cc:
SA/J. Kerwin
SA2/J. Stonesifer
SB/J. Vanderploeg
M. Moon
S. Wood
SE/W. Bush
SE3/J. Bost
D. White
SE5/F. Spross
CB/W. Thornton
G. Nelson

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center **NASA**

REFER TO: SB-111-84	DATE SEP 1 2 1984	INITIATOR SB/TBagian:pm:9-12-84:2381	ENCL

TO: JA2/Mission Manager, Spacelab 3

CC

FROM: SB/Manager, Flight Projects Office

SIGNATURE Tandi Bagian

Tandi Bagian

SUBJ: Orbiter Centrifuge Noise

Regarding our telephone conversation (August 29, 1984) and your concerns for the middeck centrifuge noise level, I have done some research and hope that the results herein presented will answer your questions and alleviate all worries.

The comments that you heard from Jerry Shinkle, JSC timeliner, originated from Dr. Thornton, who felt that this centrifuge was too noisy and would interfere with normal sleep functions if used on this dual-shift mission. When questioned, Dr. Thornton was surprised that such a furor was being made over his off-the-cuff statement, and he promptly called your office and informed Mr. Robert MacBrayer that he really did not think that there would be a problem in using this centrifuge for the SL-3 mission.

Prior to Dr. Thornton's call to Marshall, we had asked various Spacelab 1 personnel for noise information. Two centrifuges flew on Spacelab 1. As I understand it, the one in the Spacelab was larger and quite a bit noisier than the middeck centrifuge, LSLE Part #000-1065-000. Owen Garriott, SL-1 astronaut, did not remember that this unit was especially noisy during SL-1. Project Engineer Bob Clark and associate Phyllis Grounds report that this unit flew on SL-1 middeck with no negative comment from the crew regarding undue or disturbing noise levels. Dave White, LSLE Manager, stated that this item was an approved LSLE item for SL-1, and that he heard no complaint about noise or disruption caused by this unit. Byron Lichtenberg, SL-1 PS, recalled that the centrifuge tended to vibrate quite a bit, but that there was not a problem in disturbing sleep. It was used between shifts during Spacelab 1. It is intended that the 40 min/day planned use of this centrifuge on Spacelab 3 will also occur during the 4 hr/day change of shift.

I asked our engineers to perform an Acoustic Noise test on this piece of hardware, and a copy of the test results are enclosed. It is felt that the few frequencies that registered marginally above the standard parameters were in such slight excess that no problems should be anticipated. Also enclosed is a copy of the LSLE description of this Orbiter Centrifuge.

I hope that this information will clear any concerns you may have regarding this centrifuge, and will allow you to proceed with assurance that this DSO hardware will not interfere with the Spacelab 3 mission. Please call me if you have further questions.

cc:
See attached list

cc:
SA/J. Kerwin
SA2/J. Stonesifer
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SE5/F. Spross
CB/W. Thornton
G. Nelson

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center NASA

REFER TO: SB-111-84

DATE: SEP 12 1984

INITIATOR: SB/TBagian:pm:9-12-84:2381

ENCL

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cc:
See attached list

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center NASA

REFER TO:	DATE	INITIATOR	ENCL
SD3-84-718	OCT 5 1984	SD3/JMWaligora:sj:10/2/84:5457	1

TO: LA6/Chairman, STS Payload Safety Review Panel

CC: CB/W. E. Thornton
NS2/Q. Patin
SB/J. L. Homick
SD2/J. S. Logan

FROM: SD3/James Waligora, Payload Safety Panel Member

SIGNATURE: James M. Waligora
James M. Waligora

SUBJ: Potential SL-3 Hazards Identified by Dr. Thornton, Memo CB, August 23, 1984

The concerns expressed by Dr. Thornton in the subject memorandum appear to be valid. I understand that the payload organization will be preparing hazard reports on both potential hazards. Dr. Homick/SB, has reviewed both Dr. Thornton's memorandum and the Marshall test report on the sound levels, and his comments are attached. For a complete assessment of the hazard, a worst case timeline of acoustic levels must be considered and this should be included in the hazard report.

