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OSS-1/CONTAMINATION MONITOR

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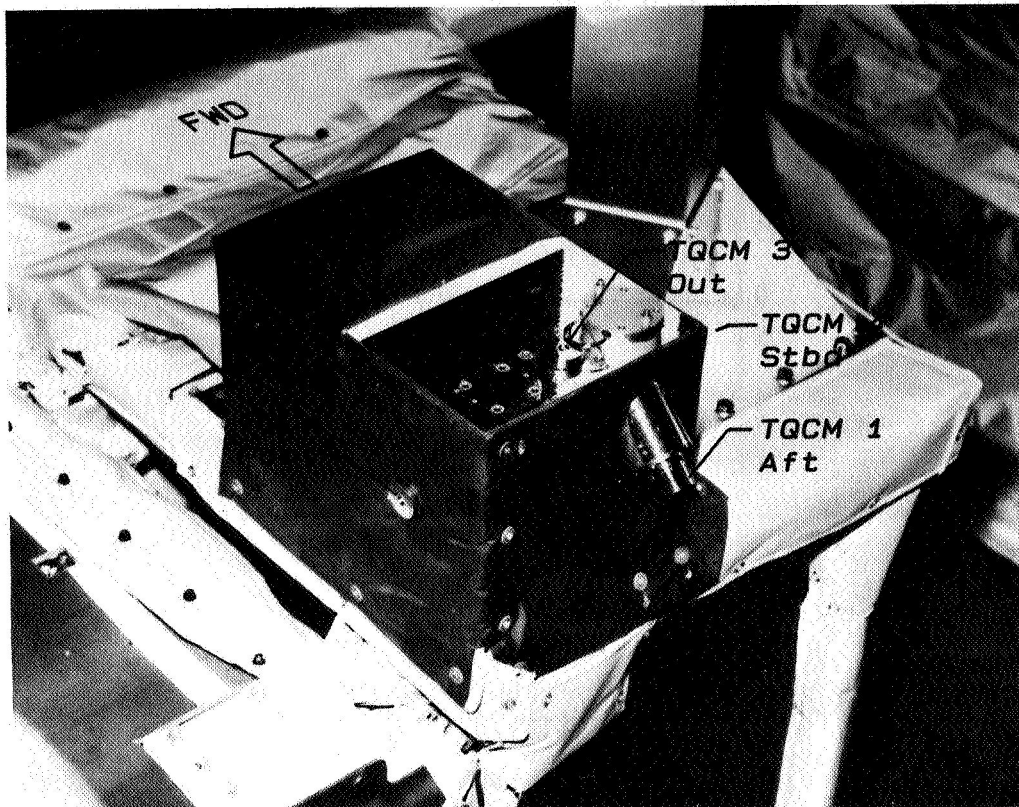
This figure shows the major participants in the program.



This figure shows a view of the Columbia and many parts of the OSS-1 pallet. The Contamination Monitor Package (CMP) is the small box shown within the circle.

The CMP effort was sponsored by the USAF; there were two major objectives:

- a. To monitor the mass build-up or accretion of condensible, volatile materials on surfaces in the Shuttle bay during all phases of ascent, on-orbit, and descent.
- b. To demonstrate the usefulness of a "small box" contamination monitor as an operational device for contamination management and control.

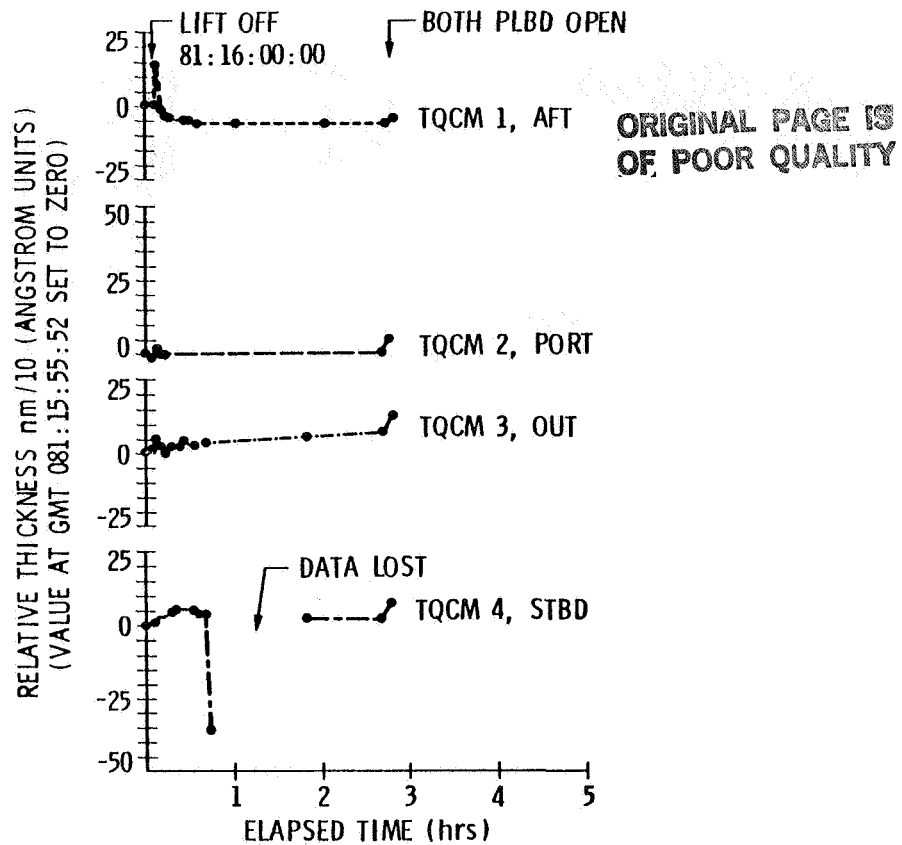


This is a view of the CMP. It is roughly 20 cm high, 18 cm wide, and 30 cm long (8x7x12 inches). It weighs about 7 kg (15 pounds). The average power consumption is about 7 watts. The box itself is passively thermally controlled using silver teflon for radiating surfaces and aluminized kapton multi-layer insulation for radiation isolation.

