

# RESEARCH REPORT



Measured Pressure Equalized Performance of Two Precast Concrete Panels. Performance of Pressure Equalized Rainscreen Walls: A Collaborative Research and Development Project.

Progress Report #3



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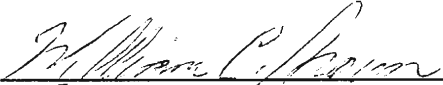
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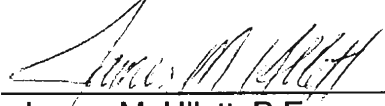
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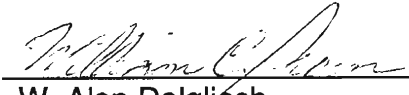
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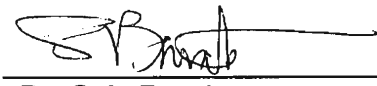
Progress Report #3  
Measured Pressure Equalized Performance of  
Two Precast Concrete Panels

Performance of Pressure Equalized Rainscreen Walls  
A Collaborative Research and Development Project

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## EXECUTIVE SUMMARY

A literature review conducted by the National Research Council (NRC) in 1992 to determine design guidelines for pressure equalized rainscreen (PER) walls concluded that current guidelines were not at all comprehensive. As a consequence, a research and development project was initiated to generate design guidelines for PER walls. Canada Mortgage and Housing Corporation (CMHC) is jointly sponsoring the experimental evaluation task of the project. In addition, several wall system manufacturers are supplying test specimens and providing technical and practical information.

This report presents data from the experimental evaluation of two precast concrete sandwich panels which were supplied by the Canadian Precast Concrete Institute (CPCI). Each test specimen is 2.40 m high by 1.19 m wide, and consists of a 100 mm thick precast concrete inner slab which acts as the air barrier, 50 mm of extruded polystyrene insulation, a 13 mm cavity, and a 64 mm precast concrete outer slab which acts as the rainscreen. The inner and outer slabs are connected by two vertical stainless steel trusses located 610 mm apart. The cavity of one specimen (Specimen 3) is a 13 mm air space, while the cavity of the other specimen (Specimen 4) is formed using 13 mm deep Miradrain™. Both cavities extend over the height and width of the specimen.

The experimental evaluation task consisted of pressure equalization, slab deflection, water penetration, and air leakage sub-tasks.

Pressure equalization performance of the cavity and deflection of the two concrete slabs was measured under dynamic pressure conditions for several leakage and vent configurations, loading scenarios, and excitation frequencies. The two specimens exhibited very similar response, suggesting that materials such as Miradrain™ could provide excellent cavity material. The following observations were found true for both specimens:

- The pressure difference across the rainscreen decreased under the following conditions:
  - ◆ the air barrier leakage decreased;
  - ◆ the rainscreen venting increased;
  - ◆ the frequency of the specimen pressure difference decreased.
- Pressure difference across the rainscreen changed negligibly with height of the specimen.
- The deflection of the rainscreen slab, although small, improved the pressure equalization performance of the wall system.

Water penetration through a defect introduced into the rainscreen of Specimen 3 was evaluated under static and dynamic pressure conditions. The following effects were observed:

- For a 'defective' face-sealed system, one third of the available water was forced through the defect with 0 Pa pressure difference across the rainscreen and most of the available water was forced through the defect with 100 Pa static pressure difference across the rainscreen.
- For an drained cavity wall, about two thirds of the available water was forced through the defect with a dynamic pressure difference across the specimen of  $0+1000\cdot\sin(2\pi ft)$  Pa at a frequency of 0.5 Hz.
- For a PER wall, about one third of the available water was forced through the defect (i.e., the same amount as with no pressure difference) with a dynamic pressure difference across the specimen of  $0+1000\cdot\sin(2\pi ft)$  Pa at a frequency of 0.5 Hz.

Little water was measured to be entrained in the air passing through shielded vent holes under static pressure difference.

## RÉSUMÉ

Une analyse documentaire qu'effectuait en 1992 le Conseil national de recherches (CNR) dans le but d'établir des directives de conception à l'égard des murs avec écran pare-pluie à pression équilibrée a permis de conclure que les directives actuelles ne sont pas du tout complètes. C'est ainsi qu'un projet de recherche et de développement a été amorcé en vue de donner lieu à des directives de conception pour les murs avec écran pare-pluie à pression équilibrée. La SCHL parraine l'évaluation expérimentale conjointement avec l'Institut de recherche en construction (IRC). De plus, plusieurs fabricants de systèmes muraux fournissent des spécimens aux fins d'essais, en plus d'offrir des renseignements technico-pratiques.

Le présent rapport livre les résultats de l'évaluation expérimentale de deux panneaux sandwichs en béton préfabriqué fournis par l'Institut canadien du béton préfabriqué et précontraint (CPCI). Chaque spécimen d'essai mesure 2,40 m de hauteur sur 1,9 m de largeur, et consiste en une dalle intérieure en béton préfabriqué de 100 mm d'épaisseur qui tient lieu de pare-air, d'isolant de polystyrène extrudé de 50 mm, d'une cavité de 13 mm, et d'une dalle extérieure en béton préfabriqué de 64 mm, qui tient lieu d'écran pare-pluie. Les dalles intérieure et extérieure sont reliées par deux éléments d'ossature préfabriqués en acier inoxydable disposés à la verticale et espacés de 610 mm. Un spécimen (spécimen n° 3) comporte une lame d'air de 13 mm, et l'autre (spécimen n° 4) comporte une cavité formée par une membrane Miradrain<sup>MD</sup> de 13 mm de profondeur. Les deux cavités se prolongent sur la hauteur et la largeur du spécimen.

L'évaluation expérimentale a porté sur l'équilibrage de la pression, le fléchissement des dalles, la pénétration d'eau et l'étanchéité à l'air.

La performance en matière d'équilibrage de la pression de la cavité et le fléchissement des deux dalles de béton a été mesurée dans des conditions de pression dynamique selon plusieurs configurations d'étanchéité et de ventilation, conditions de charge et fréquences d'excitation. Les deux spécimens ont affiché une réaction très semblable, indiquant que les matériaux tels que la membrane Miradrain<sup>MD</sup> peuvent constituer un excellent matériau pour la cavité. Les observations suivantes s'appliquent aux deux spécimens :

- La différence de pression agissant sur l'écran pare-pluie a diminué lorsque :
  - les fuites d'air du pare-air diminuaient;
  - la ventilation de l'écran pare-pluie augmentait;
  - la fréquence de la différence de pression du spécimen diminuait.
- La différence de pression agissant sur l'écran pare-pluie a subi un changement négligeable selon la hauteur du spécimen.
- Le fléchissement de la dalle écran pare-pluie, quoique faible, a amélioré l'équilibrage de la pression du système mural.

La pénétration d'eau par un défaut pratiqué dans l'écran pare-pluie du spécimen n° 3 a été évaluée dans des conditions de pression statique et de pression dynamique. Les effets suivants ont été observés :

- Pour un mur étanchéisé en surface, mais « défectueux », le tiers de l'eau disponible s'est introduit par le défaut alors que l'écran pare-pluie était soumis à une différence de pression de 0 Pa et la plupart de l'eau disponible s'est introduit par le défaut alors que l'écran pare-pluie était soumis à une différence de pression statique de 100 Pa.
- Pour un mur avec cavité d'évacuation, environ les deux tiers de l'eau disponible se sont introduits par le défaut alors que le spécimen subissait une différence de pression dynamique de  $0+1\,000 \cdot \sin(2\pi f t)$  Pa à une fréquence de 0,5 Hz.
- Pour un mur à écran pare-pluie à pression équilibrée, environ le tiers de l'eau disponible s'est introduit par le défaut (soit la même quantité lorsqu'il n'y avait aucune différence de pression) alors que le spécimen subissait une différence de pression dynamique de  $0+1\,000 \cdot \sin(2\pi f t)$  Pa à une fréquence de 0,5 Hz.

Selon les mesures, peu d'eau a été entraîné dans l'air traversant les orifices de ventilation de l'écran en raison d'une différence de pression statique.



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## INTRODUCTION

The pressure equalized rainscreen (PER) principle is considered the most effective design approach to control rain penetration in walls. However, a literature review conducted by the National Research Council (NRC) to determine design guidelines for such walls (IRC Internal Report No. 629) concluded that current guidelines are not at all comprehensive. As a consequence, a collaborative research and development project to develop design guidelines for PER walls was initiated. This project has three tasks, namely computer modeling, experimental evaluation and development of design guidelines. Canada Mortgage and Housing Corporation (CMHC) is jointly sponsoring the experimental evaluation task of the project. In addition, several wall system manufacturers are participating in the project by supplying test specimens and providing technical and practical information.

This report presents results from the experimental evaluation task. It documents pressure equalization response, deflection measurements, rain penetration control and air leakage measurements of two precast concrete sandwich panel test specimens that were supplied by the Canadian Prestressed Concrete Institute (CPCI).

## TEST SPECIMENS

The two test specimens were constructed by Central Precast Limited in Ottawa. Following is a description of the specimens. It is partially based on information supplied by Central Precast Limited.

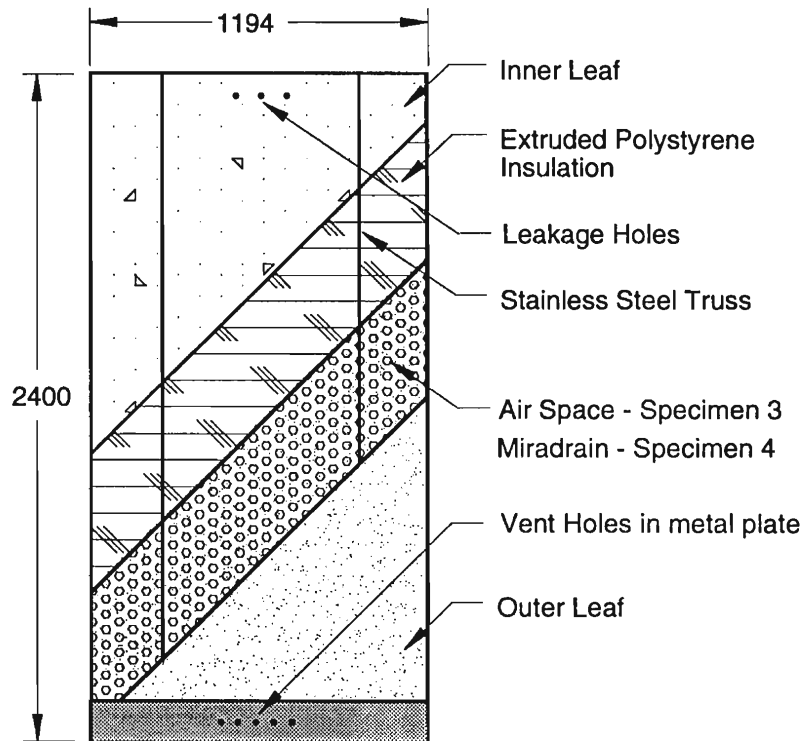
- Each specimen has overall dimensions of 2.40 m high by 1.19 m wide (Figure 1).
- The air barrier of the two specimens is a 100 mm thick reinforced concrete slab measuring 2.40 m high by 1.19 m wide and reinforced by a 100 mm by 100 mm wire mesh located at the approximate center of the slab. Four anchor points are provided at the corners of the test specimen in order to mount the specimen into the test frame. The concrete slab is reinforced at these four locations with a "U" shaped rod. Three 6 mm diameter leakage holes were drilled through the air barrier slab 100 mm apart and 70 mm from the top to simulate a leaky air barrier. The area of each hole was of a size that could be detected by visual inspection and the air flow rate was determined to be the equivalent of 0.1 L/s/m<sup>2</sup> at 75 Pa.
- The rainscreen of the two specimens is a 64 mm thick reinforced concrete slab measuring 2.36 m high by 1.19 m wide. A reinforcing mesh similar to the one in the air barrier is also used in the rainscreen. This concrete slab is 38 mm shorter than the air barrier slab with the difference located at the bottom of the specimen (Figure 2). This opening acted as the vent for the cavity in the test specimens. However, initial testing demonstrated that the opening was considerably larger than was necessary for adequate pressure equalization of the cavity. Hence, a sheet metal plate with five 13 mm diameter holes punched in the center was mounted over the opening; the size and number of holes was chosen to give venting that ranged from less to more than that required for adequate pressure equalization of the cavity.
- A 63 mm space between the air barrier and rainscreen is maintained by two stainless steel trusses (web members 4 or 5 mm in diameter), mounted vertically 610 mm apart and embedded half way into both slabs. Extruded polystyrene insulation, 2.40 m high x 1.19 m wide x 50 mm thick, is mounted in the space in intimate contact with the air barrier. Specimen 3<sup>1</sup> has an empty cavity that was formed with oiled 13 mm rubber sheets which were removed after the concrete had set; Specimen 4 utilized Miradrain™, a "dimpled" plastic sheet with a geotextile bonded to the top of the dimples, to form the cavity. The Miradrain™ was installed with the geotextile against the rainscreen. The top and bottom of each specimen cavity was finished with plywood and the sides with a bituminous membrane.
- Water penetration requires a supply of water and a defect in the rainscreen in addition to a driving force. Hence for the water penetration tests a defect in the form of a horizontal saw cut was made in the middle of the rainscreen slab of Specimen 3. The cut was 114 mm wide on the exterior by 5 mm high and located 730 mm from the top of the slab. However, when testing demonstrated that venting provided by the full saw cut allowed pressure equalization up to a frequency of 2 Hz, a 50 mm long wooden plug was inserted in the centre of the cut to reduce the length of the defect to 64 mm.

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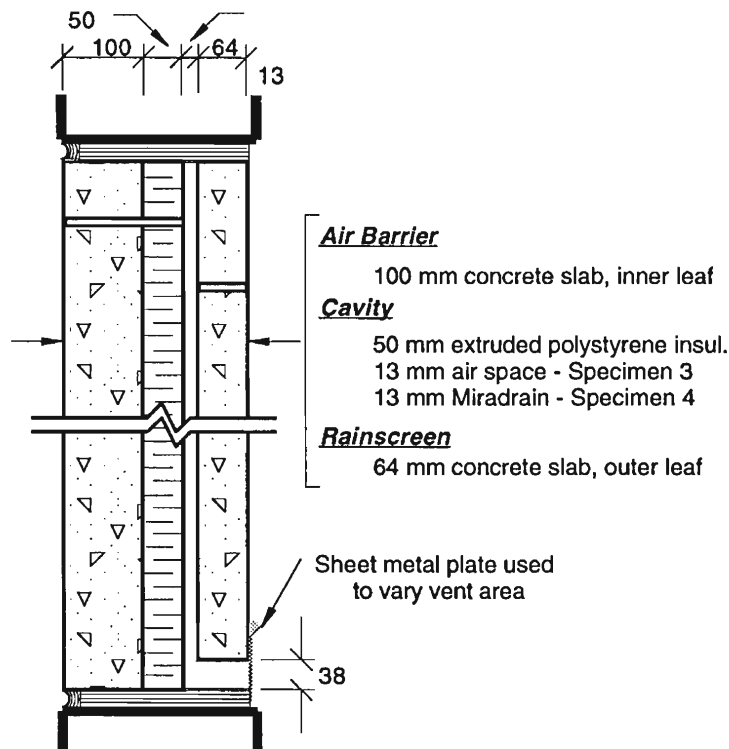
<sup>1</sup> Specimens 1 and 2 were reported on in NRC client Report A3028.2.



The two specimens were installed side by side in a steel test frame. The specimens were attached to the test frame by steel plates located at the top and bottom of the test specimens, and sealed to each other and the test frame using backer rod and dimeric sealant in a two stage joint. The test frame was mounted to the Dynamic Wall Test Facility (Appendix A) with the air barrier slabs facing the laboratory.



**Figure 1.** Details of construction of precast concrete test specimens.



**Figure 2.** Section and venting details of Specimens 3 and 4.

## TEST PROGRAM

Pressure equalization, slab deflection, water penetration, and air leakage were measured in the DWTF. The sub-tasks are summarized as follows:

1. Pressure equalization response was measured at a range of frequencies for different sinusoidal loading (i.e., mean value and amplitude) scenarios.
2. Deflection of the air barrier and rainscreen slabs in response to pressure difference was measured at two frequencies for two leakage hole, one vent hole and one sinusoidal loading scenario.
3. Water penetration was measured through the defect in the rainscreen of Specimen 3 (as an assessment of rain penetration control) with various leakage hole and vent hole combinations and with static and dynamic pressure differences.
4. Air leakage characteristics of all leakage holes and one vent hole were measured for static pressure differences.

### Pressure equalization

The dynamic component of wind approaching a building over open terrain can be represented by adding together sinusoidal components of suitable amplitude, phase, and frequency, selected from a limited range of frequencies. The higher the frequency, the more difficulty a given PER wall system will have in transmitting the fluctuation into the cavity in time to keep the pressure difference across the rainscreen within desirable limits. An important design issue is the upper bound for frequency content. The main energy content of wind flowing over open terrain is at relatively low frequencies in the range of 0.01 Hz to 0.1 Hz. The amount of energy contained at frequencies of 1 Hz and higher is normally negligible, but designers should be aware that some areas of the building envelope may experience energy at higher frequencies through interaction of the flow with parts of the building or with upwind structures. In the absence of special considerations, it is suggested that results at two frequencies, 0.5 Hz and 5 Hz, be used to evaluate the performance of test specimens.

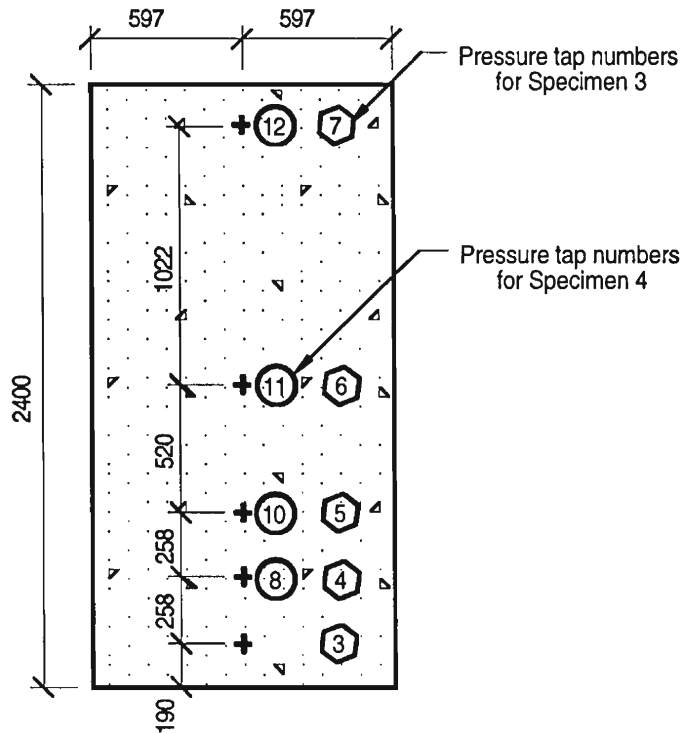
The response of the cavities of Specimens 3 and 4 was measured for sinusoidal loading at seven frequencies for four leakage hole, three vent hole and three sinusoidal loading (i.e., mean value and amplitude) scenarios (see following table).

Test Specimen	Cavity (13 mm)	Vent Holes (Ø 13 mm)	Leakage Holes (Ø 6 mm)	Loading Scenarios <sup>1</sup>	Frequencies <sup>2</sup> <i>f</i>
3	Air space	1	0, 1, 2 & 3	3	7
		3	0, 1, 2 & 3	3	7
		5	0 & 3	3	4
4	Miradrain™	1	0, 1, 2 & 3	3	7
		3	0, 1, 2 & 3	3	7

Notes: 1. The three loading scenarios were  $500+500\cdot\sin(2\pi f t)$  Pa,  $0+1000\cdot\sin(2\pi f t)$  Pa and  $1000+1000\cdot\sin(2\pi f t)$  Pa.

2. The seven frequencies, *f*, were 0.05, 0.1, 0.2, 0.5, 1, 2 and 5 Hz. With five vent holes, the four frequencies, *f*, were 0.5, 1, 2 and 5 Hz.

Pressure difference across the air barrier was measured along the height of the cavity of the two specimens (Figure 3) with Setra differential pressure transducers, all with similar frequency response characteristics. These were installed using the same length of vinyl tubing and attached to the same length of copper pressure taps. The pressure taps extended to the center of the cavity, half way between the rainscreen and the insulation, and were epoxied in place to ensure a high strength, airtight seal.



**Figure 3.** Location of pressure taps.

Figure 4 provides a graphical representation of data obtained from a typical pressure equalization test. The top half of the figure presents pressure difference measured for Specimen 3 with a loading scenario of  $500 + 500 \cdot \sin(2\pi f t)$  Pa with  $f$  equal to 1.0 Hz. The bottom half presents the pressure difference across the rainscreen. This is determined by subtracting the pressure difference across the air barrier from the pressure difference across the specimen. It is important to note that the maximum pressure difference across the rainscreen is a consequence of both the amplitude ratio and phase lag between the specimen and air barrier pressure differences. In fact, a large phase lag will produce a substantial pressure difference across the rainscreen even though the amplitude of the pressure difference across the air barrier may be close to that across the specimen.

All of the pressure data measured for each test condition were fitted to sine/cosine functions using a least squares fit. From this analysis, an amplitude and phase angle were determined and the pressure equalization response of the specimen was calculated. The pressure equalization response measured for all test conditions are presented in Appendices B (Specimen 3) and C (Specimen 4). Figures 5 and 6 provide a summary of the results obtained from Specimens 3 and 4 respectively. Plotted are the percentage load across the rainscreen versus the number of leakage holes, the number of vent holes, and the loading condition for frequencies of 0.5 Hz and 5.0 Hz.

**Observations:** The following observations on the pressure equalization response of the specimens derive from the summary of results given in Figures 5 and 6.

- Pressure equalization response improved as the leakage of the air barrier decreased. However, the governing criteria for air leakage with respect to rain penetration control may be that required for static pressure equalization rather than that required for dynamic pressure equalization. For example, an effective vent resistance to leakage resistance ratio of 20:1 will produce a rainscreen pressure difference of 25 Pa if the design pressure is 500 Pa. This ratio is best achieved by decreasing the leakage area before increasing the vent area.
- Pressure equalization response improved as the vent area in the rainscreen increased. It can be shown that dynamic pressure equalization response is directly related to the volume to vent ratio, and for these specimens a minimum volume to vent ratio of about 50 m is recommended for adequate response. This is best achieved by minimizing the volume before increasing the vent area.

- Pressure equalization response became worse as the frequency increased. This is not unexpected since the venting ranged from less than to more than necessary for the range of frequencies being considered. However, a comparison of the response at 0.5 Hz to that at 5.0 Hz demonstrates the importance of adequate dynamic pressure equalization response.
- The performances of Specimens 3 and 4 were nearly the same, with a slightly better performance measured for the open cavity of Specimen 3. The difference in performance, although measureable, is not critical and is more than compensated for by the reduced labour and greater ease of manufacture when a geosynthetic such as Miradrain™ is used to define and maintain the cavity. Note that the low water vapour transmission characteristics of the geosynthetic require that attention be paid to vapour diffusion control in such an assembly.

### **Deflection**

Deflections of the air barrier and rainscreen slabs of Specimen 3 were measured using Lucas Schaevitz DC-operated Linear Voltage Differential Transformer (LVDT) gauges. Two LVDTs located at mid-height of the air barrier slab measured deflections at the centre and the outer edge. A similar setup measured deflections at the centre and outer edge of the rainscreen slab, and a fifth LVDT measured deflection at the top centre of the rainscreen slab. Deflections were measured with 0 and 3 leakage holes, 1 vent hole and for a specimen pressure difference of  $0+1000 \cdot \sin(2\pi f t)$  Pa with  $f$  equal to 0.5 Hz and 1.0 Hz.

*Observations:* Deflections of the air barrier may adversely affect the pressure equalization response and deflections of the rainscreen may have the opposite effect. Distinguishing between the flexibility of the rainscreen and that of the air barrier is difficult, given that they are connected by two stainless steel trusses. Further, the deflections are so small ( $0.05$  to  $0.15 \pm 0.05$  mm/kPa) that the relative accuracy of the measurements is low even though they are taken to great precision. The indications are, however, that the rainscreen is somewhat more flexible than the air barrier in spite of their composite action, and this flexibility contributes to the pressure equalization response of the cavity.

### **Water penetration**

Water was sprayed on the test specimens at a rate of  $3.42 \text{ L/s/m}^2$  using the spray rack in the DWTF. The rate of water entering the cavity of Specimen 3 was measured gravimetrically using a water collection system which was installed at the bottom of the cavity.

The relationship between static pressure difference across the rainscreen and water flow through the rainscreen, i.e., the 'face seal' value of the rainscreen, was determined with all leakage holes opened, all vent holes closed, and for pressure differences across the rainscreen from 0 Pa to 500 Pa. The results are presented graphically in Figure 7. At 0 Pa, about 0.19 L/min passed through the defect due to gravity. It should be noted that if the full 5 mm height of the saw cut is assumed to be filled with water, the hydraulic head at the bottom edge is equivalent to a pressure difference of nearly 50 Pa. Therefore, even in the absence of an air pressure difference, water flows under the influence of gravity. With increasing pressure difference, the flow rate increases rapidly until at about 100 Pa when nearly all of the incident water is being driven through the defect (0.60 L/min vs 0.65 L/min).

The amount of water entrained in the air flow through the vent holes was determined with all leakage and vent holes open and the defect closed. The flow rate was less than 0.019 L/min under a static pressure difference of 250 Pa (lower curve in Figure 7). This flow, which can be attributed to entrainment of water in the air flow through the three vent holes, can be considered negligible.

*Observations:* The effect of dynamic pressure conditions was determined with a pressure difference across the specimen of  $0+1000 \cdot \sin(2\pi f t)$  Pa with  $f$  equal to 0.5 Hz. The water flow rate measured through the defect under these conditions was as follows (Figure 8):

- With a leaky air barrier, i.e., three leakage holes open, and no venting (other than that supplied by the defect), 0.48 L/min passed through the defect. Note that these conditions are the equivalent of a 'face seal' system with a defect. In addition, the pressure difference measured across the rainscreen increased to  $33+177 \cdot \sin(2\pi f t)$  Pa,  $f = 0.5$  Hz.
- With an airtight air barrier and no venting (other than that supplied by the defect), 0.40 L/min passed through the defect. Note that these conditions are the equivalent of a drained cavity wall, i.e., one with an airtight air barrier to achieve static pressure equalization but insufficient venting to achieve

dynamic pressure equalization. In addition, the pressure difference measured across the rainscreen reduced to  $20 + 74 \cdot \sin(2\pi f t)$  Pa,  $f = 0.5$  Hz.

- With an airtight air barrier and five vent holes open, 0.21 L/min passed through the defect. Note that these conditions are the equivalent of a PER wall i.e., one with an airtight air barrier to achieve static pressure equalization and sufficient venting to achieve dynamic pressure equalization. In this case the amount of water passing through the defect was about the same as with no pressure difference across the rainscreen (0.19 L/min). In addition, the pressure difference measured across the rainscreen was reduced to essentially zero ( $1 + 6 \cdot \sin(2\pi f t)$  Pa,  $f = 0.5$  Hz).

The **Pressure equalization** sub-task demonstrated that the average pressure difference across the rainscreen remained zero under dry test conditions. Therefore, the increase in average pressure difference with the application of water bears further analysis. A review of the pressure difference measured across the rainscreen (Figure 9) shows that it does not follow a sinusoidal waveform when water is present. On the positive half of the pressure cycle, water blocks the defect, venting decreases, and the pressure difference across the rainscreen increases. On the negative half of the cycle, the blockage is removed, venting increases, and the pressure difference across the rainscreen decreases. As a result, an asymmetrical waveform is present which induces a higher average pressure difference across the rainscreen.

### **Air leakage**

Air leakage was measured with Miriam Laminar Flow Elements (LFE) and Air Limited's Micromanometers at static pressure differences across the specimen ranging up to approximately 1000 Pa. The measurements were performed with one vent hole open, and for the following conditions:

- *Base Leakage.* Polyethylene was tightly sealed to the steel frame on the laboratory side of the DWTF, covering both specimens and their seal to the frame. The only leakage would be through the seals around the door and piston.
- *Specimen Perimeter Leakage.* All leakage holes in the air barrier slabs were closed. The polyethylene was removed so that leakage could occur through the specimen perimeter seals.
- *Specimens 3 & 4 Leakage.* 1, 2 and 3 leakage holes were opened in Specimen 3 and Specimen 4.
- *Specimen 3 Leakage.* 1, 2 and 3 leakage holes were opened in Specimen 3 and all leakage holes were closed in Specimen 4.
- *Defect Leakage.* Flow through the defect in the rainscreen of Specimen 3 was measured.

The *Base Leakage*, *Specimen Perimeter Leakage* and *Specimen 3 & 4 Leakage* measured for the experimental setup are shown in Figure 10. The *Base Leakage* and *Specimen Perimeter Leakage* are less than 10% of that measured through the leakage holes.

To determine the air flow characteristics of the leakage holes, leakage rate (L/s) is fitted to the pressure difference across the air barrier (Pa) by a least squares fit to the following equation:

$$Q = C \cdot \Delta P^n \quad (1)$$

where  $Q$  is the air flow through the air barrier and  $\Delta P$  is the pressure difference across the air barrier. Values for  $C$  and  $n$  determined for each of the *Specimen 3 & 4 Leakage* test conditions are also shown in Figure 10. The air leakage characteristic determined for *Defect Leakage* in Specimen 3 is shown in Figure 11. The air leakage characteristics determined for the *Specimen 3 Leakage* test conditions are shown in Figure 12. The air leakage characteristics determined for the Specimen 4 leakage test conditions are shown in Figure 13.

**Observations:** Air leakage through the air barrier system can be minimized by careful design and construction, but it is unwise to ignore the likelihood that some level of leakage will be present. According to a recently prepared guide<sup>2</sup> for the evaluation of air barrier systems, a properly functioning air barrier system should have a flow rate of not more than 0.1 L/s/m<sup>2</sup> at a pressure difference of 75 Pa,

<sup>2</sup> Technical Guide for Air Barrier Systems, Canadian Construction Materials Centre, National Research Council Canada, Ottawa Canada.

or approximately 0.3 L/min for a specimen area of 2.87 m<sup>2</sup>. This is approximately what was measured for 1 leakage hole for both Specimen 3 and Specimen 4.

It is obvious from Figure 12 that the flow rate measured through three leakage holes on Specimen 3 was not three times the flow rate through one leakage hole, as should be anticipated. Prior to this measurement, the results from the pressure equalization tests had been consistent with the hypothesis that all leakage holes were of similar resistance. Figure 14 illustrates the relative resistance of leakage holes as determined from the nominal area, from the two non-zero frequency response tests (at  $f = 0.05$  Hz), and from the flow rate data. All but the flow rate data are consistent with the hypothesis that all leakage holes were of similar resistance. Physical investigation of the third leakage hole in Specimen 3 after the flow rate test indicated that an obstruction existed in the hole. The nature of this obstruction and when it occurred has not been determined, but it is concluded that it did not exist during the previous tests.

## DESIGN CONSIDERATIONS

Three main points should be made for the benefit of the designer of the rain penetration control system:

1. Accidental defects are unlikely to be dead level, and water will run into the wall under the influence of gravity if the inner end of the leakage path is lower than the outer end. The effect in terms of pressure difference amounts to nearly 10 Pa per mm of difference in elevation.
2. The limitation on the amount of water passing through a defect may be the quantity of water presented at the outer end of the leakage path, rather than the magnitude of the pressure difference. Further work is required on the complex interplay of direct impact of rain, absorption by porous surfaces, and surface drainage in order to estimate the supply of water. However, for the supply rates applied to Specimen 3, flow through the defect rose steeply as the pressure difference increased to about 100 Pa, at which point all of the available water was passing through the defect.
3. Entrainment of water into the air flow through vent holes should not pose a problem, provided proper use is made of drips, baffles, and upward slope of flashing to control the movement of water wherever openings are deliberately made in the rainscreen.

**Figure 4:** Typical Test Data. Measured for Specimen Number 3 with 1 vent hole and 3 leakage holes under a loading condition of  $500 + 500 \cdot \sin(2\pi ft)$  Pa with  $f$  equal to 1.0 Hz (See Figure 3 for location of Channels).

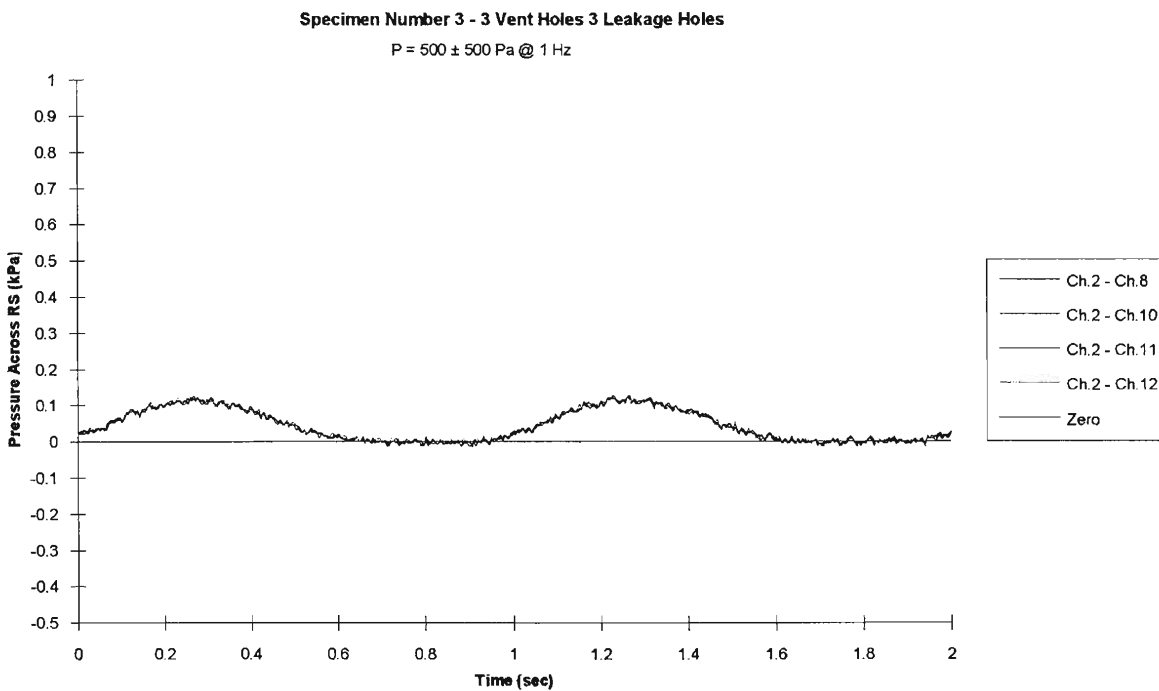
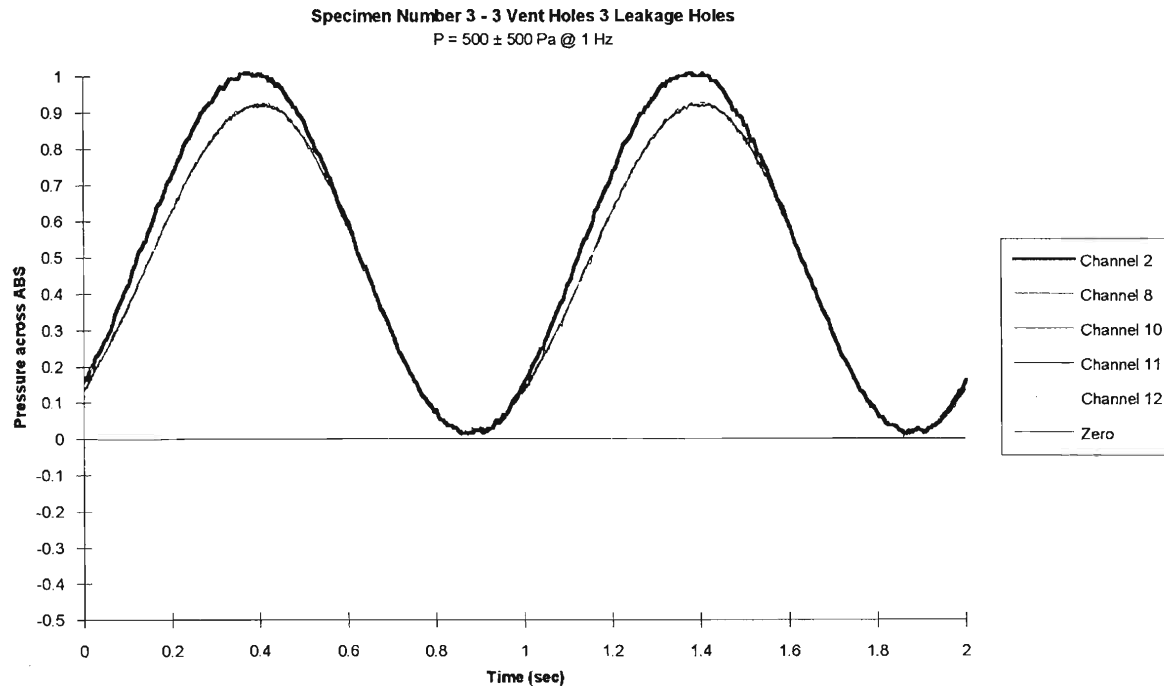


Figure 5: Pressure difference measured across the rainscreen of Specimen 3 for various test conditions.

