY.. 01-05-88. R

U456 — FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/29/87 TIME 11:45:11

FIRST BLADE... R. J. ROWEY... 06/11/87... RJ

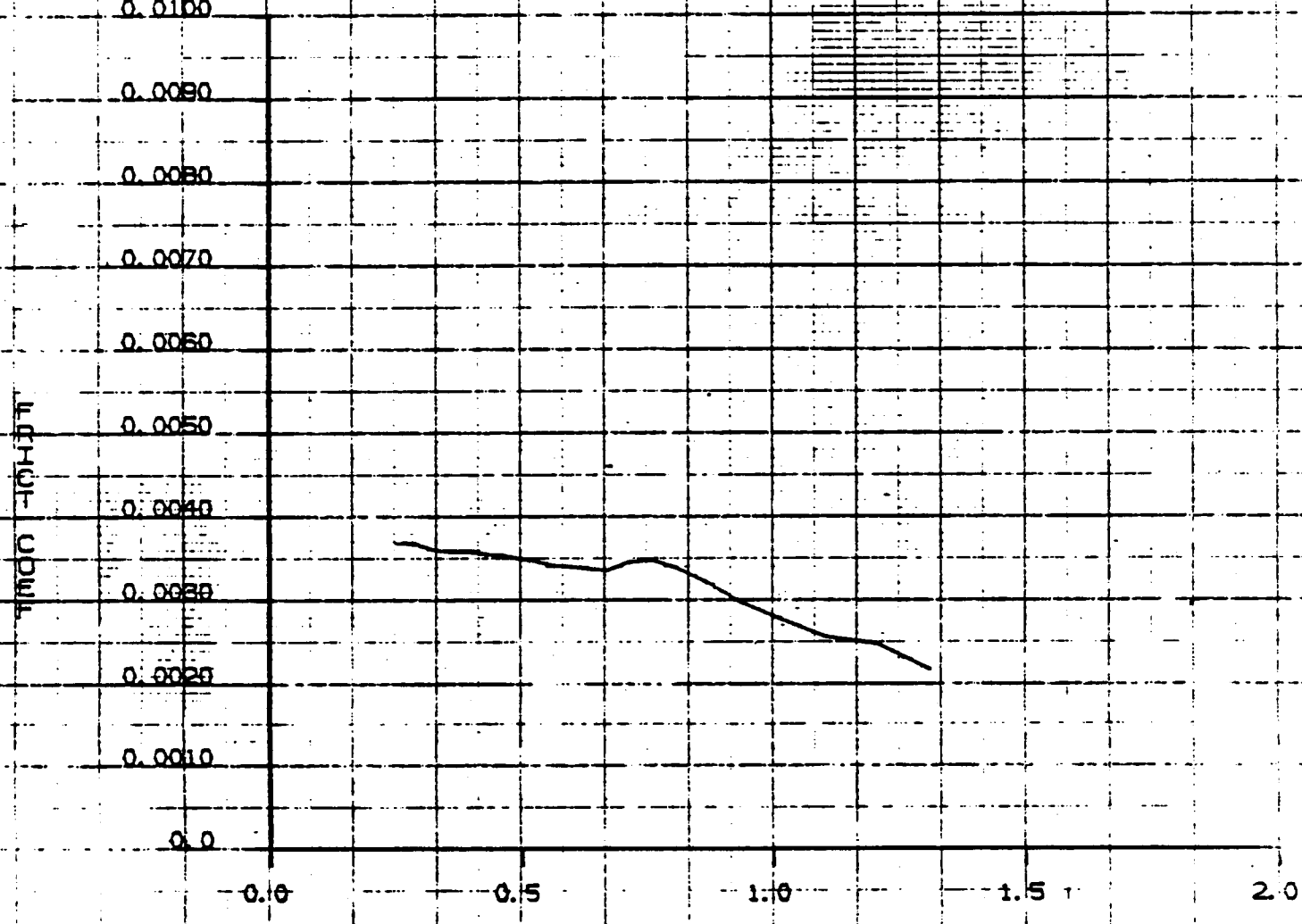
RFUEL2 U760 RLF= 4.36 RTF= 4.37

4.00% TU

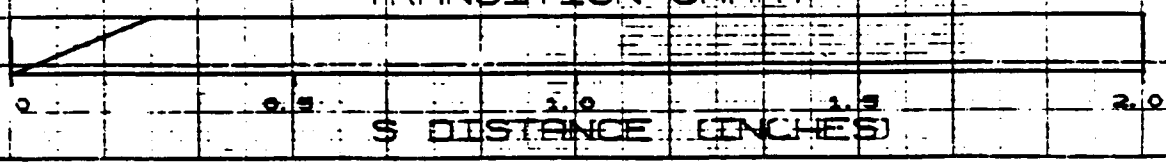
| | INLET | EXIT |
|---|---|---|
| MACH NO. | 0.266 | 0.490 |
| GAS ANGLES | 33.63 | 19.32 |

