

# **MAINBRN Program**

## **Example Screens**

**Version 1.1**

**December 8, 2003**

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# Main Burner (MAINBNR) Program – Example Screens

**MAINBRN - Design of Annular Main Burner**

File Help Plot Units

1) DATA ENTRY | 2) AIR PARTITIONING | 3) DIFFUSER | 4) PRIMARY ZONE | 5) SECONDARY ZONE | 6) DILUTION ZONE

Station 3.1  
HPC exit / MB diffuser entrance

Total pressure, psia	585.11
Total temperature, °R	1660.0
Air mass flow, lbm/s	104.24
Mach number	0.29780
Mean radius **, in.	9.0000
Outer radius, in.	9.2472
Inner radius, in.	8.7528
Height, in.	0.49444
Static pressure, psia	550.19
Velocity, ft/s	589.53
Area, ft²	0.19417

\* fixed by design of HPC outlet

Station 3.2  
MB diffuser exit / MB entrance

Total pressure, psia	579.26
Total temperature, °R	1660.0
Fuel mass flow, lbm/s	2.7017
Mach number **	8.21000E-02
Mean radius **, in.	5.9260
Outer radius **, in.	7.2363
Inner radius **, in.	4.6157
Height, in.	2.6205
Static pressure, psia	576.54
Velocity, ft/s	163.85
Area, ft²	0.67760

\*\* principal design variables

Station 4  
MB exit / HPT entrance (choked)

Total pressure, psia	555.86
Total temperature, °R	3138.8
Mean radius **, in.	7.0000
Mach number	1.0000
Equivalence ratio	0.37832
Outer radius, in.	7.2364
Inner radius, in.	6.7636
Height, in.	0.47289
Static pressure, psia	303.35
Velocity, ft/s	2467.7
Area, ft²	0.14444

\* fixed by design of HPT inlet

CURRENT DATA FILE: AAF Final Engine.mbn

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DESIGN INPUTS

Estimated B.L. thickness at diffuser entry  $Bt$ : 0.0239  
(see Eq. (9.68):  $0.01 < Bt < 0.12$ )

Number of subdivided 9 deg streams: 3  
(see Fig. 9.27)

Type of diffuser (see Secs. 9.1.5.1 and 9.2.3.1):  
 Flat-wall  Flat-wall+Dump  Dump

Optimal  or Selected  area  $A_m$  at flat-wall exit?  
 Area ratio at flat-wall exit  $A_m/A_1$ : 2.000

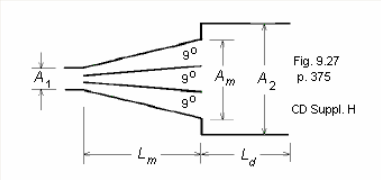


Fig. 9.27 p. 375  
CD Suppl. H

PERFORMANCE

Diffuser efficiency $\eta_{dD}$	0.8696
Pressure recovery coefficient CP	0.7973
Total pressure ratio PID	0.9928
Total pressure loss (Pt3.2-Pt3.1), psi	4.210
NEW total pressure Pt3.2, psia	580.9

DIMENSIONS

Area ratio $AR = A_2/A_1$	3.490
Height at flat-wall exit $H_m$ , in.	1.502
Length of flat-wall section $L_m$ , in.	1.590
Length of tailpipe $L_d$ , in.	1.119
Total diffuser length $L_{diff}$ , in.	2.709

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DESIGN INPUTS

Wall cooling method:  Film  Transpiration/effusion

Gas temperature: $T_g$ in Eq. (9.91), °R	3849
PZ combustion efficiency: $\epsilon_{psPZ}$ in Eq. (9.92)	0.7000
PZ equivalence ratio: $\phi$ in Eqs. (9.92-93)	0.8000
Max. material temperature: $T_m$ in Eq. (9.94), °R	2110

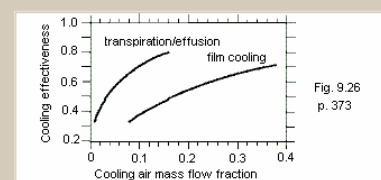


Fig. 9.26 p. 373

RESULTS

Cooling effectiveness: Eqs. (9.94) - (9.96)	0.7944	
Primary air flow: $m_{PZ}$	lbm/s	fraction
Cooling air flow: $m_c$	16.113	0.15457
Secondary air flow: $m_{SZ}$	21.126	0.20267
Dilution air flow: $m_{DZ}$	17.707	0.16986
Total air flow: $m_{3.1}$	104.24	1.0000

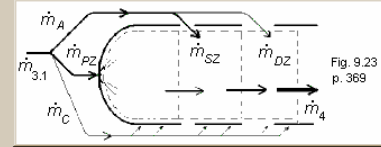


Fig. 9.23 p. 369

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LINER and FUEL NOZZLES

Single- or double-annular array?