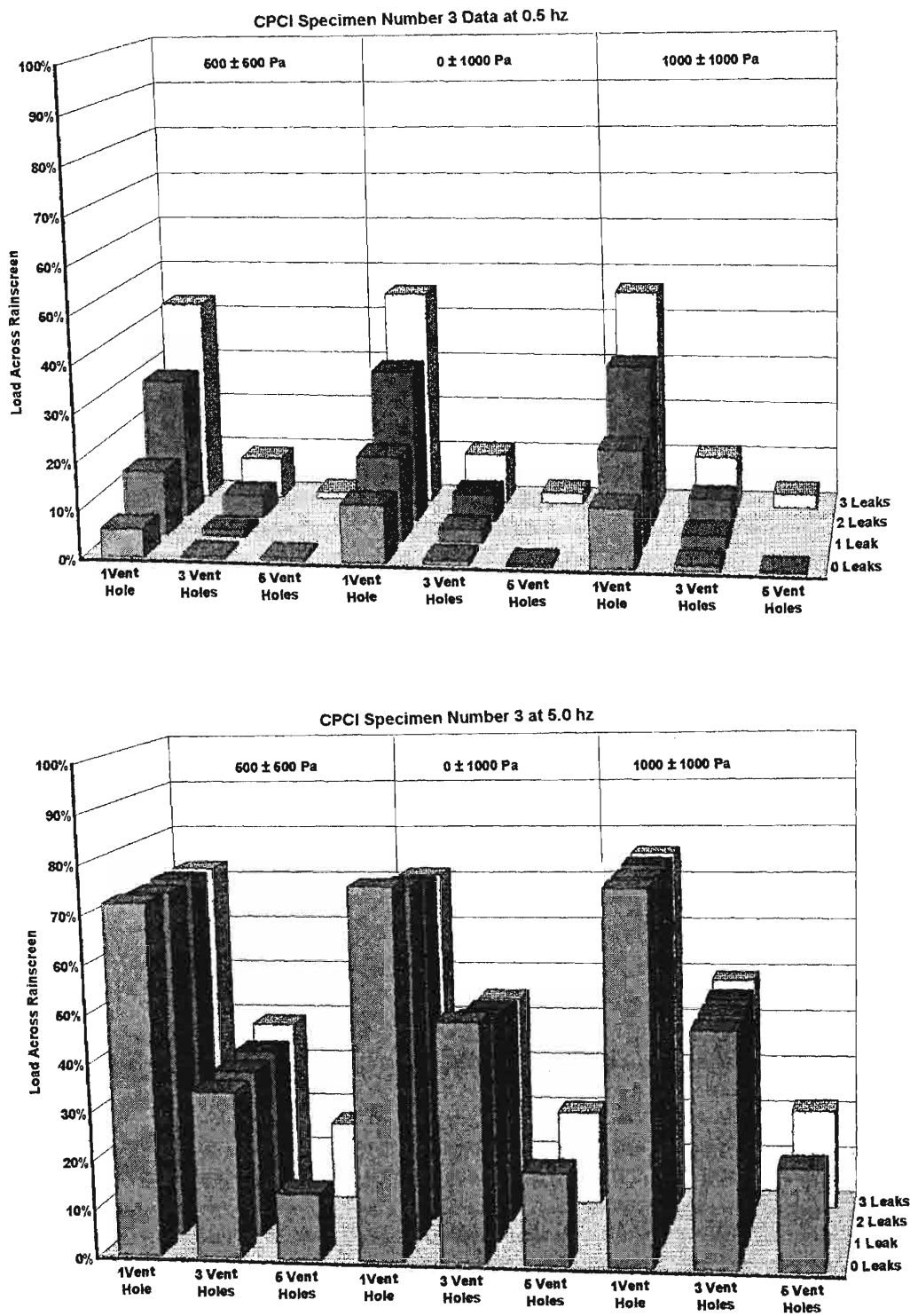
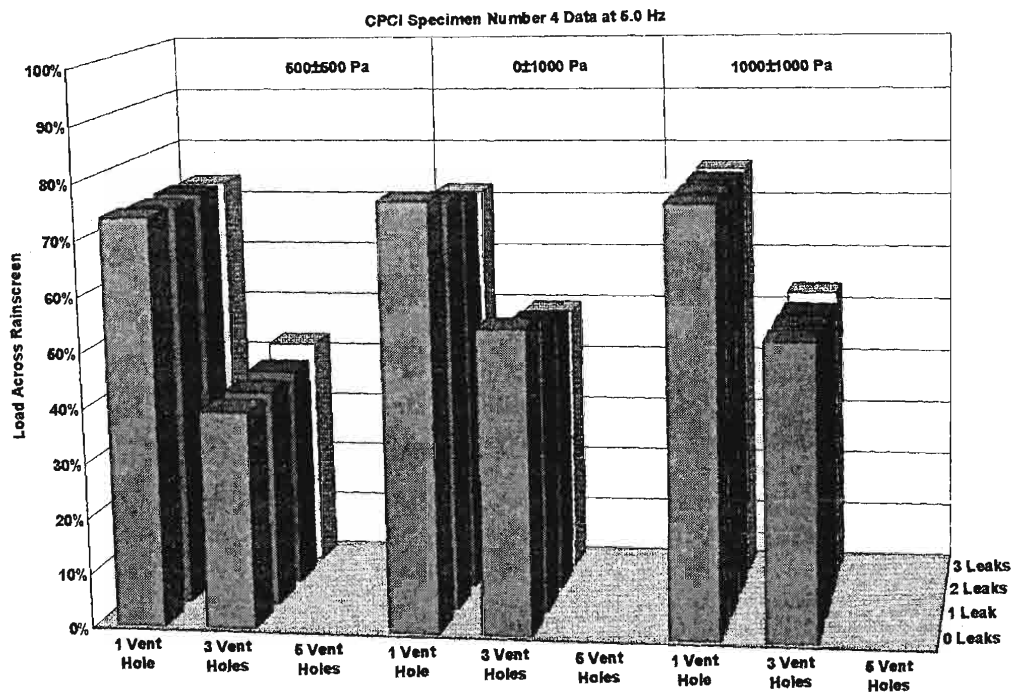
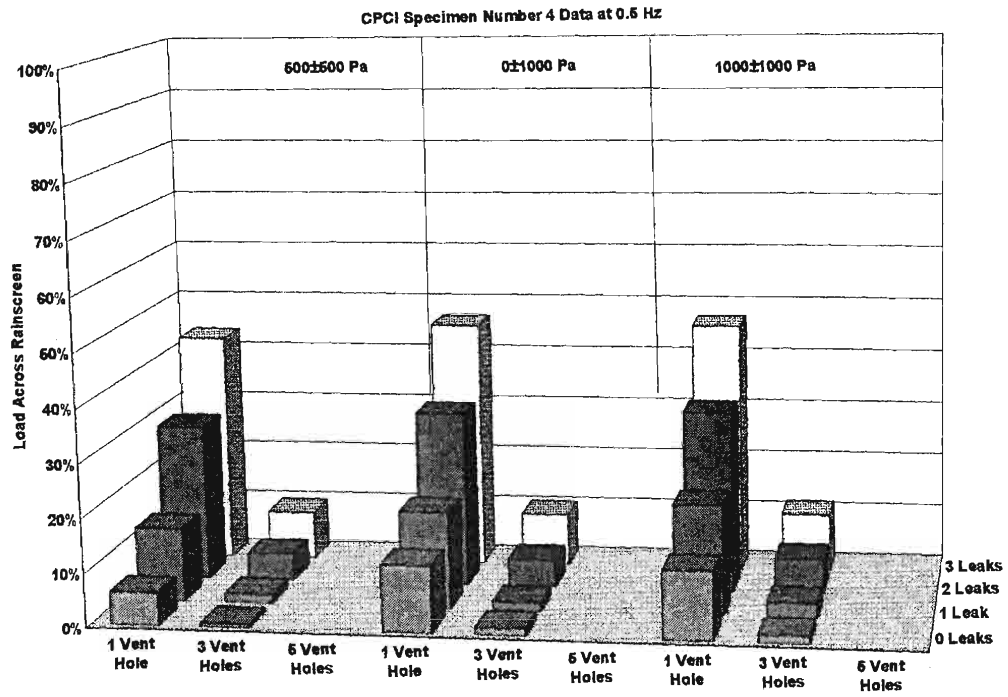
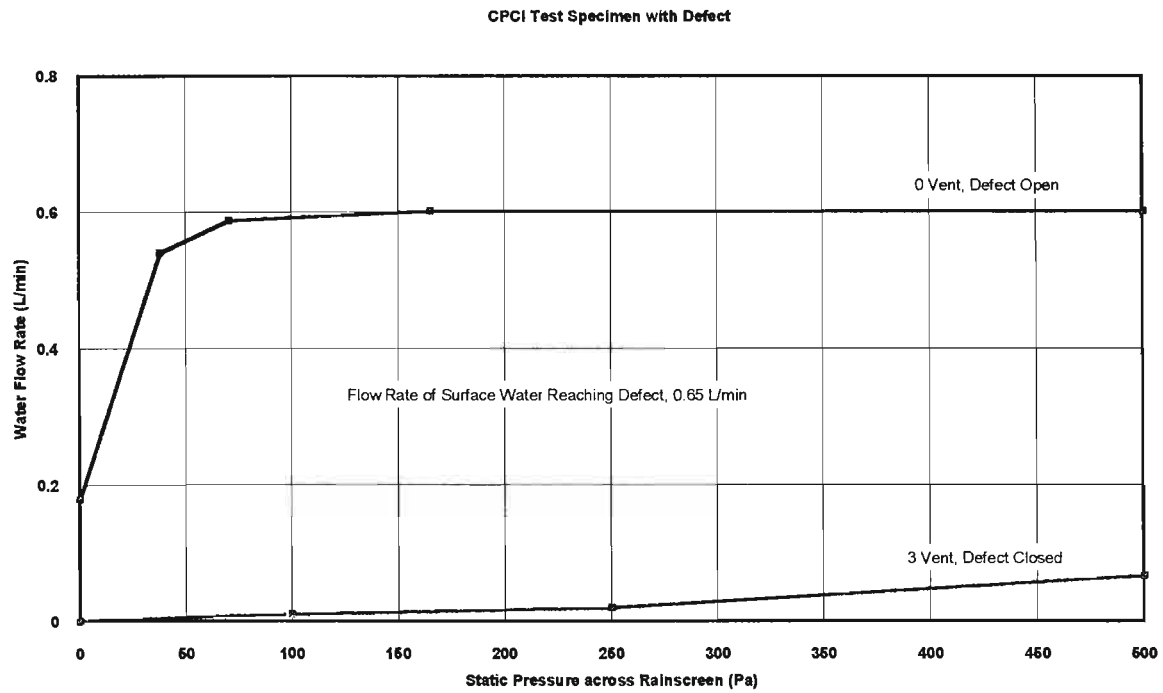




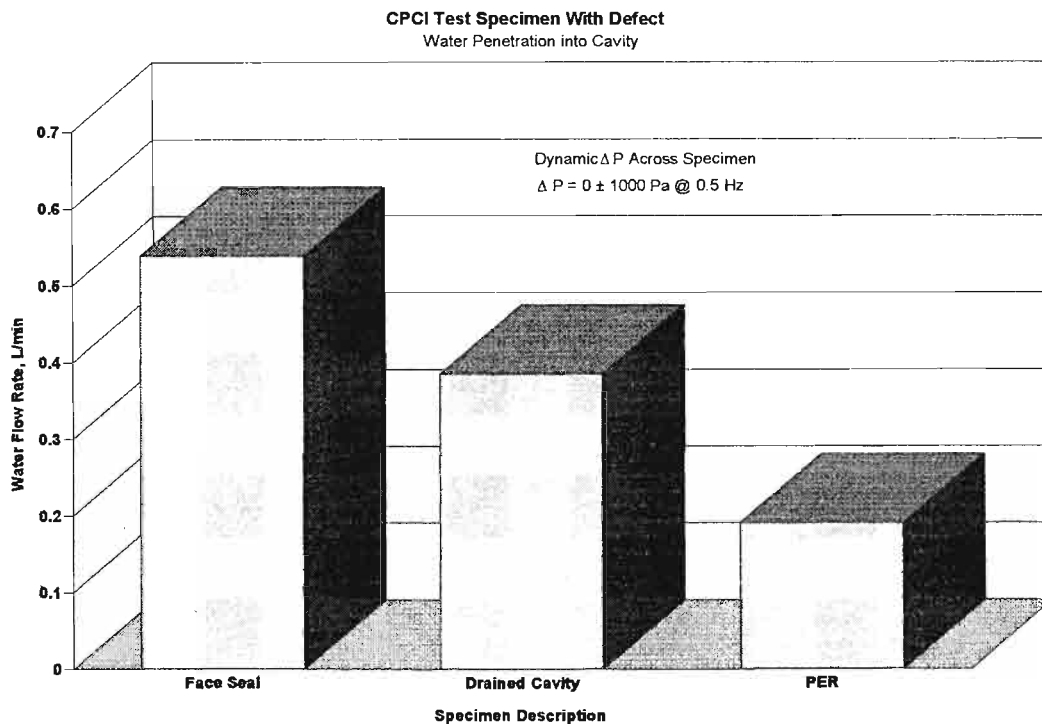
Figure 6: Pressure difference measured across the rainscreen of Specimen 4 for various test conditions.



**Figure 7:** Water flow rate measured through the defect and vents of Specimen 3 under static pressure difference.



**Figure 8:** Water flow rate measured through the defect of Specimen 3 under dynamic pressure difference.



**Figure 9:** Pressure difference measured across the rainscreen of Specimen 3 with and without water sprayed on the surface.

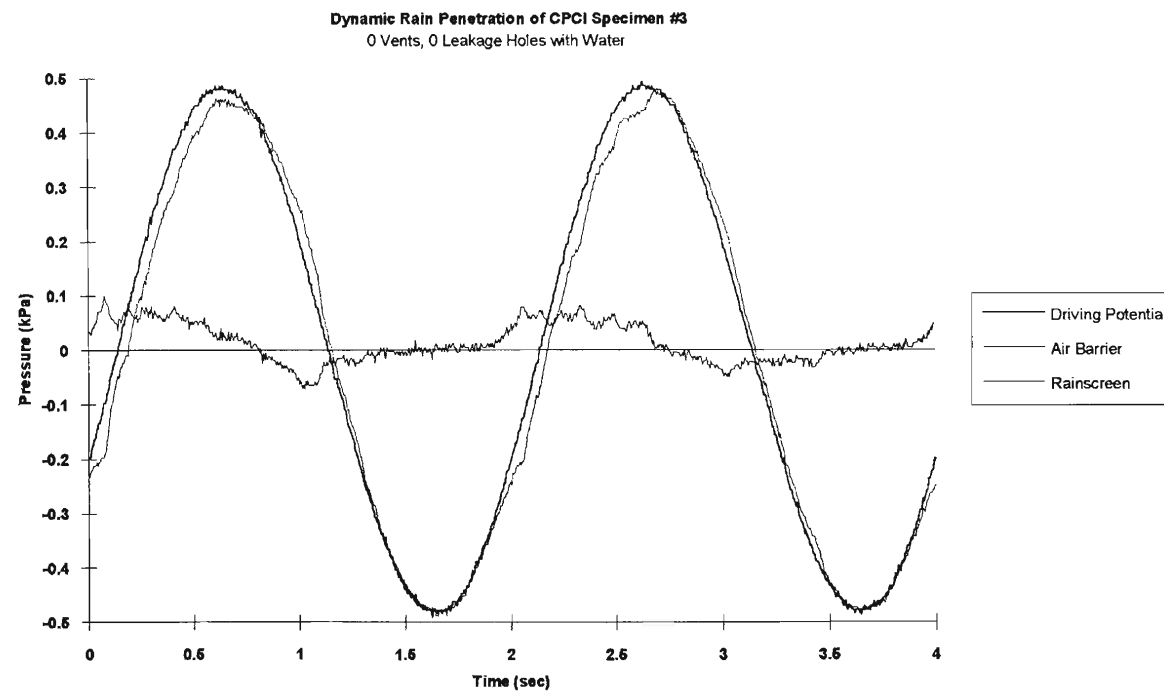
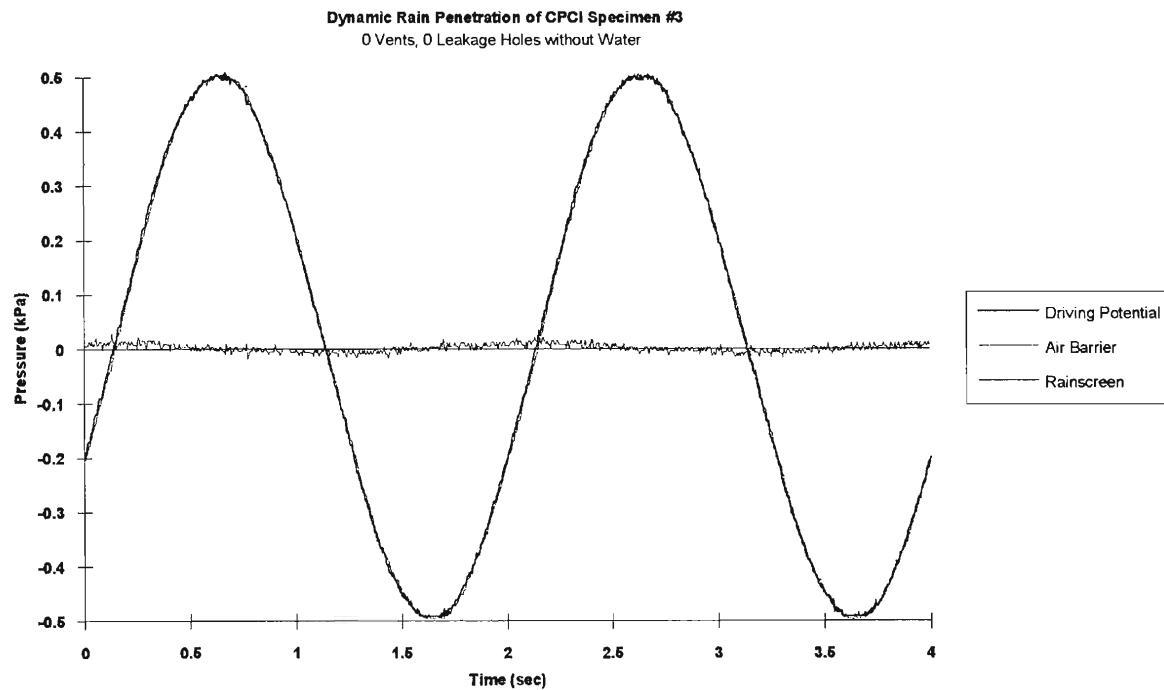


Figure 10: Air flow measured for Base Leakage, Specimen Perimeter Leakage and Specimen 3 and 4 Leakage.

### CPCI Specimens 3 and 4 - Air Leakage Results

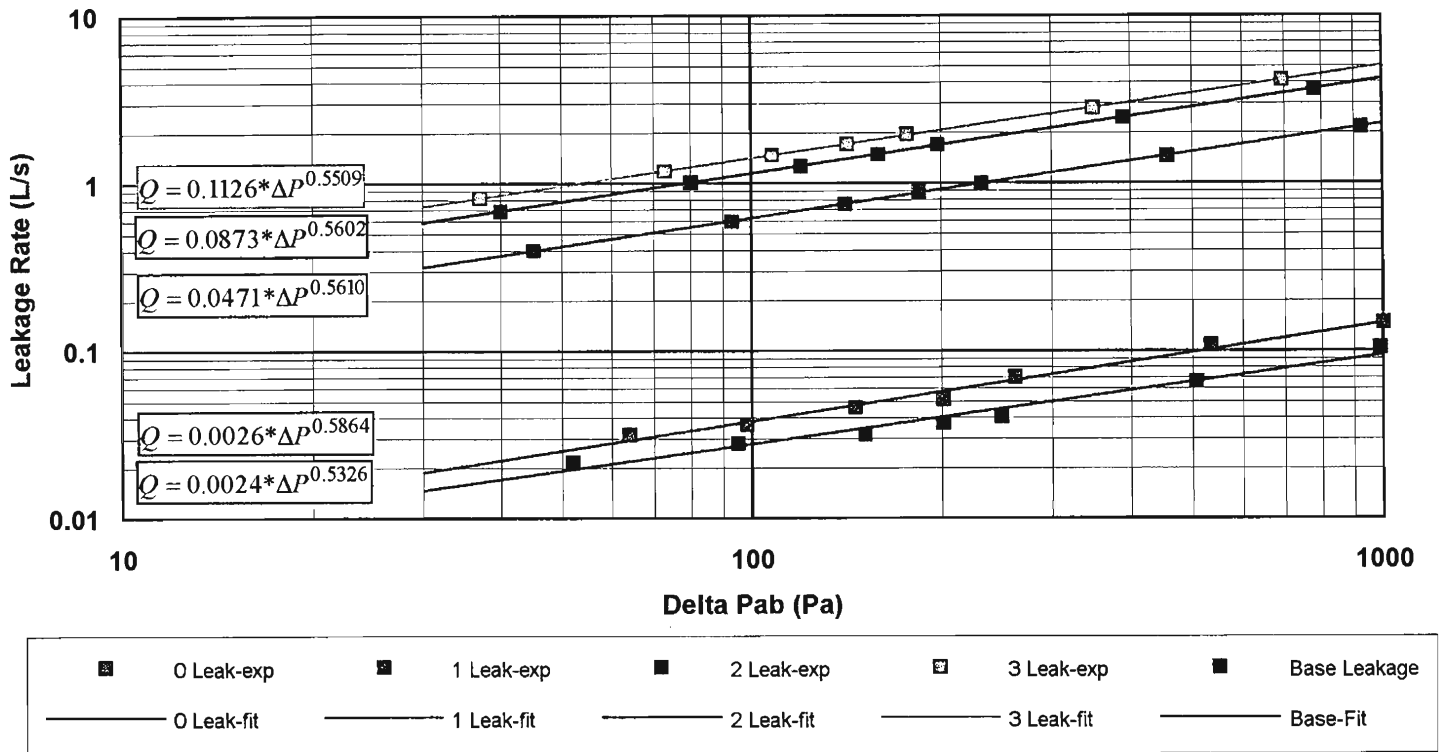


Figure 11: Air flow measured for Defect Leakage.

### Test Specimen 3 - Defect Flow Characteristics 0 Vent Holes, All Leakage Open

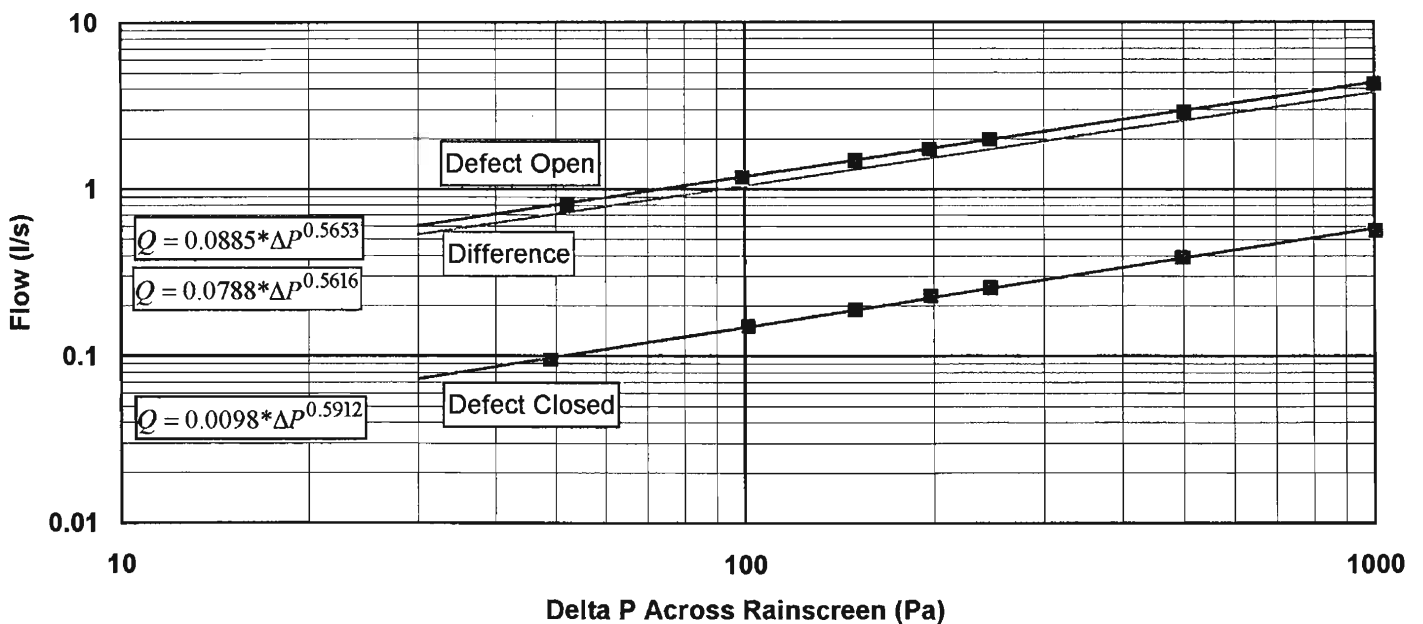


Figure 12: Air flow measured for Specimen 3 Leakage.

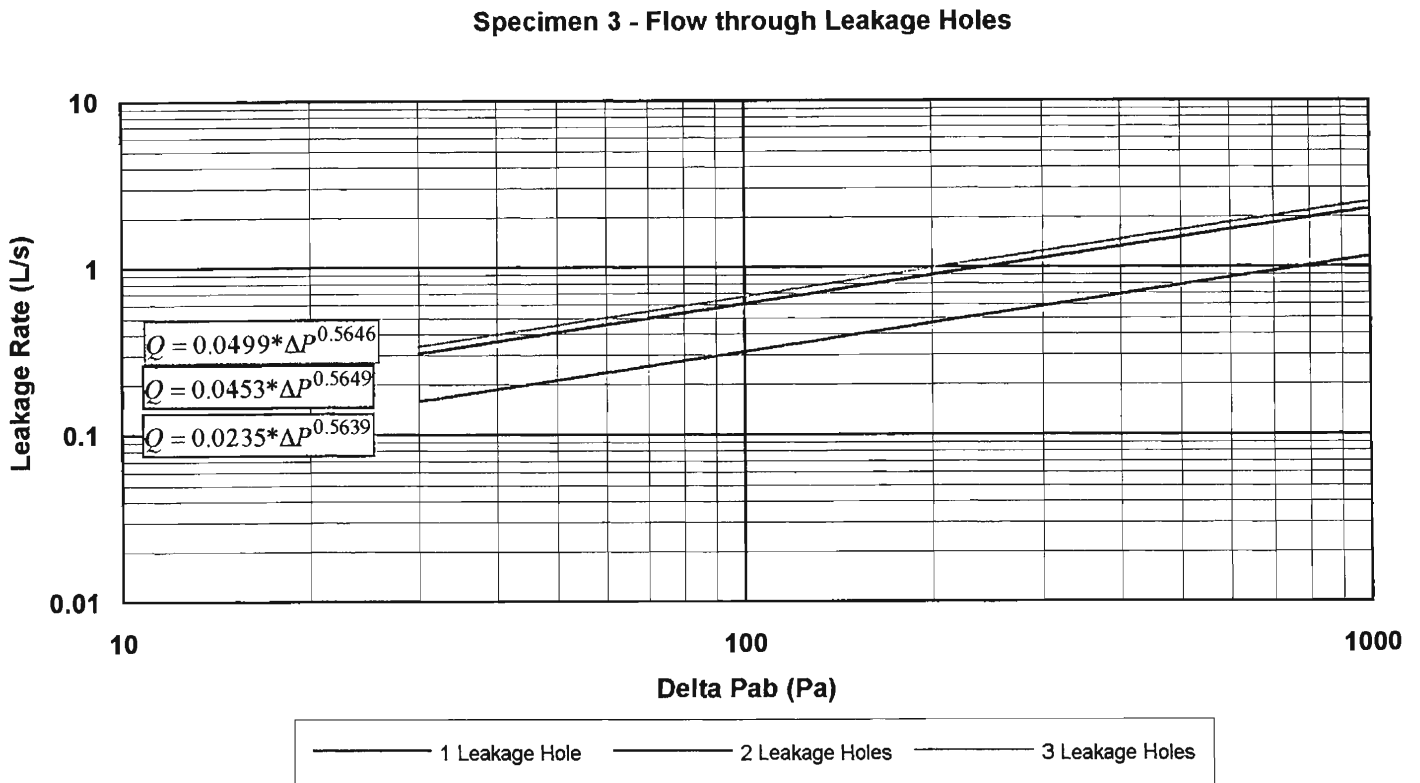
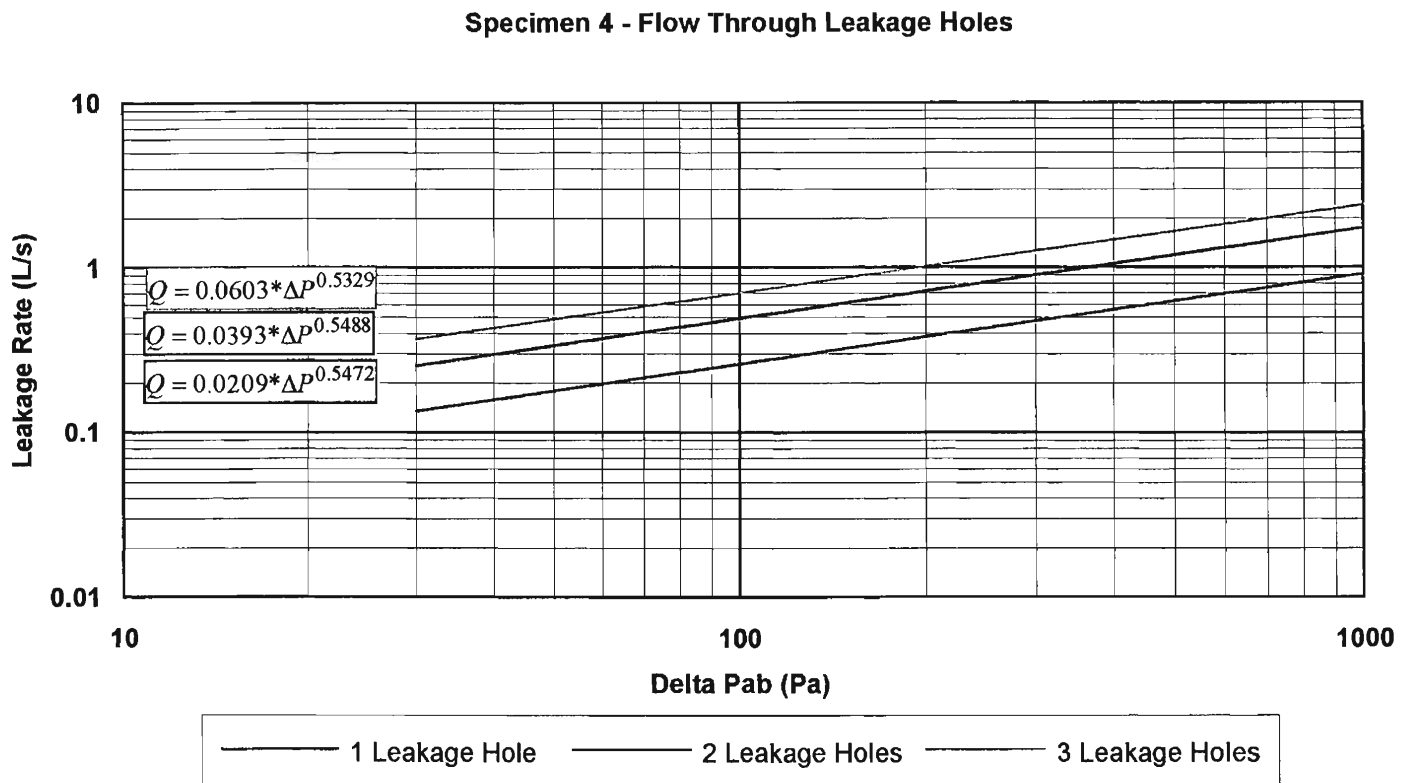
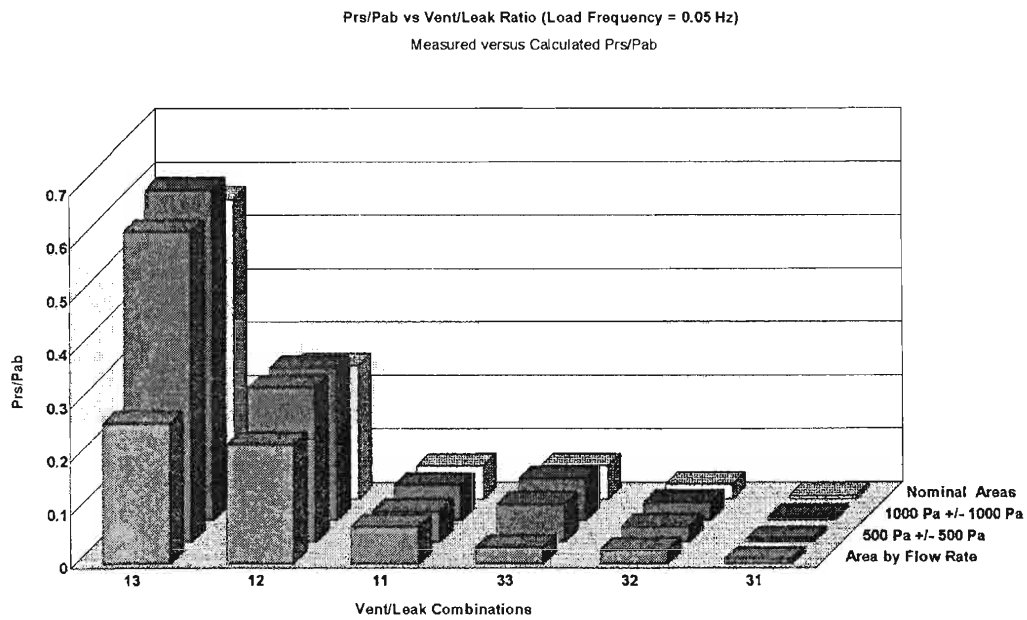


Figure 13: Air flow calculated for Specimen 4 Leakage.



*Figure 14. Comparison of relative resistance of leakage holes determined from various tests.*



## **APPENDIX A**

### **DYNAMIC WALL TEST FACILITY**

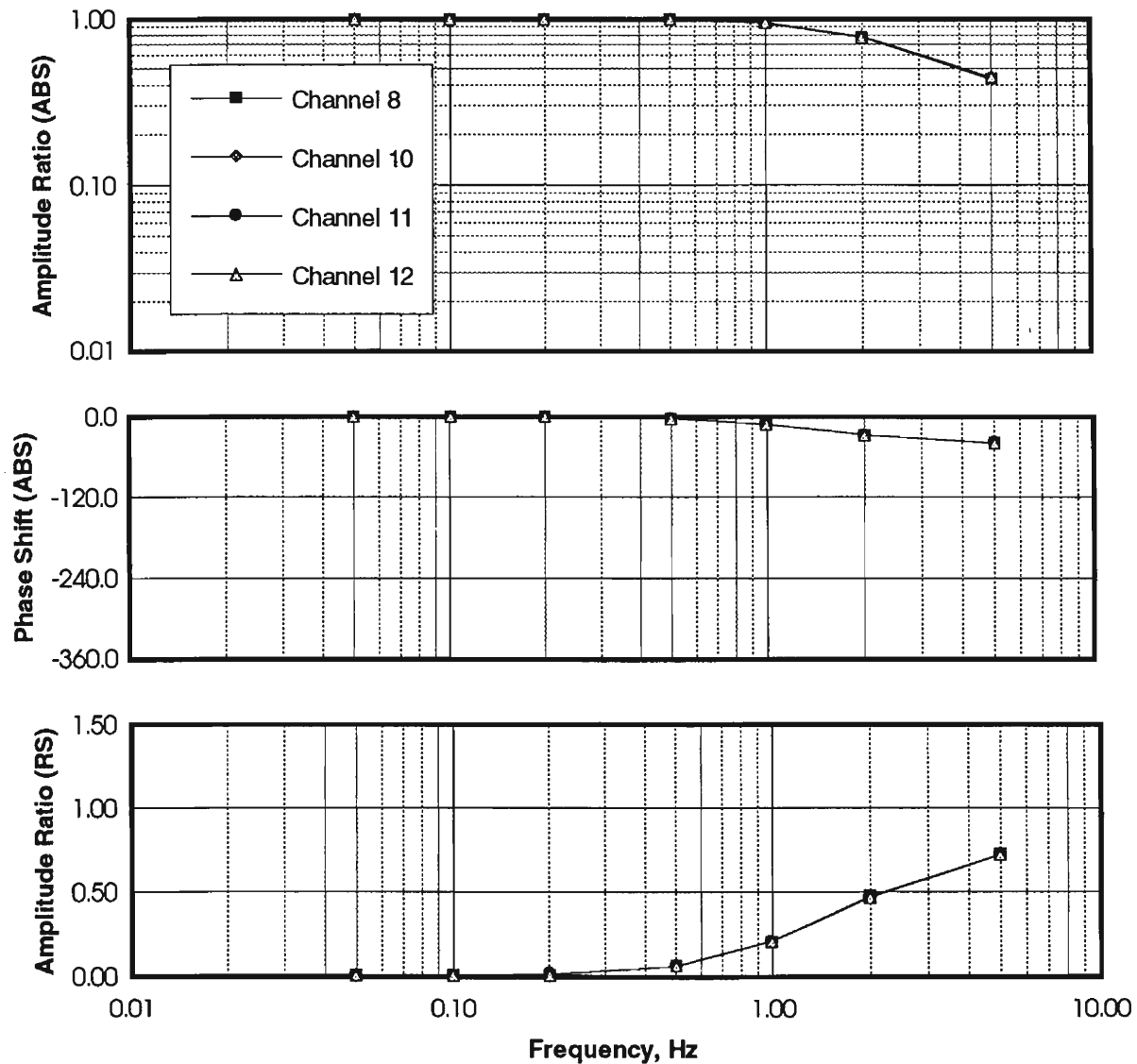
The DWTF has undergone major changes. The previous door supported test specimens 1.22 m by 2.44 m. It was replaced to allow for a 2.44 by 2.44 m test specimen. The hydraulic actuator used to move the 2.36 m diameter piston has been upgraded. The counter balanced, double rod cylinder was replaced with a linear bearing/actuator system. This greatly reduced the mass of the moving system and greatly improved the dynamic performance of the actuator/piston assembly. The seals for the door and the piston were also replaced. The heat exchanger and the hydraulic pump were upgraded to provide better cooling at higher hydraulic fluid flow rates. A computer controlled flow valve was added to the make up air system. This system prevents the piston from drifting to either limit of its travel when a leaky specimen is tested at a mean pressure other than zero.

The computerized data acquisition and control of the DWTF has been dramatically improved. Previous wave forms were limited to those found on any function generator and the operator had to adjust the output voltage to attain the desired pressure. The make up air system was a series of gate valves that were manually adjusted to prevent the piston from drifting to its limits. The data acquisition was performed on a maximum of eight channels at a sample rate of 50 samples/sec/channel (400 samples total per second) on an independent platform. Now all of these functions are performed by a single machine and without manual adjustments by the operator. In addition to the standard wave forms (i.e., sine, saw tooth, square, etc.) the new system allows data files containing set points to be transferred to the control system. These files may be either created by NRC researchers or may be actual measured wind records. The sample collection has been improved to 24 channels at a sample rate of 200 samples/sec/channel (48 000 samples total per second).

Although the overall thrust of the actuator system has been reduced from 231 kN to 45 kN, the dynamic characteristics have been improved. Previously, the system was capable of traversing 75 mm at a frequency of 0.4 Hz. Now the system will move the same distance at frequencies of up to 2 Hz.