SUCTION SIDE

REF. REYNOLDS NO. ********




TRANSITION CHART



U456 — FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/29/87 TIME 11:47:35

FIRST BLADE... R. J. ROWEY... 06/11/87... RJ

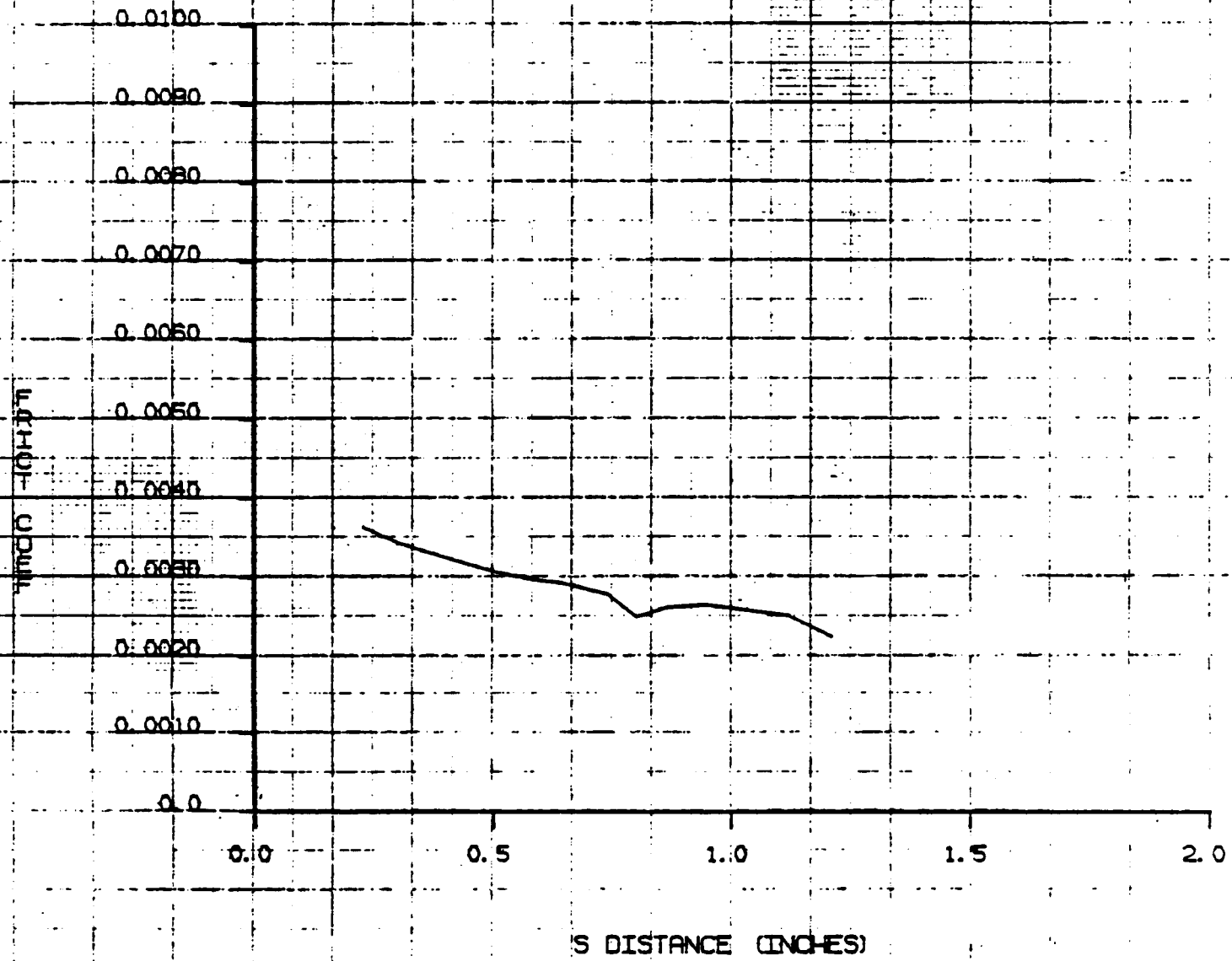
RFUEL2 U760 RLE= 4.61 RTE= 4.61

4.00% TU

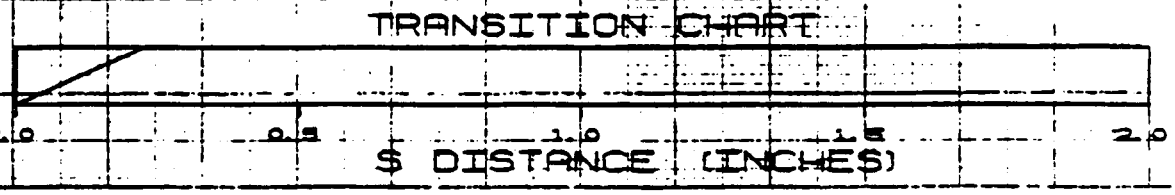
| | INLET | EXIT |
|---|---|---|
| MACH NO. | 0.233 | 0.490 |
| GAS ANGLES | 36.31 | 20.04 |

SUCTION SIDE

REF. REYNOLDS NO. ********




TRANSITION CHART



U456 — FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/28/87 TIME 11:14:46