Optimal area ratio  $AL/Ar$  (alfa-opt in Eq. (9.109)) 0.7472

Number of swirler assemblies (Nnoz in Eq. (9.105)) 14

AIR SWIRLER

Swirler blade angle, deg (see Eq. (9.46)) 45

Air flow per swirler (see Eq. (9.111)) 2.942 lbm/s

Max flow per swirler, lbm/s (when  $t = HL/2$ ) 3.154

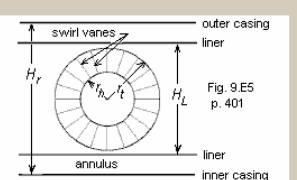


Fig. 9.E5 p. 401

PERFORMANCE

Swirl number $S'$ (see Eq. (9.48))	0.7867
Assigned total pressure loss coefficient	8.589
Minimum required total pressure loss coefficient	3.378
Annulus entry $U_A$ , ft/s	241.4
Mixing jets $V_j$ , ft/s	480.2

DIMENSIONS (inches)

Swirler hub radius $r_h$	0.5000
Swirler tip radius $r_t$	0.9544
Liner height $HL$ (see Figs. 9.30, 32)	1.958
PZ length, LPZ	1.502

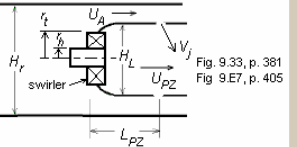


Fig. 9.33, p. 381  
Fig. 9.E7, p. 405

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**SECONDARY ZONE**

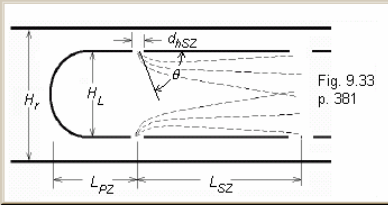
Sharp- or round-edged holes?  Plain  Plunged  
(see Eq. (9.33))

Secondary jet inclination angle theta, deg 53.81  
(see Fig. 9.15 and Eq. (9.115))

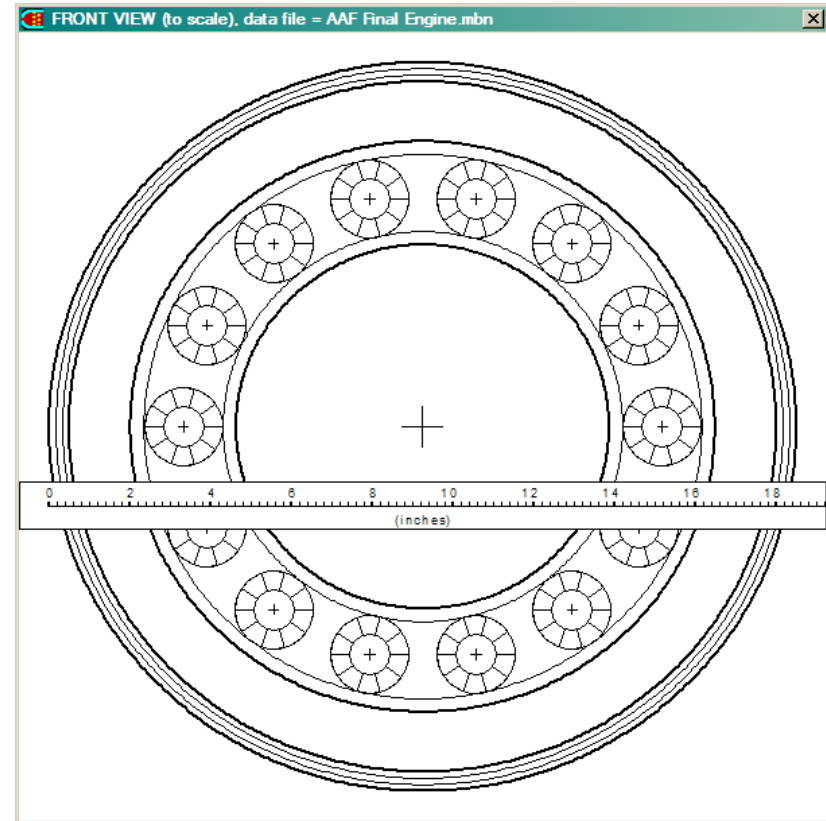
Number of secondary holes NhSZ 327  
(see Eq. (9.113))

Diameter of secondary holes dhSZ, inches 0.2081  
(see Eq. (9.114))

Length of secondary zone LSZ, inches 3.916  
(see Eq. (9.116))



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**DILUTION ZONE**

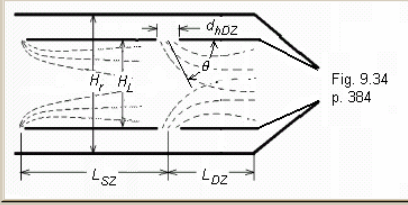
Sharp- or round-edged holes?  Plain  Plunged  
(see Eq. (9.33))

Dilution jet inclination angle theta, deg 76.75  
(see Fig. 9.15 and Eq. (9.115))

Number of dilution holes NhDZ 95  
(see Eq. (9.113))

Diameter of dilution holes dhDZ, inches 0.3127  
(see Eq. (9.114))

Length of dilution zone LDZ, inches 2.937  
(see p. 384)



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