**Figure B1** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 0 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

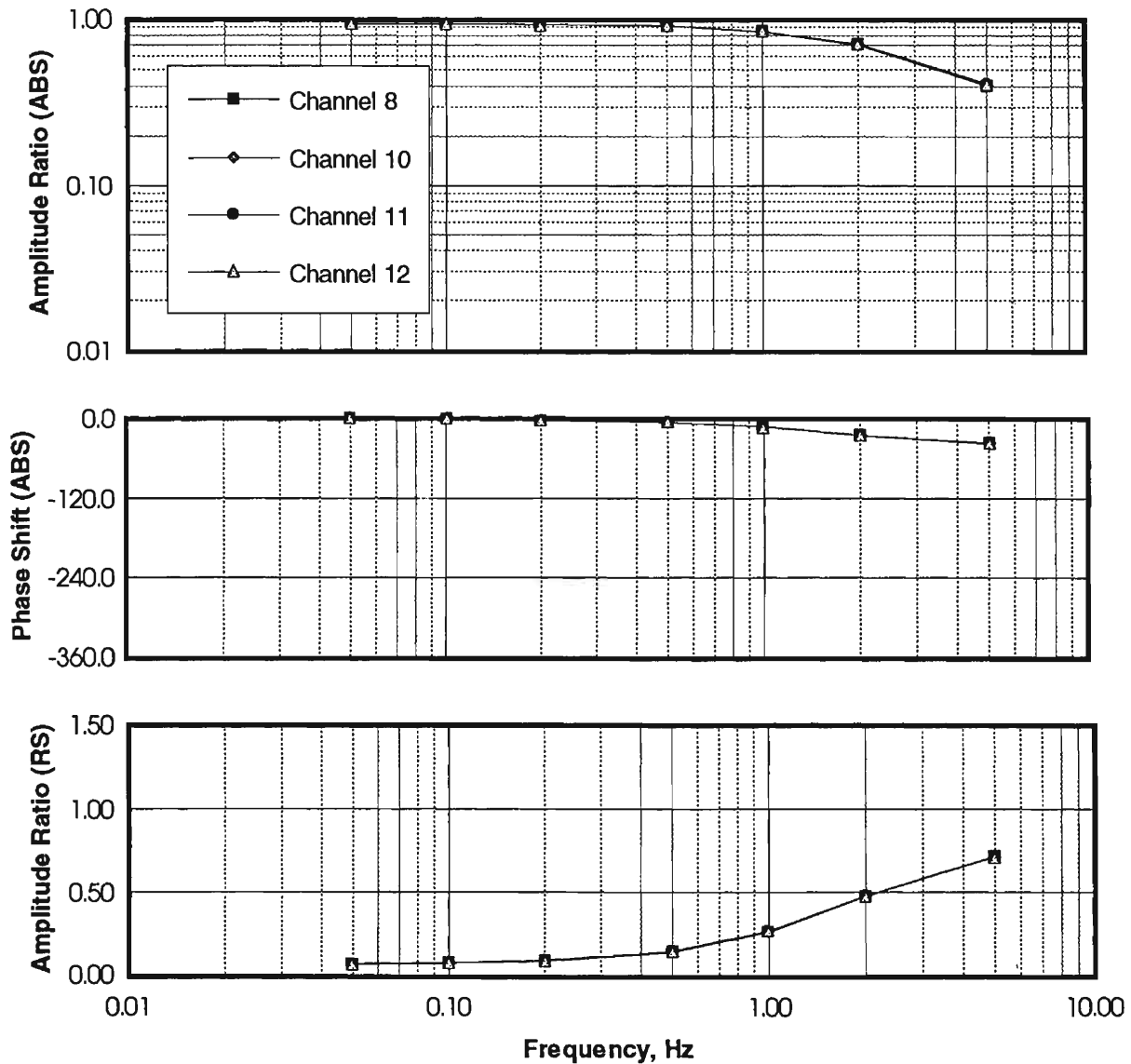
		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.77	0.43
	Phase ABS	-0.1	-0.1	-0.6	-3.4	-12.0	-27.3	-39.9
	Amp RS	0.00	0.00	0.01	0.06	0.21	0.47	0.72
Channel 10	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.77	0.43
	Phase ABS	-0.1	-0.1	-0.6	-3.4	-11.9	-27.2	-39.7
	Amp RS	0.00	0.00	0.01	0.06	0.21	0.47	0.72
Channel 11	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.77	0.44
	Phase ABS	-0.1	-0.1	-0.7	-3.4	-12.1	-27.2	-40.0
	Amp RS	0.00	0.00	0.01	0.06	0.21	0.47	0.72
Channel 12	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.78	0.44
	Phase ABS	-0.1	-0.2	-0.6	-3.4	-12.0	-27.2	-40.4
	Amp RS	0.00	0.00	0.01	0.06	0.21	0.47	0.72





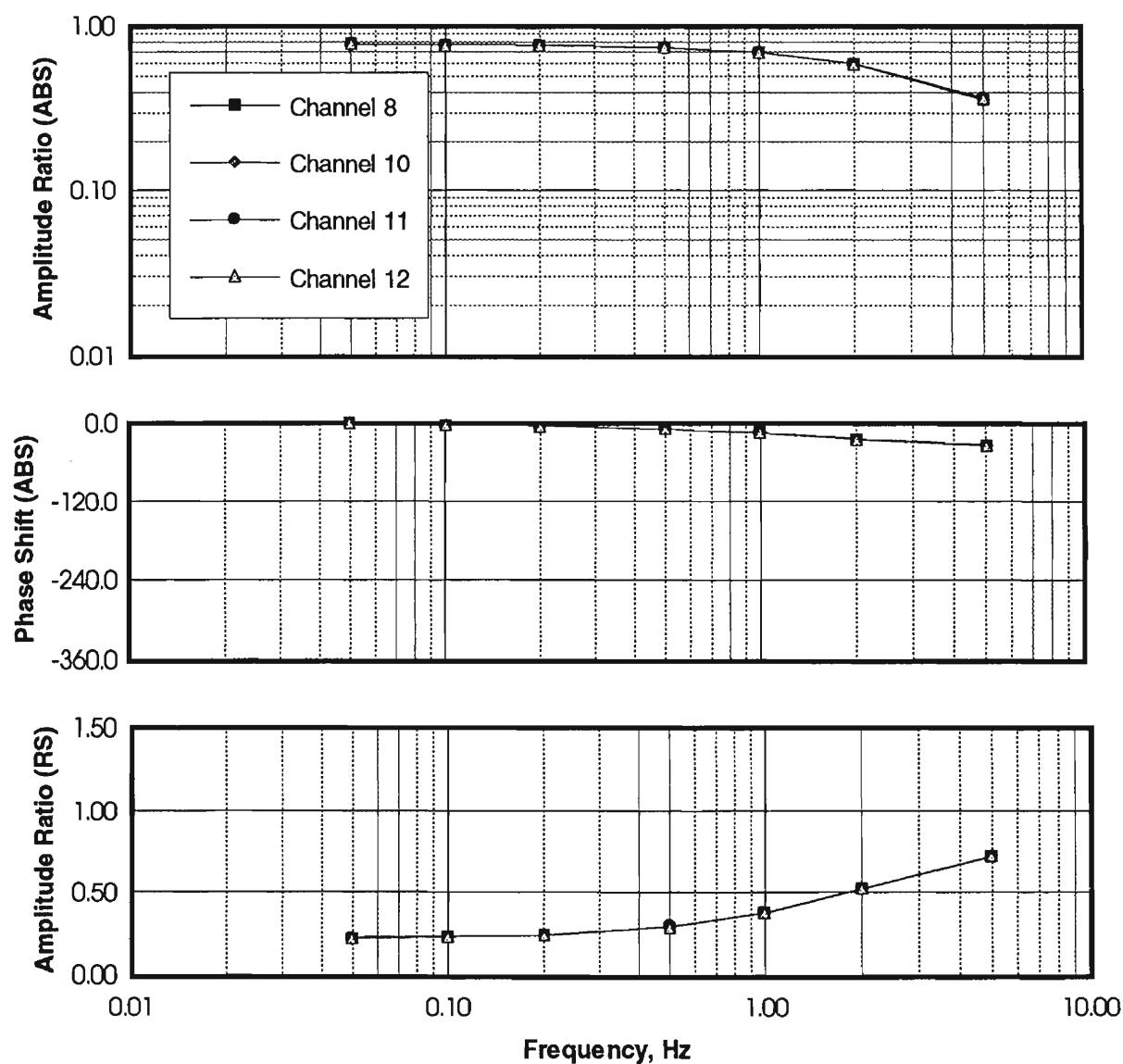
**Figure B2** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 1 leakage hole under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.94	0.94	0.93	0.91	0.85	0.70	0.40
	Phase ABS	-0.8	-1.6	-2.9	-6.4	-13.4	-25.6	-37.1
	Amp RS	0.06	0.07	0.08	0.14	0.26	0.48	0.72
Channel 10	Amp. ABS	0.94	0.94	0.93	0.91	0.84	0.70	0.40
	Phase ABS	-0.8	-1.5	-2.9	-6.4	-13.3	-25.5	-36.9
	Amp RS	0.06	0.07	0.08	0.14	0.26	0.47	0.72
Channel 11	Amp. ABS	0.94	0.93	0.93	0.91	0.84	0.70	0.41
	Phase ABS	-0.8	-1.6	-2.9	-6.4	-13.4	-25.6	-37.5
	Amp RS	0.07	0.07	0.09	0.14	0.26	0.47	0.72
Channel 12	Amp. ABS	0.94	0.94	0.93	0.91	0.85	0.71	0.41
	Phase ABS	-0.8	-1.6	-2.9	-6.4	-13.3	-25.6	-37.7
	Amp RS	0.06	0.07	0.08	0.14	0.26	0.47	0.72



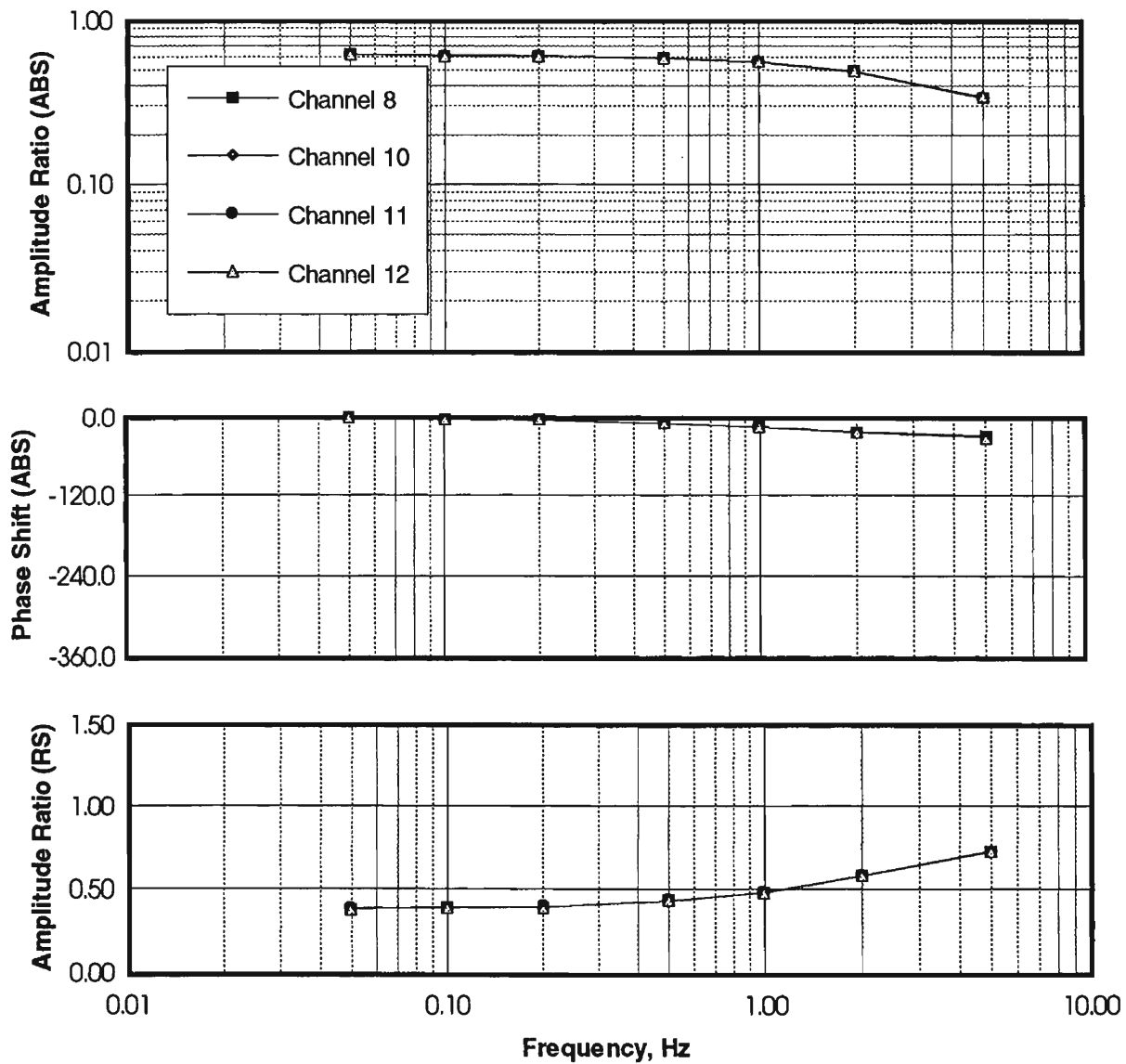
**Figure B3** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 2 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.78	0.77	0.77	0.74	0.69	0.59	0.36
	Phase ABS	-1.2	-2.4	-4.4	-9.4	-15.1	-24.2	-33.0
	Amp RS	0.22	0.23	0.24	0.29	0.38	0.52	0.72
Channel 10	Amp. ABS	0.78	0.77	0.77	0.74	0.69	0.59	0.36
	Phase ABS	-1.2	-2.4	-4.4	-9.5	-15.1	-24.1	-32.8
	Amp RS	0.22	0.23	0.24	0.29	0.38	0.52	0.72
Channel 11	Amp. ABS	0.78	0.77	0.77	0.74	0.69	0.59	0.37
	Phase ABS	-1.2	-2.4	-4.4	-9.5	-15.1	-24.2	-33.1
	Amp RS	0.22	0.23	0.24	0.29	0.38	0.52	0.72
Channel 12	Amp. ABS	0.78	0.77	0.77	0.74	0.70	0.60	0.37
	Phase ABS	-1.2	-2.4	-4.4	-9.5	-15.2	-24.4	-33.9
	Amp RS	0.22	0.23	0.24	0.29	0.38	0.52	0.72



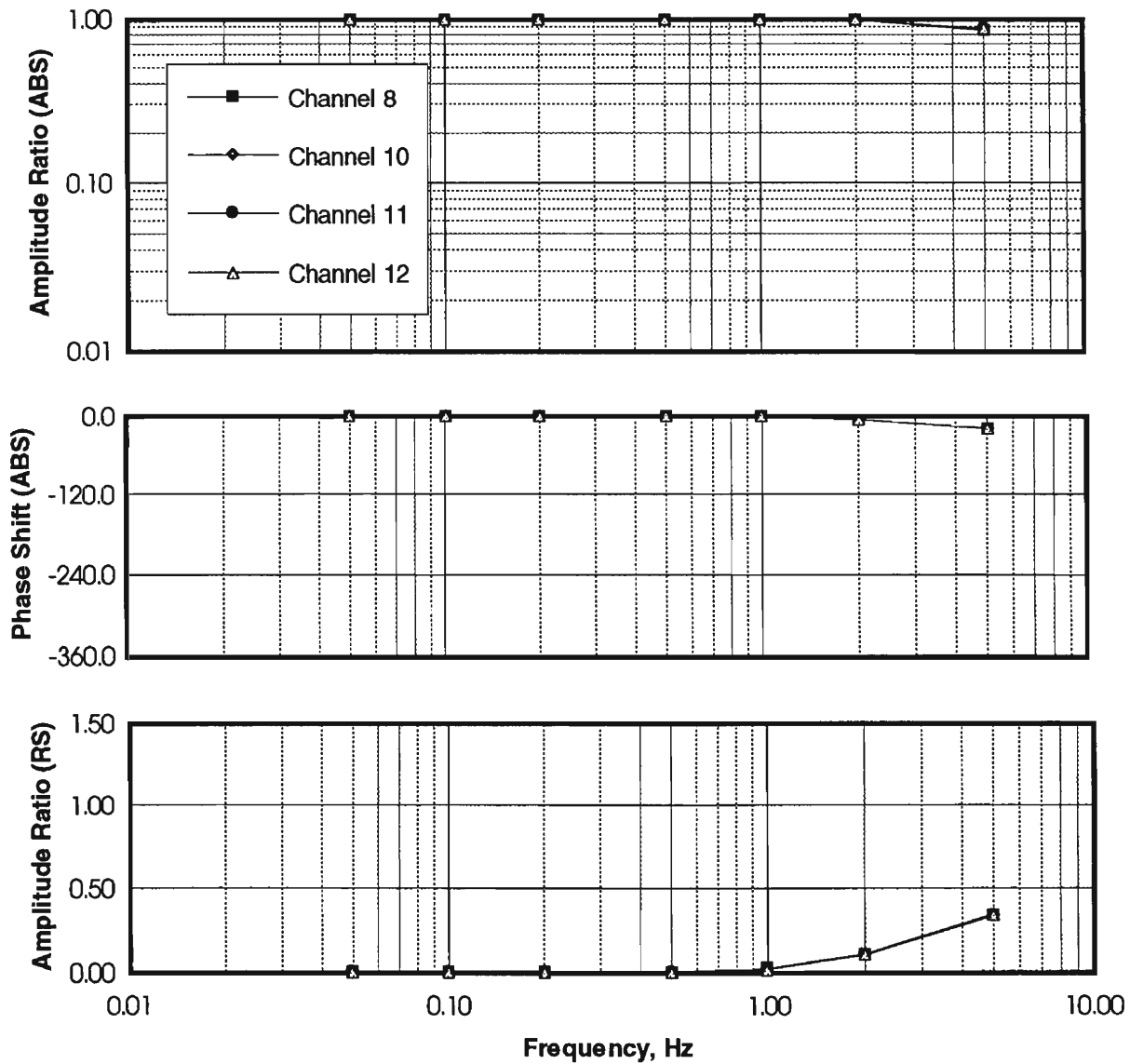
**Figure B4** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent holes and 3 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.62	0.61	0.61	0.59	0.56	0.49	0.33
	Phase ABS	-1.3	-2.4	-4.4	-9.4	-14.5	-22.3	-28.4
	Amp RS	0.38	0.39	0.39	0.43	0.48	0.58	0.72
Channel 10	Amp. ABS	0.62	0.61	0.61	0.59	0.56	0.49	0.34
	Phase ABS	-1.3	-2.4	-4.3	-9.3	-14.6	-22.2	-28.4
	Amp RS	0.38	0.39	0.39	0.43	0.48	0.58	0.72
Channel 11	Amp. ABS	0.62	0.61	0.61	0.59	0.56	0.49	0.34
	Phase ABS	-1.3	-2.4	-4.3	-9.4	-14.6	-22.2	-29.0
	Amp RS	0.38	0.39	0.40	0.43	0.48	0.58	0.72
Channel 12	Amp. ABS	0.62	0.61	0.61	0.59	0.56	0.49	0.34
	Phase ABS	-1.3	-2.4	-4.3	-9.4	-14.7	-22.6	-30.0
	Amp RS	0.38	0.39	0.39	0.43	0.48	0.58	0.73



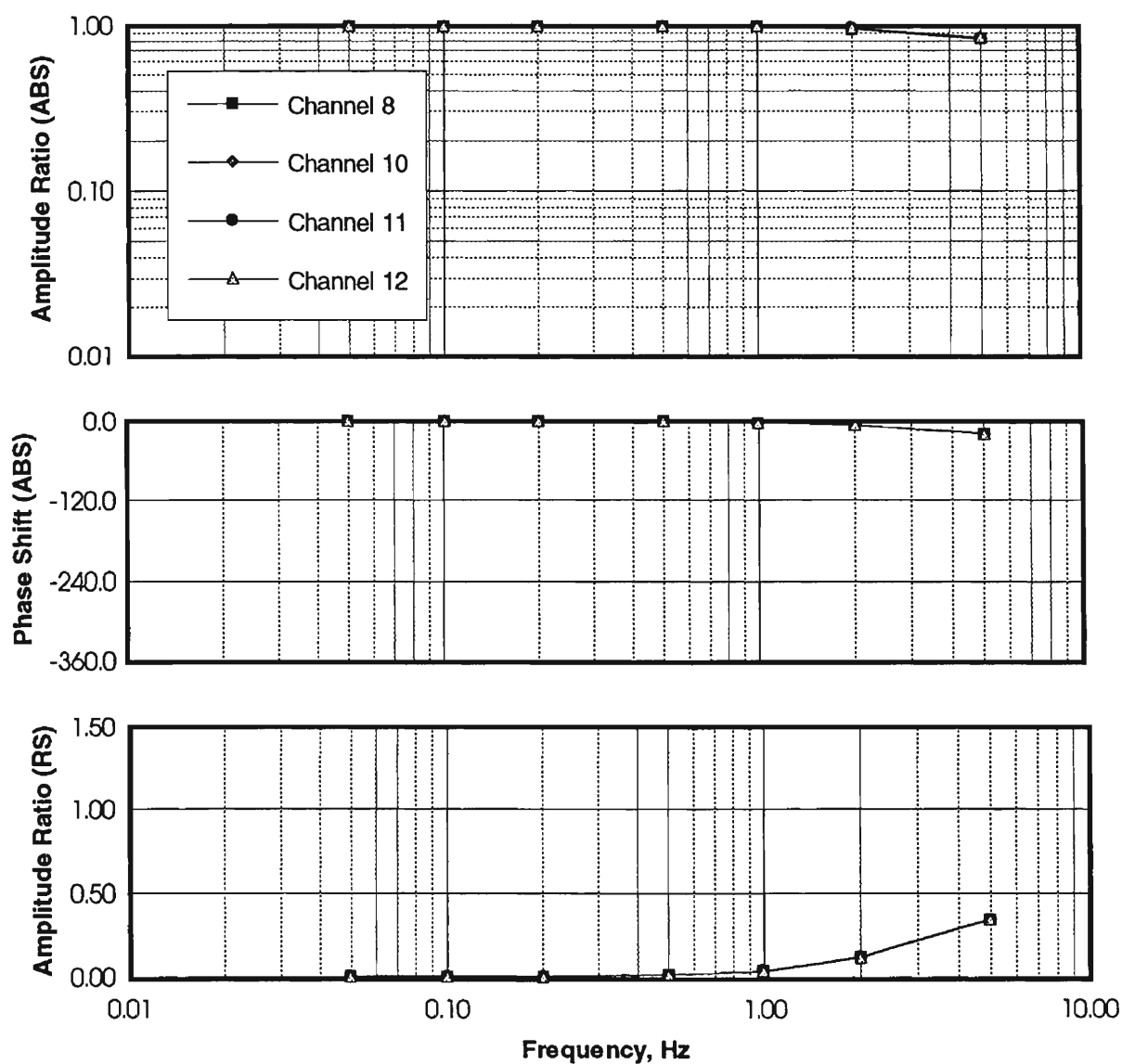
**Figure B5** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 0 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.98	0.85
	Phase ABS	0.0	0.0	0.0	-0.3	-1.3	-6.0	-19.4
	Amp RS	0.00	0.00	0.00	0.01	0.02	0.11	0.35
Channel 10	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.98	0.85
	Phase ABS	0.0	0.0	0.0	-0.3	-1.3	-5.9	-19.1
	Amp RS	0.00	0.00	0.00	0.00	0.02	0.10	0.34
Channel 11	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.98	0.86
	Phase ABS	0.0	0.0	0.0	-0.3	-1.3	-5.9	-19.3
	Amp RS	0.00	0.00	0.00	0.00	0.02	0.10	0.34
Channel 12	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.99	0.87
	Phase ABS	0.0	0.0	0.0	-0.3	-1.2	-5.9	-19.5
	Amp RS	0.00	0.00	0.00	0.01	0.02	0.10	0.34



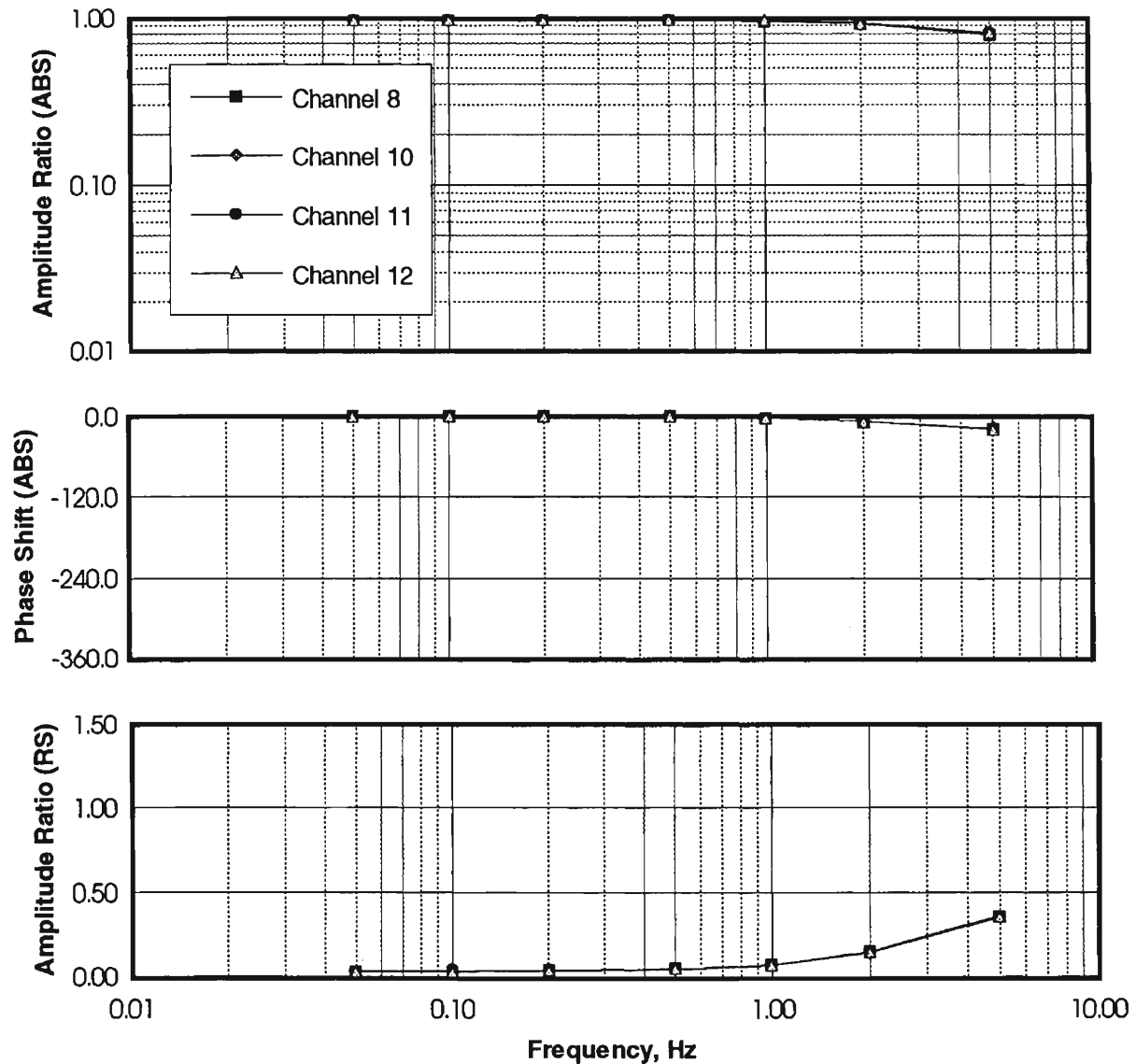
**Figure B6** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 1 leakage hole under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.95	0.82
	Phase ABS	-0.1	-0.2	-0.4	-0.8	-2.0	-6.6	-19.0
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.12	0.35
Channel 10	Amp. ABS	0.99	0.99	0.99	0.99	0.98	0.95	0.82
	Phase ABS	-0.1	-0.2	-0.3	-0.8	-2.0	-6.4	-18.7
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.12	0.34
Channel 11	Amp. ABS	0.99	0.99	0.99	0.99	0.98	0.96	0.83
	Phase ABS	-0.1	-0.2	-0.3	-0.8	-2.0	-6.7	-19.0
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.12	0.35
Channel 12	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.96	0.84
	Phase ABS	-0.1	-0.2	-0.4	-0.8	-2.0	-6.6	-19.4
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.12	0.35



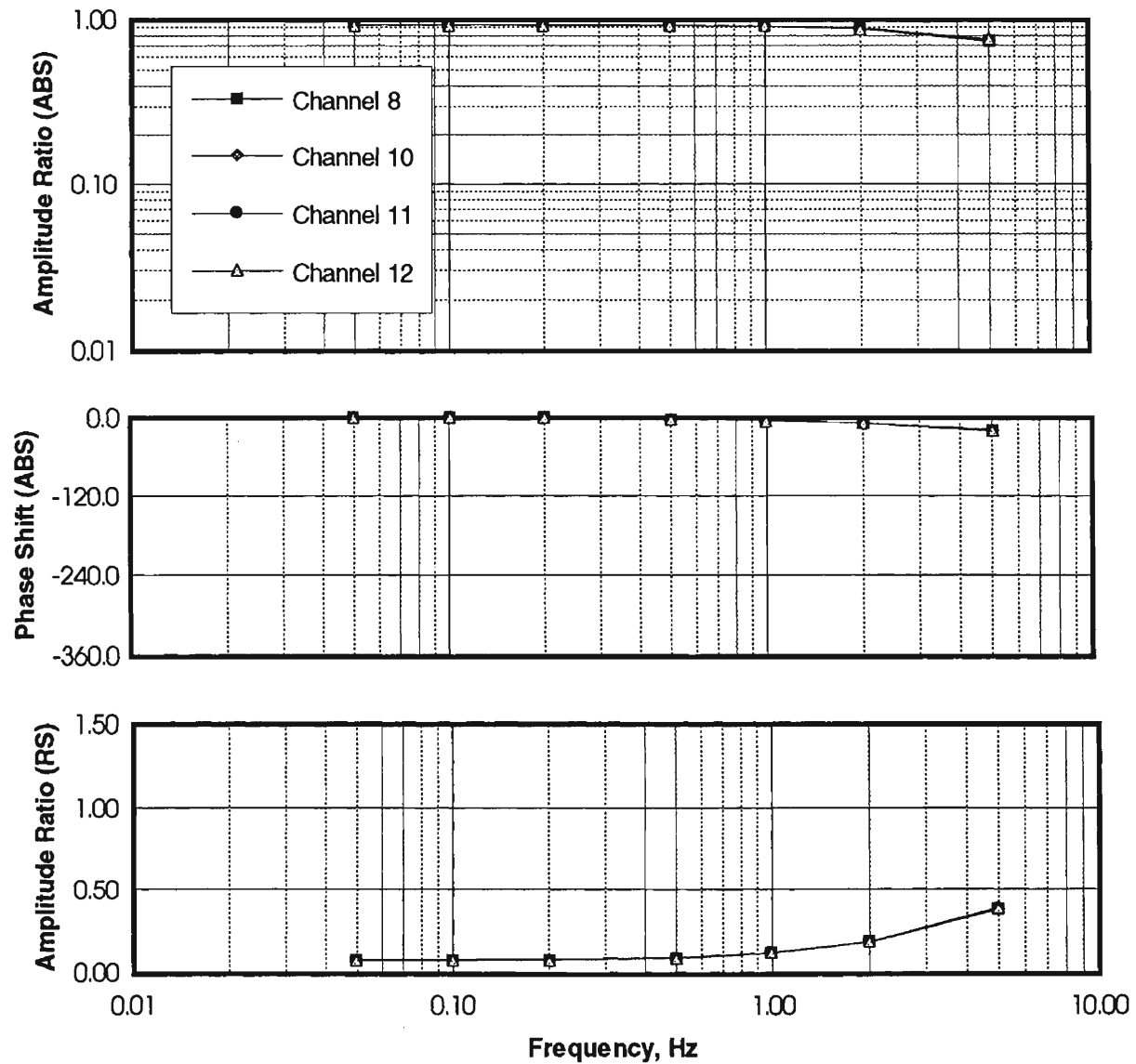
**Figure B7** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 2 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.97	0.97	0.97	0.96	0.95	0.92	0.79
	Phase ABS	-0.2	-0.4	-0.8	-1.7	-3.3	-7.5	-18.5
	Amp RS	0.03	0.03	0.04	0.05	0.07	0.15	0.36
Channel 10	Amp. ABS	0.97	0.97	0.97	0.96	0.95	0.92	0.79
	Phase ABS	-0.2	-0.4	-0.8	-1.7	-3.3	-7.4	-18.3
	Amp RS	0.03	0.03	0.04	0.05	0.07	0.15	0.35
Channel 11	Amp. ABS	0.97	0.97	0.96	0.96	0.95	0.92	0.80
	Phase ABS	-0.2	-0.4	-0.8	-1.7	-3.3	-7.6	-18.8
	Amp RS	0.03	0.04	0.04	0.05	0.07	0.15	0.35
Channel 12	Amp. ABS	0.97	0.97	0.97	0.96	0.96	0.93	0.81
	Phase ABS	-0.2	-0.4	-0.8	-1.7	-3.3	-7.7	-19.2
	Amp RS	0.03	0.03	0.04	0.05	0.07	0.15	0.36



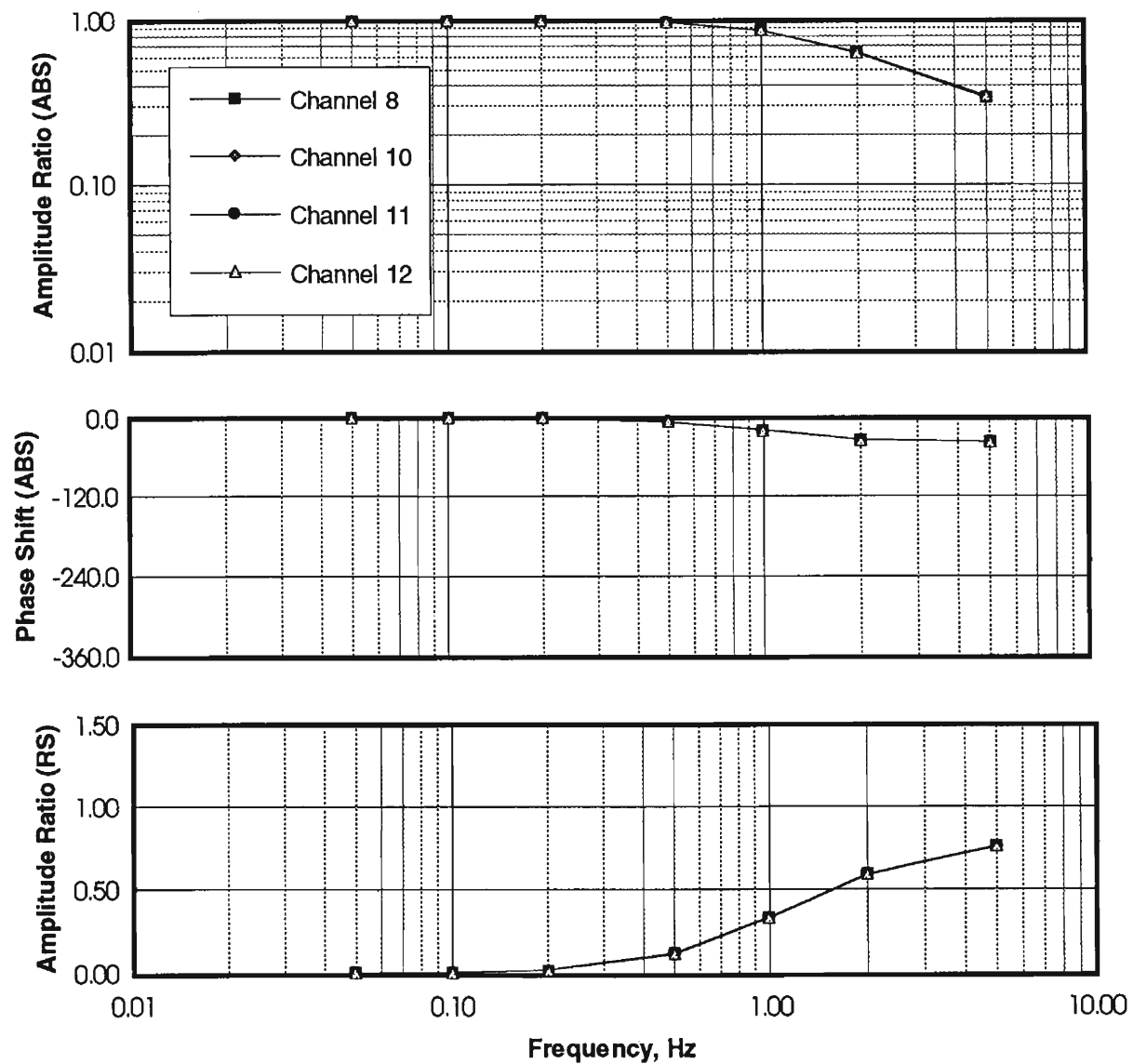
**Figure B8** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 3 leakage hole under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.93	0.93	0.93	0.92	0.91	0.88	0.74
	Phase ABS	-0.3	-0.6	-1.1	-2.4	-4.5	-8.4	-18.8
	Amp RS	0.07	0.07	0.08	0.09	0.12	0.18	0.38
Channel 10	Amp. ABS	0.93	0.93	0.93	0.92	0.91	0.88	0.75
	Phase ABS	-0.3	-0.5	-1.1	-2.4	-4.5	-8.3	-18.8
	Amp RS	0.07	0.07	0.08	0.09	0.12	0.18	0.38
Channel 11	Amp. ABS	0.93	0.93	0.92	0.92	0.91	0.88	0.75
	Phase ABS	-0.3	-0.5	-1.1	-2.4	-4.5	-8.4	-19.0
	Amp RS	0.07	0.07	0.08	0.09	0.12	0.18	0.38
Channel 12	Amp. ABS	0.93	0.93	0.93	0.92	0.91	0.88	0.76
	Phase ABS	-0.3	-0.6	-1.1	-2.4	-4.7	-8.7	-19.9
	Amp RS	0.07	0.07	0.08	0.09	0.12	0.18	0.38



**Figure B9** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 0 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

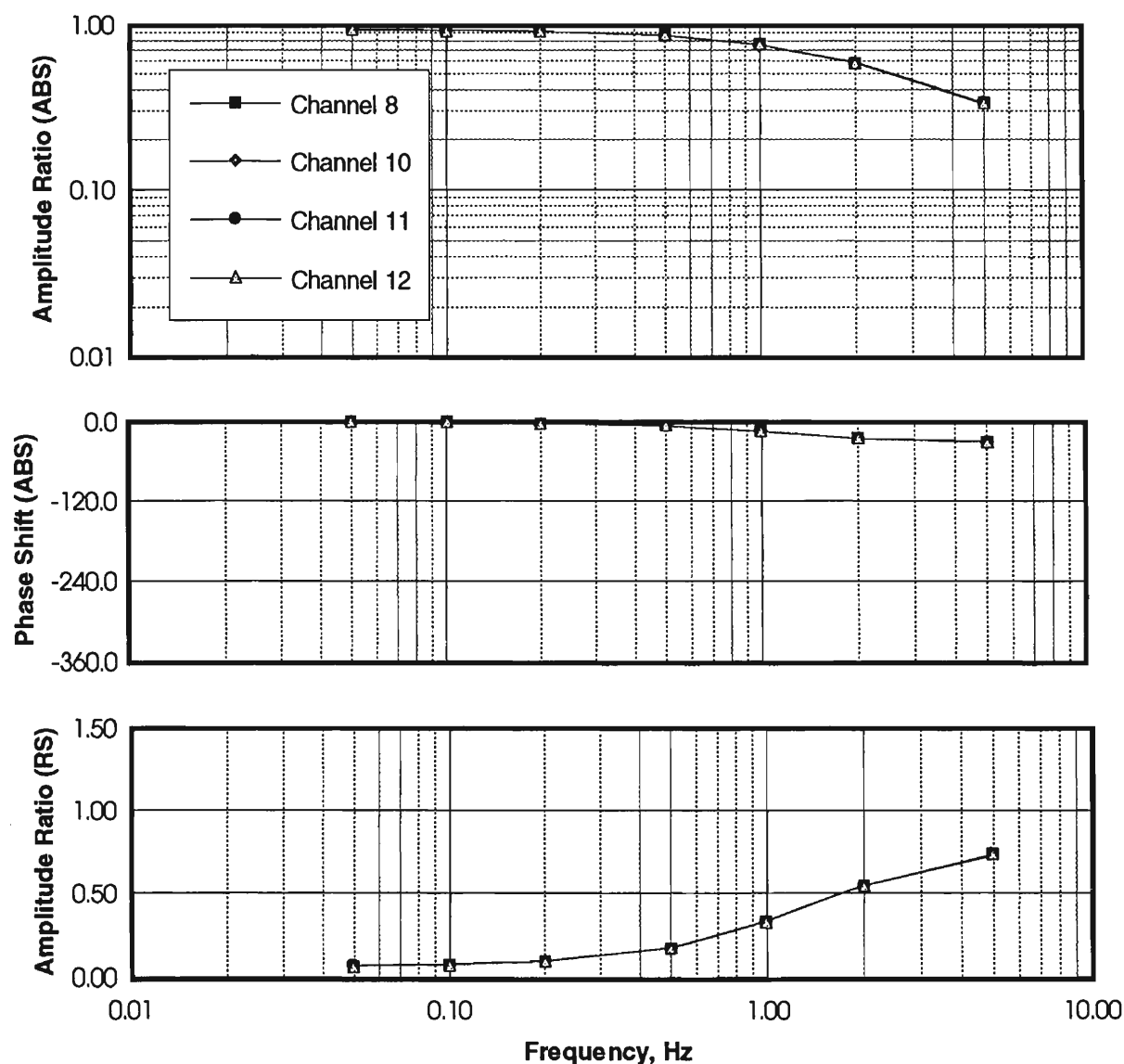
		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	1.00	0.97	0.87	0.64	0.33
	Phase ABS	-0.1	-0.4	-1.3	-6.8	-18.8	-33.8	-36.3
	Amp RS	0.00	0.01	0.02	0.12	0.33	0.59	0.76
Channel 10	Amp. ABS	1.00	1.00	1.00	0.97	0.87	0.64	0.33
	Phase ABS	-0.1	-0.3	-1.3	-6.7	-18.7	-33.7	-36.1
	Amp RS	0.00	0.01	0.02	0.12	0.33	0.59	0.76
Channel 11	Amp. ABS	1.00	1.00	1.00	0.97	0.86	0.64	0.34
	Phase ABS	-0.1	-0.3	-1.3	-6.7	-18.8	-33.6	-36.4
	Amp RS	0.00	0.01	0.02	0.12	0.33	0.59	0.76
Channel 12	Amp. ABS	1.00	1.00	1.00	0.97	0.87	0.64	0.34
	Phase ABS	-0.1	-0.3	-1.3	-6.7	-18.7	-33.6	-36.8
	Amp RS	0.00	0.01	0.02	0.12	0.33	0.59	0.76





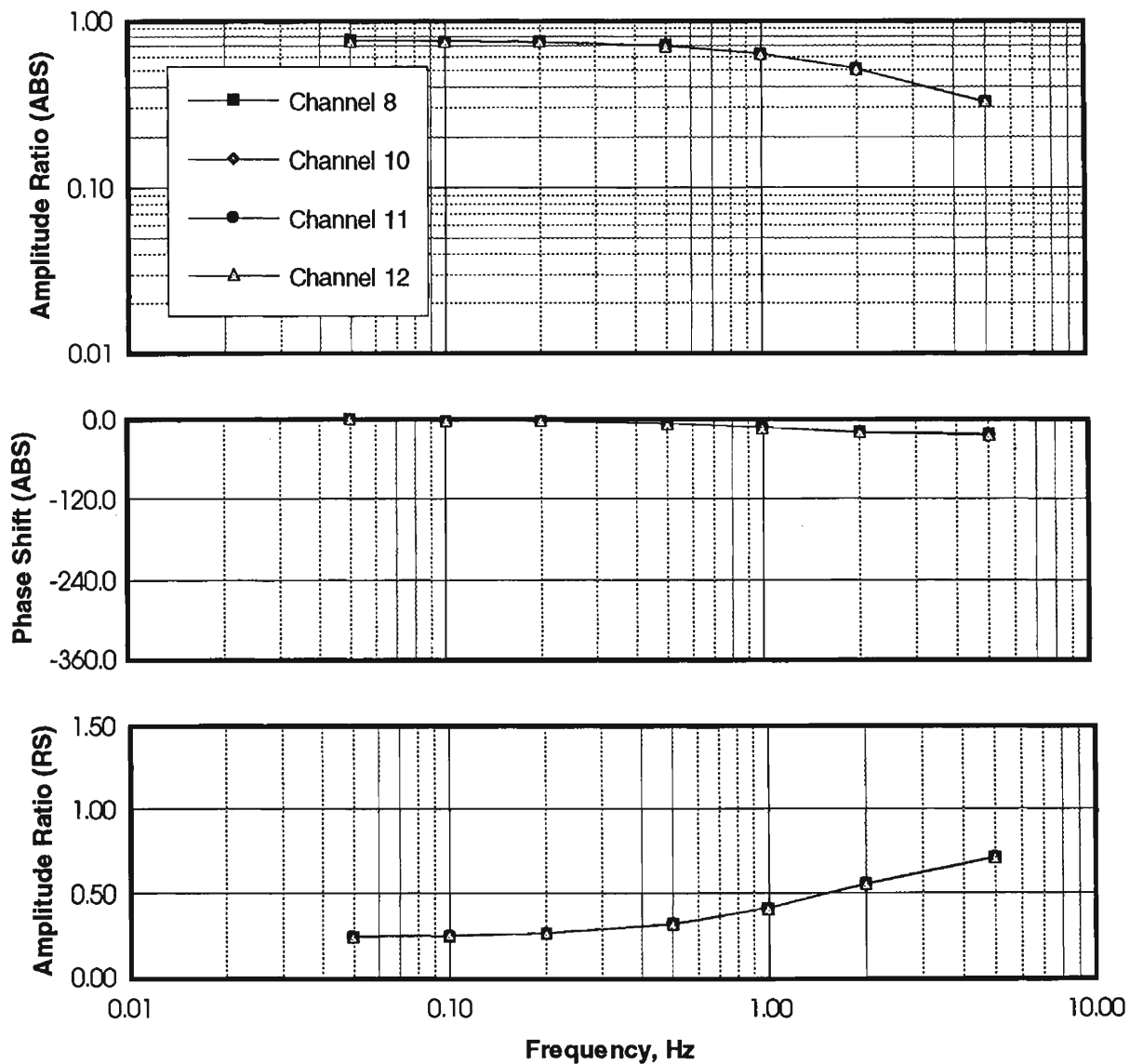
**Figure B10** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 1 leakage hole under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.93	0.93	0.92	0.86	0.76	0.58	0.33
	Phase ABS	-0.7	-1.4	-2.7	-7.0	-15.2	-26.8	-29.9
	Amp RS	0.07	0.07	0.09	0.18	0.34	0.55	0.73
Channel 10	Amp. ABS	0.93	0.93	0.92	0.86	0.76	0.58	0.33
	Phase ABS	-0.7	-1.4	-2.7	-7.0	-15.2	-26.6	-29.9
	Amp RS	0.07	0.08	0.10	0.18	0.33	0.55	0.73
Channel 11	Amp. ABS	0.93	0.93	0.91	0.86	0.76	0.58	0.33
	Phase ABS	-0.7	-1.4	-2.7	-7.0	-15.2	-26.7	-30.1
	Amp RS	0.07	0.08	0.10	0.18	0.34	0.55	0.73
Channel 12	Amp. ABS	0.93	0.93	0.92	0.86	0.76	0.58	0.33
	Phase ABS	-0.7	-1.4	-2.8	-7.0	-15.3	-26.9	-30.9
	Amp RS	0.07	0.08	0.10	0.18	0.33	0.55	0.73