FIRST BLADE. . . R. J. ROWEY. . . 06/11/87. . . RJ

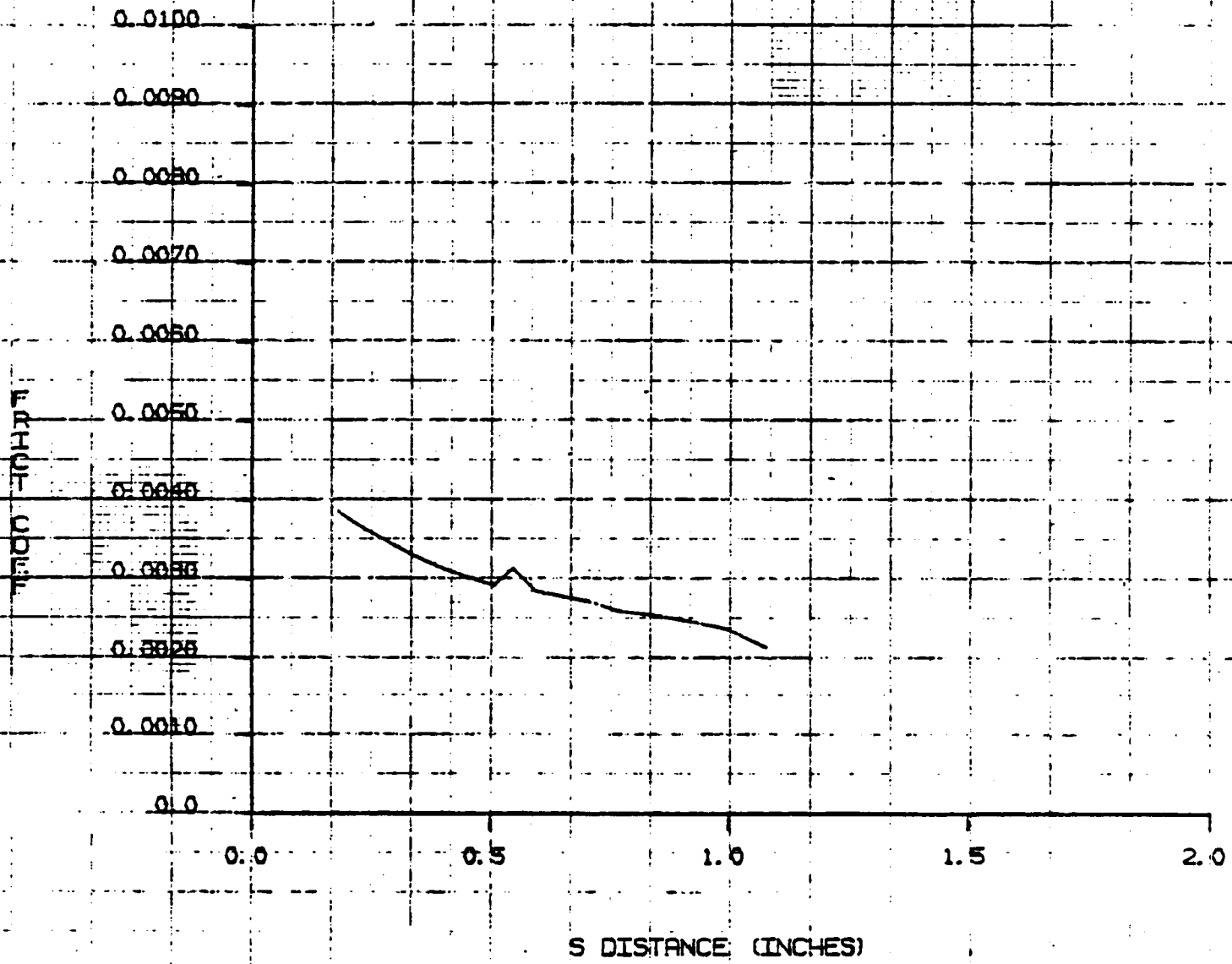
RFUEL2 U760 RLE= 4.85 RTE= 4.86

4.00% TU

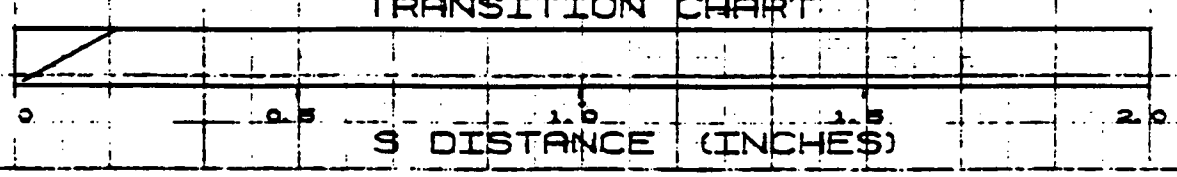
| | INLET | EXIT |
|---|---|---|
| MACH NO. | 0.207 | 0.494 |
| GAS ANGLES | 48.63 | 20.58 |

SUCTION SIDE

REF. REYNOLDS NO. ********




TRANSITION CHART



U456 — FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/28/87 TIME 11:30:52

