Enclosure 2 (w/ attached paper)

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Temp

NASA Johnson Space Center
Life Sciences Project Division
Houston, TX 77058

Attention: J. Brock Westover
Mail Code SE3

Subject: Temperature Stability of BMMDs

Dear Mr. Westover:

In response to your request about additional information about the effects of temperature on Body Mass Measurement Device (BMMD) measurements, the following information is provided.

The original flight equipment of BMMDs and Specimen Mass Measurement Devices (SMMDs) developed for NASA for use on Skylab approximately twenty-one years ago had plate fulcra springs fabricated from a material called isoelastic. During the development of the Small Mass Measurement Instrument (SMMI), significant improvements and expansion of capabilities of the SMMD, William Oakey found that the isoelastic material was no longer available and that elinvar extra was a better material and was available for fabricating the plate fulcra springs. Mr. Oakey had been involved with mass measurement equipment from the start at SwRI.

Also, the enclosed portion (Paragraph 3.3.2 on Drift) from R. F. Solberg, Jr., and W. E. Oakey, "Design, Development, and Fabrication of Mass Measurement Instruments," 17 August 1979 shows the effects of temperature on an SMMD, with isoelastic plate fulcra springs. These measurements and the data obtained for these graphs were obtained under better controls than any other known data. This helped to document that for the new requirements of the SMMI, the temperature effects had to be corrected properly or reduced greatly.

From general observations, the SMMI operations, with elinvar extra plate fulcra springs, did not show a significant correlation with temperature. The SMMI automatically corrects for any drifts each time power is turned on and it is operated and after about twenty minutes of operation, which greatly reduces any effects of temperature if they should be present.

The temperature corrections for the BMMDs, as presented in the enclosed Paragraph 4.1.4 and the note on Figure 4.2-1, were obtained from tests of the original BMMDs with the isoelastic springs. The referenced documentation is from OMH-2, "Operating, Maintenance, and Handling Procedures for the M172 Body Mass Measurement Device Flight Hardware." The conditions under which the data were obtained were much less than ideal, so there is not great confidence in the

values of the temperature corrections which were obtained; however, for measurement of human subjects near 72° F, the temperature affects the measurements very small amounts. In fact, I found notes where I had concluded that for the operating temperature limits (65° F - 80° F), the worst case adjustment of 0.00007 per F degree was at the "noise level" and not significant when measuring human beings.

The enclosed copies of data obtained for 115 and 221 pounds from my project notebooks from Section 9 of the Acceptance Data Package (I did not find our copies of the Acceptance Data Packages.) for serial number 001 give an indication of the effects of temperature over a broader temperature range. However, again this data was obtained under rather poor conditions as mentioned in the previous paragraph. It is particularly important to discard the obviously bad measurements from the raw data. The data sheets also show that the temperature measurements by the electronics package of the BMMD varies significantly from the thermocouple measurements.

I hope this information is helpful to you. Feel free to contact me at 210-522-2764 if you have additional questions.

Very truly yours,

Ruell F. Solberg, Jr., P.E.
Principal Engineer
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encs.