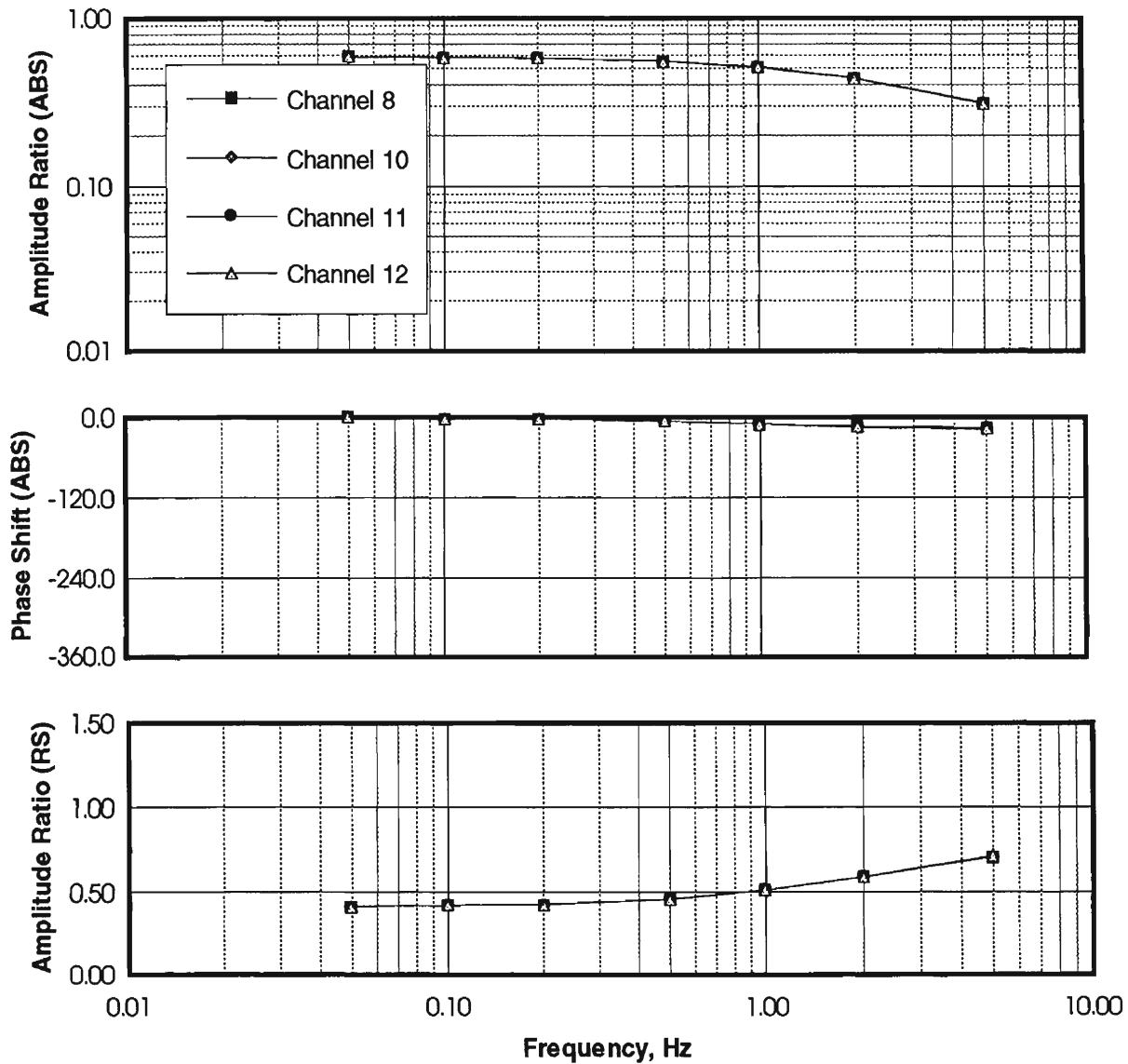
**Figure B11** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 2 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.76	0.75	0.74	0.70	0.62	0.51	0.32
	Phase ABS	-1.1	-2.0	-3.8	-7.6	-12.9	-20.2	-22.7
	Amp RS	0.24	0.25	0.26	0.32	0.42	0.55	0.71
Channel 10	Amp. ABS	0.76	0.75	0.74	0.70	0.62	0.51	0.32
	Phase ABS	-1.0	-2.0	-3.8	-7.5	-12.9	-20.1	-22.7
	Amp RS	0.24	0.25	0.26	0.32	0.42	0.55	0.71
Channel 11	Amp. ABS	0.75	0.75	0.74	0.70	0.62	0.51	0.32
	Phase ABS	-1.1	-2.0	-3.8	-7.7	-13.0	-20.3	-23.2
	Amp RS	0.25	0.25	0.27	0.32	0.42	0.55	0.71
Channel 12	Amp. ABS	0.76	0.75	0.74	0.70	0.62	0.51	0.33
	Phase ABS	-1.1	-2.1	-3.8	-7.8	-13.1	-20.6	-24.3
	Amp RS	0.24	0.25	0.27	0.32	0.42	0.55	0.72



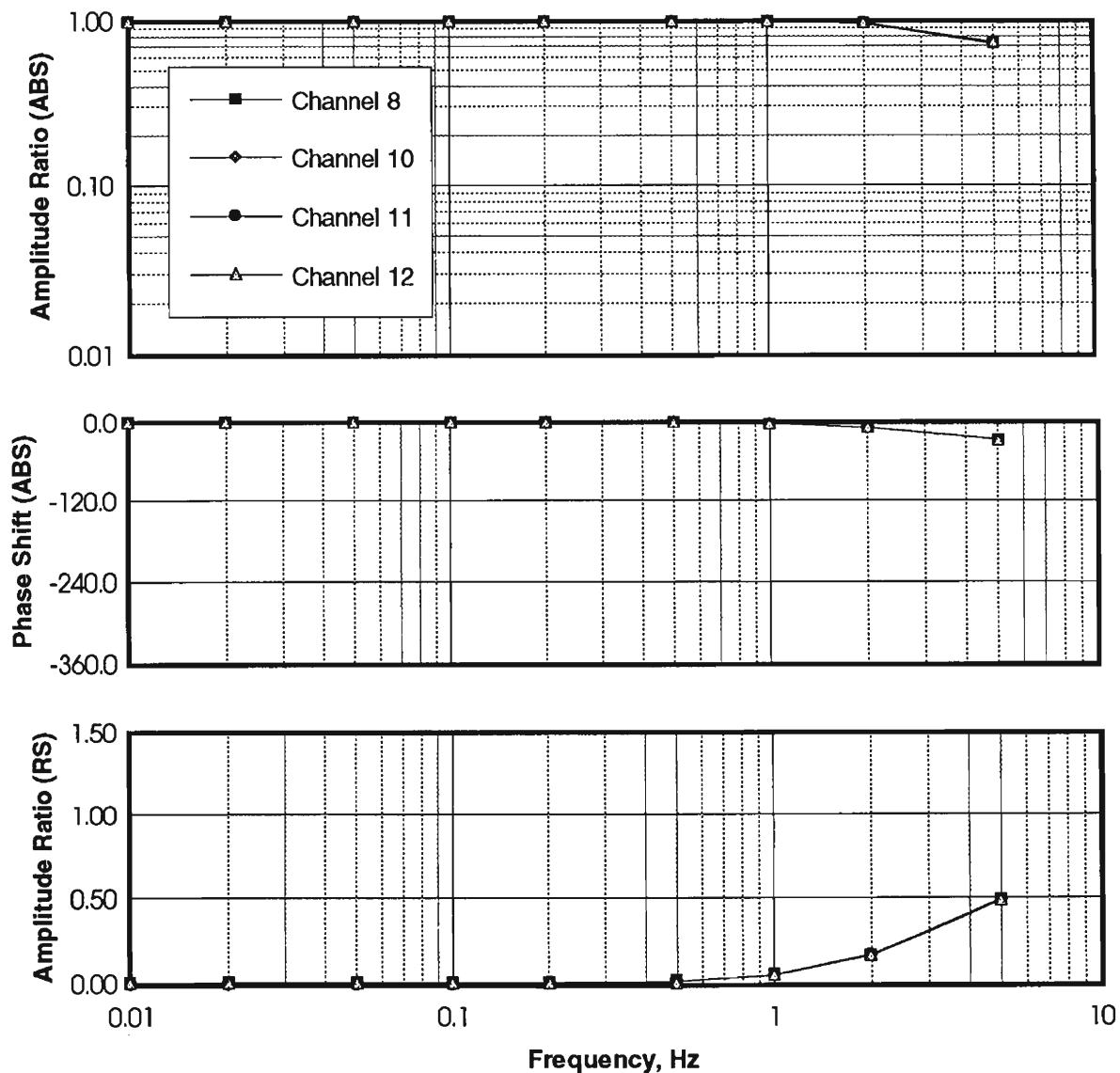
**Figure B12** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 3 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.59	0.58	0.58	0.55	0.51	0.44	0.31
	Phase ABS	-1.0	-1.8	-3.5	-6.9	-10.6	-14.9	-16.1
	Amp RS	0.41	0.42	0.43	0.46	0.51	0.59	0.71
Channel 10	Amp. ABS	0.59	0.58	0.58	0.55	0.51	0.44	0.31
	Phase ABS	-1.0	-1.8	-3.4	-6.9	-10.5	-14.9	-16.2
	Amp RS	0.41	0.42	0.43	0.46	0.51	0.59	0.71
Channel 11	Amp. ABS	0.58	0.58	0.58	0.55	0.51	0.44	0.31
	Phase ABS	-1.0	-1.8	-3.5	-7.0	-10.7	-15.0	-16.9
	Amp RS	0.42	0.42	0.43	0.46	0.51	0.59	0.71
Channel 12	Amp. ABS	0.59	0.58	0.58	0.55	0.51	0.44	0.31
	Phase ABS	-1.0	-1.9	-3.6	-6.8	-10.9	-15.5	-18.3
	Amp RS	0.42	0.42	0.43	0.46	0.51	0.59	0.71



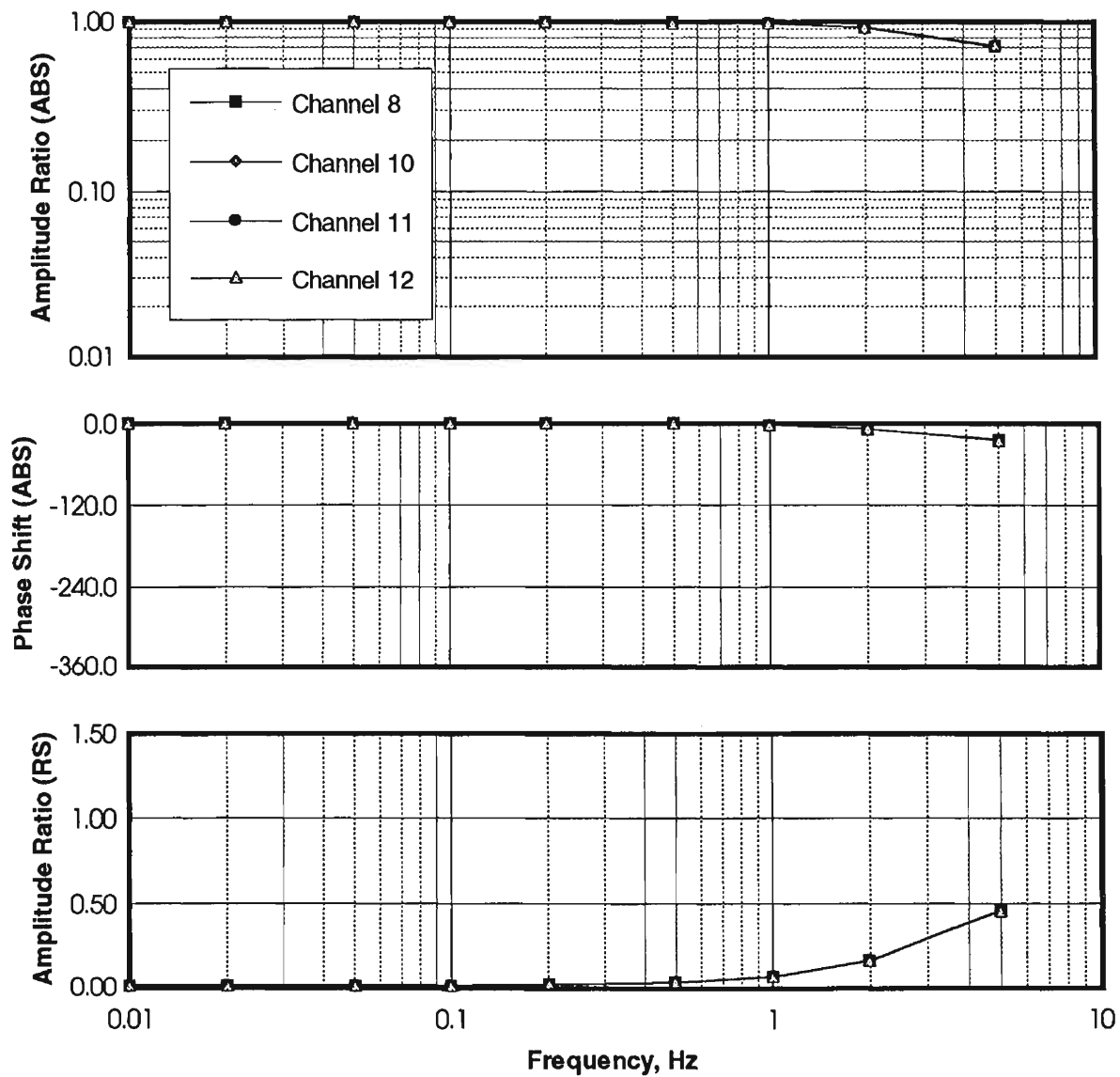
**Figure B13** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 0 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.72
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.7	-2.7	-9.2	-27.6
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.16	0.49
Channel 10	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.73
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.7	-2.6	-9.1	-27.3
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.16	0.49
Channel 11	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.73
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.7	-2.7	-9.1	-27.5
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.16	0.49
Channel 12	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	0.74
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.6	-2.6	-9.1	-27.8
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.16	0.49



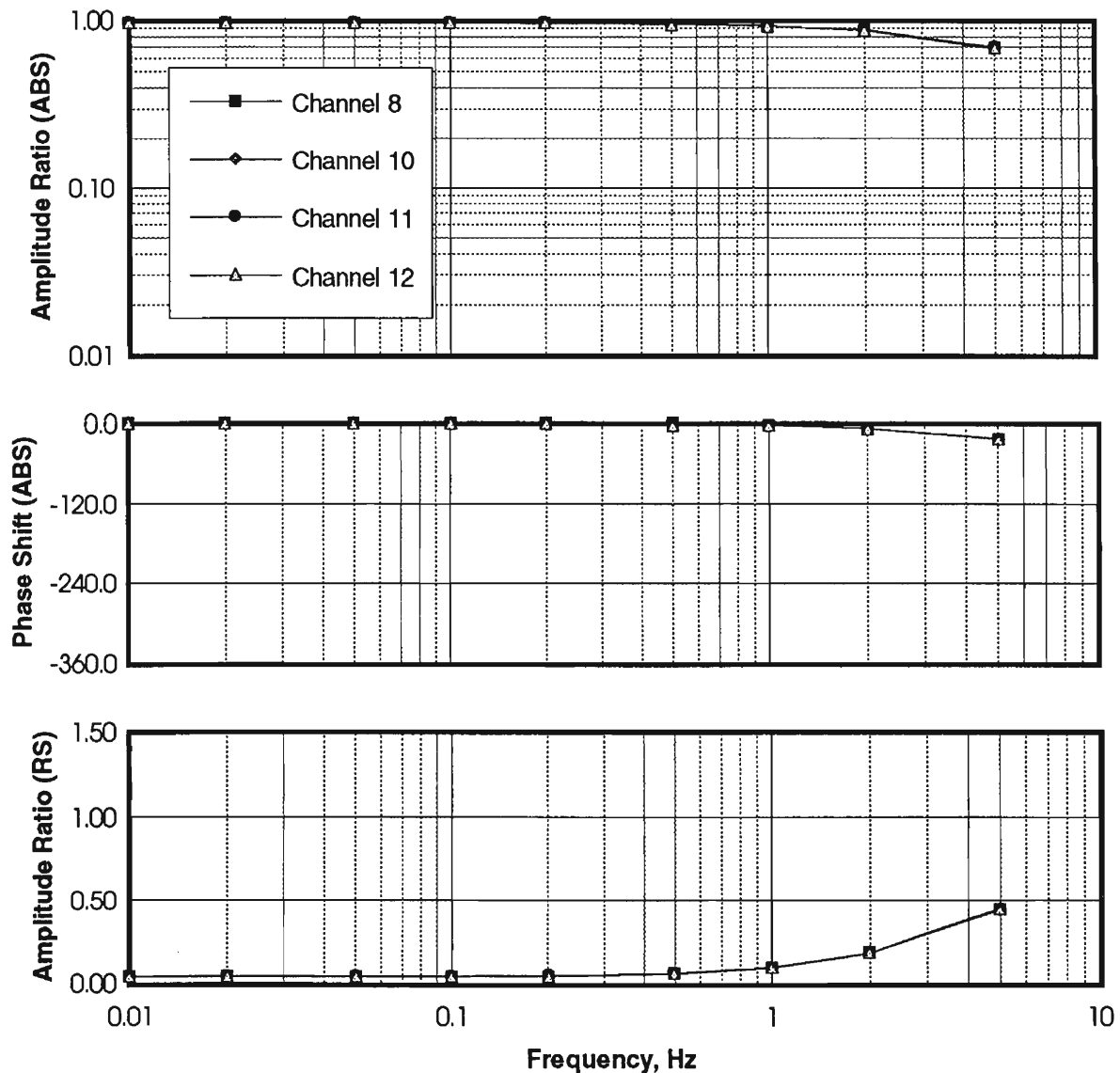
**Figure B14** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 1 leakage hole under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.92	0.70
	Phase ABS	0.0	-0.1	-0.1	-0.2	-0.4	-1.1	-2.9	-8.4	-24.3
	Amp RS	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.16	0.46
Channel 10	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.92	0.71
	Phase ABS	0.0	0.0	-0.1	-0.2	-0.4	-1.1	-2.9	-8.2	-24.1
	Amp RS	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.16	0.46
Channel 11	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.92	0.71
	Phase ABS	0.0	0.0	-0.1	-0.2	-0.4	-1.1	-2.9	-8.3	-24.4
	Amp RS	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.16	0.46
Channel 12	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.92	0.72
	Phase ABS	0.0	0.0	-0.1	-0.2	-0.4	-1.1	-2.9	-8.4	-24.9
	Amp RS	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.16	0.46



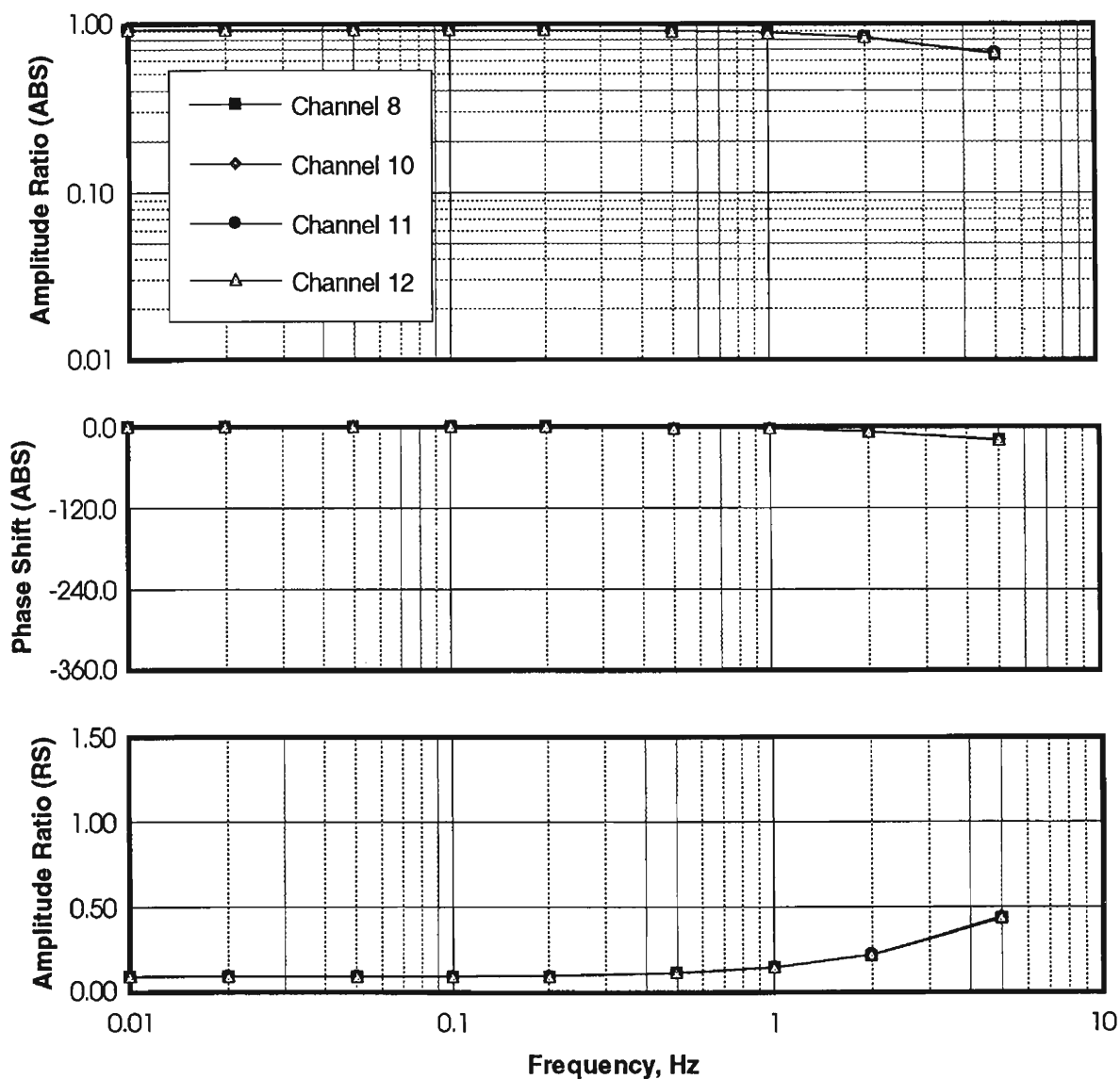
**Figure B15** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 2 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.96	0.96	0.96	0.96	0.96	0.95	0.93	0.87	0.68
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.7	-1.7	-3.5	-7.9	-21.7
	Amp RS	0.04	0.04	0.04	0.04	0.04	0.06	0.09	0.18	0.44
Channel 10	Amp. ABS	0.96	0.96	0.96	0.96	0.96	0.95	0.93	0.87	0.69
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.7	-1.6	-3.5	-7.8	-21.6
	Amp RS	0.04	0.04	0.04	0.04	0.04	0.06	0.09	0.18	0.44
Channel 11	Amp. ABS	0.96	0.96	0.96	0.96	0.96	0.95	0.92	0.87	0.69
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.7	-1.7	-3.5	-8.0	-22.0
	Amp RS	0.04	0.04	0.04	0.04	0.05	0.06	0.10	0.18	0.44
Channel 12	Amp. ABS	0.96	0.96	0.96	0.96	0.96	0.95	0.93	0.87	0.70
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.7	-1.7	-3.6	-8.2	-22.8
	Amp RS	0.04	0.04	0.04	0.04	0.05	0.06	0.10	0.18	0.45



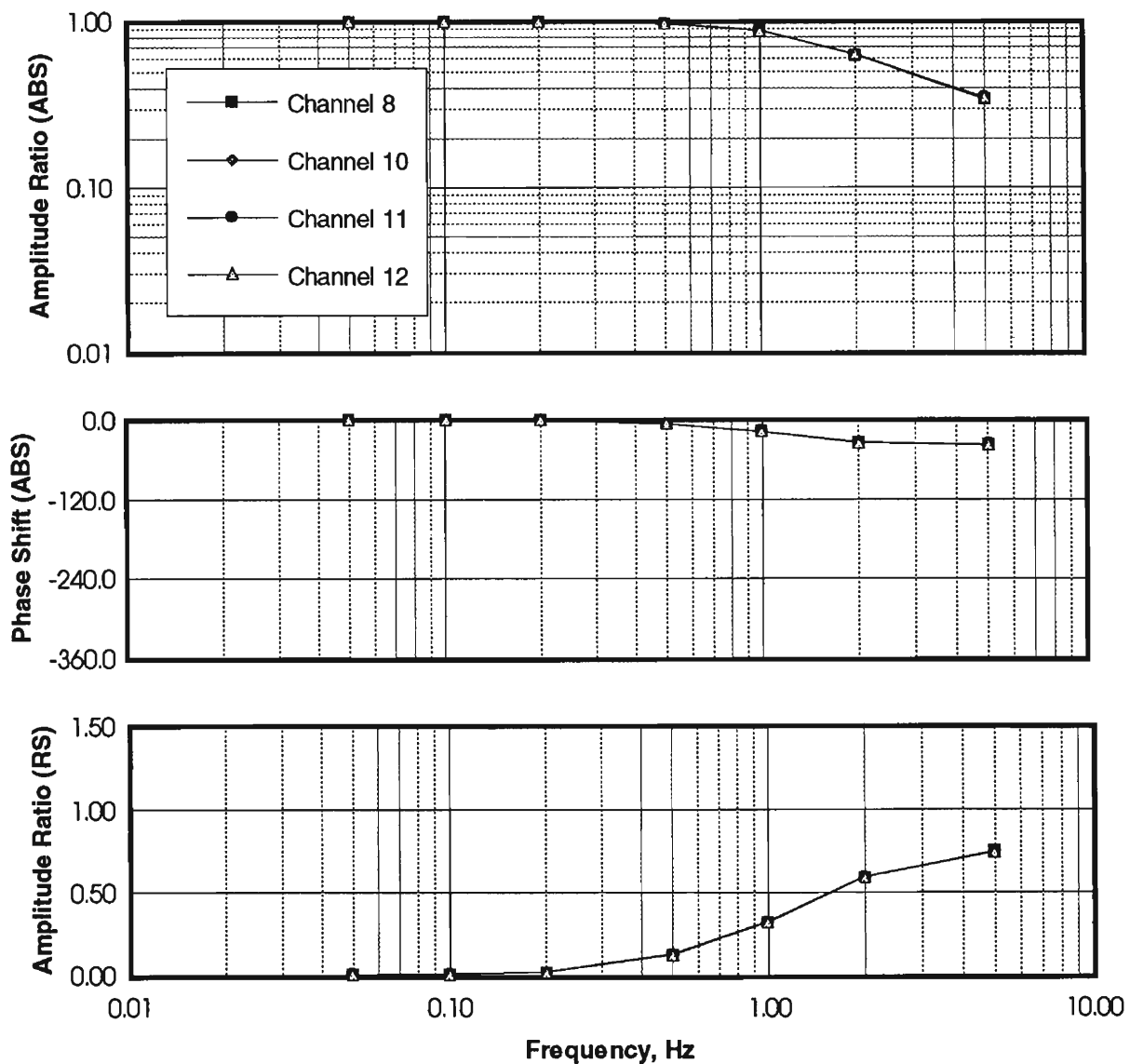
**Figure B16** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 3 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.92	0.92	0.92	0.92	0.91	0.90	0.88	0.83	0.66
	Phase ABS	-0.1	-0.1	-0.2	-0.5	-1.0	-2.2	-4.1	-7.8	-19.1
	Amp RS	0.08	0.08	0.08	0.08	0.09	0.10	0.14	0.21	0.44
Channel 10	Amp. ABS	0.92	0.92	0.92	0.92	0.91	0.90	0.88	0.82	0.66
	Phase ABS	0.0	-0.1	-0.2	-0.5	-0.9	-2.2	-4.0	-7.7	-19.0
	Amp RS	0.08	0.08	0.08	0.09	0.09	0.11	0.14	0.21	0.43
Channel 11	Amp. ABS	0.92	0.91	0.91	0.91	0.91	0.90	0.88	0.82	0.66
	Phase ABS	-0.1	-0.1	-0.2	-0.5	-1.0	-2.3	-4.1	-7.9	-19.7
	Amp RS	0.08	0.09	0.09	0.09	0.09	0.11	0.14	0.22	0.44
Channel 12	Amp. ABS	0.92	0.92	0.92	0.91	0.91	0.90	0.88	0.83	0.67
	Phase ABS	0.0	-0.1	-0.2	-0.5	-1.0	-2.3	-4.3	-8.3	-20.7
	Amp RS	0.08	0.08	0.08	0.09	0.09	0.11	0.14	0.22	0.44



**Figure B17** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 0 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

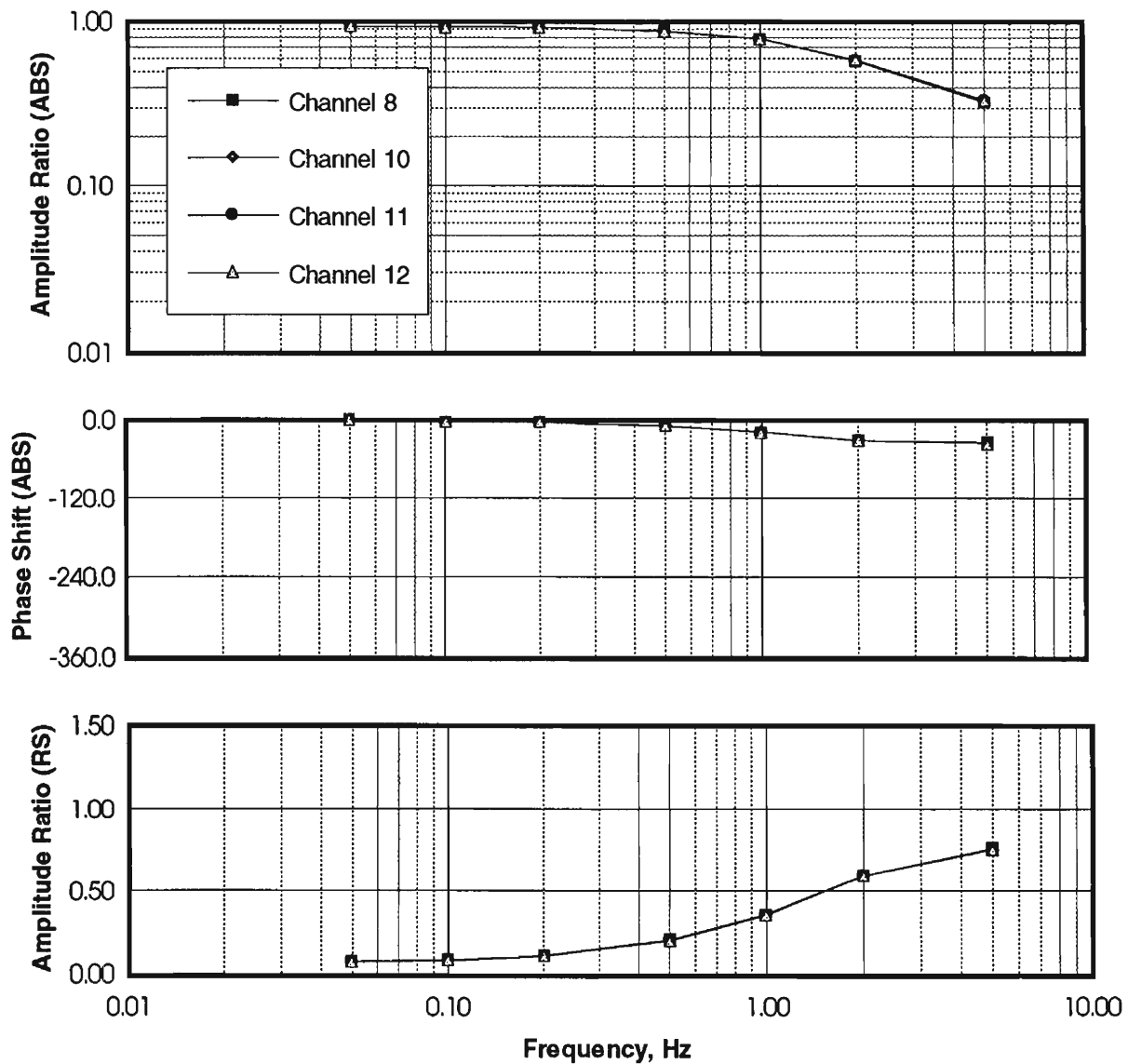
		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	0.99	0.97	0.87	0.63	0.34
	Phase ABS	-0.1	-0.4	-1.3	-6.9	-18.4	-34.2	-37.0
	Amp RS	0.00	0.01	0.02	0.12	0.32	0.60	0.76
Channel 10	Amp. ABS	1.00	1.00	0.99	0.97	0.87	0.63	0.34
	Phase ABS	-0.1	-0.3	-1.3	-6.8	-18.3	-34.1	-37.0
	Amp RS	0.00	0.01	0.02	0.12	0.32	0.59	0.75
Channel 11	Amp. ABS	1.00	1.00	0.99	0.96	0.87	0.63	0.35
	Phase ABS	-0.1	-0.3	-1.3	-6.9	-18.3	-34.1	-37.3
	Amp RS	0.00	0.01	0.02	0.12	0.32	0.59	0.75
Channel 12	Amp. ABS	1.00	1.00	1.00	0.97	0.88	0.63	0.35
	Phase ABS	-0.1	-0.3	-1.2	-7.0	-18.3	-34.1	-37.7
	Amp RS	0.00	0.01	0.02	0.12	0.32	0.59	0.75





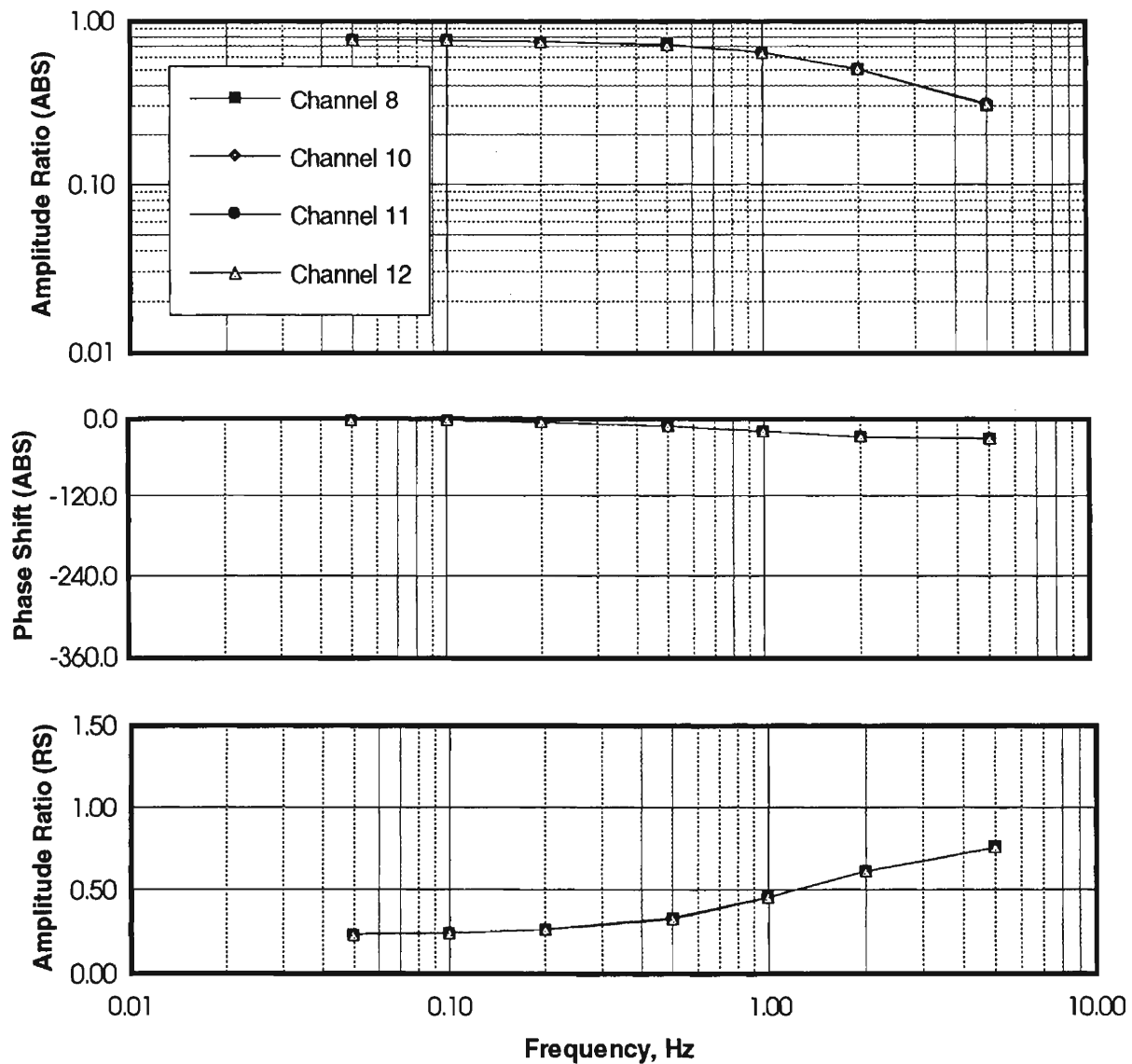
**Figure B18** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 1 leakage hole under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.93	0.93	0.92	0.87	0.79	0.58	0.33
	Phase ABS	-1.2	-2.2	-4.2	-9.8	-18.5	-31.7	-34.7
	Amp RS	0.07	0.08	0.11	0.20	0.36	0.59	0.75
Channel 10	Amp. ABS	0.93	0.93	0.92	0.87	0.79	0.58	0.33
	Phase ABS	-1.2	-2.2	-4.1	-9.9	-18.5	-31.6	-34.6
	Amp RS	0.07	0.08	0.11	0.21	0.36	0.59	0.75
Channel 11	Amp. ABS	0.93	0.93	0.92	0.87	0.78	0.58	0.33
	Phase ABS	-1.1	-2.2	-4.1	-9.7	-18.5	-31.7	-34.9
	Amp RS	0.07	0.08	0.11	0.20	0.36	0.59	0.75
Channel 12	Amp. ABS	0.93	0.93	0.92	0.88	0.79	0.59	0.34
	Phase ABS	-1.2	-2.2	-4.2	-9.8	-18.5	-31.8	-35.4
	Amp RS	0.07	0.08	0.11	0.20	0.36	0.59	0.75



