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GENERAL VIBRATION MONITORING

Experimental Hall

by

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The reported vibration data were generated from measurements made on the experimental hall floor on December 2, 1992. At the time of the measurements, the ESRF hydrolevel was set-up in the Early Assembly Area (EAA) of the experimental hall and was being used to measure static displacement (settlement) of the floor. The vibration measurement area was on and adjacent to the EAA, in the vicinity of the ESRF hydrolevel test which was in progress. This report summarizes the objectives, instrumentation, measurement locations, observations, and conclusions, and provides selected results in the form of RMS vs. time plots, and power spectral densities from which frequency information can be derived. Measured response amplitudes were within the vibration criteria established for the APS.

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APS VIBRATION MONITORING

Location: Experimental Hall

Date: 12/2/92

Time: 16:30-22:10

File #: 8

Objective: Measure vibration response of Experimental Hall floor adjacent to ESRF hydrolevel test

Site/Location Conditions: Cold and damp, approximately 20-35° F

Instrumentation:

<u>Storage Device:</u>		<u>Transducer:</u>		<u>Mount:</u>	
FM tape	<u> x </u>	S-500	<u> x </u>	Single	<u> x </u>
On line	<u> </u>	393C	<u> </u>	Biaxial	<u> </u>
Other	<u> </u>	Other	<u> </u>	Triaxial	<u> </u>

Orientation and Identification: See Instrumentation Layout (attached)

<u>Ch. #</u>	<u>Acc. Loc.</u>	<u>Orientation</u>	<u>Scale/Range</u>	<u>Approx. Noise Floor</u>
1				
2				
3	Location 1	Vertical	531 v/g, 0.2	
4	Location 2	Vertical	431 v/g, 0.2	
5	Location 3	Vertical	556 v/g, 0.2	
6	Location 4	Vertical	537 v/g, 0.2	
7	Location 5	Vertical	495 v/g, 0.2	

Observations/Conclusions: See Attachment 1

Also attached:

- RMS response vs. time plots (1-100 Hz range)
- RMS response vs. time plots (10-100 Hz range)
- RMS response vs. time plots (20-100 Hz range)
- PSD plots (Time 17:14)
- PSD plots (Time 17:19)
- PSD plots (Time 17:32)
- PSD plots (Time 19:24)
- PSD plots (Time 21:10)
- PSD plots (Time 21:21)

Instrumentation Layout, File #8

Attachment 1

Observations/Conclusions

RMS Displacement:

1-100 Hz

There is a low frequency cyclic (≈ 9 min. period) response observed at all locations. The large response at 17:32 at Location 2 is due to a temperature effect on the seismometer (it was determined that the seismometers must be allowed to stabilize upon exposure to a severe temperature change as represented by the cold environment in the EAA). The large response at 19:20 is possibly related to activity (personnel walking) in the immediate vicinity of the seismometers, as the increase in response is basically at low frequencies. The approximate average response is $0.05 \mu\text{m}$ RMS. The large displacements observed at Location 5 (soil response) are due to activity adjacent to the measurement area.

10-100 Hz

The low frequency cyclic response, present in the 1-100 Hz data, is observed. The displacements measured before 17:00 are considerably larger than later measurements; this is a result of the seismometers not being stable in the cold environment. The overall displacement ranges from approximately $0.003 \mu\text{m}$ RMS at Location 1 (near the storage ring basemat) to $0.0045 \mu\text{m}$ RMS near the exterior of the building. Assuming the vibration source is external to the building, this is an indication of attenuation with distance through the experimental hall floor.

20-200 Hz

The cyclic response is considerably less than that measured in the other frequency analysis ranges, indicating it is a lower frequency (< 20 Hz) phenomenon. Amplitudes range from an approximate average value of $0.0012 \mu\text{m}$ RMS close to the storage ring to $0.002 \mu\text{m}$ RMS near the building exterior. There are several response peaks observed at Locations 4 and 5 where the amplitude is in excess of $0.0065 \mu\text{m}$ RMS. These are the soil and building response to the engine of the vehicle housing the data acquisition equipment; the vehicle had to be operated to keep the tape recorder warm. Although the experimental hall response is low, it points to the fact that soil vibration can be transmitted to the experimental hall

floor. With a little imagination, the response can be observed as far as Location 3. See the discussion of the PSD-frequency plots at 21:10 for additional information.

