CHANDRA
X-ray Center

MEMORANDUM

September 25, 2002

To: ACIS Operations Team
From: Paul Plucinsky
Subject: Revision History of ACIS PSMC, DPA & DEA Temperature Limits

1 Introduction

The ACIS thermal limits have undergone several revisions from tests before launch until three years into the mission. Recent data indicate that one temperature value (1PIN1AT) has exceeded the Yellow Hi limit and other values are trending upward to their Yellow Hi limits. The ACIS Operations Team must review these limits and decide if it is appropriate to modify the limit set. Before recommending a modification which would increase the allowed range of a given temperature, it is important to understand the revision history of these limits and what the limits were based on.

2 ACIS Limit Set Philosophy

There have been several philosophies which have affected the the ACIS thermal limit sets. During the instrument and spacecraft thermal vacuum tests, the limit sets were defined in terms of "Normal Operations" and "Survival". This usually, but not always, meant that the Yellow limits were the "Normal Operations" limits and the Red limits were the "Survival" limits. The "Survival" values were not to be exceeded during these thermal vacuum tests. This philosophy carried over to the Orbital Activation & Checkout period and the beginning of the *Chandra* mission. The ACIS engineering team's philosophy evolved to a concept of having two separate limit sets, one being "Normal Operations" and the other being "Survival". The CXC ACIS Operations Team (AOT) and CXC Monitoring & Trends Analysis (M&TA) teams adopted this limit set philosophy recommended by the MIT ACIS engineering with a small modification. One set is the so-called "Health & Safety (HS)" set and is analogous to the limit sets used by the rest of the subsystems on the *Chandra* spacecraft. The second set is the so-called "Data Quality (DQ)" set and is intended to indicate conditions which *might* affect the quality of the science data from ACIS but which represent no threat to the hardware. See reference # 1 for description of the limit set currently in use.

3 Revision History of the Limit Sets

As the *Chandra* project progressed, the limit sets were revised based on the experience of ground tests or on-orbit experience. I have identified seven major revisions of the limits. This is not every revision, but I believe they include all the major revisions and are useful for understanding the basis of the limits. Table 1 lists the seven limit sets. The first limit set was established in May 1997 by Ellen Sen before the ISIM and spacecraft thermal vacuum tests. The second limit set was a small revision of the previous limit set by Ellen Sen in February 1998. The third limit set was a response by Ellen to TRW to modify the ACIS limit set such that there was a 5 C separation between the Yellow and Red limits. This limit set was the primary input to the first version of the *Chandra* Operations DataBase (ODB). The fourth limit set was Bob Goeke's revision of the flight limits in May 1999. This limit set introduced the concept of two limit sets. The fifth limit set was a final review of the flight limits collected by Bob which included input from Ellen. The sixth limit set was Bob's first revision of the flight limits based on one year's worth of flight experience. The seventh limit set was created jointly by the FOT, AOT, and ACIS engineering in the Fall of 2001. The "Health & Safety" limits were made to be consistent between the P008 version of the ODB and the CXC AOT, CXC M&TA, and the ACIS engineering team. In addition, the "Data Quality" limits were made to be consistent between CXC AOT, CXC MT&A, and the ACIS engineering team.

Table 1: **ACIS Thermal Limits Revision History**

Limit Set	Date	Description
1	1998 Jan 22	Ellen Sen Memo, Proposed On-Orbit Limit Set
2	1998 Feb 3	Ellen Sen memo Revision to On-Orbit Limit Set
3	1998 Feb 16	Ellen Sen memo Input to AXAF ODB
4	1999 May 3	Bob Goeke Memo, MIT Drawing 36-02215 Rev 1
5	1999 Jun 24	Bob Goeke Memo, MIT Drawing 36-02215 Rev 2
6	2000 Aug 3	Bob Goeke Memo MIT Drawing 36-02215 Rev 3
7	2001 Oct 11	FOT/SOT/ACIS Update to ODB P008

4 Detailed Revision History for 1PDEA[AB]T, 1PIN1AT, 1DEAMZT, 1DPAMYT, & 1DPAMZT

There are 6 MSIDs that are being monitored closely now as they have recently shown significant excursions from normal operating temperatures which have approached the DQ yellow upper limits (see reference # 2). The relevant MSIDs and yellow and red limits for the seven revisions of the limit sets are listed in Tables 2-6. The PSMC Temp 1A (1PIN1AT) exceeded its Yellow Hi limit for the first time on day 2002:267. A detailed analysis of this excursion is in progress.

A review of these tables indicates that in general the range of allowed temperatures has been narrowed. Since none of the ACIS temperatures had exceeded a yellow limit, it was decided that a narrowing of the allowed range would be useful to detect any trends sooner. For the first time in the mission, we must consider broadening the range for 1PIN1AT. The Yellow Hi limit for 1PIN1AT is currently set at 30 C, but it has been at higher values in previous versions of the limit sets. Presumably, these earlier values were still safe for hardware. Nevertheless, the AOT and the ACIS engineering team must review the basis for each of the limits and determine if a modification is warranted.