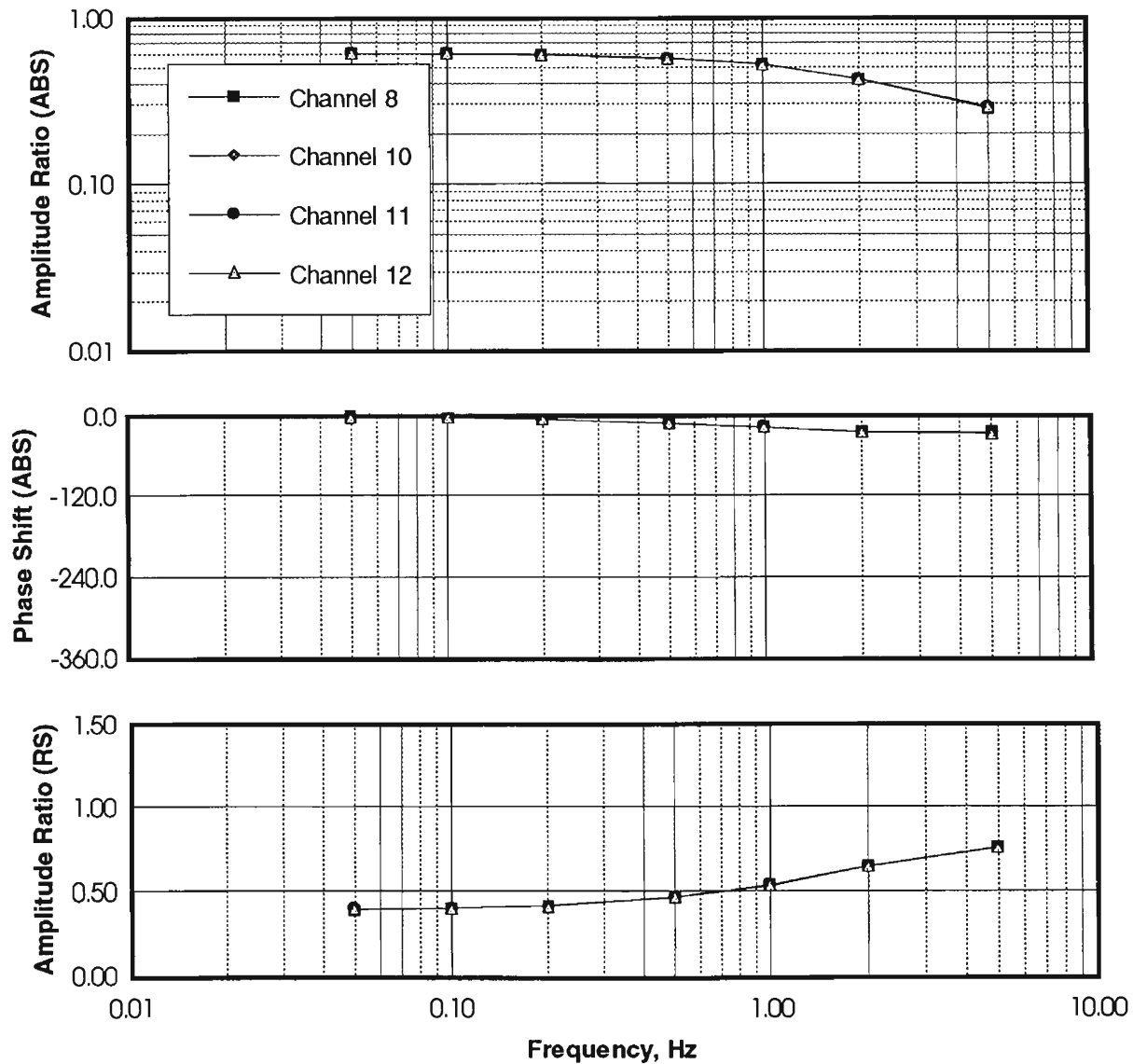
**Figure B19** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 2 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.77	0.76	0.75	0.72	0.64	0.50	0.30
	Phase ABS	-1.8	-3.5	-6.3	-12.0	-20.0	-29.0	-31.1
	Amp RS	0.23	0.24	0.26	0.33	0.45	0.61	0.76
Channel 10	Amp. ABS	0.77	0.76	0.75	0.72	0.64	0.50	0.30
	Phase ABS	-1.8	-3.4	-6.3	-11.9	-19.9	-28.9	-30.9
	Amp RS	0.23	0.24	0.26	0.33	0.45	0.61	0.75
Channel 11	Amp. ABS	0.77	0.76	0.75	0.72	0.64	0.50	0.31
	Phase ABS	-1.8	-3.4	-6.3	-11.8	-19.9	-29.0	-31.2
	Amp RS	0.23	0.24	0.27	0.33	0.45	0.61	0.75
Channel 12	Amp. ABS	0.77	0.76	0.75	0.71	0.64	0.51	0.31
	Phase ABS	-1.8	-3.5	-6.3	-11.9	-19.9	-29.1	-32.0
	Amp RS	0.23	0.24	0.26	0.34	0.45	0.61	0.76



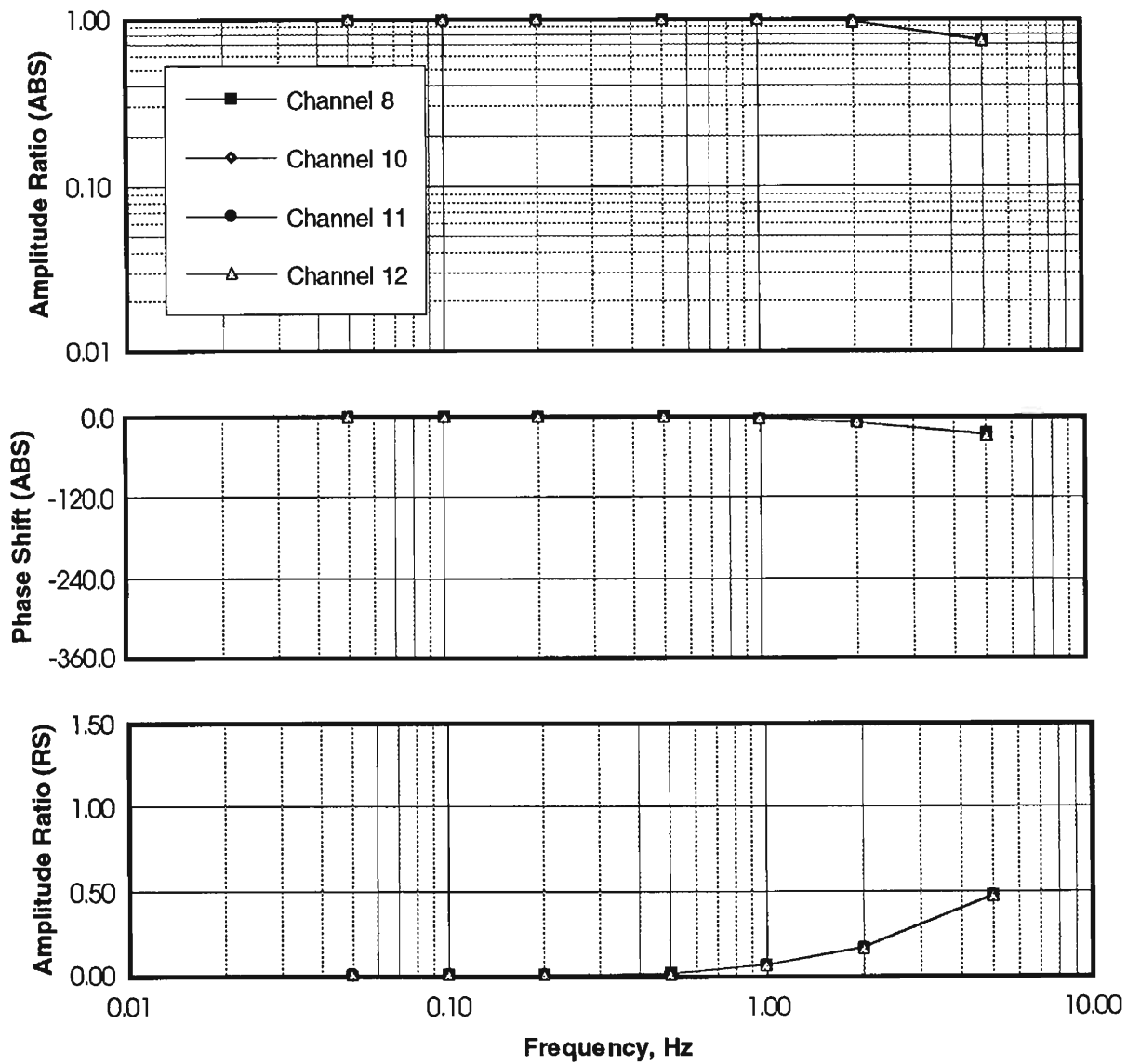
**Figure B20** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 1 vent hole and 3 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.61	0.60	0.59	0.56	0.52	0.42	0.28
	Phase ABS	-1.7	-3.3	-6.1	-12.4	-18.3	-25.7	-26.3
	Amp RS	0.39	0.40	0.41	0.46	0.53	0.64	0.76
Channel 10	Amp. ABS	0.61	0.60	0.59	0.56	0.52	0.42	0.28
	Phase ABS	-1.7	-3.3	-6.0	-12.4	-18.3	-25.7	-26.3
	Amp RS	0.39	0.40	0.41	0.47	0.53	0.64	0.76
Channel 11	Amp. ABS	0.61	0.60	0.59	0.56	0.52	0.42	0.28
	Phase ABS	-1.7	-3.3	-6.1	-12.4	-18.2	-25.8	-26.8
	Amp RS	0.40	0.40	0.42	0.47	0.53	0.65	0.76
Channel 12	Amp. ABS	0.61	0.60	0.59	0.57	0.52	0.43	0.29
	Phase ABS	-1.7	-3.3	-6.1	-12.3	-18.5	-25.9	-27.6
	Amp RS	0.39	0.40	0.41	0.46	0.53	0.64	0.76



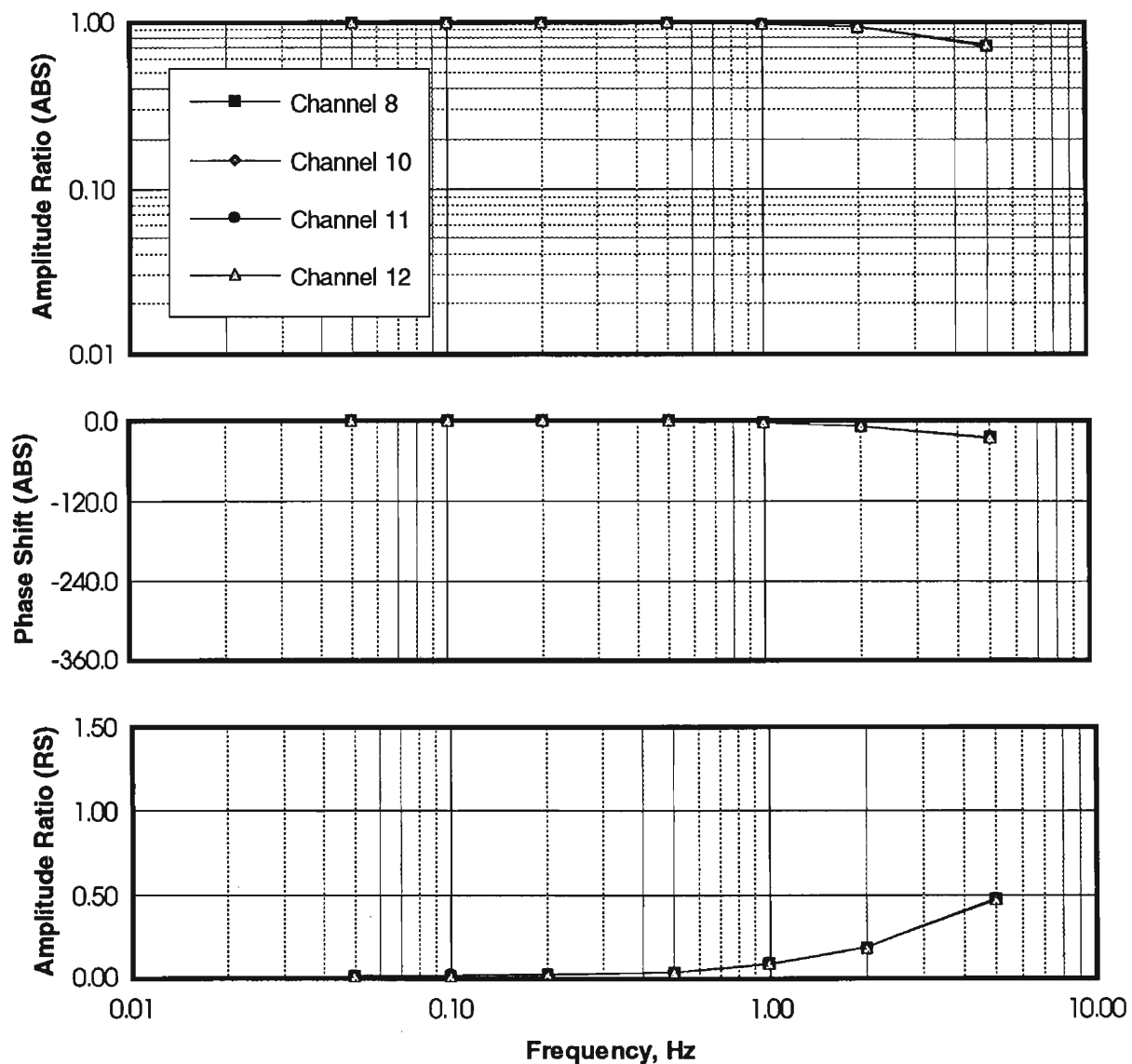
**Figure B21** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 0 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.95	0.73
	Phase ABS	0.0	0.0	-0.1	-0.7	-3.7	-9.5	-26.8
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.17	0.48
Channel 10	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.95	0.73
	Phase ABS	0.0	0.0	-0.1	-0.7	-3.7	-9.4	-26.6
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.17	0.48
Channel 11	Amp. ABS	1.00	1.00	1.00	1.00	0.98	0.96	0.74
	Phase ABS	0.0	0.0	-0.1	-0.7	-3.7	-9.4	-26.7
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.17	0.48
Channel 12	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.96	0.74
	Phase ABS	0.0	0.0	-0.1	-0.7	-3.6	-9.4	-27.0
	Amp RS	0.00	0.00	0.00	0.01	0.06	0.17	0.48



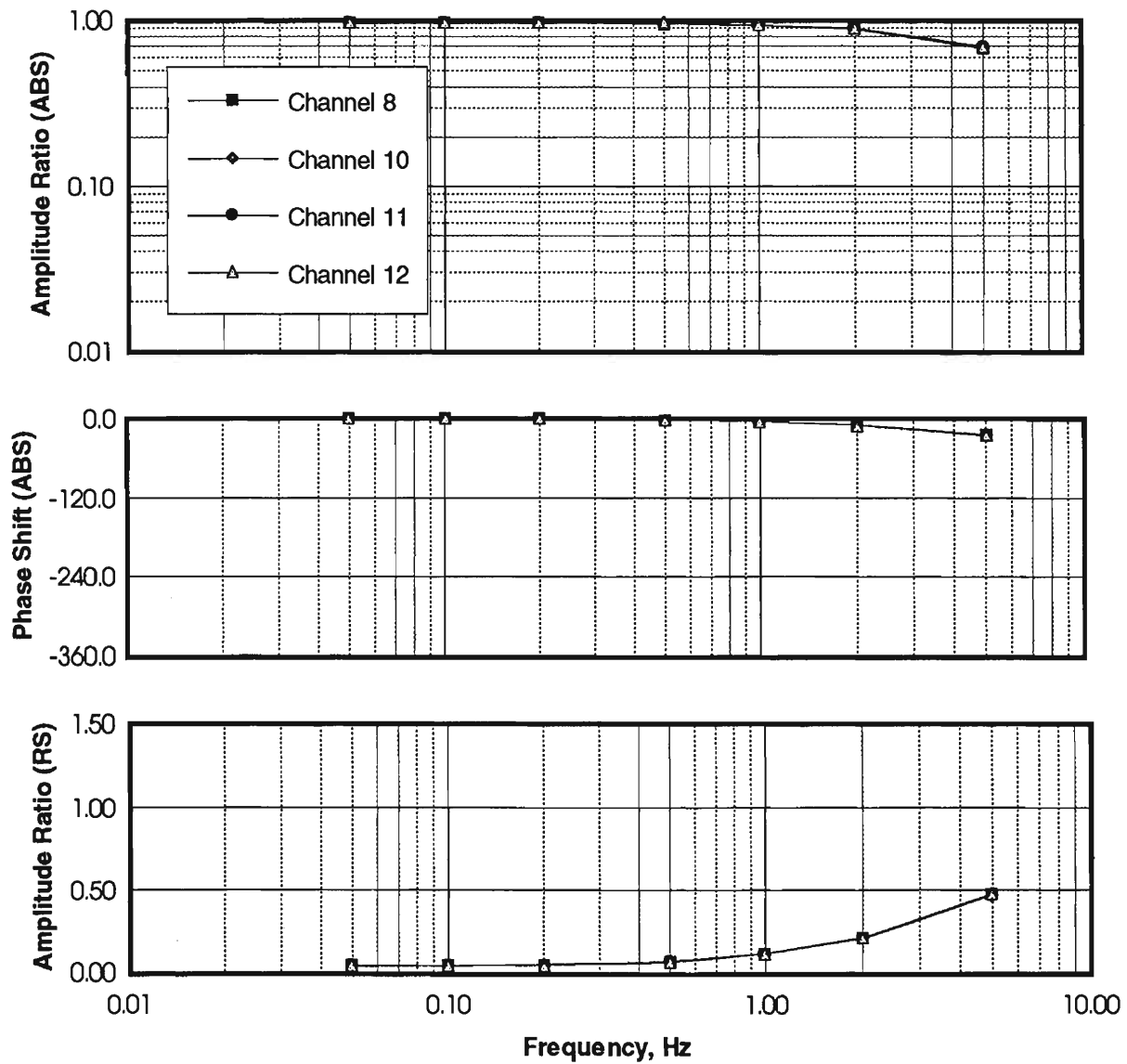
**Figure B22** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 1 leakage hole under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.99	0.99	0.99	0.99	0.96	0.93	0.71
	Phase ABS	-0.2	-0.3	-0.6	-1.3	-4.3	-9.9	-26.2
	Amp RS	0.01	0.01	0.02	0.03	0.08	0.18	0.48
Channel 10	Amp. ABS	0.99	0.99	0.99	0.99	0.96	0.93	0.71
	Phase ABS	-0.2	-0.3	-0.6	-1.3	-4.3	-9.7	-25.9
	Amp RS	0.01	0.01	0.02	0.03	0.08	0.18	0.48
Channel 11	Amp. ABS	0.99	0.99	0.99	0.98	0.96	0.93	0.72
	Phase ABS	-0.1	-0.3	-0.6	-1.3	-4.3	-9.7	-26.0
	Amp RS	0.01	0.01	0.02	0.03	0.08	0.18	0.47
Channel 12	Amp. ABS	0.99	0.99	0.99	0.99	0.97	0.93	0.72
	Phase ABS	-0.2	-0.3	-0.5	-1.3	-4.3	-9.8	-26.4
	Amp RS	0.01	0.01	0.01	0.03	0.08	0.18	0.48



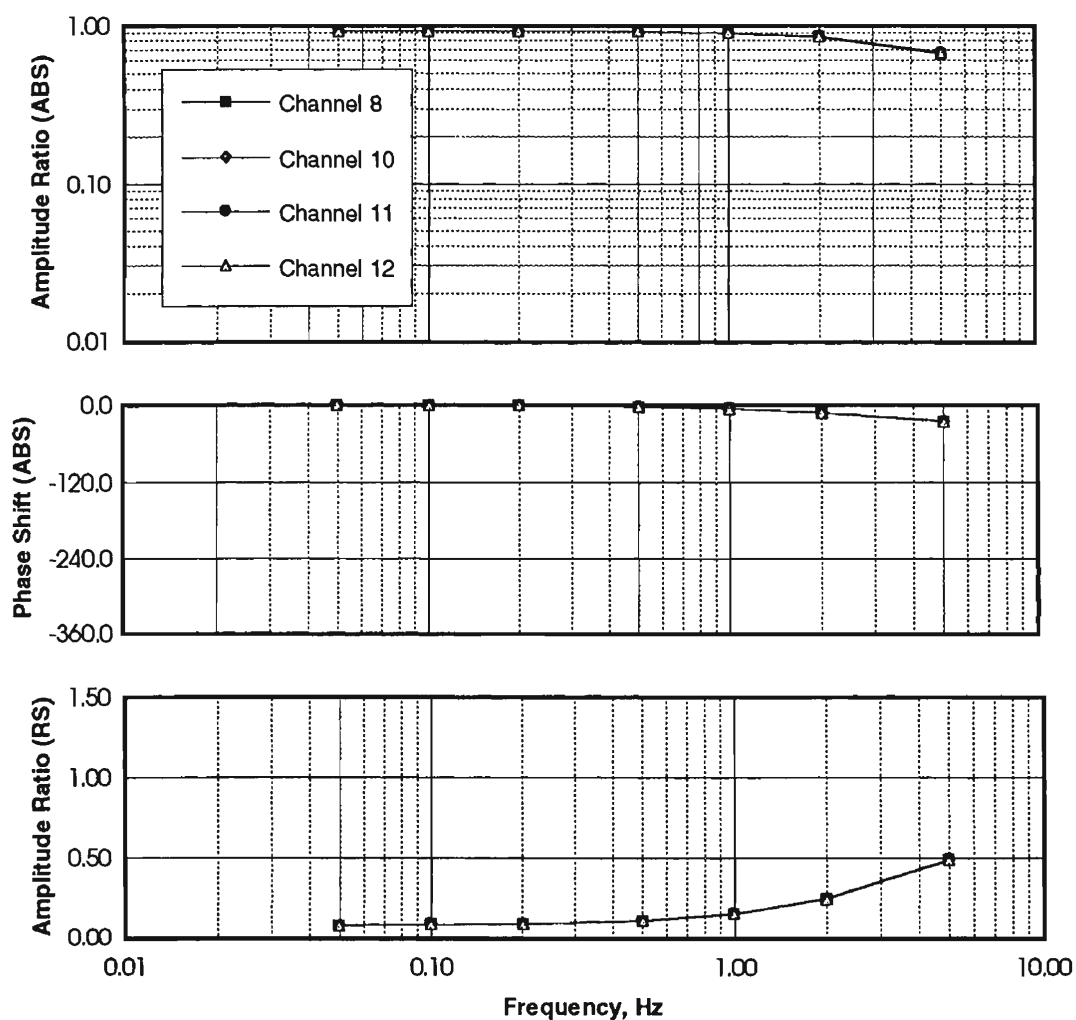
**Figure B23** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 2 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.96	0.96	0.96	0.96	0.93	0.89	0.68
	Phase ABS	-0.3	-0.6	-1.1	-2.5	-5.2	-10.7	-24.8
	Amp RS	0.04	0.04	0.04	0.06	0.11	0.21	0.48
Channel 10	Amp. ABS	0.96	0.96	0.96	0.96	0.93	0.89	0.68
	Phase ABS	-0.3	-0.6	-1.1	-2.4	-5.1	-10.5	-24.6
	Amp RS	0.04	0.04	0.04	0.06	0.11	0.21	0.47
Channel 11	Amp. ABS	0.96	0.96	0.96	0.95	0.93	0.89	0.69
	Phase ABS	-0.3	-0.6	-1.1	-2.5	-5.2	-10.6	-24.8
	Amp RS	0.04	0.04	0.05	0.06	0.11	0.21	0.47
Channel 12	Amp. ABS	0.96	0.96	0.96	0.96	0.93	0.89	0.70
	Phase ABS	-0.3	-0.6	-1.2	-2.5	-5.2	-10.7	-25.4
	Amp RS	0.04	0.04	0.04	0.06	0.11	0.21	0.48



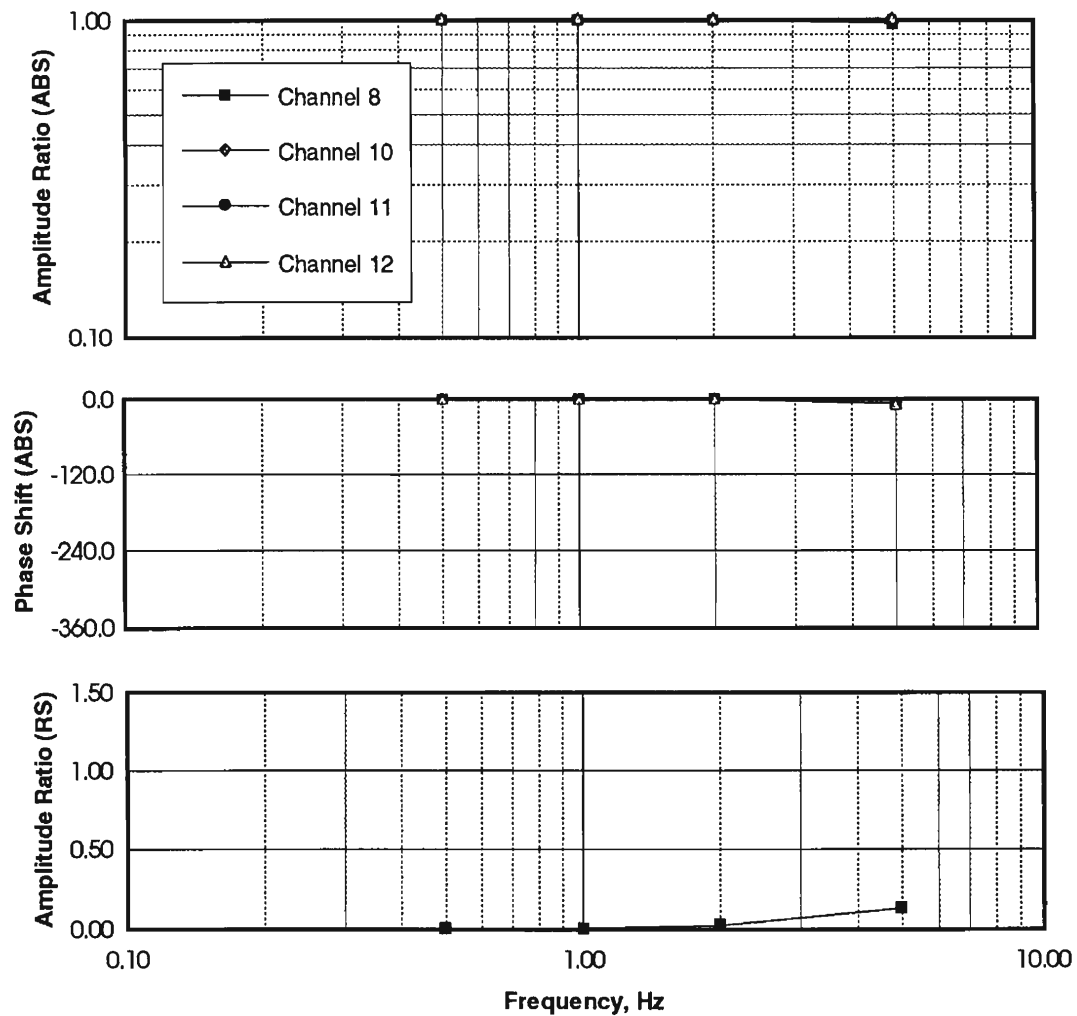
**Figure B24** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 3 vent holes and 3 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.92	0.92	0.92	0.91	0.89	0.84	0.66
	Phase ABS	-0.5	-0.9	-1.6	-3.5	-6.1	-11.7	-24.7
	Amp RS	0.08	0.08	0.09	0.11	0.15	0.24	0.49
Channel 10	Amp. ABS	0.92	0.92	0.92	0.91	0.89	0.84	0.66
	Phase ABS	-0.4	-0.9	-1.6	-3.4	-6.1	-11.6	-24.6
	Amp RS	0.08	0.08	0.08	0.10	0.15	0.24	0.48
Channel 11	Amp. ABS	0.92	0.92	0.92	0.91	0.89	0.85	0.66
	Phase ABS	-0.5	-0.9	-1.6	-3.5	-6.1	-11.7	-25.0
	Amp RS	0.08	0.08	0.09	0.11	0.15	0.24	0.49
Channel 12	Amp. ABS	0.92	0.92	0.92	0.91	0.89	0.85	0.67
	Phase ABS	-0.4	-0.9	-1.6	-3.6	-6.2	-11.8	-25.6
	Amp RS	0.08	0.08	0.09	0.11	0.15	0.24	0.49



**Figure B25** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 5 vent holes and 0 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

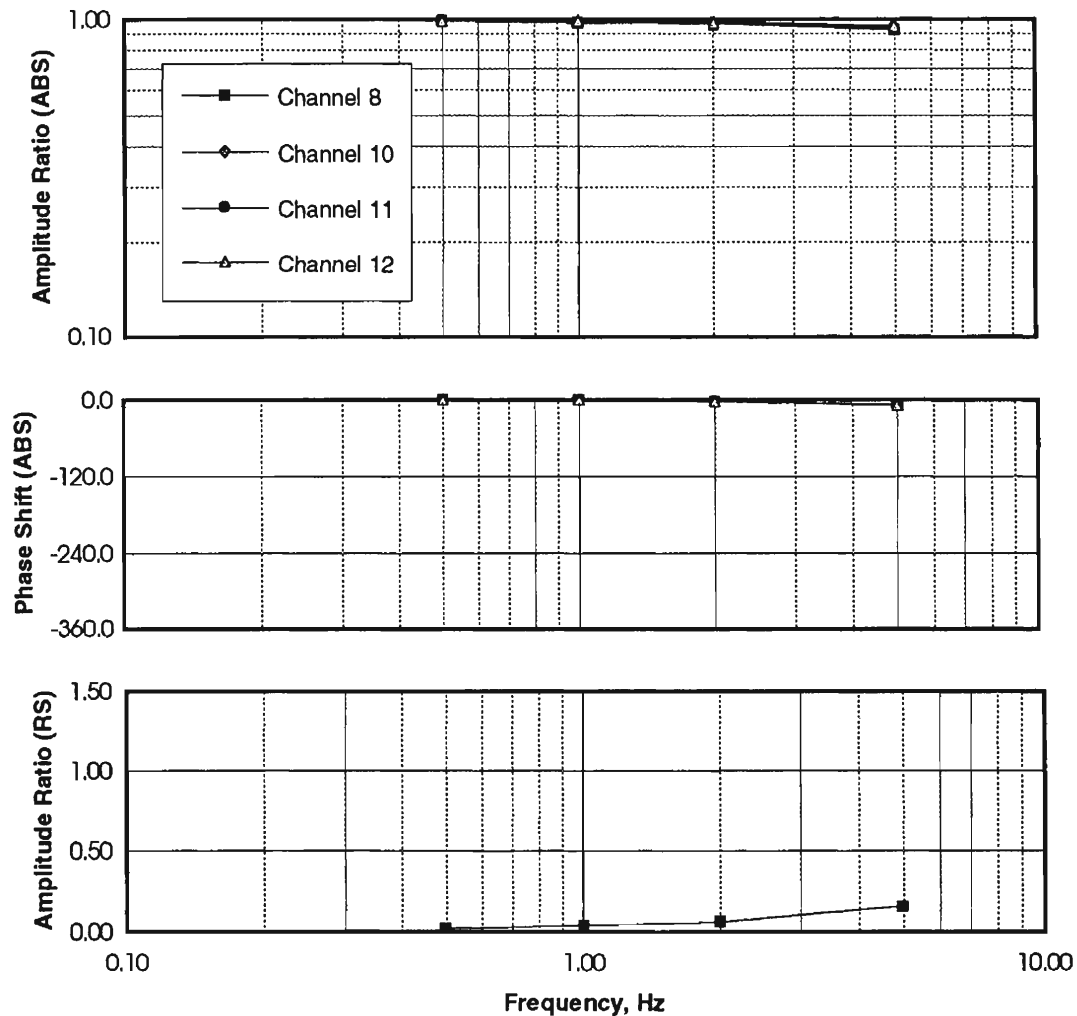
		Test Frequency			
		0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	1.00	0.97
	Phase ABS	-0.1	-0.3	-1.4	-7.4
	Amp RS	0.00	0.01	0.02	0.13
Channel 10	Amp. ABS	1.00	1.00	1.00	0.98
	Phase ABS	-0.1	-0.3	-1.3	-7.2
	Amp RS	0.00	0.01	0.02	0.13
Channel 11	Amp. ABS	1.00	1.00	1.00	0.99
	Phase ABS	0.0	-0.3	-1.3	-7.4
	Amp RS	0.00	0.00	0.02	0.13
Channel 12	Amp. ABS	1.01	1.01	1.01	1.01
	Phase ABS	0.0	-0.3	-1.4	-7.7
	Amp RS	0.01	0.01	0.03	0.14





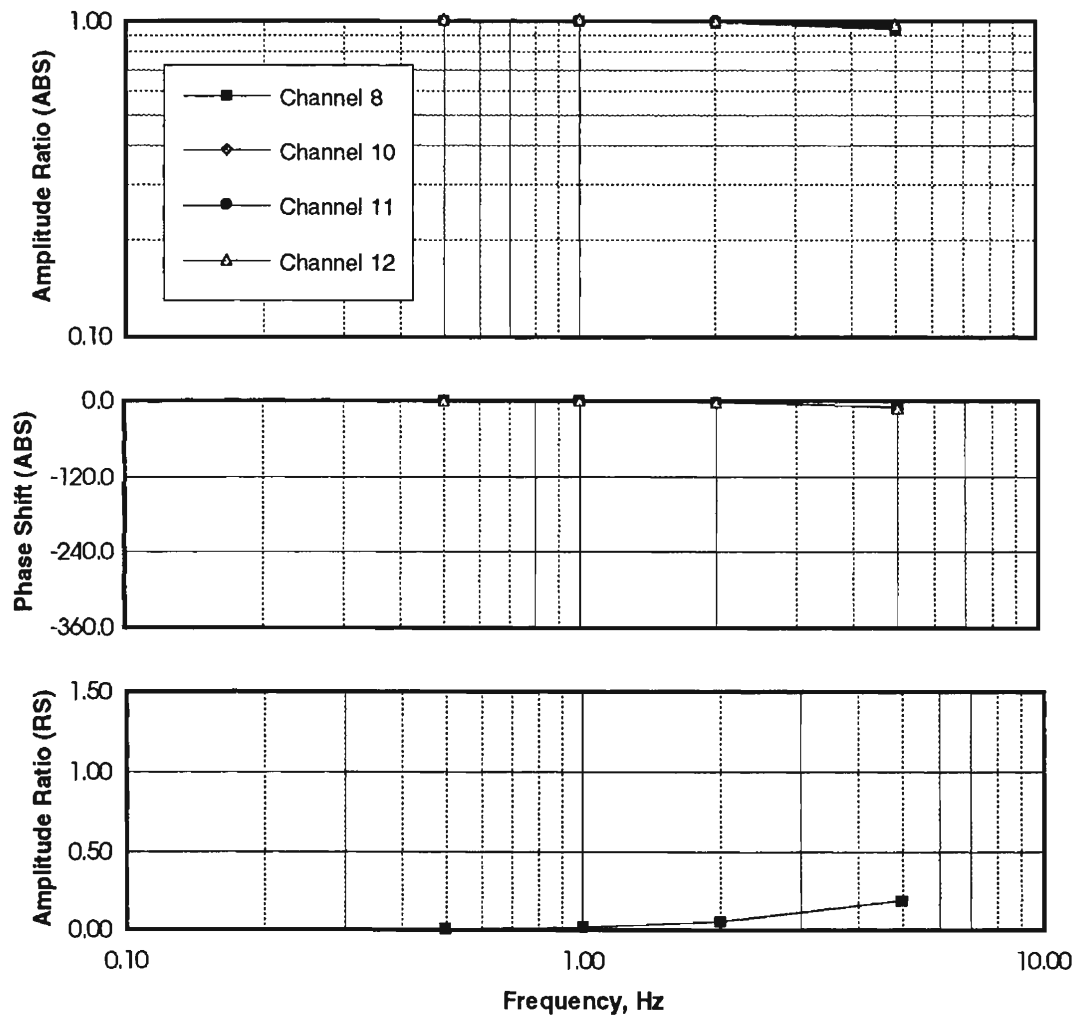
**Figure B26** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 5 vent holes and 3 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency			
		0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.98	0.97	0.96	0.92
	Phase ABS	-0.6	-1.5	-2.8	-8.0
	Amp RS	0.02	0.04	0.06	0.15
Channel 10	Amp. ABS	0.99	0.97	0.97	0.93
	Phase ABS	-0.6	-1.6	-2.8	-7.9
	Amp RS	0.02	0.04	0.06	0.15
Channel 11	Amp. ABS	0.98	0.97	0.97	0.94
	Phase ABS	-0.6	-1.5	-2.8	-8.5
	Amp RS	0.02	0.04	0.06	0.16
Channel 12	Amp. ABS	0.99	0.98	0.98	0.95
	Phase ABS	-0.6	-1.7	-3.1	-9.3
	Amp RS	0.01	0.04	0.06	0.17



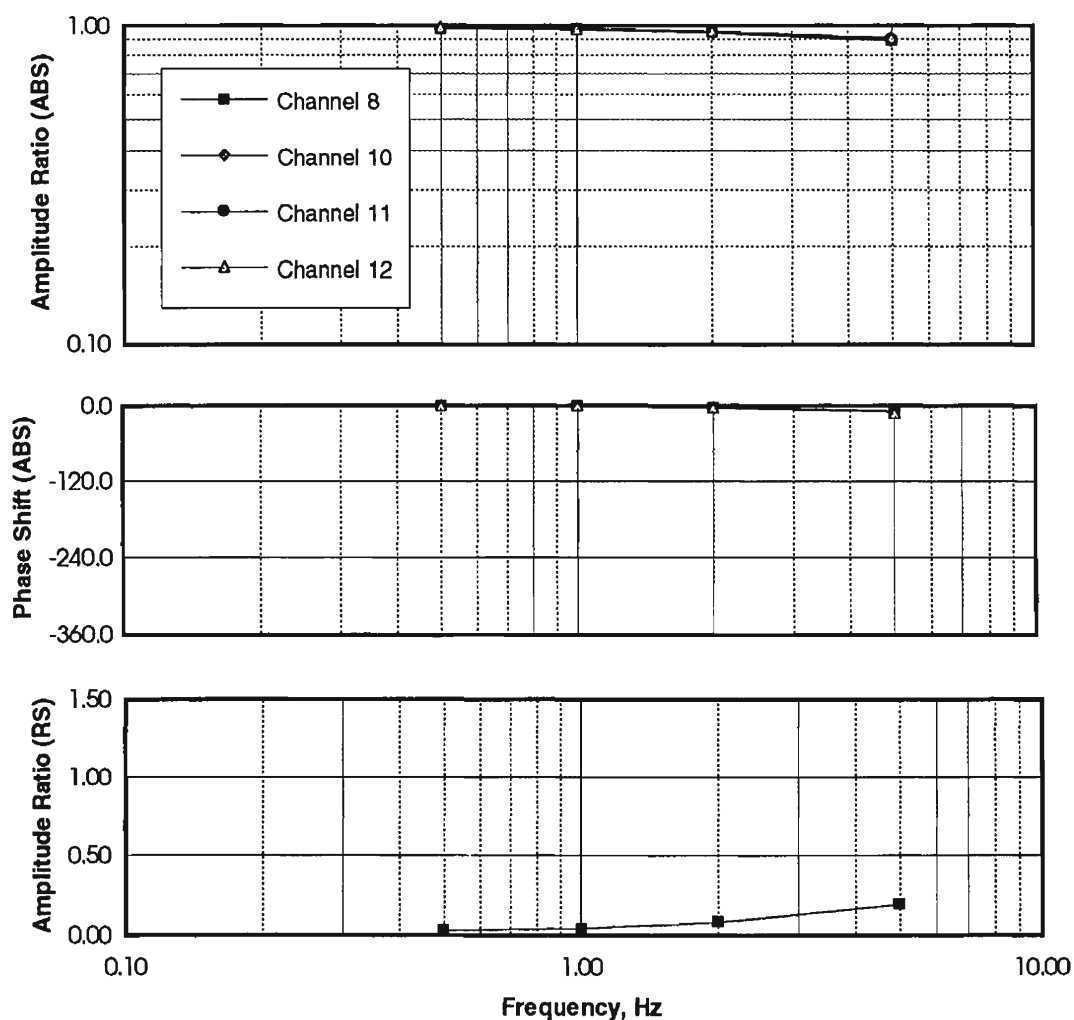
**Figure B27** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 5 vent holes and 0 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency			
		0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	0.99	0.94
	Phase ABS	-0.2	-0.8	-2.8	-10.6
	Amp RS	0.00	0.01	0.05	0.19
Channel 10	Amp. ABS	1.00	1.00	0.99	0.95
	Phase ABS	-0.2	-0.8	-2.7	-10.6
	Amp RS	0.00	0.01	0.05	0.19
Channel 11	Amp. ABS	1.00	1.00	0.99	0.96
	Phase ABS	-0.2	-0.8	-2.7	-10.7
	Amp RS	0.00	0.01	0.05	0.19
Channel 12	Amp. ABS	1.01	1.00	1.00	0.97
	Phase ABS	-0.2	-0.8	-2.7	-10.9
	Amp RS	0.01	0.01	0.05	0.19