The instruments included two passively controlled witness samples (which will not be discussed here) and four actively temperature controlled quartz crystal microbalances (TQCM). The TQCM temperatures can be varied from -60°C to $+80^{\circ}\text{C}$. This control can be exercised by telemetry from the ground; there is no crew involvement. The data was recorded on the OSS-1 tape recorder for later playback on the ground, recorded on the Orbiter tape recorder for playback from orbit, and was telemetered in real-time during passes over ground stations.

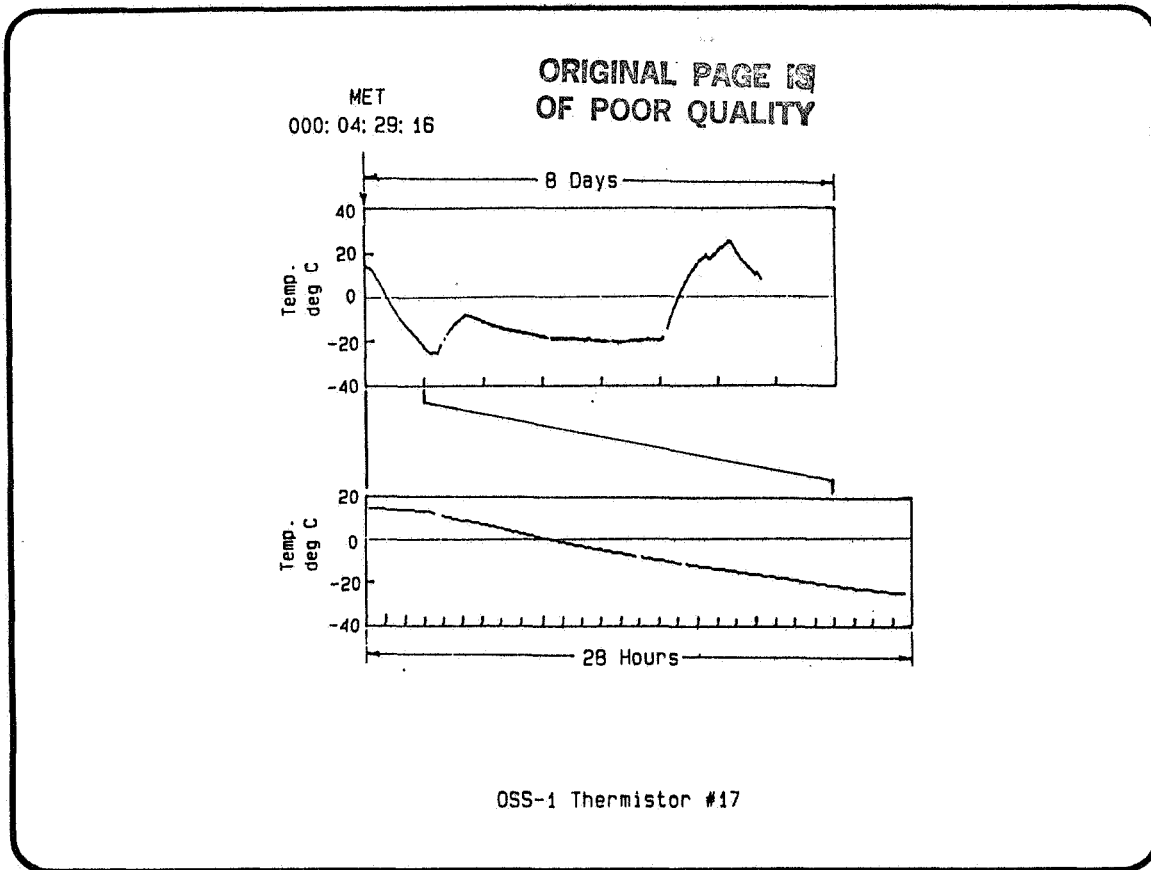
The TQCM's have a sensitivity of $1.56 \times 10^{-9} \text{g.cm}^{-2}.\text{Hz}^{-1}$, and the data was recorded to ± 1 Hz. While the more basic unit of measure for the TQCM is a surface loading density (g.cm^{-2}), much of this report will be in terms of nm/10 (or Angstrom units) of thickness, assuming a contaminant density of 1.0g.cm^{-3} .

ACCRETION DURING ASCENT PHASE



This figure shows the accretion indicated by the four TQCM's during the launch and early orbital phase. Note that the zero value has been set as the values indicated by the TQCM's at about 4 minutes prior to launch. (Launch occurred at 081:16:00:00 GMT.) The TQCM's were set to be controlled at +15°C during these phases.

Certain segments of the data have been lost.