FIRST BLADE...R. J. ROWEY...06/11/87...RJ

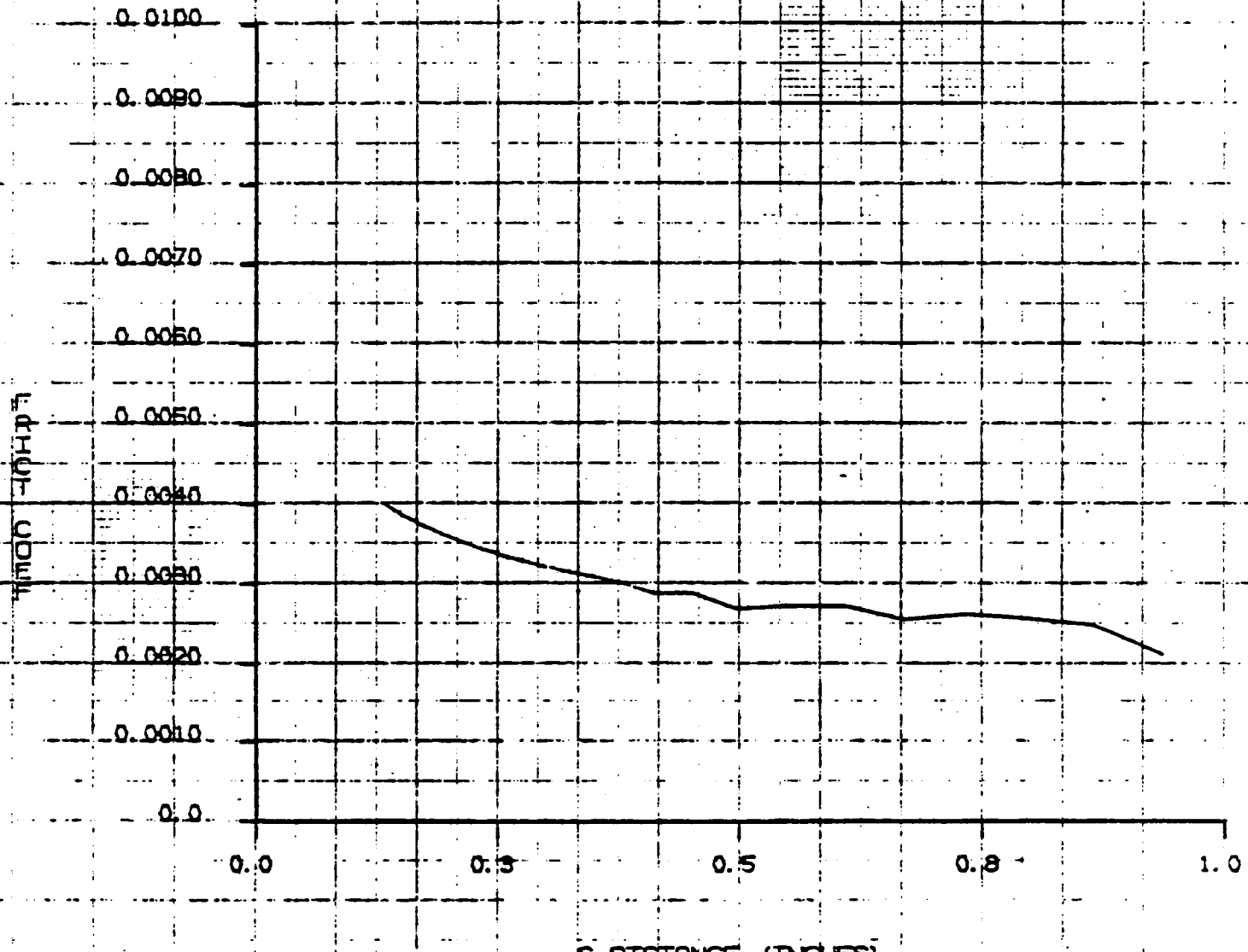
RFUEL2 U760 RLE= 5.10 RTE= 5.10

4.00% TU

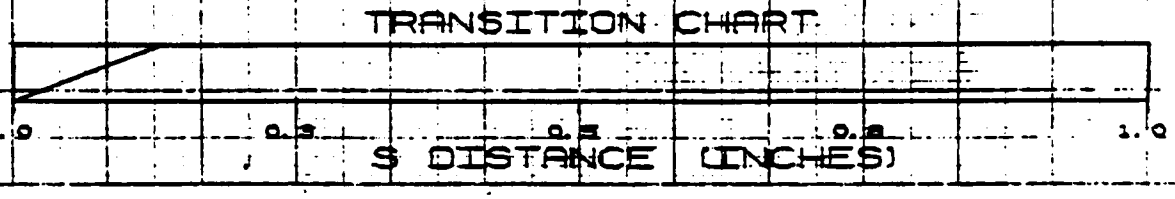
| | INLET | EXIT |
|---|---|---|
| MACH NO. | 0.194 | 0.485 |
| GAS ANGLES | 67.67 | 23.61 |

SUCTION SIDE

REF. REYNOLDS NO. ********




TRANSITION CHART



U456 — FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/29/87 TIME 11:42:53