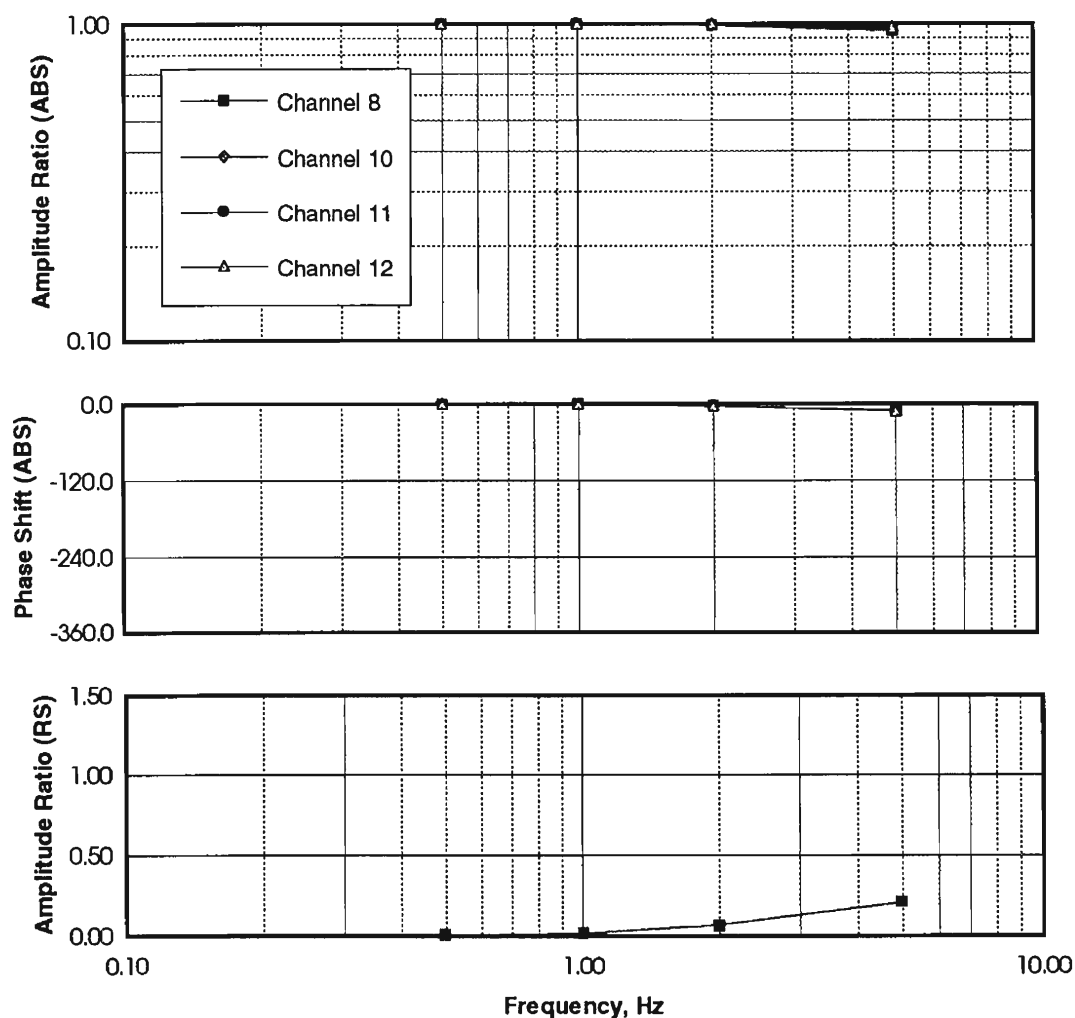
**Figure B28** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 5 vent holes and 3 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency			
		0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.97	0.97	0.94	0.89
	Phase ABS	-0.7	-1.4	-3.5	-9.5
	Amp RS	0.03	0.04	0.08	0.19
Channel 10	Amp. ABS	0.98	0.97	0.95	0.89
	Phase ABS	-0.7	-1.4	-3.5	-9.5
	Amp RS	0.03	0.04	0.08	0.19
Channel 11	Amp. ABS	0.98	0.97	0.95	0.90
	Phase ABS	-0.7	-1.4	-3.6	-9.9
	Amp RS	0.03	0.04	0.08	0.19
Channel 12	Amp. ABS	0.98	0.97	0.95	0.91
	Phase ABS	-0.7	-1.5	-3.9	-10.6
	Amp RS	0.02	0.04	0.08	0.20



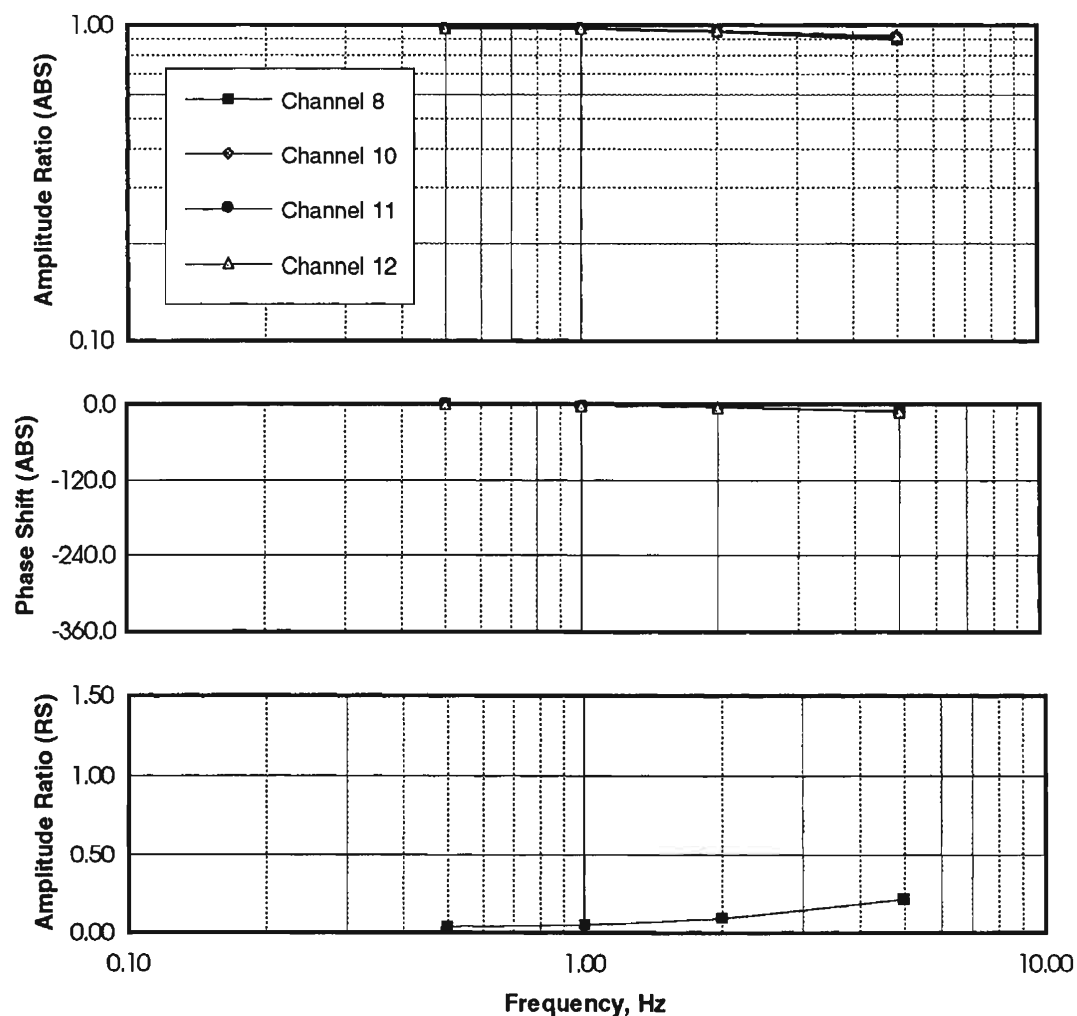
**Figure B29** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 5 vent holes and 0 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency			
		0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	1.00	1.00	0.98	0.94
	Phase ABS	-0.2	-0.9	-3.8	-11.7
	Amp RS	0.00	0.02	0.07	0.21
Channel 10	Amp. ABS	1.00	1.00	0.99	0.95
	Phase ABS	-0.2	-0.8	-3.7	-11.6
	Amp RS	0.00	0.02	0.07	0.20
Channel 11	Amp. ABS	1.00	1.00	0.99	0.96
	Phase ABS	-0.2	-0.8	-3.7	-11.7
	Amp RS	0.00	0.01	0.07	0.20
Channel 12	Amp. ABS	1.00	1.00	1.00	0.97
	Phase ABS	-0.2	-0.8	-3.8	-11.9
	Amp RS	0.00	0.01	0.07	0.21



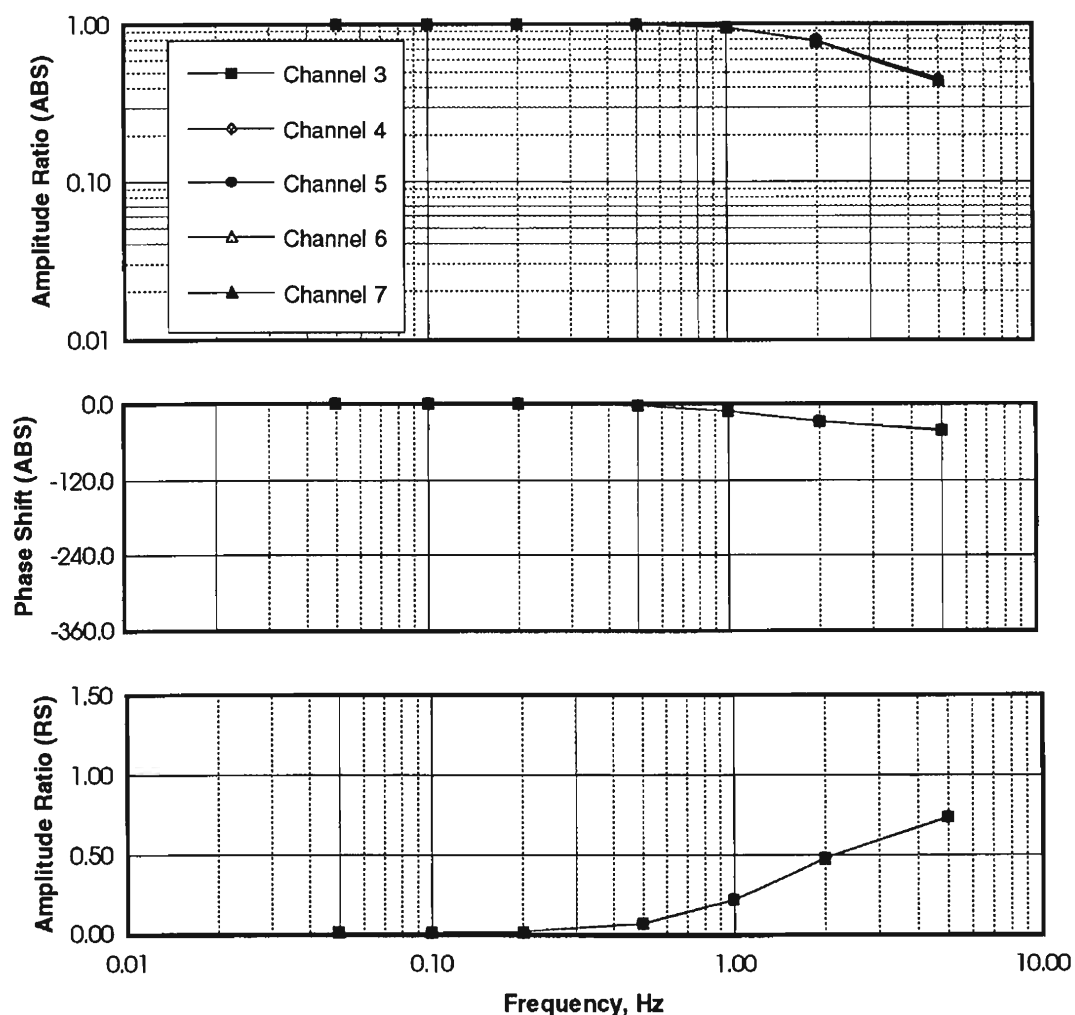
**Figure B30** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 3 with 5 vent holes and 3 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency			
		0.50	1.00	2.00	5.00
Channel 8	Amp. ABS	0.97	0.97	0.95	0.89
	Phase ABS	-1.1	-2.0	-4.4	-11.5
	Amp RS	0.03	0.05	0.09	0.22
Channel 10	Amp. ABS	0.97	0.97	0.95	0.90
	Phase ABS	-1.1	-2.0	-4.4	-11.5
	Amp RS	0.03	0.05	0.09	0.21
Channel 11	Amp. ABS	0.97	0.97	0.95	0.91
	Phase ABS	-1.2	-2.0	-4.4	-11.7
	Amp RS	0.03	0.05	0.09	0.22
Channel 12	Amp. ABS	0.98	0.97	0.96	0.92
	Phase ABS	-1.2	-2.1	-4.6	-12.2
	Amp RS	0.03	0.04	0.09	0.22



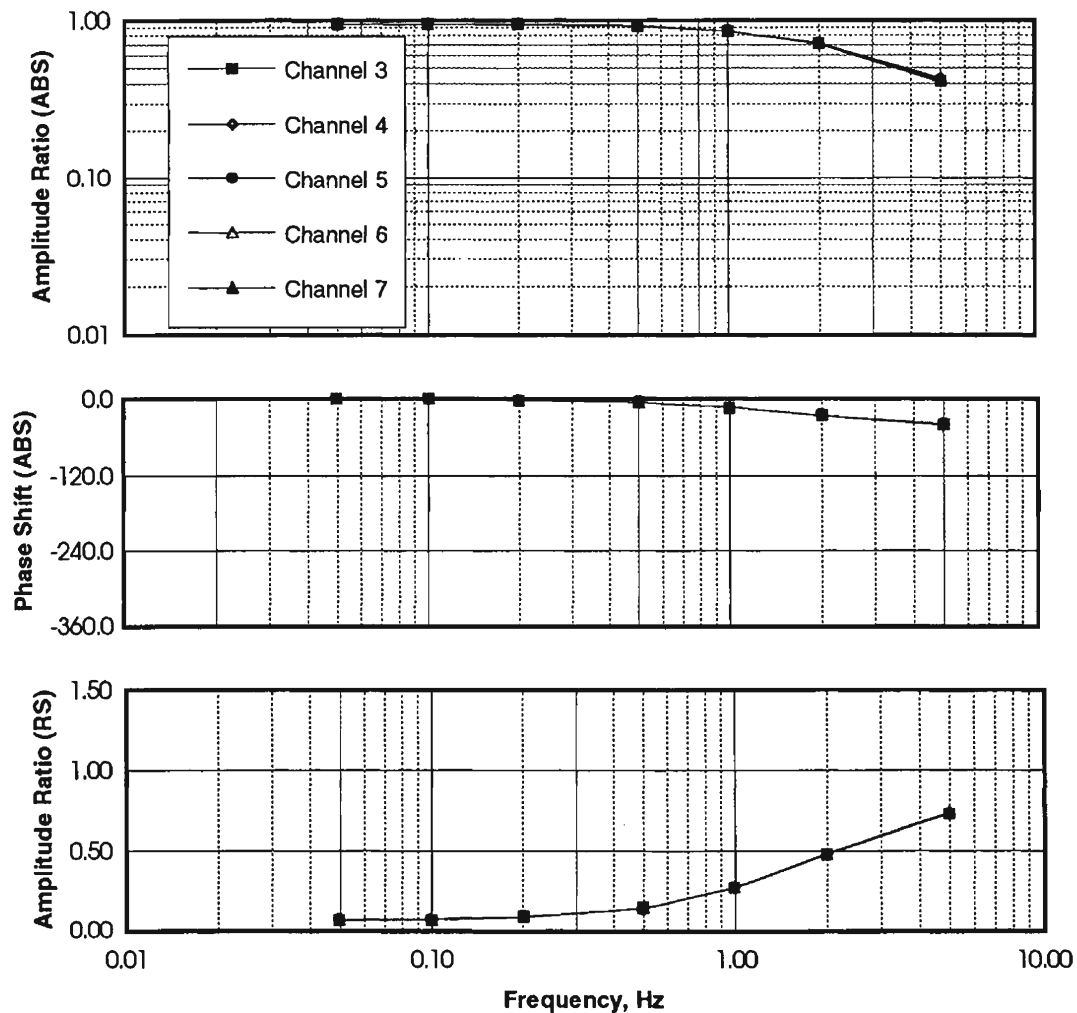
**Figure C1** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 0 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.77	0.43
	Phase ABS	-0.1	-0.2	-0.7	-3.5	-12.3	-27.9	-41.6
	Amp RS	0.00	0.00	0.01	0.06	0.22	0.48	0.74
Channel 4	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.77	0.44
	Phase ABS	-0.1	-0.2	-0.6	-3.5	-12.3	-27.9	-42.1
	Amp RS	0.00	0.00	0.01	0.06	0.22	0.48	0.74
Channel 5	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.78	0.44
	Phase ABS	-0.1	-0.2	-0.6	-3.5	-12.3	-27.9	-42.3
	Amp RS	0.00	0.00	0.01	0.06	0.22	0.48	0.74
Channel 6	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.78	0.45
	Phase ABS	-0.1	-0.1	-0.7	-3.5	-12.4	-28.0	-42.9
	Amp RS	0.00	0.00	0.01	0.06	0.22	0.48	0.74
Channel 7	Amp. ABS	1.00	1.00	1.00	0.99	0.94	0.78	0.46
	Phase ABS	-0.1	-0.2	-0.6	-3.5	-12.3	-28.1	-43.3
	Amp RS	0.00	0.00	0.01	0.06	0.22	0.48	0.74



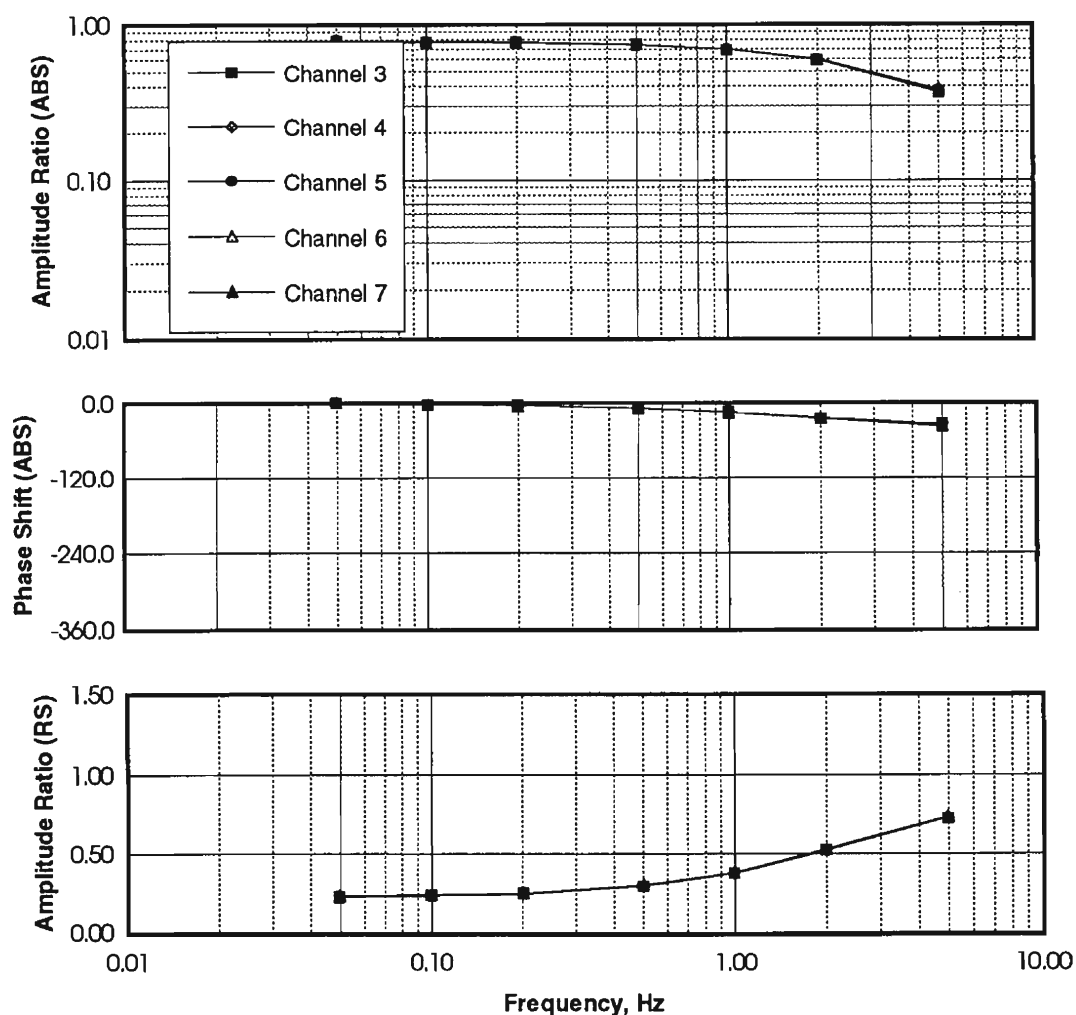
**Figure C2** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 1 leakage hole under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.94	0.94	0.93	0.91	0.85	0.71	0.41
	Phase ABS	-0.8	-1.5	-2.8	-6.4	-13.6	-26.0	-39.0
	Amp RS	0.06	0.07	0.08	0.14	0.27	0.48	0.73
Channel 4	Amp. ABS	0.94	0.94	0.93	0.91	0.85	0.71	0.41
	Phase ABS	-0.8	-1.5	-2.8	-6.4	-13.6	-26.2	-39.5
	Amp RS	0.06	0.07	0.08	0.14	0.27	0.48	0.73
Channel 5	Amp. ABS	0.94	0.94	0.94	0.92	0.85	0.71	0.42
	Phase ABS	-0.8	-1.5	-2.9	-6.4	-13.6	-26.1	-39.8
	Amp RS	0.06	0.06	0.08	0.14	0.27	0.48	0.73
Channel 6	Amp. ABS	0.94	0.94	0.93	0.91	0.85	0.71	0.42
	Phase ABS	-0.8	-1.6	-2.9	-6.4	-13.6	-26.4	-40.5
	Amp RS	0.06	0.07	0.08	0.14	0.27	0.48	0.73
Channel 7	Amp. ABS	0.94	0.94	0.93	0.91	0.85	0.71	0.43
	Phase ABS	-0.8	-1.6	-2.9	-6.5	-13.7	-26.5	-41.0
	Amp RS	0.06	0.07	0.08	0.14	0.27	0.48	0.73



**Figure C3** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 2 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

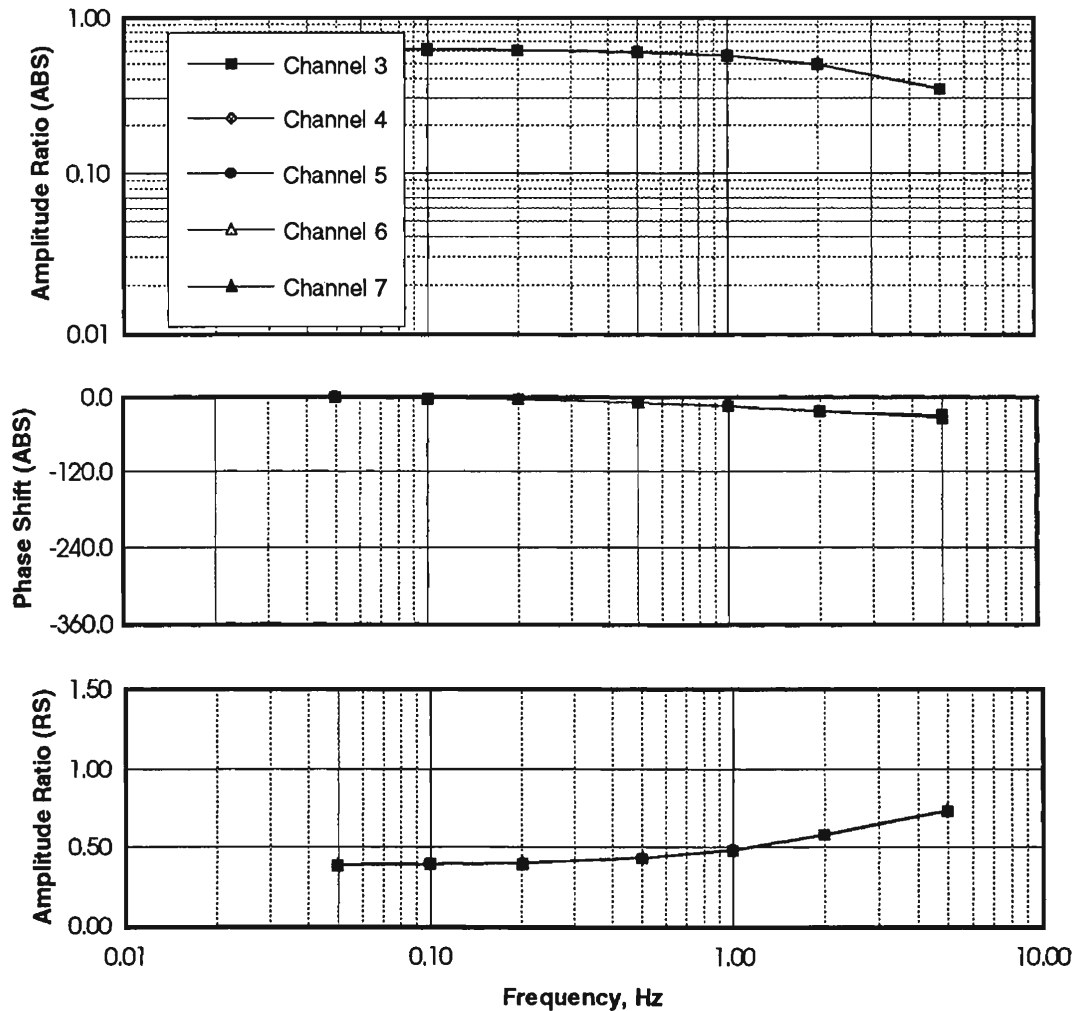
		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.78	0.78	0.77	0.75	0.70	0.60	0.36
	Phase ABS	-1.2	-2.4	-4.4	-9.6	-15.3	-24.4	-34.3
	Amp RS	0.22	0.23	0.24	0.29	0.37	0.52	0.73
Channel 4	Amp. ABS	0.78	0.77	0.77	0.75	0.70	0.60	0.37
	Phase ABS	-1.2	-2.3	-4.4	-9.5	-15.3	-24.5	-35.0
	Amp RS	0.22	0.23	0.24	0.29	0.38	0.52	0.73
Channel 5	Amp. ABS	0.78	0.78	0.77	0.75	0.70	0.60	0.37
	Phase ABS	-1.2	-2.4	-4.4	-9.6	-15.4	-24.6	-35.5
	Amp RS	0.22	0.23	0.24	0.29	0.37	0.52	0.73
Channel 6	Amp. ABS	0.78	0.77	0.77	0.74	0.70	0.60	0.38
	Phase ABS	-1.2	-2.4	-4.5	-9.6	-15.4	-24.8	-36.2
	Amp RS	0.22	0.23	0.24	0.29	0.38	0.52	0.73
Channel 7	Amp. ABS	0.77	0.77	0.77	0.74	0.69	0.60	0.38
	Phase ABS	-1.2	-2.4	-4.5	-9.7	-15.7	-25.3	-37.3
	Amp RS	0.23	0.23	0.24	0.30	0.38	0.53	0.74





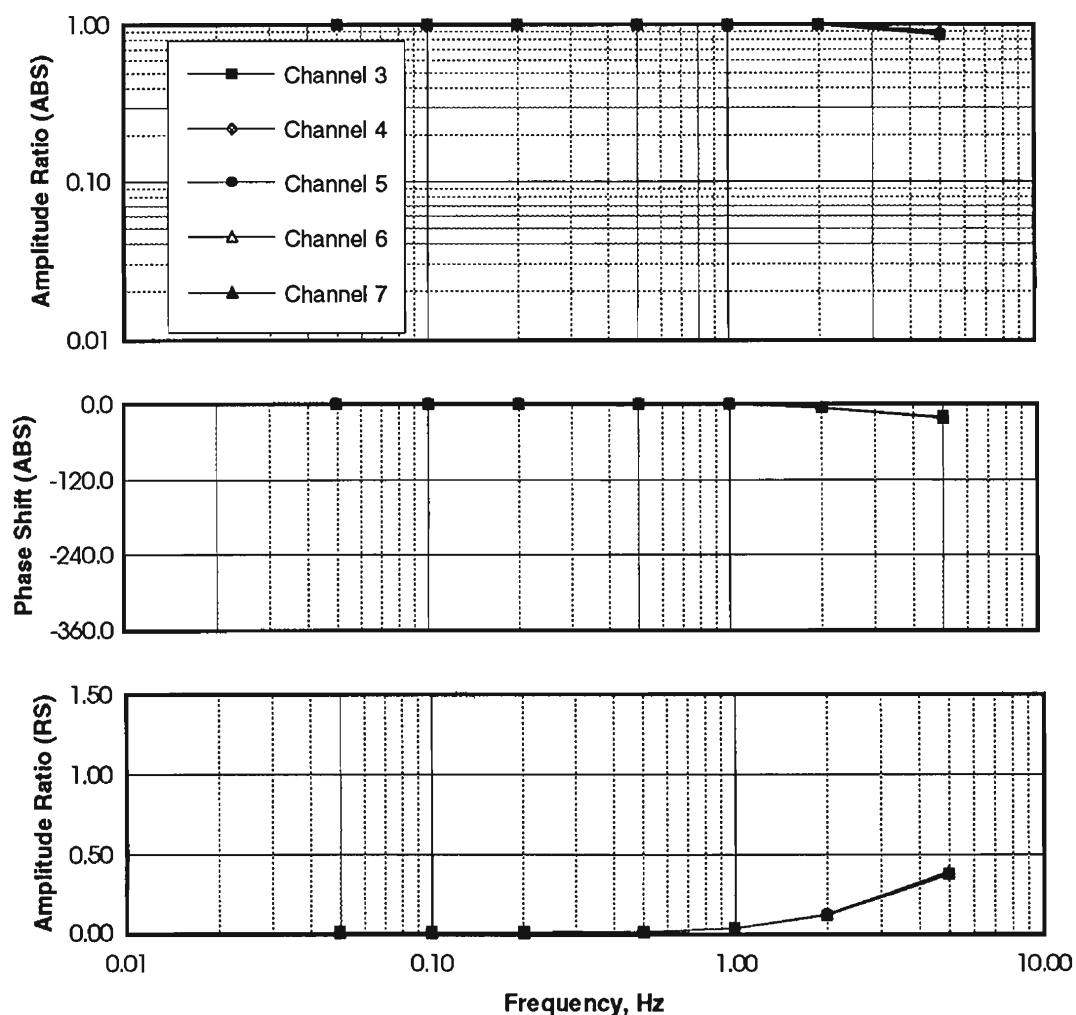
**Figure C4** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent holes and 3 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.62	0.62	0.61	0.59	0.56	0.49	0.34
	Phase ABS	-1.3	-2.3	-4.2	-9.4	-14.6	-22.3	-29.3
	Amp RS	0.38	0.38	0.39	0.43	0.48	0.58	0.72
Channel 4	Amp. ABS	0.62	0.62	0.61	0.59	0.56	0.49	0.34
	Phase ABS	-1.3	-2.4	-4.3	-9.5	-14.8	-22.5	-30.0
	Amp RS	0.38	0.39	0.39	0.43	0.48	0.58	0.73
Channel 5	Amp. ABS	0.62	0.62	0.61	0.59	0.56	0.49	0.34
	Phase ABS	-1.2	-2.3	-4.2	-9.5	-14.8	-22.7	-30.6
	Amp RS	0.38	0.38	0.39	0.43	0.48	0.58	0.73
Channel 6	Amp. ABS	0.62	0.61	0.61	0.59	0.56	0.49	0.35
	Phase ABS	-1.2	-2.4	-4.3	-9.5	-14.9	-22.9	-31.5
	Amp RS	0.38	0.39	0.39	0.43	0.48	0.58	0.73
Channel 7	Amp. ABS	0.61	0.61	0.61	0.59	0.56	0.49	0.35
	Phase ABS	-1.2	-2.4	-4.4	-9.6	-15.2	-23.5	-33.1
	Amp RS	0.39	0.39	0.40	0.43	0.48	0.58	0.73



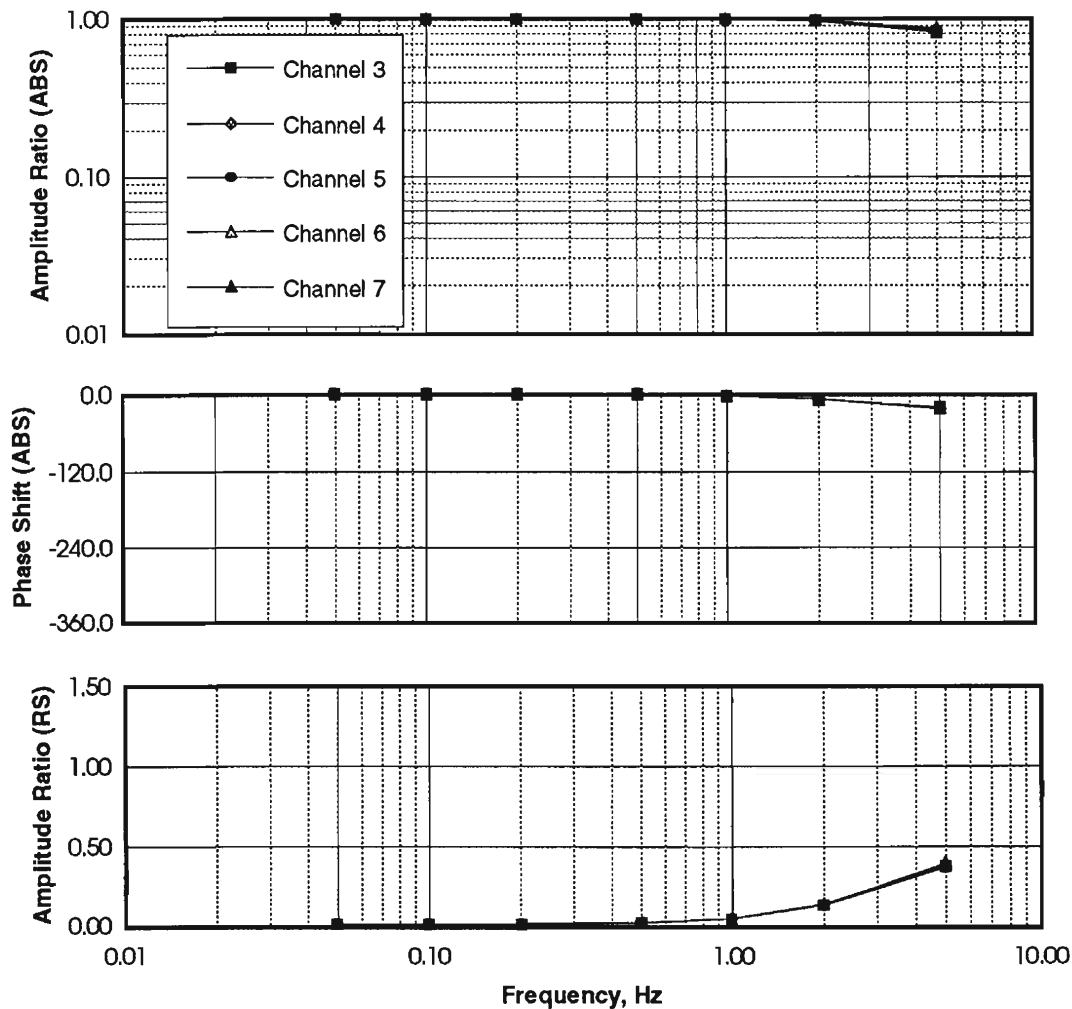
**Figure C5** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 0 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.98	0.85
	Phase ABS	0.0	0.0	-0.1	-0.4	-1.5	-6.4	-21.4
	Amp RS	0.00	0.00	0.00	0.01	0.03	0.11	0.37
Channel 4	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.99	0.86
	Phase ABS	0.0	0.0	0.0	-0.4	-1.5	-6.5	-21.9
	Amp RS	0.00	0.00	0.00	0.01	0.03	0.11	0.38
Channel 5	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.99	0.87
	Phase ABS	0.0	0.0	-0.1	-0.4	-1.5	-6.6	-22.2
	Amp RS	0.00	0.00	0.00	0.01	0.03	0.11	0.38
Channel 6	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.99	0.89
	Phase ABS	0.0	0.0	0.0	-0.4	-1.5	-6.7	-22.7
	Amp RS	0.00	0.00	0.00	0.01	0.03	0.12	0.39
Channel 7	Amp. ABS	1.00	1.00	1.00	1.00	1.00	0.99	0.90
	Phase ABS	0.0	0.0	0.0	-0.4	-1.6	-6.7	-23.1
	Amp RS	0.00	0.00	0.00	0.01	0.03	0.12	0.39



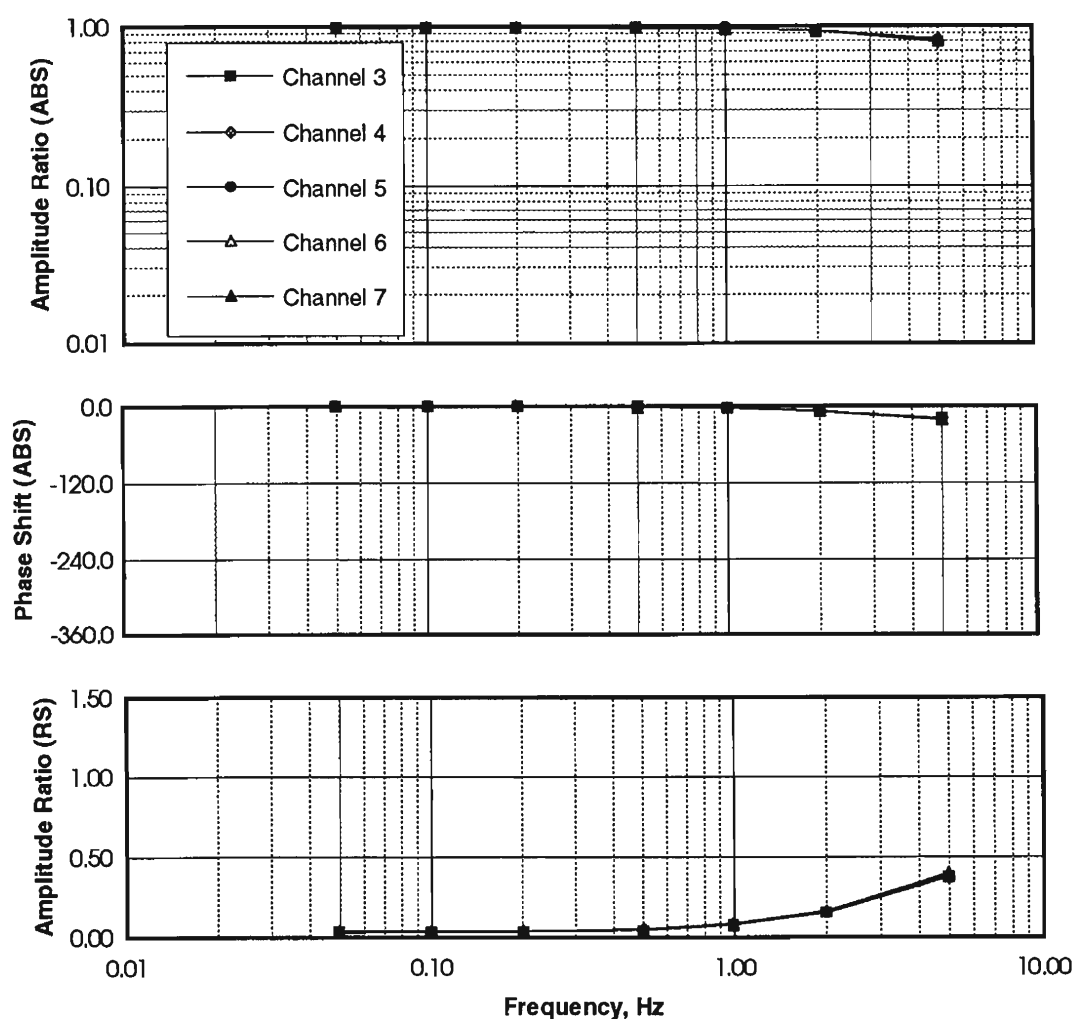
**Figure C6** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 1 leakage hole under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.99	0.99	1.00	0.99	0.98	0.96	0.82
	Phase ABS	-0.1	-0.2	-0.4	-0.8	-2.2	-7.2	-20.7
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.13	0.37
Channel 4	Amp. ABS	0.99	0.99	0.99	0.99	0.98	0.96	0.83
	Phase ABS	-0.1	-0.2	-0.3	-0.8	-2.2	-7.3	-21.3
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.13	0.38
Channel 5	Amp. ABS	1.00	1.00	1.00	0.99	0.99	0.96	0.84
	Phase ABS	-0.1	-0.2	-0.3	-0.8	-2.3	-7.4	-21.7
	Amp RS	0.00	0.00	0.01	0.02	0.04	0.13	0.38
Channel 6	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.96	0.85
	Phase ABS	-0.1	-0.1	-0.3	-0.9	-2.3	-7.6	-22.3
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.14	0.39
Channel 7	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.96	0.86
	Phase ABS	-0.1	-0.2	-0.4	-0.9	-2.4	-7.7	-23.0
	Amp RS	0.01	0.01	0.01	0.02	0.04	0.14	0.40