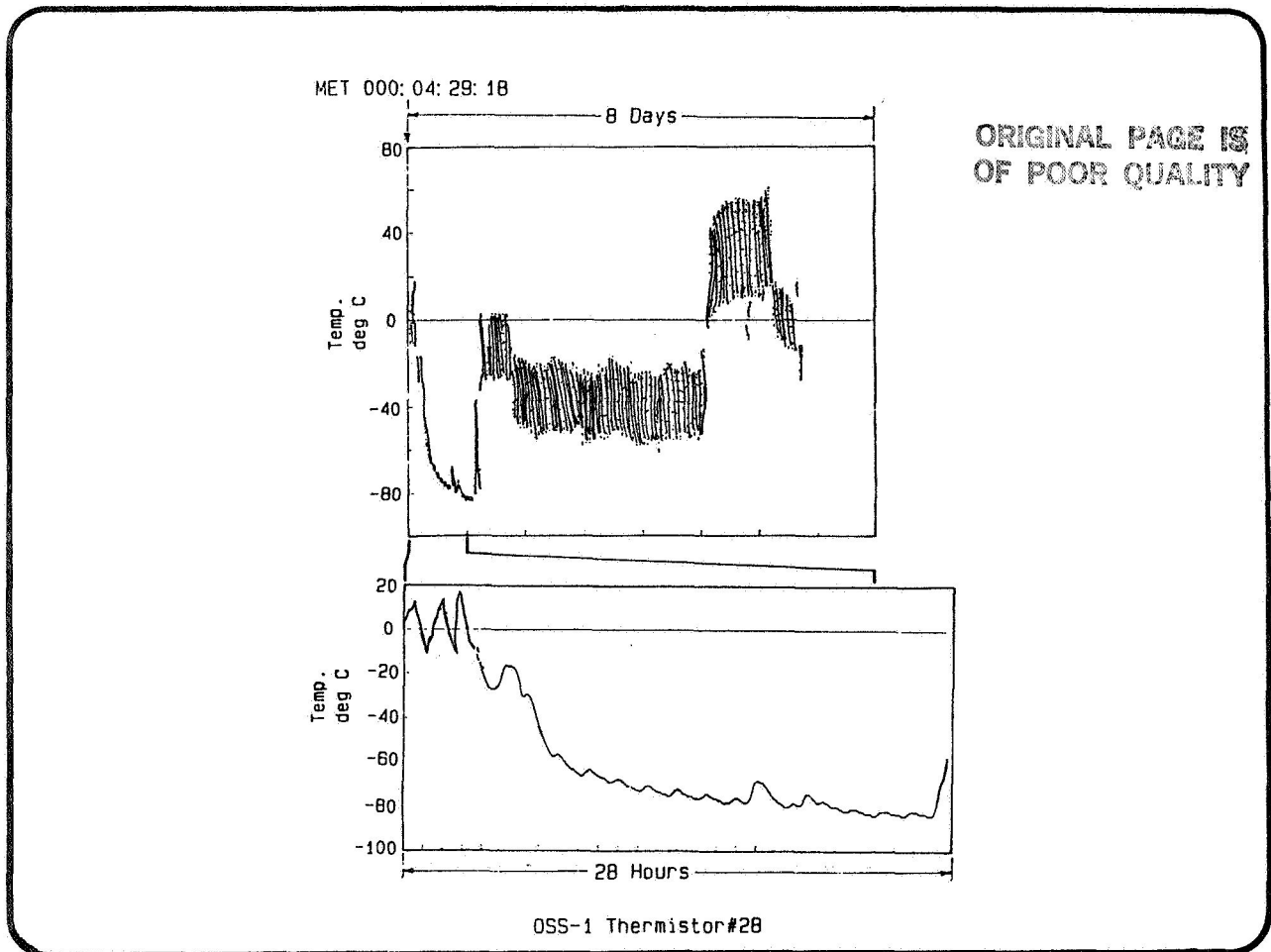


The STS-3 mission involved three major attitudes with respect to the sun for the purpose of verifying the Orbiter thermal design. These were: tail to the sun (TTS) with the orbiter bay always facing away from the earth; nose to the sun (NTS) where the roll rate allowed the orbiter to view the earth, and bay to sun (BTS) where the orbiter bay faced the sun. The TTS condition provided a very cold condition, NTS a moderately cold condition, and BTS a very hot condition.

These conditions are reflected in the temperatures indicated by OSS-1 thermistor #17 which was attached to a piece of equipment under the thermal blanket on the pallet.

For about the first day (TTS) the temperatures dropped sharply. This was followed by a Passive Thermal Control (PTC) mode that provided a more benign thermal environment indicated by the rise in temperature. This was followed by about 3-1/4 days in the NTS attitude shown by the cool-down. This was followed by the BTS condition for about a day with a warming trend. PTC, TTS, BTS, and other attitudes followed until deorbit.

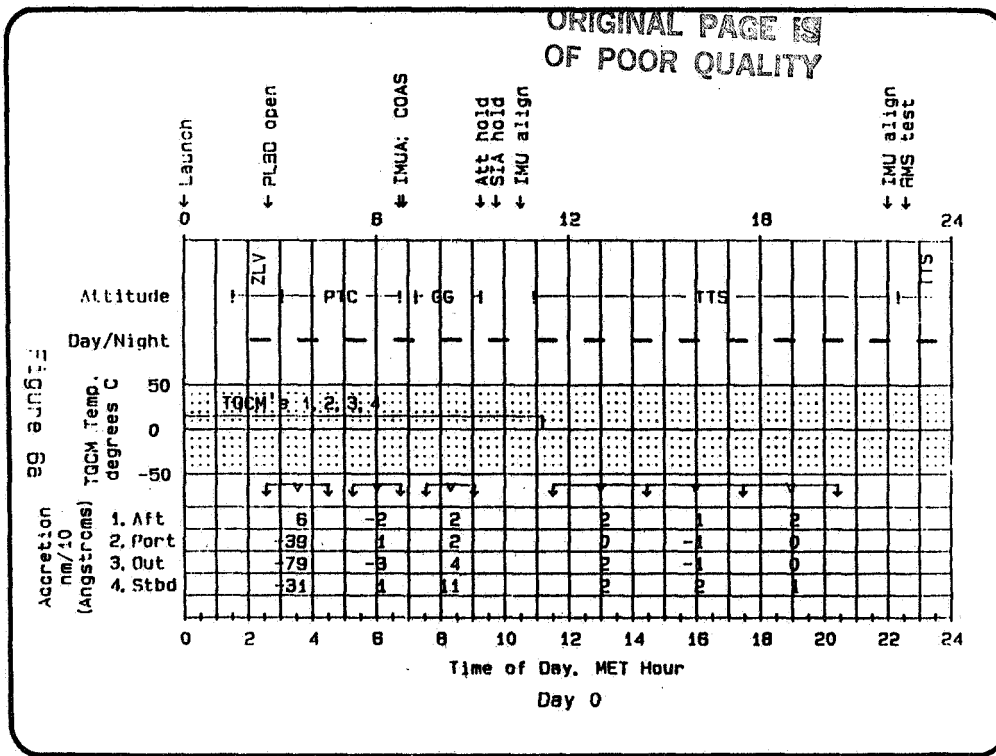
The importance of these temperatures is that they influence the outgassing rates of the various materials, and so influence the measurements made by the CMP.



It is interesting to look at data from OSS-1 pallet thermistor #28 which basically measures the temperature of low thermal mass multi-layer insulation. Here we can see wide fluctuations in rapid response to the various Orbiter orientations. These are more specific in the expanded time-scale portion of the chart where the fluctuations with each orbit become apparent. Other temperature variations appear to be correlatable to other Orbiter maneuvers such as those for alignment of the Inertial Measurement Unit (IMU).

As one might expect, other temperature data exists for items with very high thermal inertia and these show relatively small changes with Orbiter attitude.

Since outgassing is a strong function of temperature, we can expect to see significant differences with orbiter attitude as indeed we do. However, since so many different temperatures and outgassing sources exist, one would expect to be able to predict only general trends. It is possible that in some cases, depletion of an outgassing source will occur while the temperature is increasing. These competing effects add to the uncertainty of predicting what will occur.



