

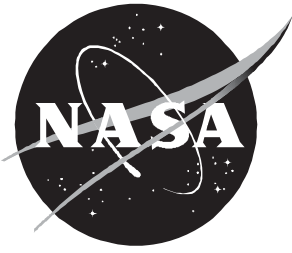
Supplement to  
NASA Technical Paper 3669

# Cavity Unsteady-Pressure Measurements at Subsonic and Transonic Speeds

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*Maureen B. Tracy and E. B. Plentovich*  
*Langley Research Center • Hampton, Virginia*

National Aeronautics and Space Administration  
Langley Research Center • Hampton, Virginia 23681-2199

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## Summary

An experimental investigation was conducted in the Langley 8-Foot Transonic Pressure Tunnel to determine the flow characteristics of rectangular cavities with varying relative dimensions at subsonic and transonic speeds. Cavities were tested with width-to-depth ratios  $w/h$  of 1, 4, 8, and 16 for length-to-depth ratios  $l/h$  of 1 through 17.5. The maximum cavity dimensions were 42.0 in. in length, 9.6 in. in width, and 2.4 in. in depth. The boundary layer approaching the cavity was turbulent and had an approximate thickness of 0.5 in. Unsteady- and static-pressure measurements were obtained at free-stream Mach numbers from 0.20 to 0.95 at a unit Reynolds number per foot of approximately  $3 \times 10^6$ . (Static-pressure results were reported in NASA TP-3358.) This electronic "Supplement to NASA TP-3669" contains the listings of unsteady-pressure spectra presented graphically in NASA TP-3669.