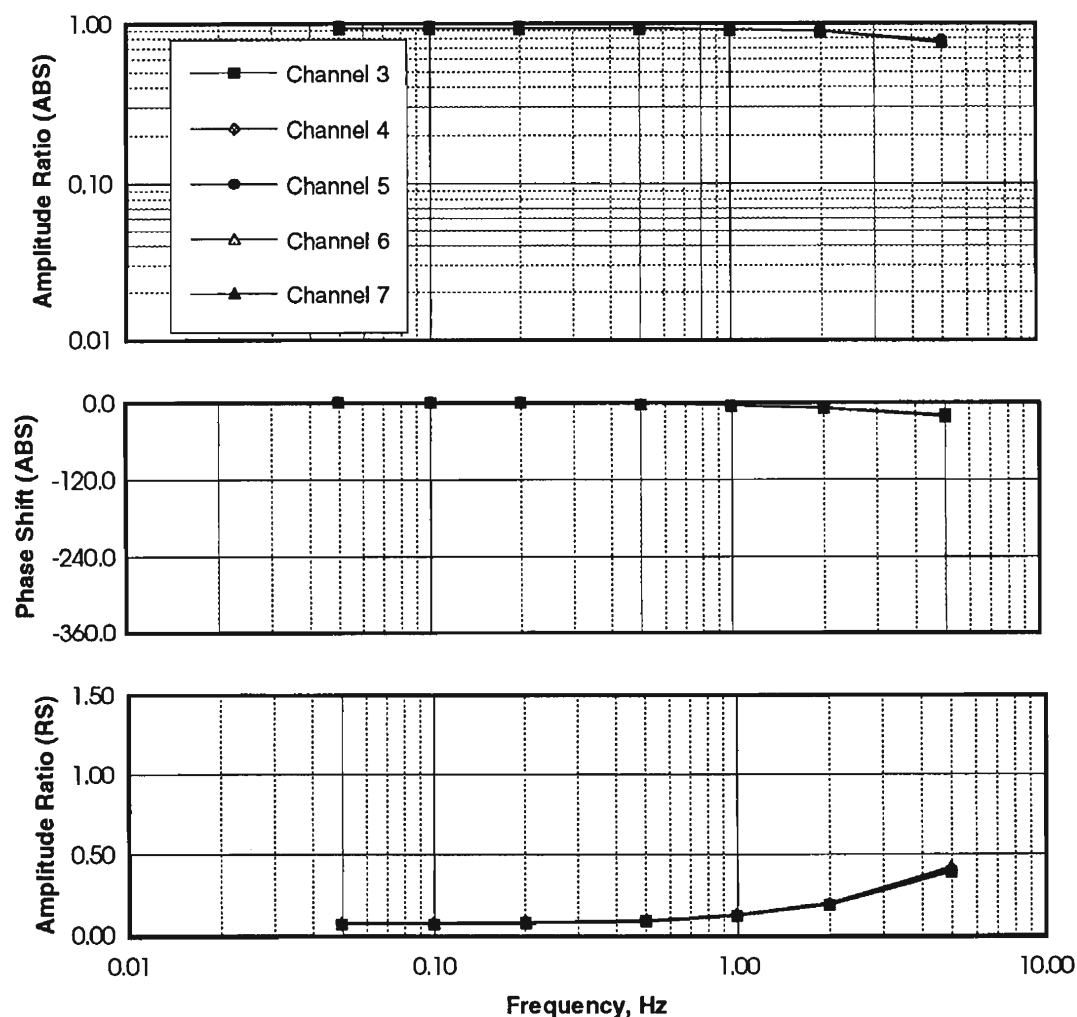
**Figure C7** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 2 leakage holes under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.97	0.97	0.97	0.97	0.95	0.92	0.79
	Phase ABS	-0.2	-0.4	-0.7	-1.7	-3.5	-7.9	-20.1
	Amp RS	0.03	0.03	0.03	0.04	0.08	0.15	0.38
Channel 4	Amp. ABS	0.97	0.97	0.97	0.97	0.95	0.92	0.80
	Phase ABS	-0.2	-0.4	-0.8	-1.7	-3.5	-8.1	-20.8
	Amp RS	0.03	0.03	0.03	0.05	0.08	0.16	0.38
Channel 5	Amp. ABS	0.97	0.97	0.97	0.97	0.96	0.93	0.81
	Phase ABS	-0.2	-0.4	-0.8	-1.8	-3.6	-8.2	-21.1
	Amp RS	0.03	0.03	0.03	0.04	0.08	0.16	0.38
Channel 6	Amp. ABS	0.97	0.97	0.97	0.96	0.95	0.93	0.82
	Phase ABS	-0.2	-0.4	-0.8	-1.8	-3.6	-8.5	-22.0
	Amp RS	0.03	0.03	0.04	0.05	0.08	0.16	0.39
Channel 7	Amp. ABS	0.96	0.96	0.96	0.96	0.95	0.92	0.83
	Phase ABS	-0.2	-0.4	-0.8	-1.9	-3.8	-8.8	-23.0
	Amp RS	0.04	0.04	0.04	0.05	0.08	0.17	0.40



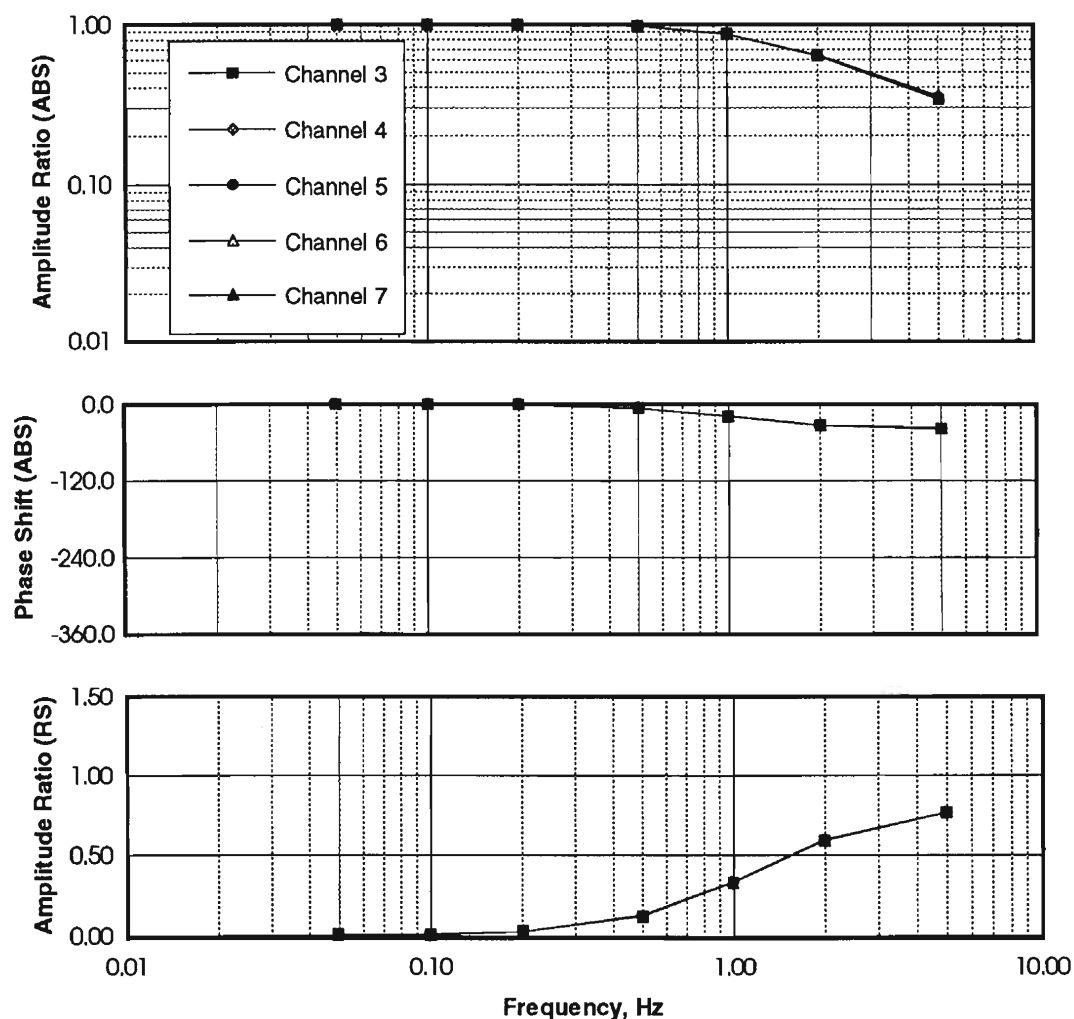
**Figure C8** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 3 leakage hole under a loading condition of 500 Pa Mean and 500 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.93	0.93	0.93	0.93	0.91	0.88	0.74
	Phase ABS	-0.3	-0.5	-1.0	-2.4	-4.6	-8.6	-19.8
	Amp RS	0.07	0.07	0.07	0.08	0.12	0.18	0.39
Channel 4	Amp. ABS	0.93	0.93	0.93	0.93	0.91	0.88	0.75
	Phase ABS	-0.3	-0.5	-1.0	-2.4	-4.7	-8.9	-20.6
	Amp RS	0.07	0.07	0.07	0.08	0.12	0.19	0.40
Channel 5	Amp. ABS	0.93	0.93	0.93	0.93	0.91	0.89	0.76
	Phase ABS	-0.3	-0.5	-1.1	-2.4	-4.7	-9.0	-21.0
	Amp RS	0.07	0.07	0.07	0.08	0.12	0.19	0.40
Channel 6	Amp. ABS	0.93	0.93	0.93	0.93	0.91	0.88	0.77
	Phase ABS	-0.3	-0.5	-1.1	-2.5	-4.9	-9.2	-22.0
	Amp RS	0.07	0.07	0.07	0.08	0.12	0.19	0.41
Channel 7	Amp. ABS	0.92	0.92	0.92	0.92	0.90	0.88	0.77
	Phase ABS	-0.3	-0.6	-1.1	-2.6	-5.1	-9.8	-23.5
	Amp RS	0.08	0.08	0.08	0.09	0.13	0.20	0.42



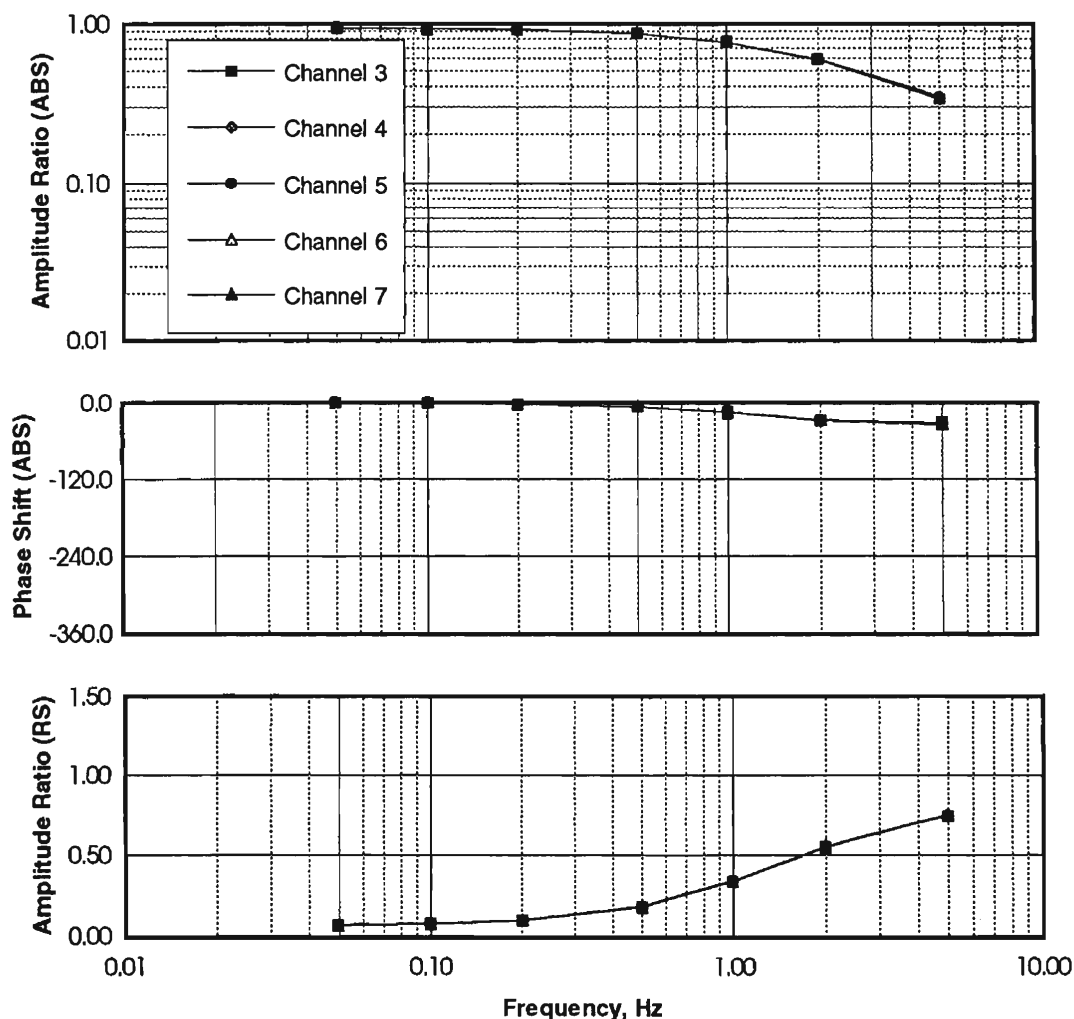
**Figure C9** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 0 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	1.00	1.00	1.00	0.97	0.86	0.64	0.33
	Phase ABS	-0.1	-0.4	-1.4	-6.9	-19.1	-34.3	-38.7
	Amp RS	0.00	0.01	0.02	0.12	0.34	0.59	0.77
Channel 4	Amp. ABS	1.00	1.00	1.00	0.97	0.86	0.64	0.34
	Phase ABS	-0.1	-0.3	-1.4	-6.9	-19.1	-34.3	-39.3
	Amp RS	0.00	0.01	0.02	0.12	0.34	0.59	0.77
Channel 5	Amp. ABS	1.00	1.00	1.00	0.97	0.87	0.64	0.34
	Phase ABS	-0.1	-0.3	-1.4	-6.9	-19.1	-34.4	-39.6
	Amp RS	0.00	0.01	0.02	0.12	0.34	0.59	0.77
Channel 6	Amp. ABS	1.00	1.00	0.99	0.97	0.87	0.64	0.34
	Phase ABS	-0.1	-0.4	-1.4	-6.9	-19.1	-34.5	-40.2
	Amp RS	0.00	0.01	0.02	0.12	0.34	0.60	0.77
Channel 7	Amp. ABS	1.00	1.00	1.00	0.97	0.87	0.64	0.35
	Phase ABS	-0.1	-0.3	-1.4	-6.9	-19.2	-34.6	-40.7
	Amp RS	0.00	0.01	0.02	0.12	0.34	0.60	0.77



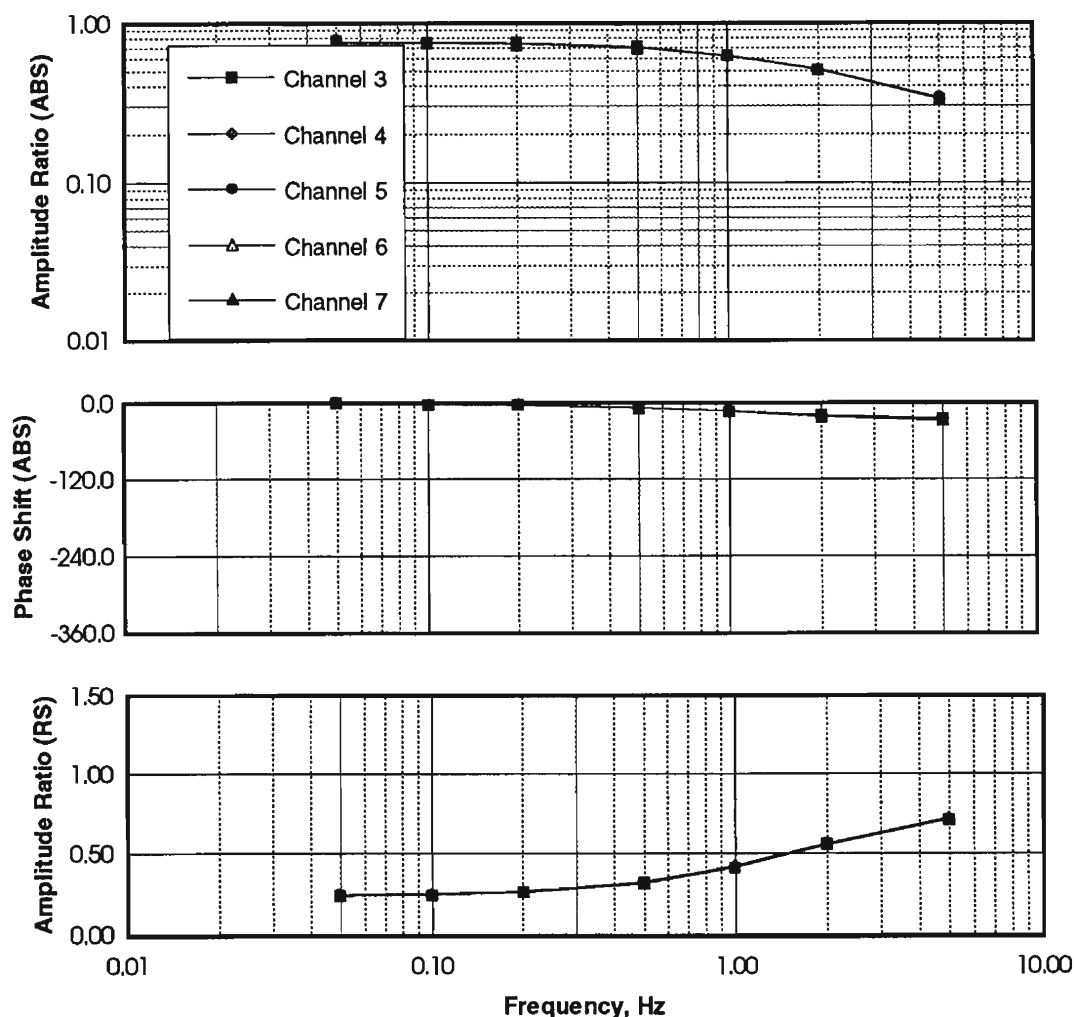
**Figure C10** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 1 leakage hole under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.94	0.93	0.92	0.86	0.76	0.58	0.33
	Phase ABS	-0.7	-1.4	-2.7	-7.1	-15.5	-27.3	-32.3
	Amp RS	0.07	0.07	0.09	0.18	0.34	0.55	0.74
Channel 4	Amp. ABS	0.93	0.93	0.92	0.86	0.76	0.59	0.34
	Phase ABS	-0.7	-1.4	-2.7	-7.1	-15.5	-27.4	-33.0
	Amp RS	0.07	0.07	0.09	0.18	0.34	0.55	0.74
Channel 5	Amp. ABS	0.94	0.93	0.92	0.87	0.76	0.59	0.34
	Phase ABS	-0.7	-1.4	-2.8	-7.1	-15.6	-27.5	-33.4
	Amp RS	0.06	0.07	0.09	0.18	0.34	0.55	0.74
Channel 6	Amp. ABS	0.93	0.93	0.92	0.86	0.76	0.59	0.34
	Phase ABS	-0.7	-1.4	-2.8	-7.2	-15.6	-27.6	-34.1
	Amp RS	0.07	0.07	0.10	0.18	0.34	0.55	0.74
Channel 7	Amp. ABS	0.93	0.93	0.92	0.86	0.76	0.59	0.35
	Phase ABS	-0.7	-1.4	-2.8	-7.2	-15.7	-27.9	-35.1
	Amp RS	0.07	0.07	0.09	0.18	0.34	0.55	0.74



**Figure C11** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 2 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

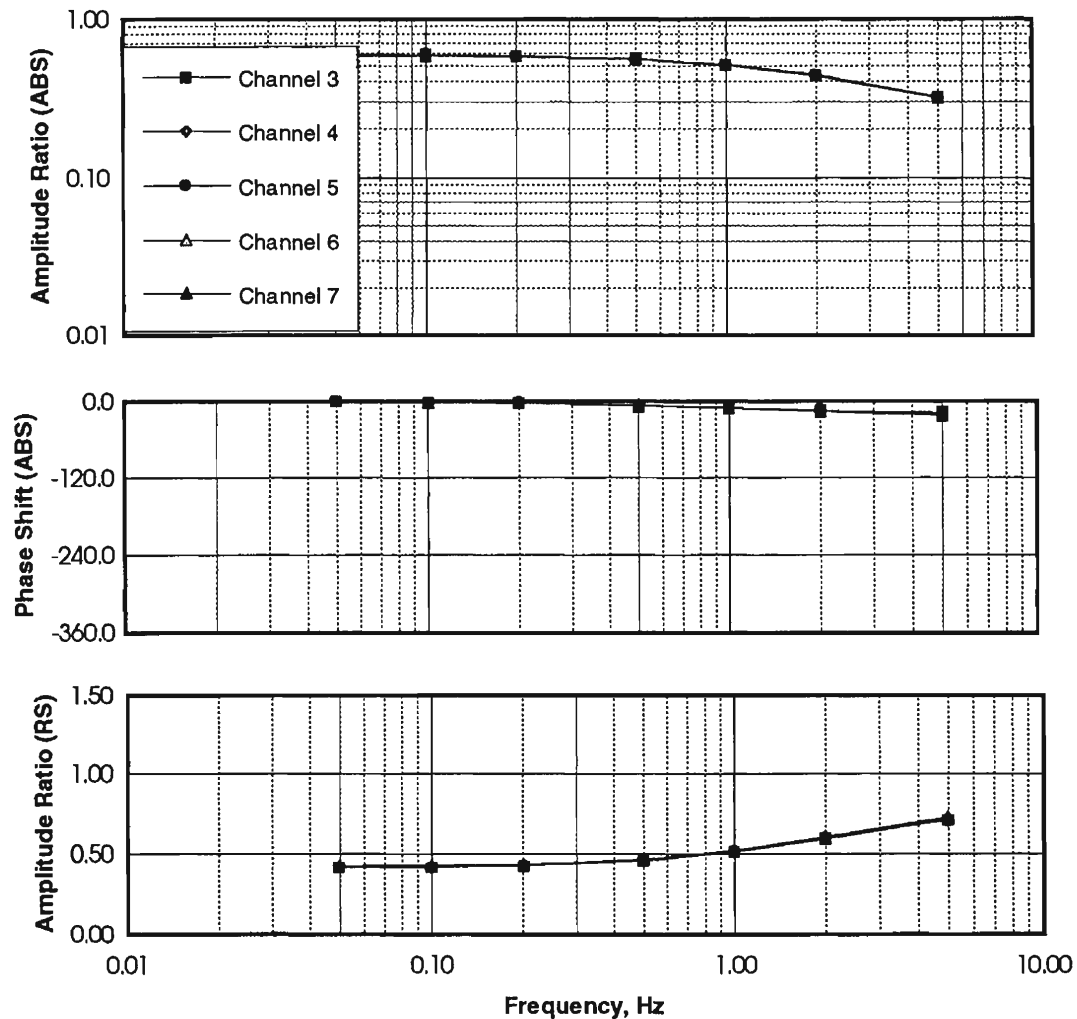
		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.76	0.75	0.74	0.70	0.63	0.51	0.33
	Phase ABS	-1.1	-2.0	-3.8	-7.7	-13.1	-20.5	-24.9
	Amp RS	0.24	0.25	0.26	0.32	0.42	0.55	0.72
Channel 4	Amp. ABS	0.76	0.75	0.74	0.70	0.62	0.51	0.33
	Phase ABS	-1.0	-2.0	-3.8	-7.7	-13.2	-20.7	-25.6
	Amp RS	0.24	0.25	0.26	0.32	0.42	0.55	0.72
Channel 5	Amp. ABS	0.76	0.75	0.74	0.70	0.63	0.51	0.33
	Phase ABS	-1.1	-2.0	-3.8	-7.8	-13.2	-20.9	-26.2
	Amp RS	0.24	0.25	0.26	0.32	0.42	0.55	0.72
Channel 6	Amp. ABS	0.75	0.75	0.74	0.70	0.62	0.51	0.33
	Phase ABS	-1.1	-2.0	-3.8	-7.9	-13.4	-21.2	-27.1
	Amp RS	0.25	0.25	0.27	0.32	0.42	0.56	0.72
Channel 7	Amp. ABS	0.75	0.75	0.74	0.70	0.62	0.51	0.33
	Phase ABS	-1.1	-2.1	-3.9	-8.0	-13.6	-21.8	-28.6
	Amp RS	0.25	0.25	0.27	0.33	0.42	0.56	0.73





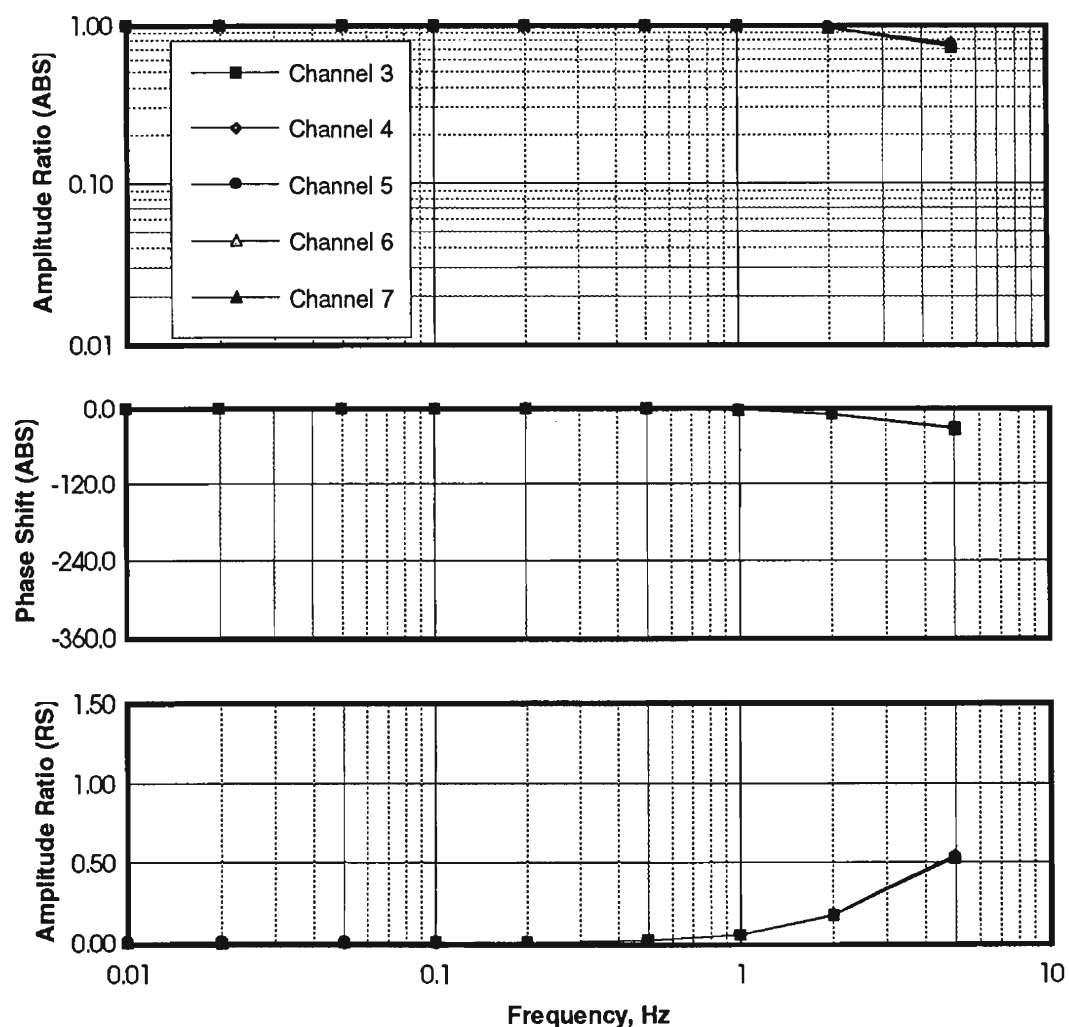
**Figure C12** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 3 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.59	0.59	0.58	0.55	0.51	0.44	0.32
	Phase ABS	-1.0	-1.8	-3.5	-6.9	-10.7	-15.1	-18.0
	Amp RS	0.41	0.42	0.42	0.45	0.51	0.59	0.70
Channel 4	Amp. ABS	0.59	0.58	0.58	0.55	0.51	0.44	0.32
	Phase ABS	-0.9	-1.8	-3.5	-6.9	-10.8	-15.3	-18.8
	Amp RS	0.41	0.42	0.42	0.46	0.51	0.59	0.71
Channel 5	Amp. ABS	0.59	0.59	0.58	0.55	0.51	0.44	0.32
	Phase ABS	-1.0	-1.8	-3.5	-7.0	-10.9	-15.5	-19.4
	Amp RS	0.41	0.42	0.42	0.46	0.51	0.59	0.71
Channel 6	Amp. ABS	0.58	0.58	0.58	0.55	0.51	0.44	0.32
	Phase ABS	-1.0	-1.9	-3.6	-7.1	-11.1	-15.9	-20.5
	Amp RS	0.42	0.42	0.43	0.46	0.51	0.59	0.71
Channel 7	Amp. ABS	0.58	0.58	0.57	0.55	0.50	0.43	0.32
	Phase ABS	-1.0	-1.9	-3.6	-7.3	-11.5	-16.8	-22.7
	Amp RS	0.42	0.42	0.43	0.46	0.52	0.60	0.72



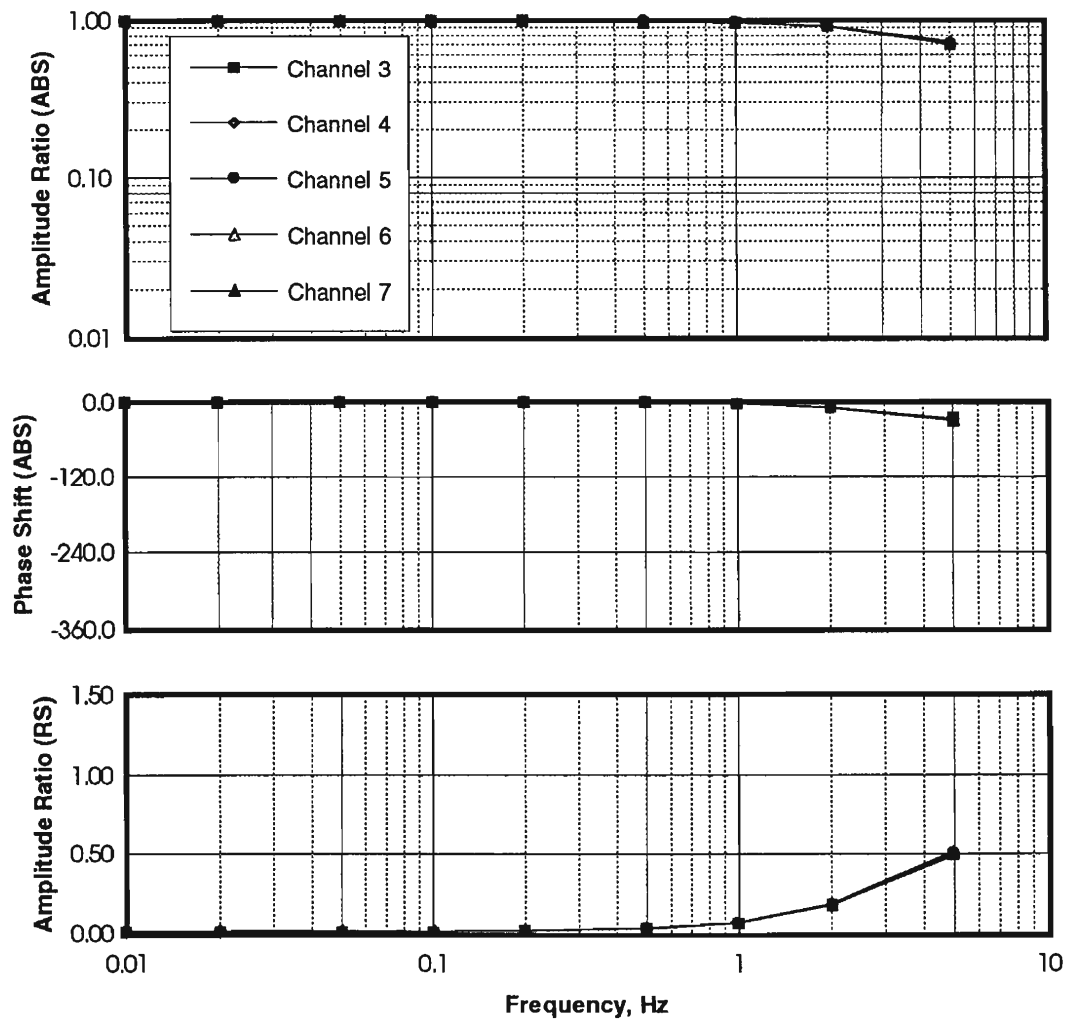
**Figure C13** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 0 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.95	0.72
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.8	-2.9	-9.7	-30.5
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.17	0.53
Channel 4	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.73
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.8	-3.0	-9.8	-31.2
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.17	0.53
Channel 5	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	0.74
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.8	-3.0	-9.9	-31.6
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.17	0.54
Channel 6	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.75
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.8	-3.0	-10.0	-32.2
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.18	0.54
Channel 7	Amp. ABS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.76
	Phase ABS	0.0	0.0	0.0	0.0	-0.1	-0.8	-3.0	-10.1	-32.8
	Amp RS	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.18	0.55



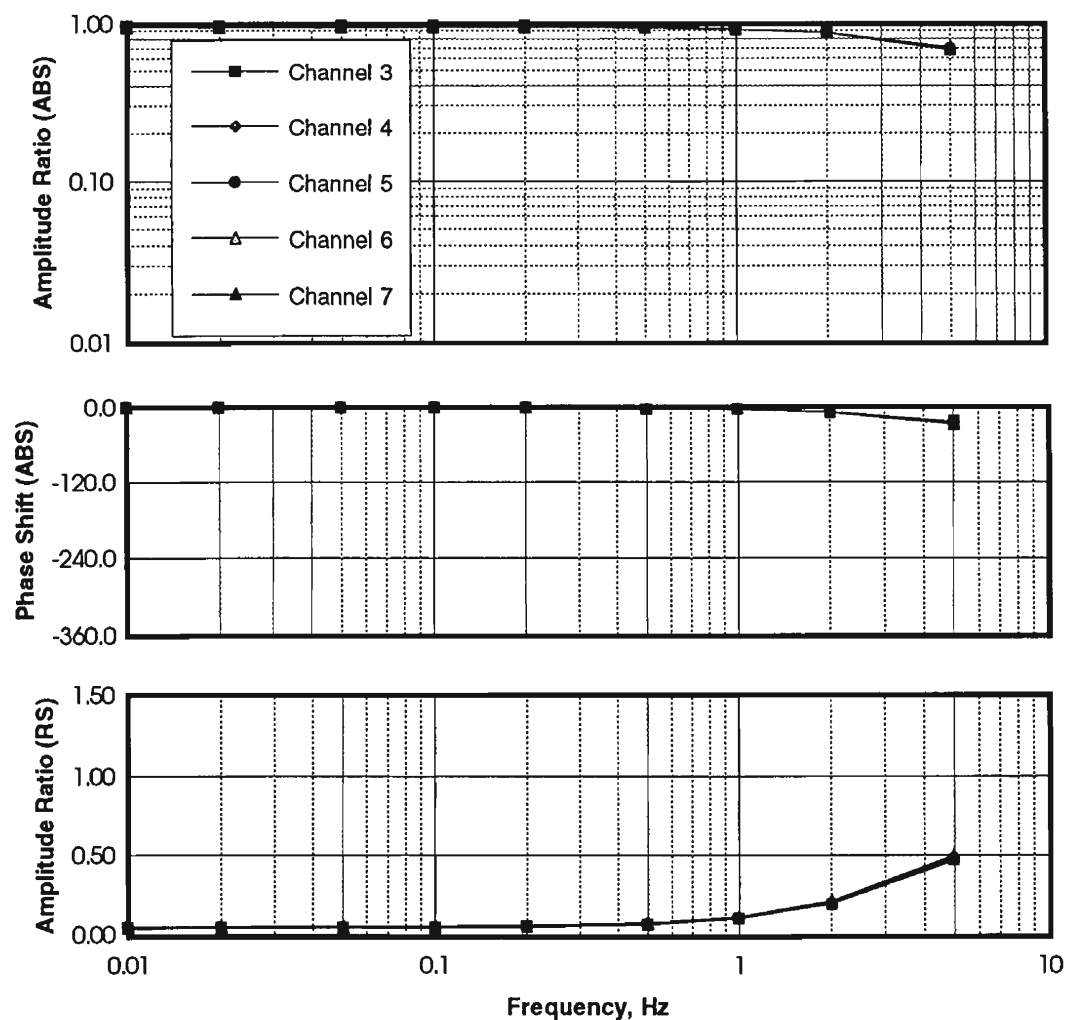
**Figure C14** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 1 leakage hole under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.91	0.70
	Phase ABS	0.0	-0.1	-0.1	-0.2	-0.4	-1.2	-3.1	-8.9	-26.8
	Amp RS	0.01	0.01	0.01	0.01	0.01	0.03	0.07	0.17	0.49
Channel 4	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.91	0.71
	Phase ABS	0.0	0.0	-0.1	-0.2	-0.4	-1.2	-3.2	-9.0	-27.5
	Amp RS	0.01	0.01	0.01	0.01	0.02	0.03	0.07	0.17	0.50
Channel 5	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.92	0.72
	Phase ABS	0.0	0.0	-0.1	-0.2	-0.4	-1.2	-3.2	-9.1	-28.0
	Amp RS	0.01	0.01	0.01	0.01	0.01	0.03	0.07	0.17	0.50
Channel 6	Amp. ABS	0.99	0.99	0.99	0.99	0.99	0.98	0.96	0.92	0.72
	Phase ABS	0.0	0.0	-0.1	-0.2	-0.4	-1.2	-3.3	-9.3	-28.8
	Amp RS	0.01	0.01	0.01	0.01	0.02	0.03	0.07	0.18	0.51
Channel 7	Amp. ABS	0.99	0.98	0.98	0.98	0.98	0.98	0.96	0.92	0.73
	Phase ABS	0.0	-0.1	-0.1	-0.2	-0.4	-1.4	-3.4	-9.6	-29.9
	Amp RS	0.01	0.02	0.02	0.02	0.02	0.03	0.07	0.18	0.52