The published proceedings of this meeting contain data on 8 days of the mission so that they may be reviewed by the reader more carefully. In the interest of time, only some significant points will be highlighted in the presentation.

This figure is rather complicated in order to include many of the parameters that bear on the TQCM data.

Starting at the bottom, the Mission Elapsed Time (MET) is shown on the abscissa and includes the day and the hour of the day. The first section of the ordinate is labeled "Accretion." The values shown are the net accretions (given in nm/10 or Angstrom units assuming a material density of $1g.cm^{-3}$) occurring between the two downward pointing arrows above the printed values. These values may be either positive or negative indicating material being added to the TQCM or leaving it. The arrows, incidentally, are generally one or two orbits apart in time (1-1/2 or 3 hours). This is done to choose thermal conditions which are similar and thereby minimize corrections. Similarly, most data points used in this report are selected from the dark portion of the orbit.

Immediately above is the approximate temperature of the sensing surface of the TQCM. The TQCM's were actively controlled to $+15^{\circ}C$ at launch. Changes in orbit were commanded by telemetry.

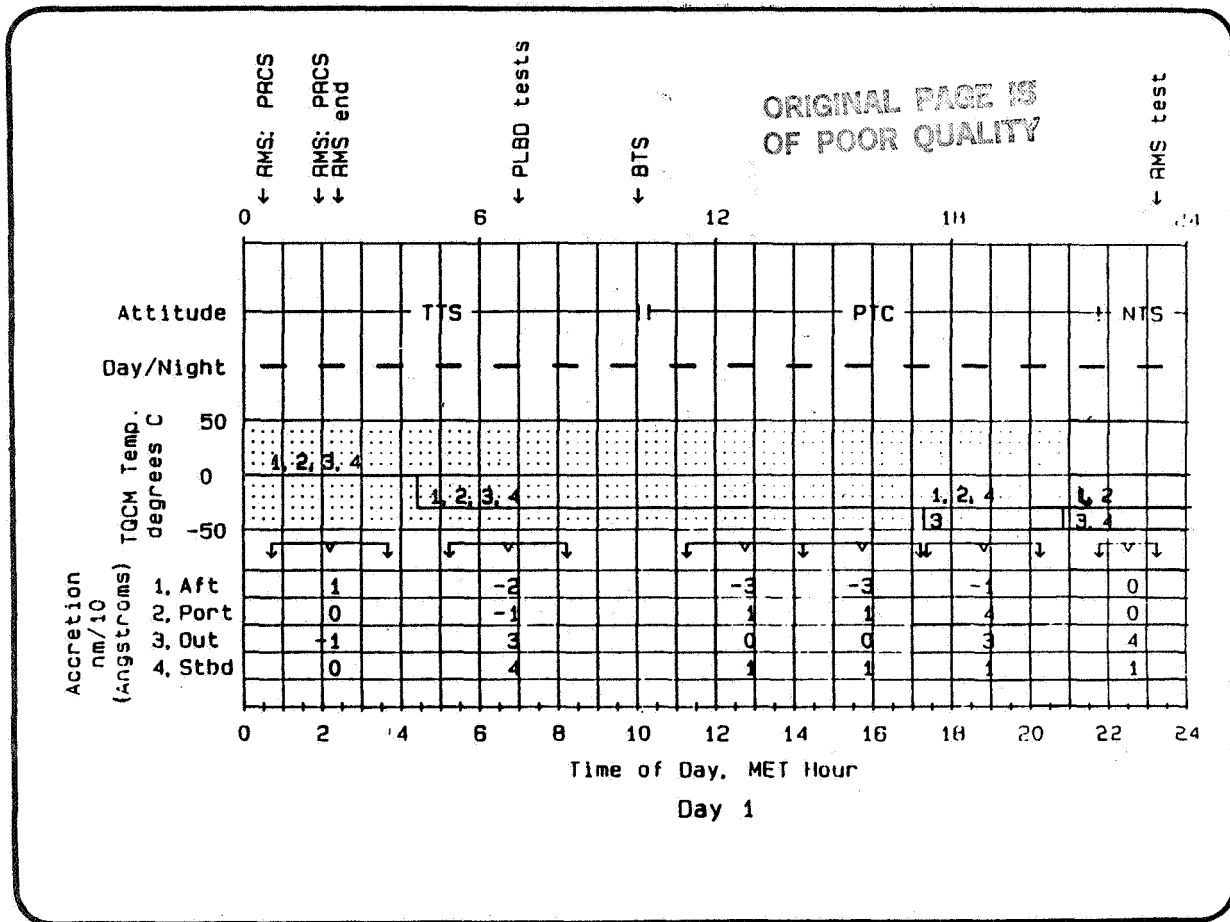
Day and night are shown next with the dark line indicating the shadow portion of the orbit. Attitude is shown next. ZLV (the Orbiter Z axis in the local vertical) is shown first; the PTC, TTS, NTS, and BTS descriptions are as noted before. "GG" is a gravity gradient mode.

Finally, at the very top are notes indicating events during the flight--"PLBD" are bay door activities, IMU and COAS refer to Orbiter attitudes taken for purposes of the Inertial Measurement Unit and the Crew Optical Alignment System. SIA is an attitude taken for obtaining certain instrument measurements. RMS notes refer to the Remote Manipulator System.