U.S. Government

MEMORANDUM

Lyndon B. Johnson Space Center NASA

REFER TO: SB	DATE: SEP 1 1 1984	INITIATOR: SB/JLHomick:pm:9-11-84:2381	ENCL

TO: SD3/James M. Waligora

CC

FROM: SB/Jerry L. Homick

SIGNATURE: Jerry L. Homick
Jerry L. Homick

SUBJ: Potential Noise Hazard Associated with SL-3 Drop Dynamic Module (DDM) Experiment

In response to your request I have reviewed Dr. Thornton's memorandum (enclosed) on the above subject as well as the MSFC memorandum (enclosed) which summarizes the results of acoustic noise measurements made on the Drop Dynamic Module (DDM). I have considered the potential effect of the noise on permanent threshold shifts, temporary threshold shifts, speech communications and annoyance. In making these considerations I have treated the DDM noise as narrow-band noise with a sharp peak at 1000 Hz.

According to damage risk (permanent threshold shift) criteria developed by the Committee on Hearing, Bioacoustics and Biomechanics of the National Research Council, one would have to be exposed continuously for three hours to the maximum DDM noise level (87 dB) before some permanent hearing damage might occur. Continuous exposure of up to nearly eight hours duration to the mean DDM noise level (81 dB) could be tolerated without significant risk of hearing damage. The information given to me for review does not make it entirely clear as to the duration of crew exposure to the DDM noise each mission day, however, it appears that the exposures are short enough to preclude serious concerns about permanent hearing damage.

Exposure to the DDM noise could cause some temporary threshold shift (TTS) in auditory acuity. For example, according to criteria published by J. D. Miller (Journal of the Acoustical Society of America, Vol. 56, No 3, 1974) continuous exposure to a 4000 Hz pure tone at 85 dB for 100 minutes would produce a TTS of about 20 dB. Complete recovery from such an exposure would occur in about one hour if the individual returns to a noise environment of 60 dB or less. Similar results could be expected with the DDM noise assuming that the maximum level of 86 dB were continously present for up to 100 minutes. Shorter duration exposures and/or exposures lower than 86 dB would produce less TTS. The mean DDM noise level (approximately 81 dB) would produce a TTS of less than 10 dB. Any such TTS could make speech communications and auditory signal detection more difficult.

The maximum and mean noise spectra produced by the DDM are equivalent to speech interference levels of 74 dB and 66 dB respectively. Speech interference levels in the 70-80 dB range imply that person to person communication with raised voice is satisfactory over a distance of 1 to 2 feet and slightly difficult over a distance of 3 to 6 feet. Thus, with the maximum DDM noise level speech intelligibility in the vicinity of the DDM will be impaired. The mean DDM noise level should not appreciably effect speech communications.

The most probable effect of the DDM noise, and the most difficult to quantitate is annoyance. The DDM noise peak is in the most sensitive region of hearing and will undoubtedly be perceived as annoying by crewmembers working in that area.

Given all of the above I concur with Dr. Thornton's recommendations. The DDM noise apparently cannot be reduced, therefore reasonable steps should be taken to ensure that the noise does not adversely affect the crew. Implementing noise surveys inflight, having available suitable earplugs and conducting pre and postflight audiometric tests are reasonable and can be done at little cost.

Dovis Atkins

Government
MEMORANDUM

Lyndon B Johnson Space Center **NASA**

REFER TO: CB	DATE August 23, 1984	INITIATOR CB/WEThornton:tl:8/6/84:3721	ENCL.
TO: SD/S. Pool		CC See list.	
FROM: CB/W. E. Thornton		SIGNATURE W. Thornton William E. Thornton	

JSC ... AUG 24 12 40 PM '84

SUBJ: Potential Hazards on SL-3

In the process of training, two potential hazards have become obvious. While not of primary concern they are 3-4 orders of magnitude greater than other hazards that have required hardware and procedures to avoid.