FIRST BLADE...R. J. ROWEY...06/11/87...RJ

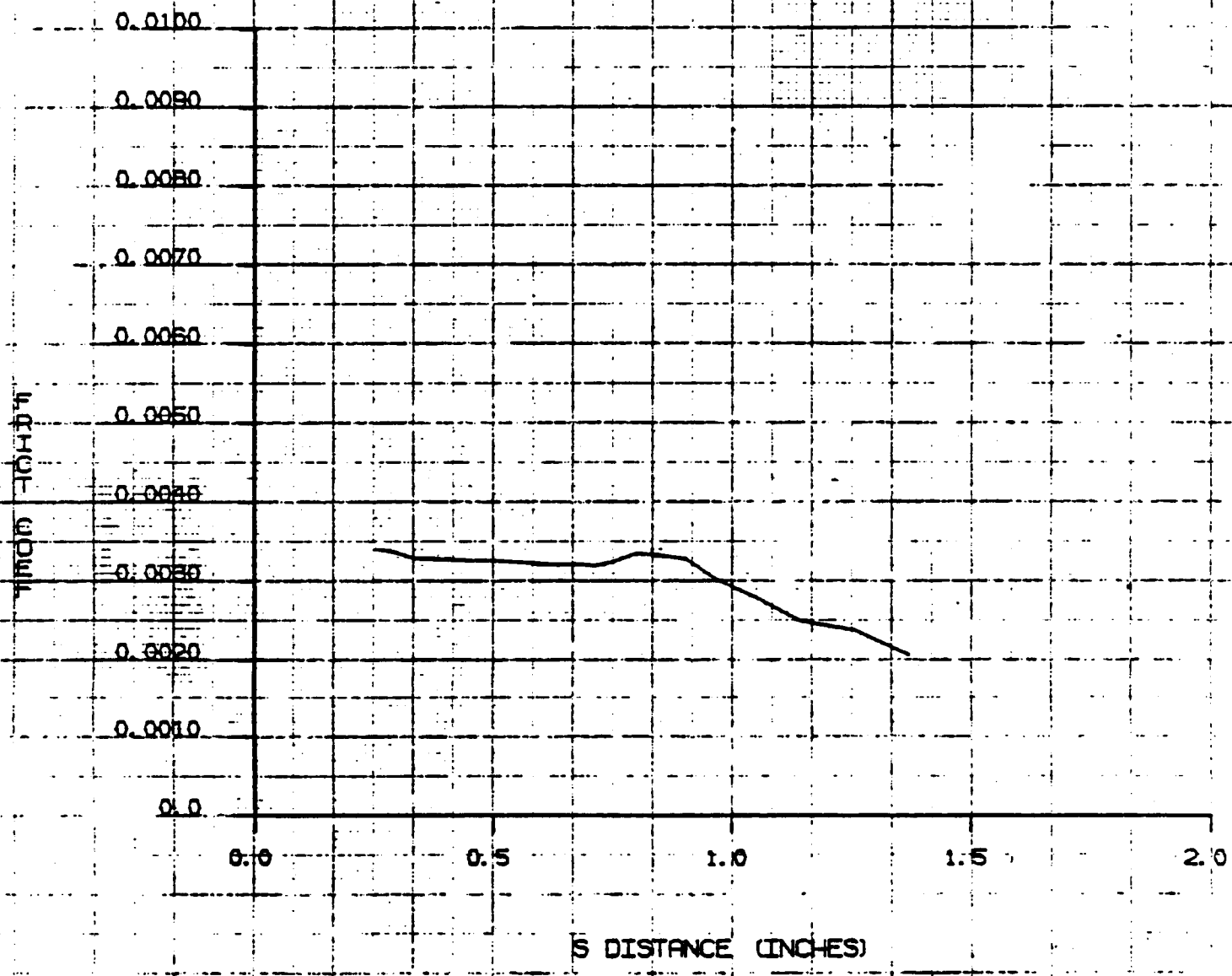
RFUEL2 U760 RLF= 4.12 RTF= 4.12

4.00% TU

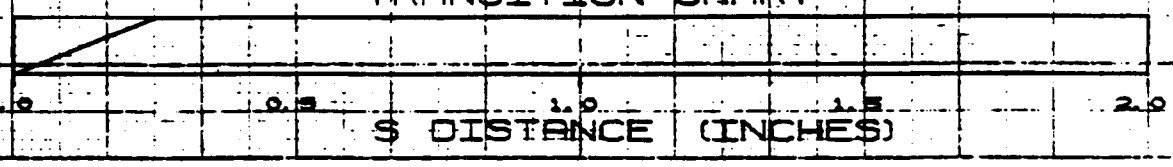
| | INLET | EXIT |
|---|---|---|
| MACH NO. | 0.299 | 0.498 |
| GAS ANGLES | 39.00 | 21.34 |

SUCTION SIDE

REF. REYNOLDS NO. ********




TRANSITION CHART



U456 — FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/29/87 TIME 11:11:48