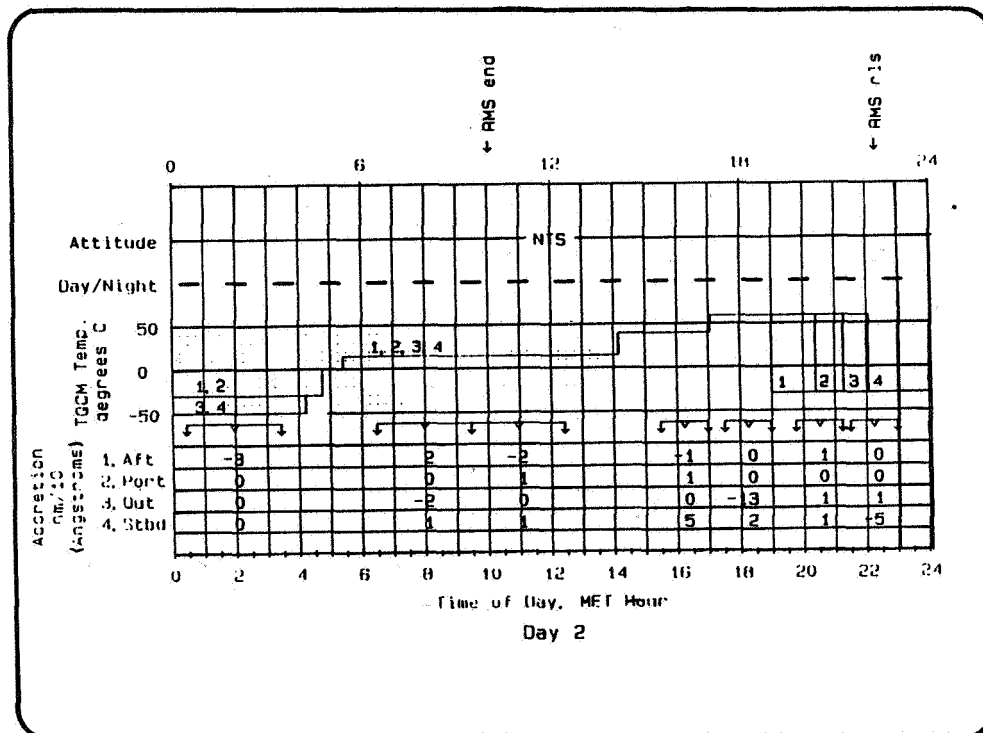
Other notes (DSCr, LZU, VRCS, etc.) refer to other operations that affected the Orbiter Attitude. The "IECM ops" note refers to the gas release phase of the Integrated Environmental Contamination Monitor operations.

As yet, no accretions have been noted that could be related to RMS, PDP, VCAP, or similar operations with any certainty. None of these are therefore included in the notes.

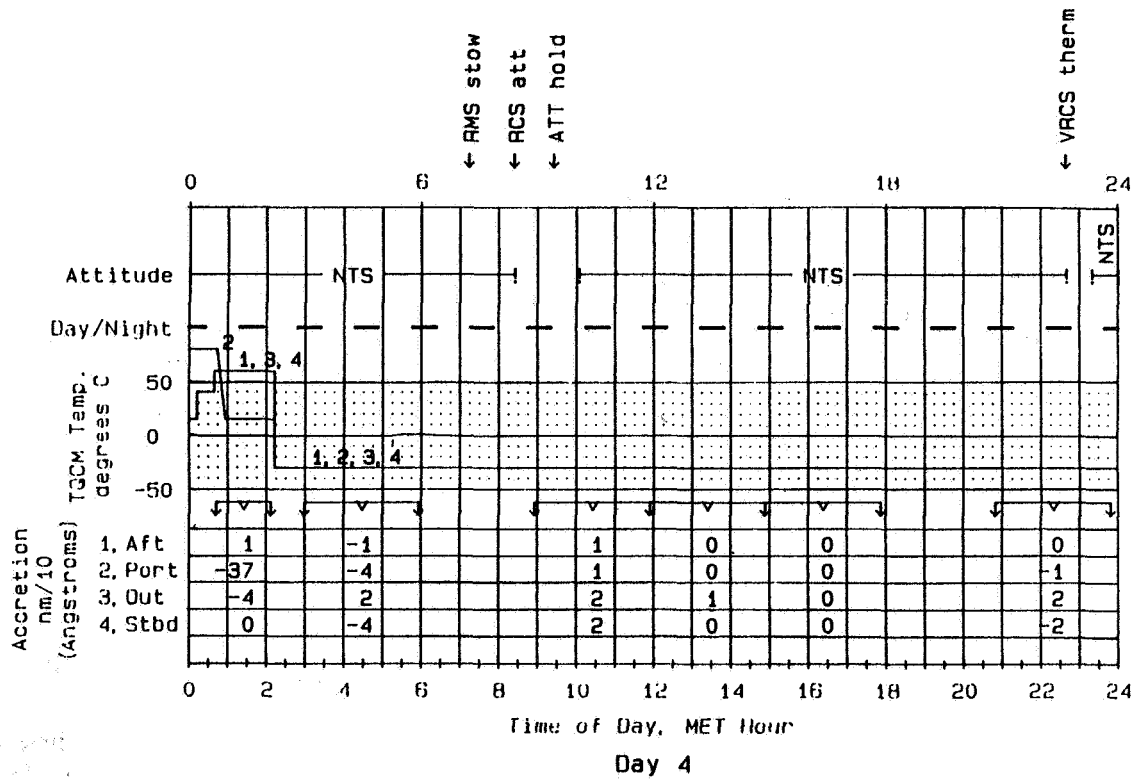
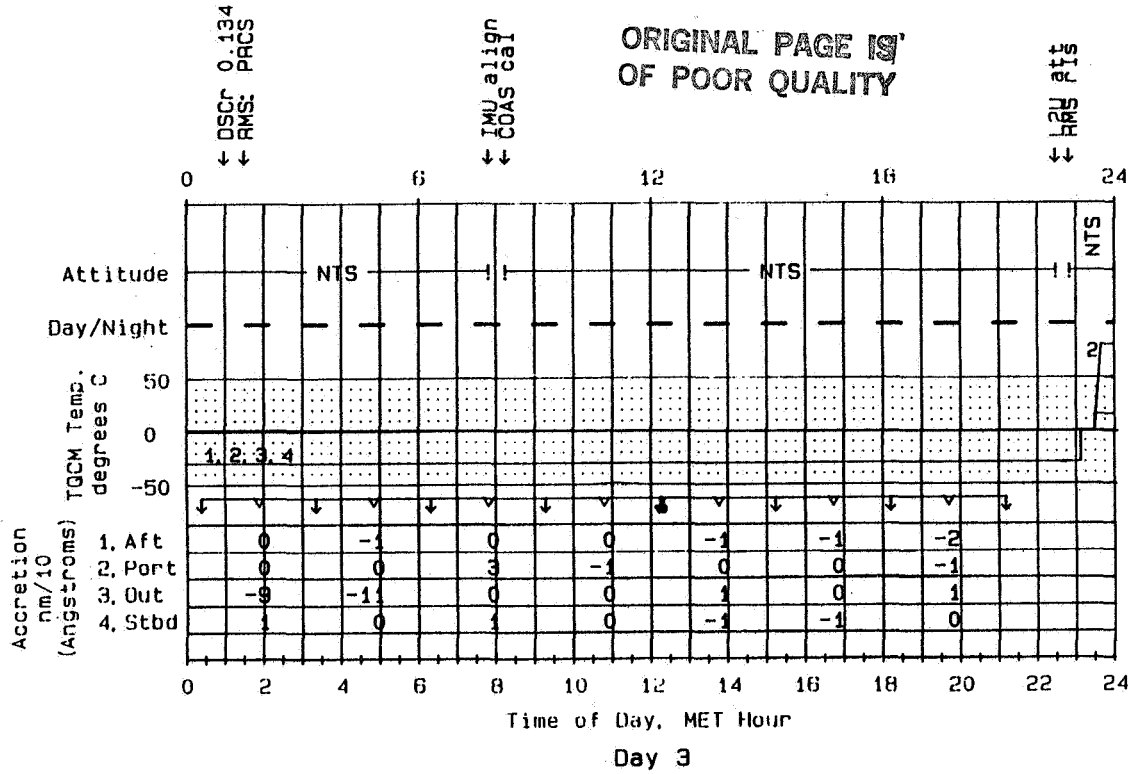
The accretions shown are generally below 2 nm/10 (Angstrom units) with the TQCM's at $0^{\circ}C$ and the Orbiter in the TTS attitude.