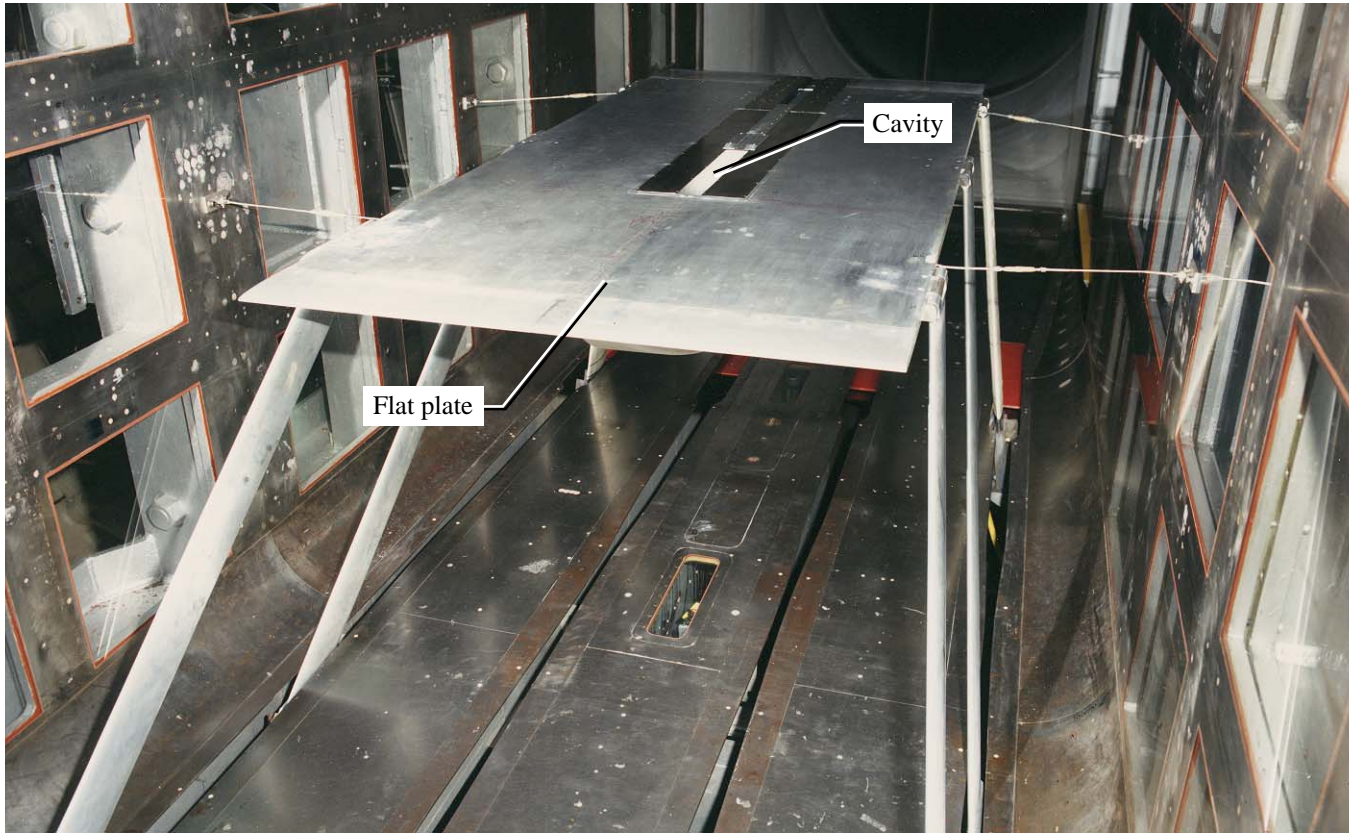
## Symbols

AC	alternating current
$a_\infty$	acoustic wave speed, fps
FPL	fluctuating pressure level, normalized with respect to $q_\infty$ , dB
$h$	cavity depth, in.
$l$	cavity length, measured in streamwise direction, in.
$M_\infty$	free-stream Mach number
$p'$	measured unsteady pressure, psi
$p'_{rms}$	root-mean-square pressure, $\sqrt{(p')^2}$ , psi
$p_t$	free-stream total pressure, psi
$q_\infty$	free-stream dynamic pressure, psi
$R_\infty$	free-stream unit Reynolds number per foot
SPL	sound pressure level, normalized with respect to audible sound, $2.9 \times 10^{-9}$ psi, dB
$T_{t,\infty}$	free-stream total temperature, °F
$U_\infty$	free-stream velocity, fps
$w$	cavity width, in.
$x$	distance in streamwise direction, positive downstream, in. ( see fig. 2 )
$y$	distance in spanwise direction, positive left facing upstream, in. (see fig. 2)
$z$	distance normal to flat plate, positive down, in. (see fig. 2)
$\delta$	boundary-layer thickness, measured at center of leading edge of cavity, in.

## Description of Experiment

A flat plate with a rectangular, three-dimensional cavity was mounted on six legs in the tunnel as shown in figure 1. The maximum dimensions of the cavity were 42.0 in. long, 4.2 in. deep, and 9.6 in. wide. The length of the cavity could be varied by remote control of a sliding assembly that combined the aft cavity wall and a portion of the plate downstream of the cavity. (See fig. 2.) A number of cavity lengths were tested from the 42.0 in. maximum to 1.2 in. The cavity floor was positioned to achieve depths of 0.6, 1.2, and 2.4 in. Cavity widths were set at 2.4 and 9.6 in. by installing walls of different thicknesses. A boundary-layer transition strip was applied to the leading edge of the flat plate in order to ensure that the approaching flow was fully turbulent for all conditions. The nominal test matrix is given in table 1 and the configuration test matrix is given in table 2. Exact test conditions for each test point are given in the previously published "Supplement to NASA TP-3358."

The unsteady-pressure measurements (fluctuations about the mean pressure) were made with flush-mounted miniature dynamic pressure transducers. Figure 3 provides the instrumentation layout. The transducers were differential gauges and were AC coupled. Data were recorded on FM tape using wide-band format at 7.5 in/sec. Calibration was achieved with a calibrated external noise source (150 dB at 1 kHz) applied to each transducer and recorded as data.



L-91-02270

Figure 1. Variable cavity model installed in Langley 8-Foot Transonic Pressure Tunnel. Downstream view.