5 References

1. DePasquale, J. *Updated ACIS Telemetry Limits Table.* Internal CXC Memo. October 2001. `http://asc.harvard.edu/acis/memos/limits_philosophy.ps`

see also: DePasquale, J. *Overview of the ACIS Limit Pager Script.* Internal CXC Memo.

Table 2: **1PDEA[AB]T Limit History**

Limit	Health & Safety				Data Quality			
Set	RedLo	YelLo	YelHi	RedHi	RedLo	YelLo	YelHi	RedHi
1	-40.0	-25.0	+62.0	+62.0				
2	-40.0	-25.0	+62.0	+62.0				
3	-26.5	-21.5	+53.5	+58.5				
4	-37.0	-32.0	+54.0	+59.0	-27.0	-22.0	+54.0	+59.0
5	-37.0	-32.0	+54.0	+59.0	-37.0	-22.0	+54.0	+59.0
6	-37.0	-32.0	+54.0	+59.0	-37.0	+8.0	+43.0	+59.0
7	-36.5	-10.0	+50.0	+58.5	-36.5	0.0	+50.0	+58.5

Table 3: **1PIN1AT Limit History**

Limit	Health & Safety				Data Quality			
Set	RedLo	YelLo	YelHi	RedHi	RedLo	YelLo	YelHi	RedHi
1	-40.0	-25.0	+35.0	+40.0				
2	-40.0	-25.0	+40.0	+40.0				
3	-26.5	-21.5	+31.5	+36.5				
4	-37.0	-32.0	+32.0	+37.0	-27.0	-22.0	+32.0	+37.0
5	-37.0	-32.0	+32.0	+37.0	-37.0	-22.0	+32.0	+37.0
6	-37.0	-32.0	+32.0	+37.0	-37.0	-5.0	+27.0	+37.0
7	-36.5	-20.0	+30.0	+36.5	-36.5	-5.0	+30.0	+36.5

October 2001. `http://asc.harvard.edu/acis/memos/limitpager_memo.ps`

2. DePasquale, J., & Plucinsky, P. *ACIS PSMC, DPA, & DEA Temperature Trends and Excursions.* Internal CXC Memo. September 2002.

Table 4: **1DEAMZT Limit History**

Limit	Health & Safety				Data Quality			
Set	RedLo	YelLo	YelHi	RedHi	RedLo	YelLo	YelHi	RedHi
1	-40.0	-20.0	+43.0	+43.0				
2	-40.0	-20.0	+43.0	+43.0				
3	-37.5	-32.5	+35.5	+40.5				
4	-37.5	-33.5	+35.5	+40.5	-22.5	-17.5	+30.5	+35.5
5	-37.5	-32.5	+35.5	+40.5	-37.5	-17.5	+30.5	+40.5
6	-37.5	-32.5	+35.5	+40.5	-37.5	+2.0	+13.0	+40.5
7	-37.5	-20.0	+20.0	+40.5	-37.5	+4.0	+12.0	+40.5

Table 5: **1DPAMYT Limit History**

Limit	Health & Safety				Data Quality			
Set	RedLo	YelLo	YelHi	RedHi	RedLo	YelLo	YelHi	RedHi
1	-40.0	-20.0	+43.0	+43.0				
2	-40.0	-20.0	+43.0	+43.0				
3	-37.5	-32.5	+35.5	+40.5				
4	-37.5	-33.5	+35.5	+40.5	-22.5	-17.5	+35.5	+40.5
5	-37.5	-32.5	+35.5	+40.5	-37.5	-17.5	+35.5	+40.5
6	-37.5	-32.5	+35.5	+40.5	-37.5	-1.0	+15.0	+40.5
7	-37.5	-20.0	+20.0	+40.5	-37.5	+1.0	+14.0	+40.5

Table 6: **1DPAMZT Limit History**

Limit	Health & Safety				Data Quality			
Set	RedLo	YelLo	YelHi	RedHi	RedLo	YelLo	YelHi	RedHi
1	-40.0	-20.0	+43.0	+43.0				
2	-40.0	-20.0	+43.0	+43.0				
3	-37.5	-32.5	+35.5	+40.5				
4	-37.5	-33.5	+35.5	+40.5	-22.5	-17.5	+35.5	+40.5
5	-37.5	-32.5	+35.5	+40.5	-37.5	-17.5	+35.5	+40.5
6	-37.5	-32.5	+35.5	+40.5	-37.5	+4.0	+17.0	+40.5
7	-37.5	-20.0	+20.0	+40.5	-37.5	+4.0	+17.0	+40.5