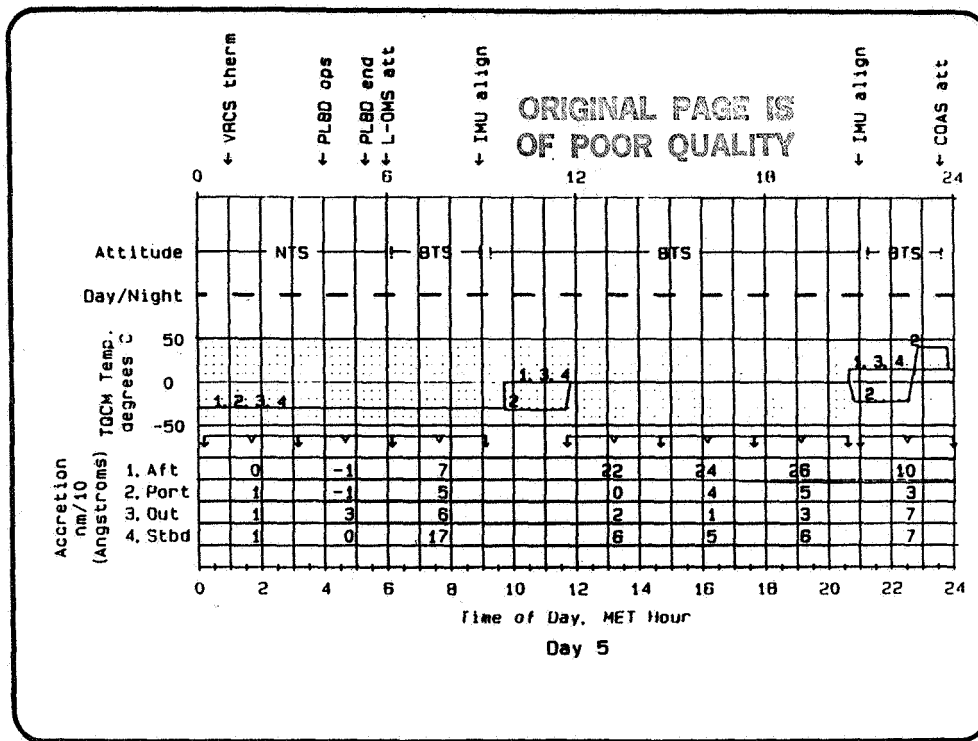


While in the NTS mode, a bake-out of the TQCM's was conducted. This involved raising their temperatures to +60°C to drive off accreted materials. This appears to happen rapidly and, possibly except for the value of -13 for TQCM 3, is not specifically seen on this chart.