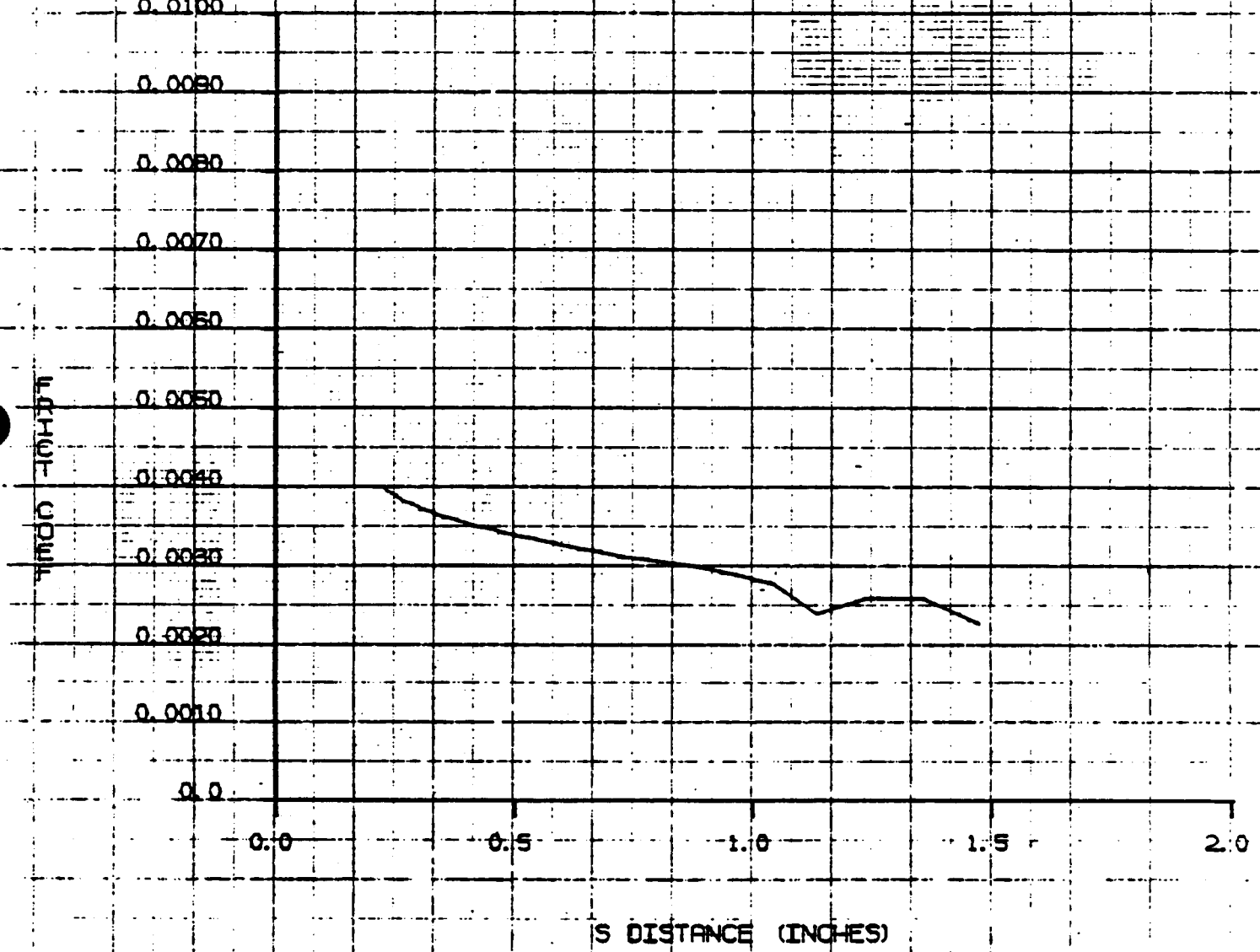
FIRST VANE...R. J..ROWEY...05/11/87...RJR

FUEL 2 11760. RLF= 4.92 RTF= 4.84

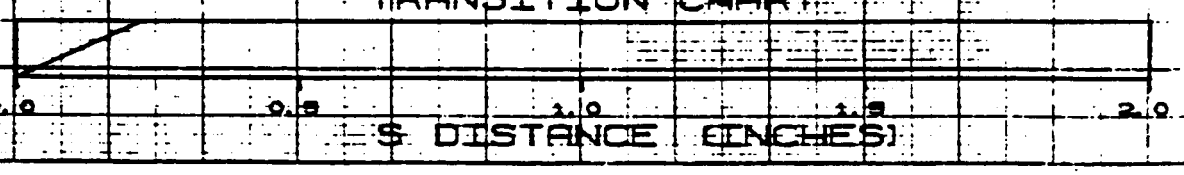
4.00% TU

| | INLET | EXIT |
|---|---|---|
| MACH NO. | 0.111 | 0.445 |
| GAS ANGLES | 89.95 | 159.30 |
| REF. REYNOLDS NO. | ******** | |

PRESSURE SIDE




TRANSITION CHART



U456 - FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 07/29/87 TIME 11:20:53