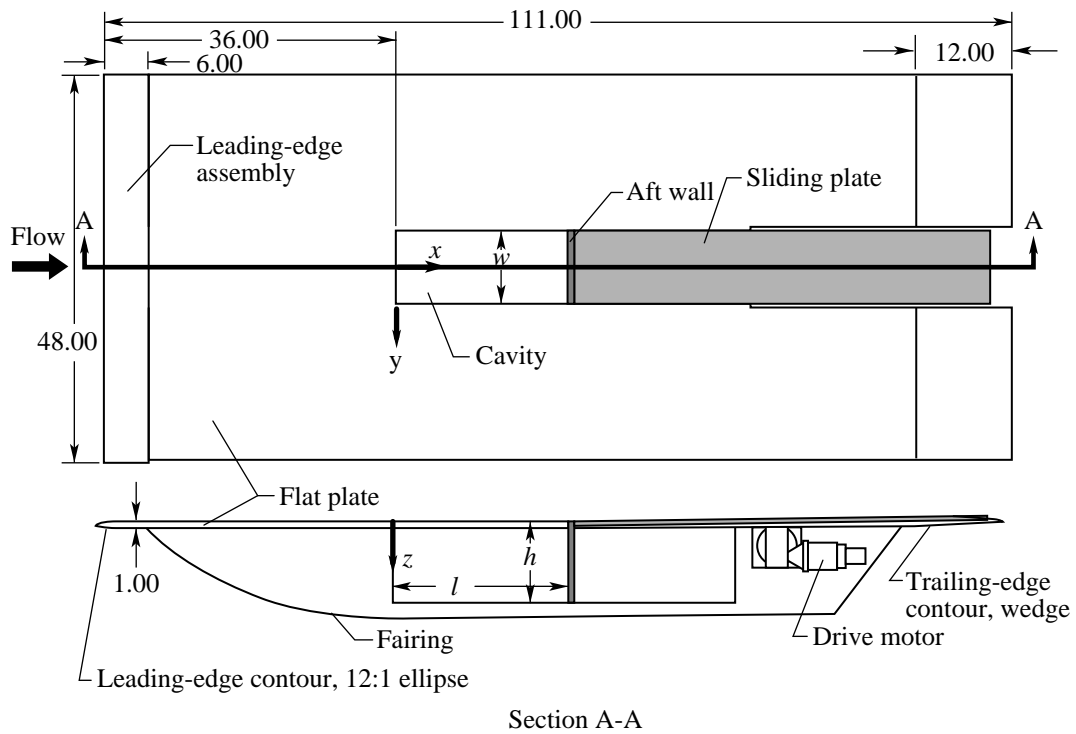
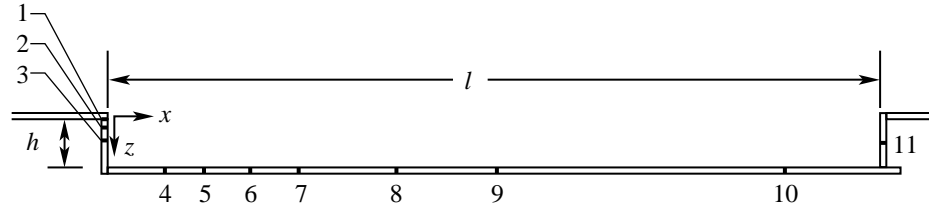


Figure 2. Sketch of variable cavity model. Linear dimensions are in inches.



Transducer	x, in.	y, in.	z, in.	Model location	Reference x, in.	Reference y, in.	Reference z, in.
1	0.00	0.00	0.3	Forward wall	2.00	2.40	$h$
2	0.00	0.00	0.6	Forward wall	2.00	2.40	$h$
3	0.00	0.00	1.2	Forward wall	2.00	2.40	$h$
4	2.64	0.00	$h$	Floor	2.00	2.40	$h$
5	5.28	0.00	$h$	Floor	2.00	2.40	$h$
6	7.92	0.00	$h$	Floor	2.00	2.40	$h$
7	10.56	0.00	$h$	Floor	2.00	2.40	$h$
8	15.72	0.00	$h$	Floor	2.00	2.40	$h$
9	21.00	0.00	$h$	Floor	2.00	2.40	$h$
10	36.56	0.00	$h$	Floor	2.00	2.40	$h$
11	$l$	0.00	$h/2$	Aft wall	$l$	0.00	$0.63h-0.74h$

Figure 3. Transducer locations.