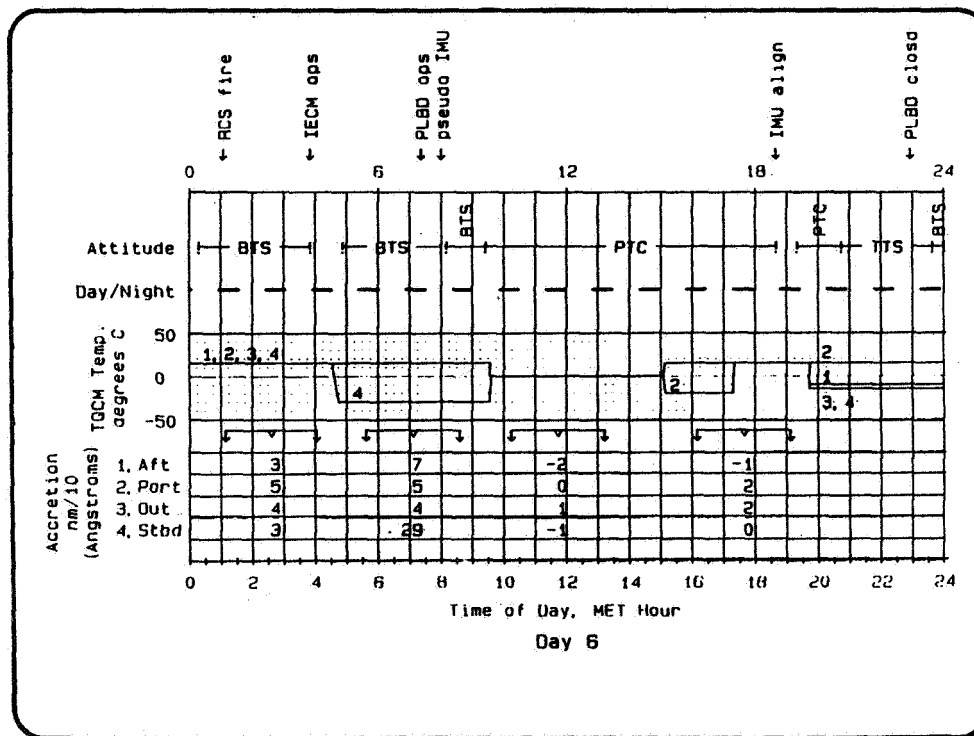


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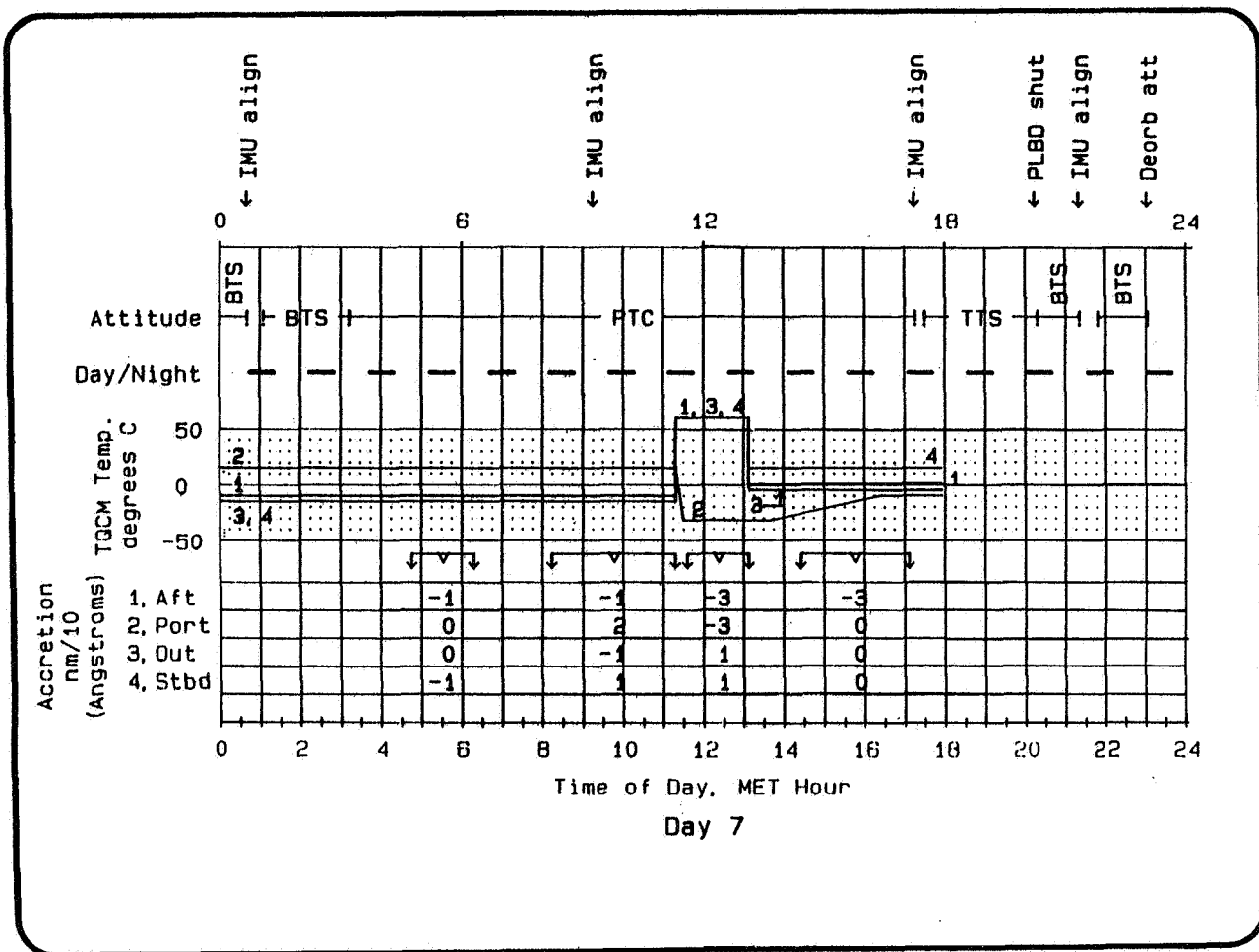




On day 5, the Orbiter took the BTS orientation. The immediate response of the TQCM's can be seen during the first section marked "BTS." Even when the TQCM temperatures were raised to 0°C and then +15°C, these accretions continue.



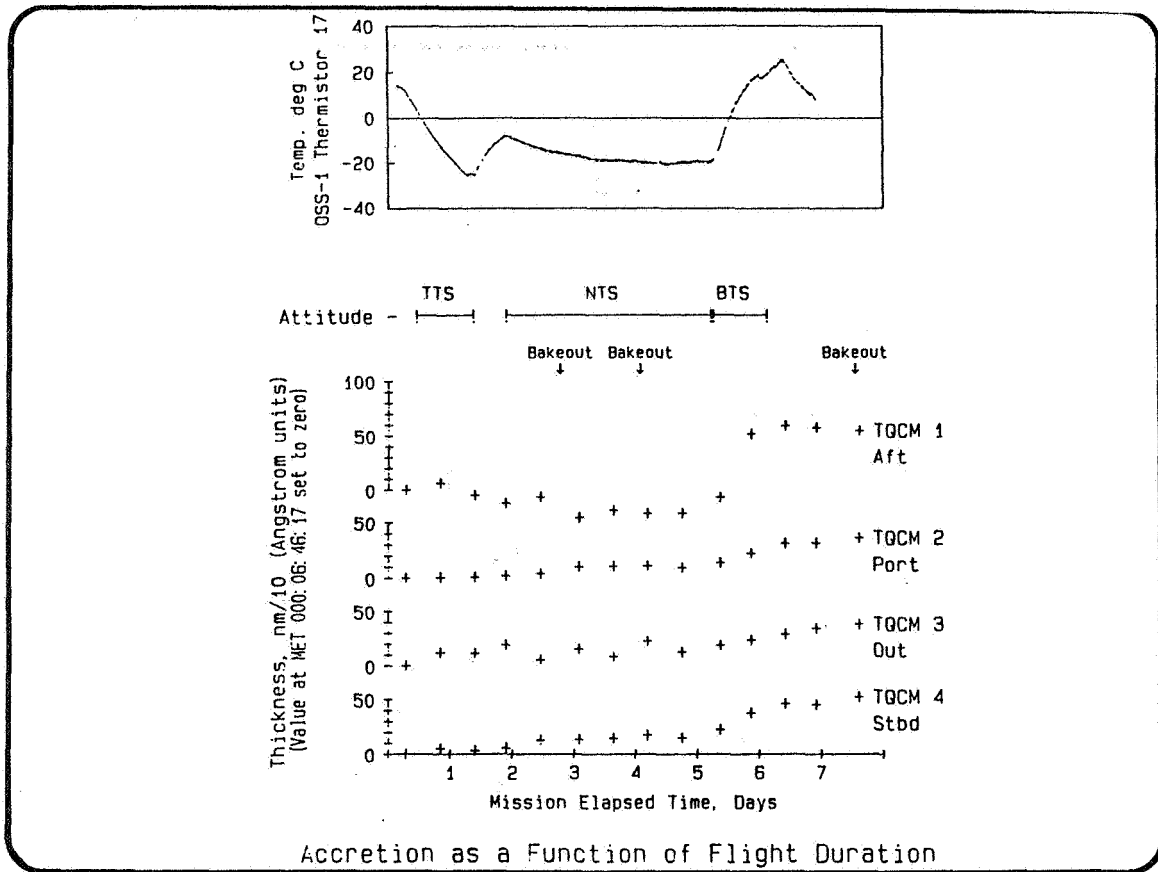
On day 6, the Orbiter left the BTS condition and the TQCM accretions show an immediate response. Towards the end of the day the TQCM's were all set to different temperatures in preparation for deorbit. However, because of landing site conditions, deorbit was delayed for 1 day.