Power Spectral Density Plots:

Time = 17:14

The primary response frequencies are indicated on all plots. An interesting feature of the plots is that in addition to frequencies of 2.67 Hz and 5.28 Hz, the frequencies of 7.62 Hz and 10.5 Hz were observed during previous measurements on other structures. The 26 Hz frequency, corresponding to that of the instrumentation vehicle engine, is observed at all locations, with the largest amplitude observed at the exterior of the building (Location 4), and the lowest amplitude near the storage ring (Location 1). Again, this provides a good example of vibration transmission through the floor.

Time = 17:32

This time corresponds to the large amplitude observed on the 1-100 Hz range displacement plots at Location 2. It is suspected that this large displacement is due to a temperature response of the seismometer, as it is not observed at adjacent locations.

Time = 19:24

The large amplitude response occurs primarily at low frequencies (<10 Hz), and may be due to personnel walking in the immediate area.

Time = 21:10

This time period corresponds to a large amplitude on the 20-100 Hz displacement plot, indicating the response frequency is above 20 Hz. The response is primarily due to operation of the engine of the instrumentation vehicle. Frequencies of 36.1 Hz and 39.9 Hz correspond to two engine RPM levels, one when the engine was cold and the other as the engine warmed up and the fast idle speed was reduced. Harmonics at 73 Hz (not listed) and 79.5 Hz, correspond to 36.1 Hz and 39.9 Hz, respectively.

Time = 21:21

This time period is representative of a time with site activity at a minimum including the engine of the vehicle being off. An interesting feature of this set of plots is that the 7.92 Hz and 10.5 Hz frequencies are observed on most locations.

General Comments

- The largest contribution to floor vibration amplitude response is from frequencies less than 10 Hz. For frequencies greater than 10 Hz, the measured amplitudes can be considered acceptable.
- Previously observed frequencies of 7.6-7.9 Hz and 10.5 Hz are present at most locations on the experimental hall floor, but of low amplitude.
- Soil vibration is effectively coupled to the experimental hall floor, a fact which must be considered when locating vibration generating equipment near the building.
- The experimental hall floor attenuates ground vibration, as a function of distance from the outer wall.

EXPERIMENTAL HALL DISPLACEMENT

(1-100 Hz)

Measurement Date = December 2, 1992

File # 8

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(1-100 Hz)

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File # 8

EXPERIMENTAL HALL DISPLACEMENT

(10-100 Hz)

File # 8

Measurement Date = December 2, 1992

EXPERIMENTAL HALL DISPLACEMENT

(10-100 Hz)

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EXPERIMENTAL HALL DISPLACEMENT

(20-100 Hz)

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Measurement Date = December 2, 1992

File # 8

Time = 17:32, Large Response at Loc. 2 on 1-100 Hz Plots

EXPERIMENTAL HALL DISPLACEMENT

Measurement Date = December 2, 1992

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Time = 17:32, Large Response at Loc. 2 on 1-100 Hz Plots

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Time = 17:32, Large Response at Loc. 2 on 1-100 Hz Plots

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File # 8

Time = 19:24, Large Response on 1-100 Hz Plots

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EXPERIMENTAL HALL DISPLACEMENT

Measurement Date = December 2, 1992

File # 8

Time = 21:10, Large Response on Loc. 4,5 at 20-100 Hz

EXPERIMENTAL HALL DISPLACEMENT

Measurement Date = December 2, 1992

File # 8

Time = 21:10, Large Response on Loc. 4,5 at 20-100 Hz

EXPERIMENTAL HALL DISPLACEMENT

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Time = 21:10, Large Response on Loc. 4,5 at 20-100 Hz

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Time = 21:10, Large Response on Loc. 4,5 at 20-100 Hz

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Time = 21:10, Large Response on Loc. 4,5 at 20-100 Hz

EXPERIMENTAL HALL DISPLACEMENT

Measurement Date = December 2, 1992

File # 8

Time = 21:21, "Quiet" Response

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Measurement Date = December 2, 1992

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Time = 21:21, "Quiet" Response