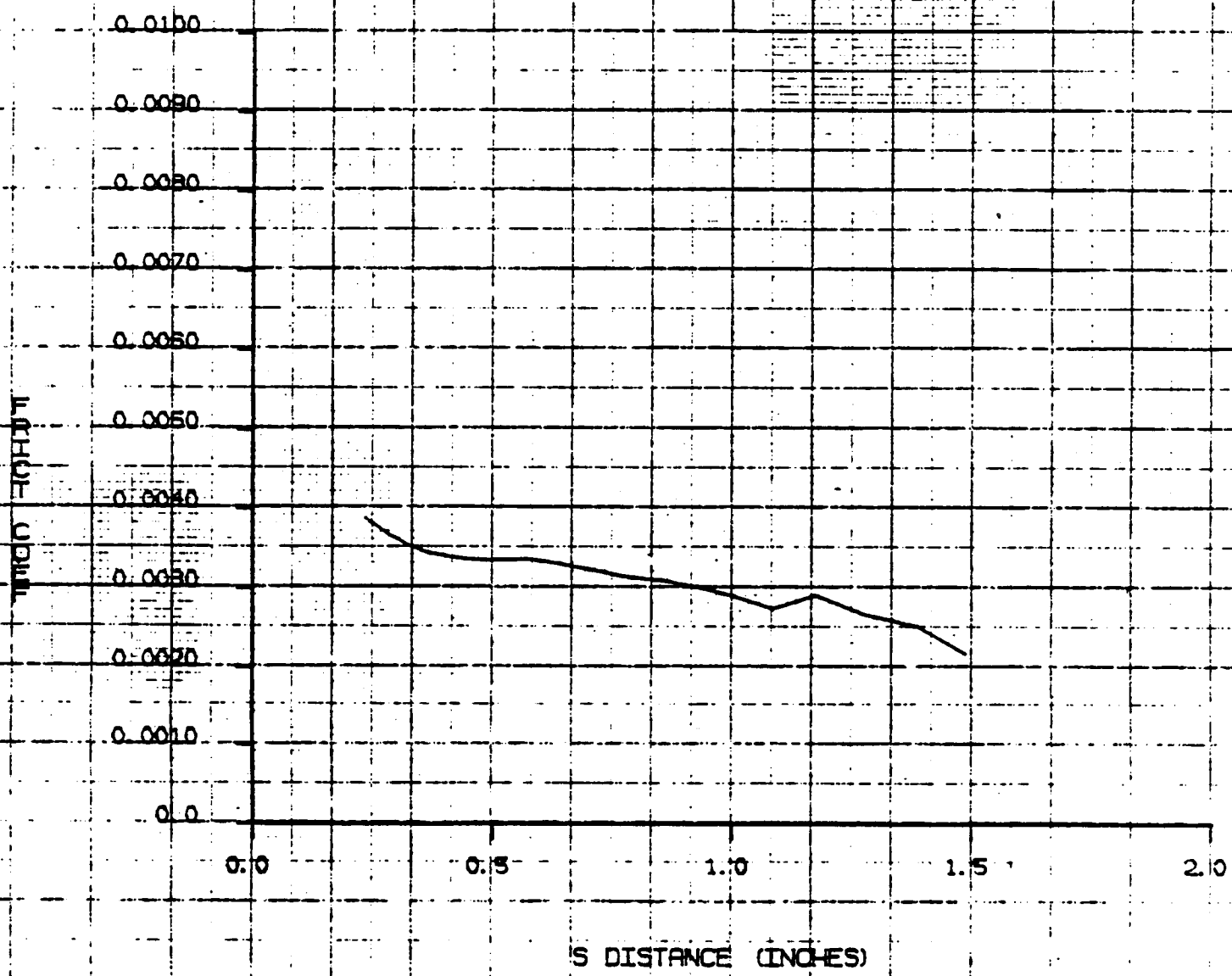
FIRST VANE... R. J. ROWEY... 06/11/87... RJR

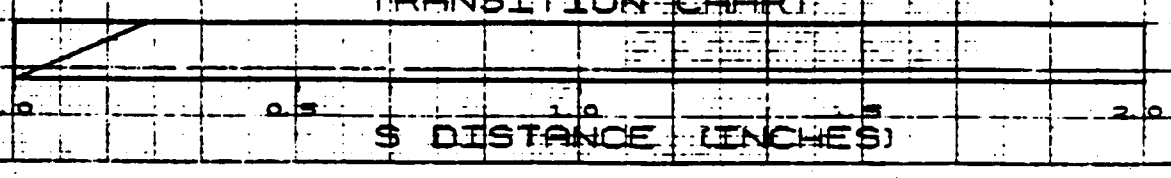
FUEL2 U760 RLE= 5.20 RTE= 5.07

4.00% TU

| | INLET | EXIT |
|---|---|---|
| MACH NO. | 0.108 | 0.422 |
| GAS ANGLES | 89.97 | 154.59 |
| REF. REYNOLDS NO. | ******** | |

PRESSURE SIDE

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