First, is the acoustic liquid drop support experiment of Dr. Wang's which will be operated more or less continuously. The support is a 1 KHz sinusoidal sound pressure wave which may reach levels of ~ 160 db. inside a shielded enclosure. While KSC has made 1 g. measurements these may not represent inflight measurements. At the maximum sound pressure level I saw lab levels as high as 86 db. The device will usually be operated well below maximum but there are periods of maximum levels planned.

Several aspects concern me: It is a pure tone and at the critical speech range and range of damage susceptibility. While 86 db. is not high and will be present for limited periods, it is above damage threshold levels. Also it was obvious that standing waves were present in the lab such that the usual dissipation with distance doesn't hold and there may be nodal points with higher levels well away from the area of the experiment.

Of most concern is that under weightlessness with the well known mechanical shifts which occur, there may be a sharp decrease in attenuation.*

My recommendations are:

1. A miniature sound pressure level meter be carried for surveys to be made during use, both as a safety monitor and to provide baseline data for the future.

2. Sound protection be provided <u>in case</u> levels should become excessive in flight. This could be EAR R or equivalent plugs.

* This experiment is currently scheduled for a number of flights which are to lead to production in space.

3. A sound dosimeter should be carried or pre-post inflight exposure thresholds measured with the existing minature audiometer. **

4. OSHA guidelines be reviewed and implemented as applicable for without the above changes we would most likely be in substantial violation.

The second potential is of more concern and involves the square metal unguarded box containing the AFT recorder. It is continuously carried on the back or side of 5 crewmen for five days, except during sleep, and its size, shape and location made collision with both the environment and other crewmen inevitable. Several have occurred in 1g and will be far more prevalent in free flight and at higher velocities. Body image does not allow for such a metal protuberance nor does it appear likely that one will learn to incorporate it in 5 days, hence there is considerable probability of damage to soft material especially human flesh.

The impact of metal attached to 70 kgm of mass on other objects including glass panels, etc.. should be considered, even at low velocities.

Of equal concern to the experiment itself is the high probability of loss of the device in the event of collision. The prototype has several unprotected wire connectors and leads on the box's surface which are additional hazards.

My recommendations are: 1) that a considerable radius, inches or at least enough to preclude its entering the eye's orbit, be added to all corners, 2) that padding be added but this will increase the already large volume, 3) that in the future some thought be given to man machine interfaces for this size, shape and location is as crude as one could find.

A word of caution in the event a simple paper or static review is made; it looks as harmless as a brick and like the brick is harmless until set in motion but this device is much larger and will have an effective inertial mass of 70 to 100 kgm.

** It is recognized that thresholds change in space hence the need for pre-post measurements.

cc:
CA/G. W. S Abbey
CB/J. W. Young
CB/P. J. Weitz
CB/F. D. Gregory
CB/D. L. Lind
CB/R. F. Overmyer
CB/N. R. Thagard
CB/T. K. Mattingly
NA/M. Raines
SA/J. P. Kerwin
ARC, LR/P. Cowing
JPL/T. Wang

RECOMMENDATIONS

- o Make sure the system is delivered reliably wired as shown on the schematics. This is especially true of harnesses and connectors.

- o Use series resistors to limit currents that can flow into the body. For example, the GSR electrodes go to the input and output of an operational amplifier, which is susceptible to failure with consequent unpredictable current flow into the body. Each electrode should have a series resistor. While it is true that the GSR output would become non-linear, knowing the values of the limiting resistors would allow later linearization. This inconvenience would be worth the gain in safety.

- o Make sure that sensors that are supposed to be isolated from the body, such as the temperature sensor and its leads, are sealed properly to prevent sweat-produced conduction paths. (There are reports that bubbles were seen when SRI immersed the temperature sensor in water or saline on 10/3/84. This would indicate some kind of leakage from the sensor, or its wires, to the liquid.)

- o In retrospect, a passive temperature sensor such as a thermistor, would probably have been a better choice than the active one used. There is not enough supply voltage left with the active sensor to enable a protective resistor to be placed in series with it. With a thermistor, a series resistor could have been used and could have been located in the main pack, so that shorts at the sensor would not produce significant current flow.

- o Add a system reset switch as a convenience to the users. If a momentary short drops a battery voltage, the microprocessor needs to be reset.