## Data Reduction

Data were digitized at 5 kHz, and a 2.5-kHz antialiasing filter was applied. Forty-nine data blocks of 2048 points each were Fourier analyzed by using a Hanning window, and the resulting spectra were averaged. This process produced spectra with an upper frequency of 2.5 kHz, a resolution of 2.44 Hz, and a 90 percent confidence interval between 78 and 125 percent of the true value (90 percent confidence that the spectral estimate will be between -2.2 and +1.9 dB of the true spectra). This confidence estimation is based on a chi-square distribution which assumes an ergodic Gaussian random process and independence of sample blocks. Data are listed up to 2 kHz in sound pressure level (SPL)

$$\text{SPL} = 20 \log \left( \frac{p'_{rms}}{2.9 \times 10^{-9} \text{ psi}} \right)$$

If desired, SPL can be converted to fluctuating pressure level (FPL) as follows:

$$\text{FPL} = 20 \log \left( \frac{p'_{rms}}{q_{\infty}} \right) = \text{SPL} + 20 \log \left( \frac{2.9 \times 10^{-9} \text{ psi}}{q_{\infty}} \right)$$

Tables 3, 4, 5, and 6 contain ASCII listings of spectra obtained from transducer 1 (fig. 3) for cavities with  $w/h = 1$ , 4, 8, and 16, respectively. Tables 7 and 8 give spectral data from transducers 2 through 12 for cavities with  $w/h = 4$  at

$M_\infty = 0.90$  for  $l/h$  of 10.0 and 17.5, respectively. Numeric data are read from left to right using a FORTRAN statement of the following form:

```
read(unit,*)(spl(i),i=1,821)
```

Table 1. Nominal Test Matrix

$M_\infty$	$R_\infty$	$U_\infty$ , fps	$a_\infty$ , fps	$p_{t,\infty}$ , psi	$T_{t,\infty}$ , °F	$q_\infty$ , psi	$\delta$ , in.
0.20	$2.2 \times 10^6$	230.3	1151.5	26	97	0.7	0.45
0.40	3.6	456.8	1142.0	22	101	2.2	0.48
0.60	4.7	671.1	1118.5	21	99	4.1	0.47
0.80	3.8	876.2	1095.3	14	104	4.2	0.50
0.90	3.4	976.4	1084.9	13	110	4.2	0.52
0.95	3.4	1019.8	1073.5	12	107	4.2	0.55

Table 2. Configuration Test Matrix

$M_\infty$	Cavity, $l/h$ , of—																												
	1	1.7	2	3	3.8	4	6	7	7.5	8	8.8	9	9.4	9.6	10	10.4	11	11.7	12	13	13.4	14	14.6	15	16.8	17	17.2	17.5	
$w = 2.4; h = 2.4 (w/h = 1)$																													
0.20			✓			✓	✓	✓		✓		✓			✓		✓		✓	✓		✓							
0.40		✓				✓	✓	✓		✓		✓			✓		✓		✓	✓		✓							
0.60						✓	✓	✓		✓		✓			✓		✓		✓	✓		✓							
0.80						✓	✓	✓		✓		✓			✓		✓		✓	✓		✓							
0.90					✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓		✓			✓	✓	✓	✓	✓
0.95					✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓	✓	✓	✓	✓
$w = 9.6; h = 2.4 (w/h = 4)$																													
0.20			✓			✓	✓	✓		✓		✓			✓		✓		✓	✓		✓							✓
0.40			✓			✓	✓	✓		✓		✓			✓	✓	✓		✓	✓		✓			✓		✓		✓
0.60			✓			✓	✓	✓		✓		✓	✓		✓	✓	✓		✓	✓		✓			✓		✓		✓
0.80			✓			✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓		✓	✓
0.90			✓			✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓		✓
0.95			✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓	✓
$w = 9.6; h = 1.2 (w/h = 8)$																													
0.20	✓		✓			✓	✓	✓		✓		✓			✓		✓		✓	✓		✓			✓	✓			
0.40	✓		✓			✓	✓	✓		✓		✓			✓		✓		✓	✓		✓			✓	✓			
0.60	✓		✓			✓	✓	✓		✓		✓			✓		✓		✓	✓		✓			✓	✓			
0.80	✓		✓			✓	✓	✓		✓		✓			✓		✓		✓	✓		✓			✓	✓			
0.90	✓		✓	✓		✓	✓	✓		✓		✓			✓		✓		✓	✓		✓			✓	✓			
0.95	✓		✓	✓		✓	✓	✓		✓		✓			✓		✓		✓	✓		✓			✓	✓			
$w = 9.6; h = 0.6 (w/h = 16)$																													
0.80			✓			✓	✓	✓																					
0.90			✓			✓	✓	✓																					
0.95			✓			✓	✓	✓																					