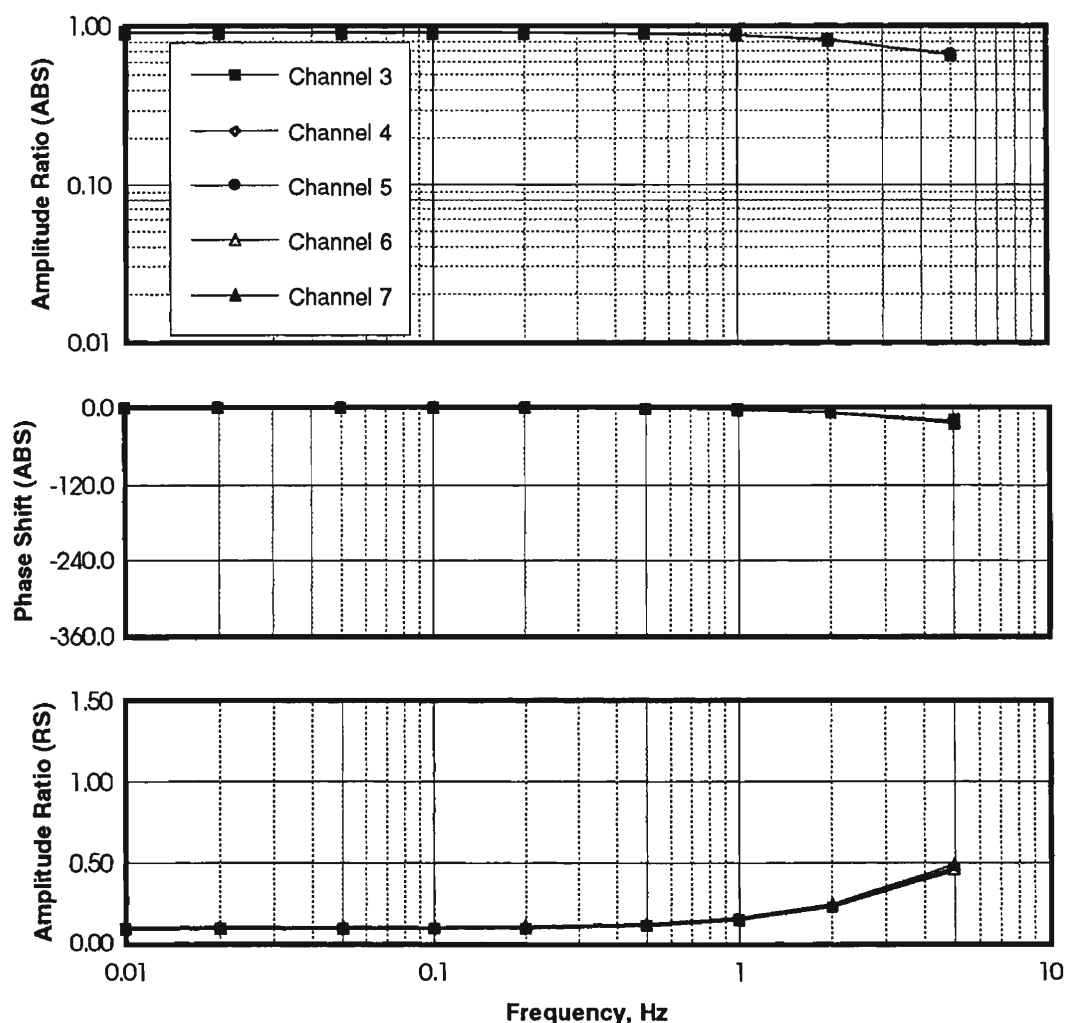
**Figure C15** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 2 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.96	0.96	0.96	0.96	0.96	0.95	0.92	0.87	0.68
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.7	-1.8	-3.7	-8.4	-23.9
	Amp RS	0.04	0.04	0.04	0.04	0.05	0.06	0.10	0.19	0.47
Channel 4	Amp. ABS	0.96	0.96	0.96	0.96	0.95	0.95	0.92	0.87	0.69
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.7	-1.8	-3.8	-8.6	-24.7
	Amp RS	0.04	0.04	0.04	0.04	0.05	0.06	0.10	0.19	0.47
Channel 5	Amp. ABS	0.96	0.96	0.96	0.96	0.96	0.95	0.92	0.87	0.69
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.8	-1.8	-3.8	-8.7	-25.3
	Amp RS	0.04	0.04	0.04	0.04	0.05	0.06	0.10	0.19	0.48
Channel 6	Amp. ABS	0.96	0.95	0.95	0.95	0.95	0.94	0.92	0.87	0.70
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.8	-1.9	-4.0	-9.0	-26.3
	Amp RS	0.04	0.05	0.05	0.05	0.05	0.07	0.10	0.20	0.49
Channel 7	Amp. ABS	0.95	0.95	0.95	0.95	0.95	0.94	0.92	0.87	0.70
	Phase ABS	0.0	-0.1	-0.2	-0.4	-0.8	-2.1	-4.2	-9.5	-27.7
	Amp RS	0.05	0.05	0.05	0.05	0.05	0.07	0.11	0.20	0.50



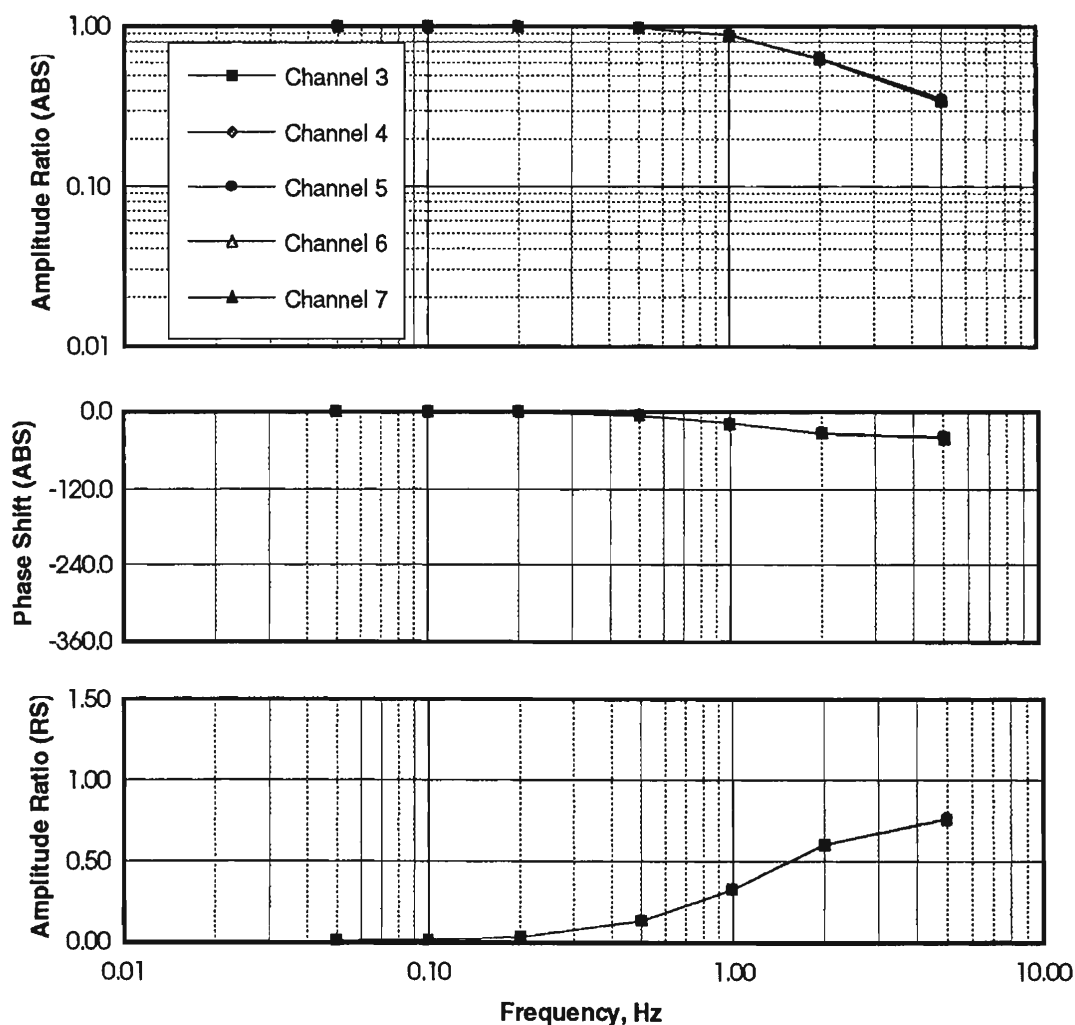
**Figure C16** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 3 leakage holes under a loading condition of 0 Pa Mean and 1000 Pa Amplitude.

		Test Frequency								
		0.01	0.02	0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.92	0.92	0.92	0.91	0.91	0.90	0.88	0.82	0.66
	Phase ABS	-0.1	-0.1	-0.3	-0.5	-1.0	-2.3	-4.2	-8.1	-20.9
	Amp RS	0.08	0.08	0.08	0.09	0.09	0.10	0.14	0.22	0.45
Channel 4	Amp. ABS	0.91	0.91	0.91	0.91	0.91	0.90	0.88	0.82	0.66
	Phase ABS	0.0	-0.1	-0.2	-0.5	-1.0	-2.3	-4.3	-8.4	-21.9
	Amp RS	0.09	0.09	0.09	0.09	0.09	0.11	0.14	0.22	0.46
Channel 5	Amp. ABS	0.92	0.92	0.92	0.91	0.91	0.90	0.88	0.83	0.67
	Phase ABS	0.0	-0.1	-0.2	-0.5	-1.0	-2.4	-4.4	-8.6	-22.6
	Amp RS	0.08	0.08	0.08	0.09	0.09	0.11	0.14	0.22	0.46
Channel 6	Amp. ABS	0.91	0.91	0.91	0.91	0.91	0.90	0.88	0.82	0.67
	Phase ABS	-0.1	-0.1	-0.3	-0.5	-1.0	-2.5	-4.6	-9.0	-23.7
	Amp RS	0.09	0.09	0.09	0.09	0.09	0.11	0.15	0.23	0.47
Channel 7	Amp. ABS	0.90	0.90	0.90	0.90	0.90	0.89	0.87	0.82	0.67
	Phase ABS	0.0	-0.1	-0.3	-0.6	-1.1	-2.6	-5.0	-9.7	-25.6
	Amp RS	0.10	0.10	0.10	0.10	0.10	0.12	0.16	0.24	0.49



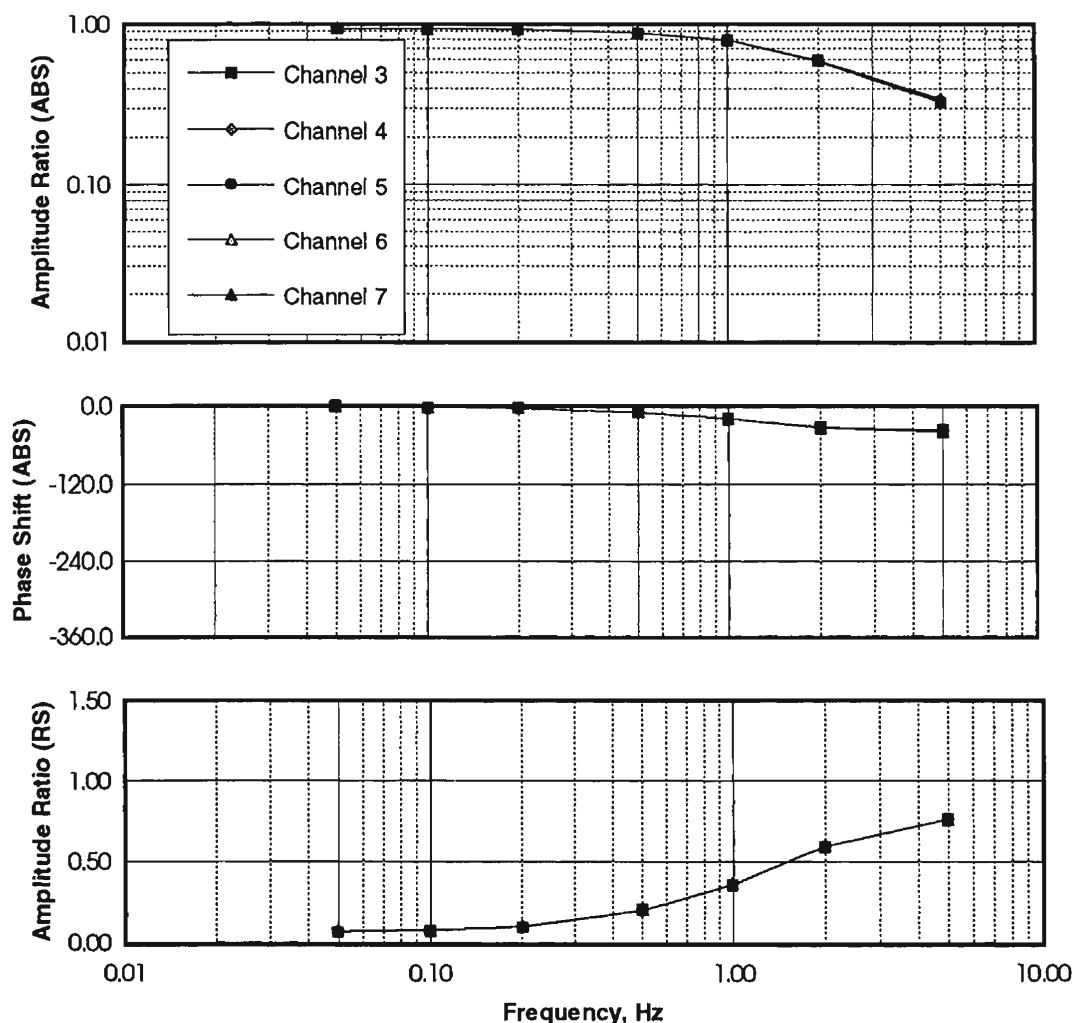
**Figure C17** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 0 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	1.00	1.00	0.99	0.97	0.88	0.63	0.34
	Phase ABS	-0.1	-0.3	-1.3	-7.1	-18.7	-34.8	-39.1
	Amp RS	0.00	0.01	0.02	0.13	0.33	0.60	0.76
Channel 4	Amp. ABS	1.00	1.00	0.99	0.97	0.88	0.63	0.35
	Phase ABS	-0.1	-0.3	-1.3	-7.1	-18.7	-34.9	-39.7
	Amp RS	0.00	0.01	0.02	0.13	0.33	0.60	0.77
Channel 5	Amp. ABS	1.00	1.00	1.00	0.97	0.88	0.63	0.35
	Phase ABS	-0.1	-0.3	-1.3	-7.1	-18.7	-34.9	-40.1
	Amp RS	0.00	0.01	0.02	0.13	0.33	0.60	0.77
Channel 6	Amp. ABS	1.00	1.00	0.99	0.97	0.88	0.63	0.35
	Phase ABS	-0.1	-0.3	-1.3	-7.1	-18.7	-35.0	-40.6
	Amp RS	0.00	0.01	0.02	0.13	0.33	0.60	0.77
Channel 7	Amp. ABS	1.00	1.00	0.99	0.97	0.88	0.64	0.36
	Phase ABS	-0.1	-0.3	-1.3	-7.1	-18.7	-35.1	-41.1
	Amp RS	0.00	0.01	0.02	0.13	0.33	0.60	0.77



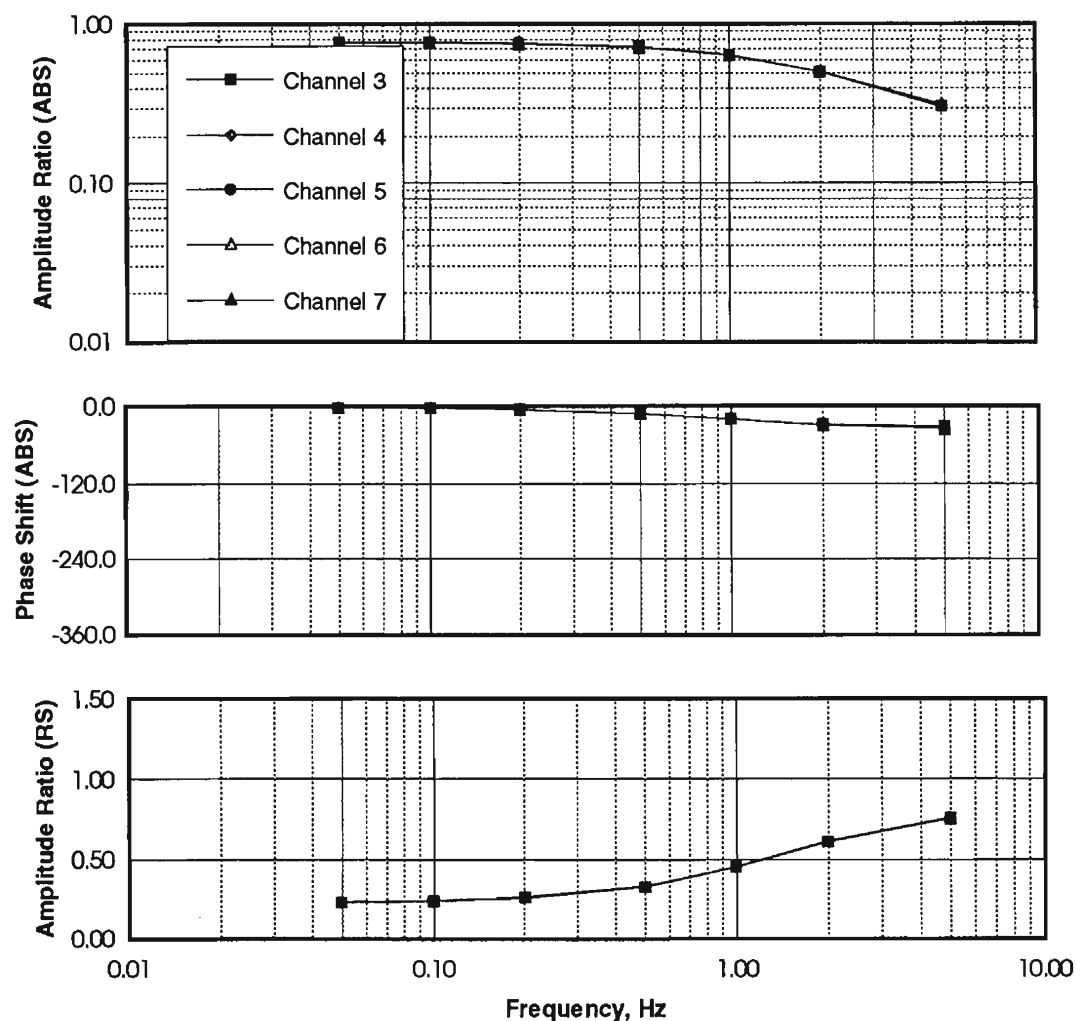
**Figure C18** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 1 leakage hole under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.93	0.93	0.92	0.88	0.79	0.58	0.33
	Phase ABS	-1.1	-2.2	-4.1	-9.9	-18.9	-32.4	-36.7
	Amp RS	0.07	0.08	0.10	0.20	0.36	0.60	0.76
Channel 4	Amp. ABS	0.93	0.93	0.92	0.88	0.79	0.59	0.33
	Phase ABS	-1.1	-2.2	-4.1	-10.0	-18.9	-32.5	-37.3
	Amp RS	0.07	0.08	0.10	0.20	0.36	0.60	0.76
Channel 5	Amp. ABS	0.94	0.93	0.93	0.88	0.79	0.59	0.34
	Phase ABS	-1.1	-2.2	-4.1	-10.0	-18.9	-32.5	-37.6
	Amp RS	0.07	0.08	0.10	0.20	0.36	0.59	0.76
Channel 6	Amp. ABS	0.93	0.93	0.92	0.88	0.79	0.59	0.34
	Phase ABS	-1.1	-2.2	-4.1	-9.9	-18.9	-32.7	-38.3
	Amp RS	0.07	0.08	0.10	0.20	0.36	0.60	0.76
Channel 7	Amp. ABS	0.93	0.93	0.92	0.88	0.79	0.59	0.35
	Phase ABS	-1.1	-2.2	-4.2	-10.0	-19.0	-32.8	-39.0
	Amp RS	0.07	0.08	0.10	0.20	0.36	0.60	0.76



**Figure C19** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 2 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

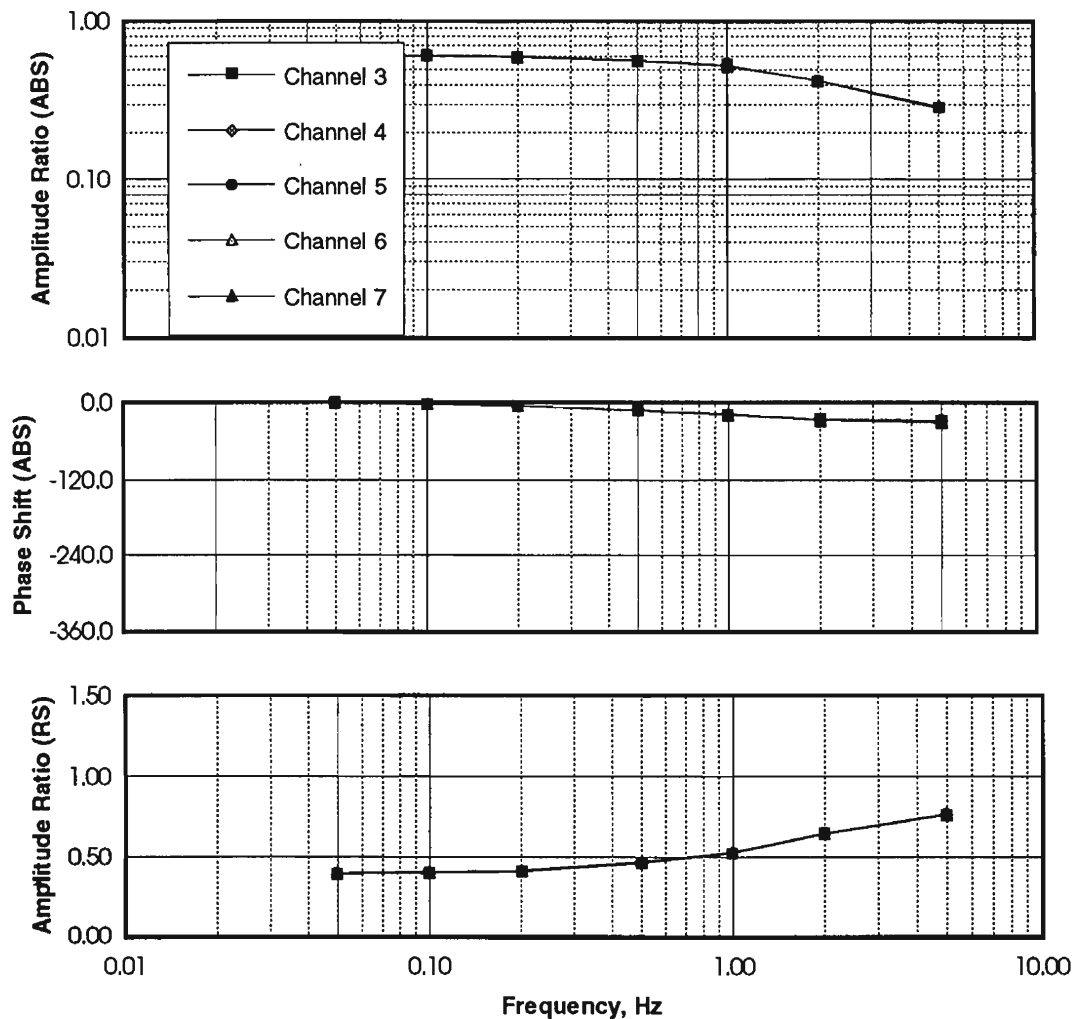
		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.77	0.77	0.76	0.72	0.64	0.51	0.31
	Phase ABS	-1.8	-3.4	-6.3	-12.0	-20.2	-29.4	-32.6
	Amp RS	0.23	0.24	0.26	0.33	0.45	0.61	0.76
Channel 4	Amp. ABS	0.77	0.77	0.76	0.72	0.64	0.51	0.31
	Phase ABS	-1.8	-3.4	-6.2	-11.9	-20.3	-29.6	-33.2
	Amp RS	0.23	0.24	0.26	0.33	0.45	0.61	0.76
Channel 5	Amp. ABS	0.77	0.77	0.76	0.72	0.65	0.51	0.31
	Phase ABS	-1.8	-3.4	-6.3	-12.0	-20.3	-29.7	-33.6
	Amp RS	0.23	0.24	0.26	0.33	0.45	0.61	0.76
Channel 6	Amp. ABS	0.77	0.76	0.75	0.72	0.64	0.51	0.32
	Phase ABS	-1.8	-3.4	-6.3	-12.2	-20.4	-29.9	-34.4
	Amp RS	0.23	0.24	0.26	0.34	0.46	0.61	0.76
Channel 7	Amp. ABS	0.77	0.76	0.75	0.72	0.64	0.51	0.32
	Phase ABS	-1.8	-3.4	-6.3	-12.1	-20.5	-30.2	-35.4
	Amp RS	0.24	0.24	0.27	0.34	0.46	0.62	0.76





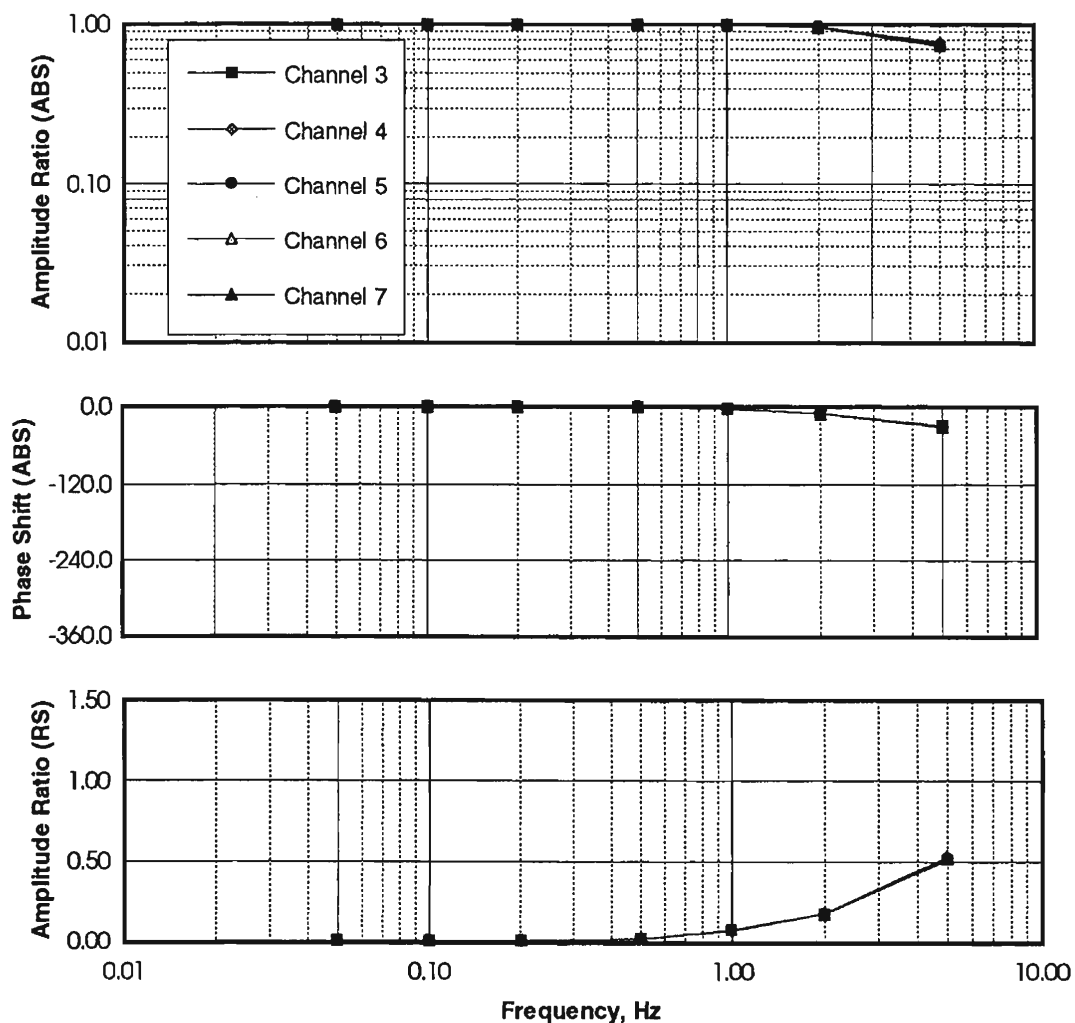
**Figure C20** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 1 vent hole and 3 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.61	0.61	0.60	0.57	0.53	0.43	0.28
	Phase ABS	-1.7	-3.3	-6.0	-12.4	-18.5	-26.0	-27.7
	Amp RS	0.39	0.40	0.41	0.46	0.53	0.64	0.76
Channel 4	Amp. ABS	0.61	0.60	0.60	0.57	0.53	0.43	0.29
	Phase ABS	-1.7	-3.3	-6.0	-12.4	-18.6	-26.2	-28.3
	Amp RS	0.39	0.40	0.41	0.46	0.53	0.65	0.76
Channel 5	Amp. ABS	0.61	0.61	0.60	0.57	0.53	0.43	0.29
	Phase ABS	-1.7	-3.3	-6.1	-12.5	-18.7	-26.3	-28.9
	Amp RS	0.39	0.40	0.41	0.46	0.53	0.65	0.76
Channel 6	Amp. ABS	0.61	0.60	0.60	0.57	0.53	0.43	0.29
	Phase ABS	-1.7	-3.3	-6.1	-12.5	-18.8	-26.6	-29.7
	Amp RS	0.39	0.40	0.41	0.46	0.53	0.65	0.76
Channel 7	Amp. ABS	0.60	0.60	0.59	0.56	0.52	0.43	0.29
	Phase ABS	-1.7	-3.3	-6.1	-12.6	-19.0	-27.0	-31.1
	Amp RS	0.40	0.40	0.42	0.47	0.53	0.65	0.77



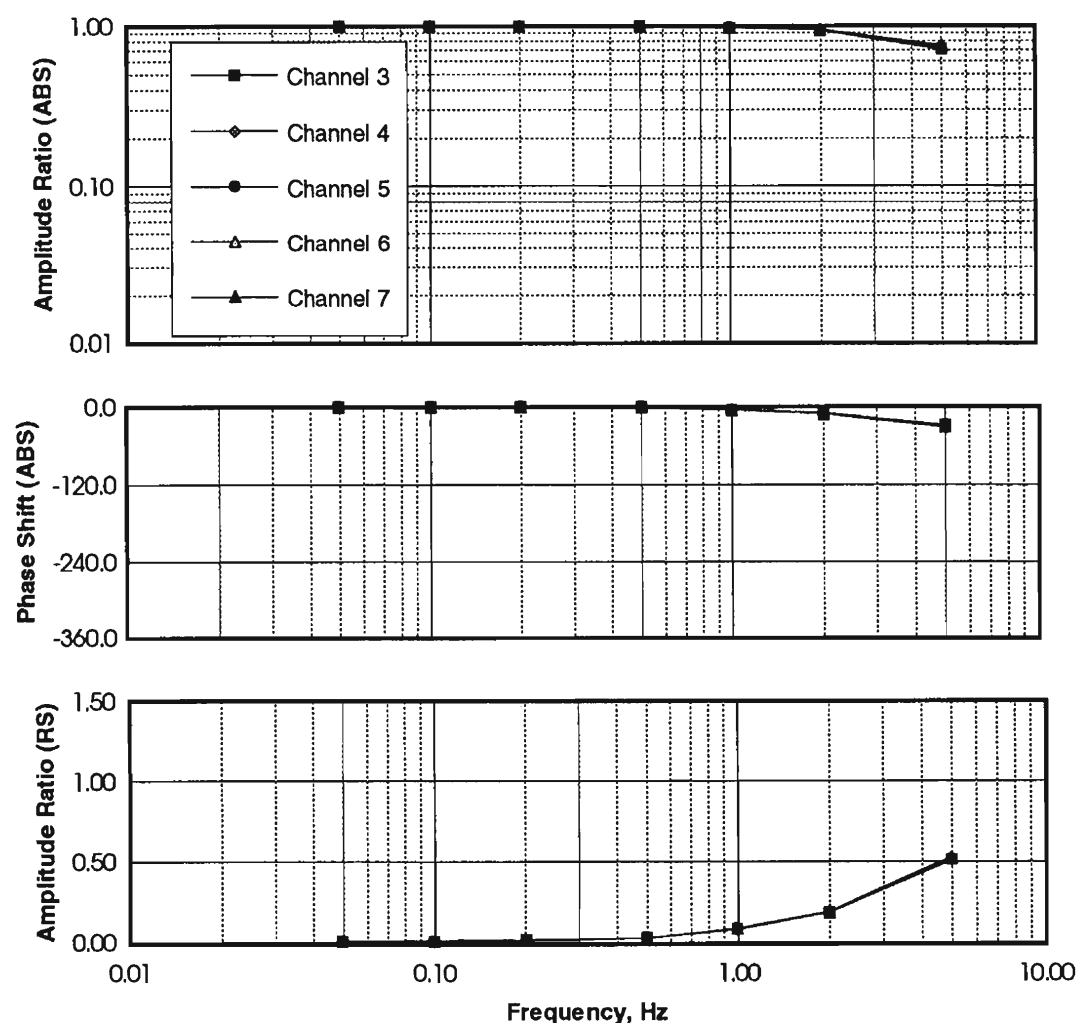
**Figure C21** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 0 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.95	0.72
	Phase ABS	0.0	0.0	-0.1	-0.8	-3.9	-10.1	-29.4
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.18	0.51
Channel 4	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.96	0.74
	Phase ABS	0.0	0.0	-0.1	-0.8	-4.0	-10.2	-30.1
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.18	0.52
Channel 5	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.96	0.74
	Phase ABS	0.0	0.0	-0.1	-0.8	-4.0	-10.2	-30.5
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.18	0.52
Channel 6	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.96	0.76
	Phase ABS	0.0	0.0	-0.1	-0.8	-4.0	-10.3	-31.1
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.18	0.53
Channel 7	Amp. ABS	1.00	1.00	1.00	1.00	0.99	0.97	0.77
	Phase ABS	0.0	0.0	-0.1	-0.8	-4.0	-10.4	-31.6
	Amp RS	0.00	0.00	0.00	0.01	0.07	0.18	0.53



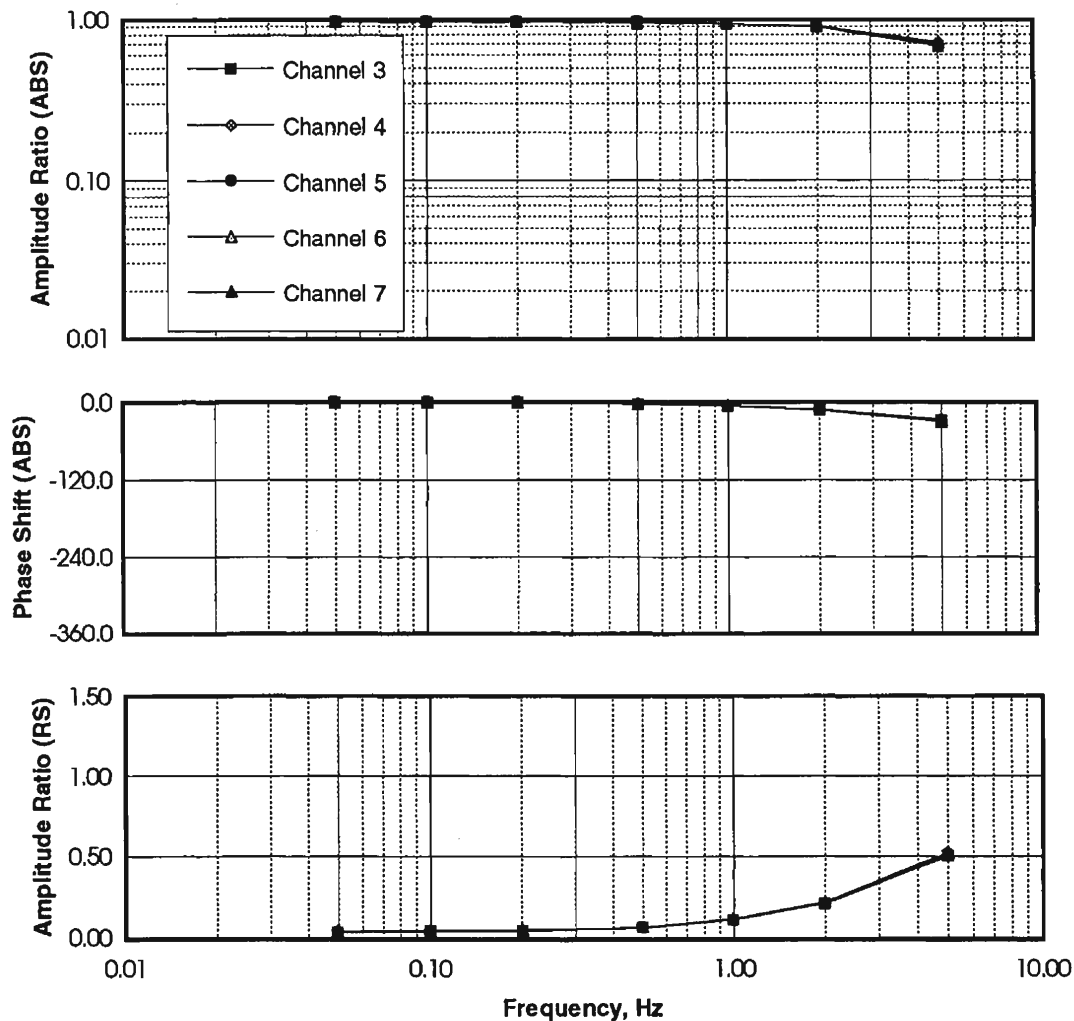
**Figure C22** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 1 leakage hole under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.99	0.99	0.99	0.99	0.97	0.93	0.70
	Phase ABS	-0.1	-0.2	-0.5	-1.3	-4.6	-10.4	-28.5
	Amp RS	0.01	0.01	0.01	0.03	0.08	0.19	0.51
Channel 4	Amp. ABS	0.99	0.99	0.99	0.99	0.97	0.93	0.71
	Phase ABS	-0.1	-0.2	-0.5	-1.3	-4.6	-10.5	-29.2
	Amp RS	0.01	0.01	0.01	0.03	0.09	0.19	0.51
Channel 5	Amp. ABS	0.99	0.99	0.99	0.99	0.97	0.94	0.72
	Phase ABS	-0.1	-0.2	-0.5	-1.4	-4.6	-10.6	-29.6
	Amp RS	0.01	0.01	0.01	0.03	0.08	0.19	0.51
Channel 6	Amp. ABS	0.99	0.99	0.99	0.99	0.97	0.94	0.73
	Phase ABS	-0.1	-0.2	-0.5	-1.4	-4.7	-10.7	-30.3
	Amp RS	0.01	0.01	0.01	0.03	0.09	0.19	0.52
Channel 7	Amp. ABS	0.99	0.99	0.99	0.99	0.97	0.94	0.75
	Phase ABS	-0.1	-0.2	-0.5	-1.4	-4.7	-10.9	-31.0
	Amp RS	0.01	0.01	0.01	0.03	0.09	0.19	0.53



**Figure C23** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 2 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.97	0.97	0.96	0.96	0.94	0.89	0.68
	Phase ABS	-0.3	-0.6	-1.1	-2.5	-5.4	-11.1	-27.0
	Amp RS	0.03	0.04	0.04	0.06	0.11	0.21	0.50
Channel 4	Amp. ABS	0.96	0.96	0.96	0.96	0.94	0.89	0.69
	Phase ABS	-0.3	-0.6	-1.1	-2.5	-5.5	-11.3	-27.7
	Amp RS	0.04	0.04	0.04	0.06	0.11	0.21	0.51
Channel 5	Amp. ABS	0.97	0.97	0.97	0.96	0.94	0.90	0.69
	Phase ABS	-0.3	-0.6	-1.1	-2.5	-5.5	-11.4	-28.1
	Amp RS	0.03	0.03	0.04	0.06	0.11	0.21	0.51
Channel 6	Amp. ABS	0.96	0.96	0.96	0.96	0.94	0.90	0.70
	Phase ABS	-0.3	-0.6	-1.1	-2.6	-5.6	-11.6	-28.9
	Amp RS	0.04	0.04	0.04	0.06	0.11	0.22	0.51
Channel 7	Amp. ABS	0.96	0.96	0.96	0.95	0.93	0.90	0.71
	Phase ABS	-0.3	-0.6	-1.1	-2.7	-5.7	-11.8	-29.8
	Amp RS	0.04	0.04	0.05	0.06	0.12	0.22	0.52



**Figure C24** Measured dynamic response across the air barrier system (ABS) and across the rainscreen (RS) for Specimen 4 with 3 vent holes and 3 leakage holes under a loading condition of 1000 Pa Mean and 1000 Pa Amplitude.

		Test Frequency						
		0.05	0.10	0.20	0.50	1.00	2.00	5.00
Channel 3	Amp. ABS	0.93	0.93	0.93	0.92	0.90	0.85	0.65
	Phase ABS	-0.4	-0.8	-1.5	-3.5	-6.3	-12.1	-26.6
	Amp RS	0.07	0.07	0.08	0.10	0.15	0.24	0.51
Channel 4	Amp. ABS	0.93	0.93	0.92	0.92	0.89	0.85	0.66
	Phase ABS	-0.4	-0.8	-1.5	-3.5	-6.4	-12.3	-27.4
	Amp RS	0.07	0.08	0.08	0.10	0.15	0.25	0.51
Channel 5	Amp. ABS	0.93	0.93	0.93	0.92	0.90	0.85	0.67
	Phase ABS	-0.4	-0.8	-1.6	-3.6	-6.4	-12.4	-27.9
	Amp RS	0.07	0.07	0.08	0.10	0.15	0.25	0.51
Channel 6	Amp. ABS	0.93	0.92	0.92	0.92	0.89	0.85	0.68
	Phase ABS	-0.4	-0.8	-1.6	-3.6	-6.5	-12.6	-28.8
	Amp RS	0.07	0.08	0.08	0.10	0.15	0.25	0.52
Channel 7	Amp. ABS	0.92	0.92	0.92	0.91	0.89	0.85	0.68
	Phase ABS	-0.4	-0.8	-1.6	-3.7	-6.7	-13.0	-30.1
	Amp RS	0.08	0.08	0.09	0.11	0.16	0.26	0.53