The data shown for day 7 is taken from the real-time transmissions. These are available only when the Orbiter passed over an appropriate ground station.

The TQCM's temperatures were reset on day 7 for deorbit which occurred at about 2300 hours.

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Accretion as a Function of Flight Duration

In order to see some of the longer-term trends, the data for the four TQCM's was plotted selecting portions about 10 orbits apart (to simplify the data reduction process). The data shown have been normalized by setting them all to zero at one time (day 0, 06:46:17).

The three bake-outs that were conducted are shown on this chart.

There is a general downward trend for TQCM 1 into day 5 and a general upward trend for TQCM's 2, 3, and 4. Most striking is the upward trend for all of them in the period from about day 5-1/2 to day 6-1/2. This corresponds to the BTS condition and occurs when we would expect outgassing to increase.

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<u>Time Difference</u>	<u>Thickness Difference, nm/10 (Angstrom Units)</u>		
	<u>TQCM 1, Aft</u>	<u>TQCM 3, Out</u>	<u>TQCM 4, Stbd</u>
Day 2 to Day 4	-5	-10	+7
Day 2 to Day 7	+89	+40	+59

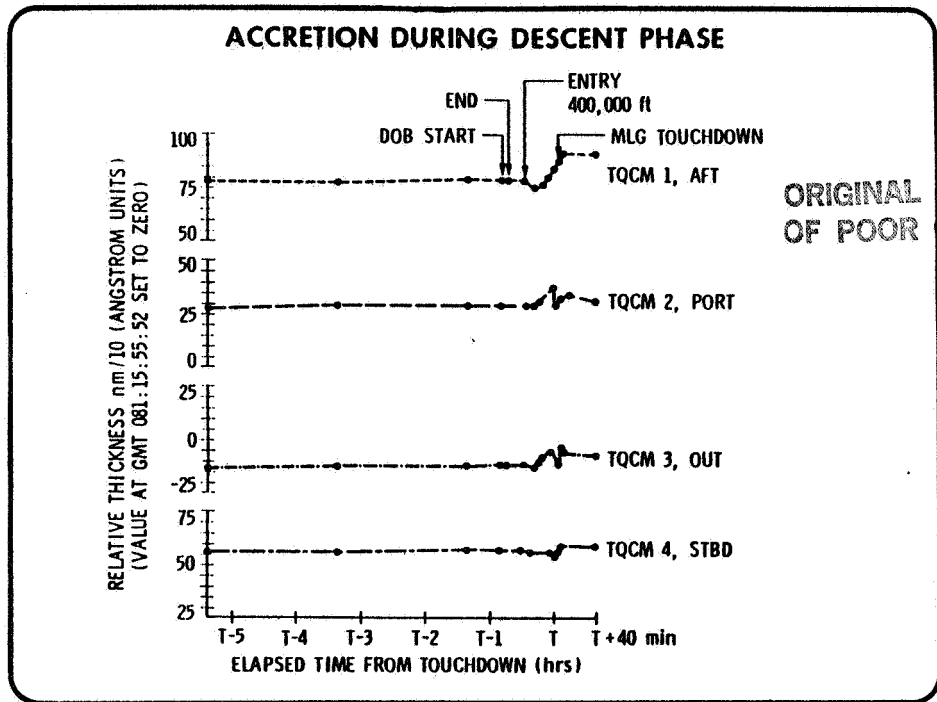
Thickness Differences Between Bake-outs

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It is most interesting to note the results of the three bake-outs conducted on days 2, 4, and 7.

The difference in the thicknesses indicated by the TQCM's after a period at +60°C between days 2 and 4 show two at a lower thickness on the later date and one with an increase in 7 nm/10 (Angstrom units). However, the second line shows that, even with bake-out, there was a net increase of 40 to 89 nm/10 (Angstrom units) between days 2 and 7. This includes the period when the Orbiter was in the BTS. (TQCM 2 data is not presented because its temperature was not at +60°C during bake-outs on days 4 and 7.)

Mr. Carl Maag of JPL will continue this presentation and will discuss data taken during ascent and descent and will present the conclusions.



The data on this figure is referenced back to approximately 4 minutes prior to launch. TQCM 1 was set to 0°C, TQCM 2 to -10°C, TQCM 3 to -5°C, and TQCM 4 to +15°C in preparation for entry. The system was designed to hold these temperatures through the landing phase.

The data has not been corrected for temperature effects on the TQCM.

It is interesting to note that not even TQCM 2 at -10°C showed a very large increase or stopped oscillating by the time of end of data. This indicates that the dew point was below -10°C for the period over which the data was taken.

- ### RESULTS
- ALL OBJECTIVES OF CMP WERE MET, PRINCIPALLY THAT OF DEMONSTRATING THE USEFULNESS OF AN OPERATIONAL MONITOR FOR CONTAMINATION MANAGEMENT AND CONTROL
 - MASS ACCRETION HIGHLY DEPENDENT UPON ORBITER ATTITUDE AND TEMPERATURE
 - SOLAR VIEWING ATTACHED PAYLOADS MAY BE SUBJECT TO IRREVERSIBLE DEGRADATION BY NON-REMOVABLE DEPOSITS

The major results based on the data reduction to date are expressed on this figure.