

# Building the Coolest X-ray Satellite

## Chapter 4 Script

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### *Chapter 4: Overcoming Challenges and Moving On*

#### **Chapter 4, part 1: First Sign of Trouble with the XRS**

Video

CLIP OF LOW ANGLE SHOT OF KEVIN WALKING INTO CRIF  
TEXT: MEANWHILE

Audio

NARRATOR: Back at the CRIF, the XRS team detects the first sign of problems.

Video

CLIP OF RICH KELLEY AT A COMPUTER  
TEXT: RICH KELLEY INFO

Audio

RICH KELLEY: So this is really, what we are seeing, this is really the indication of trouble, of a leak, which is that when you close off the valve the leak rate goes down – when you open the valve the leak rate goes up.

Video

CLIP OF THE XRS DEWAR

Audio

NARRATOR: Sensors detect a small helium leak inside the Dewar.

Video

CLIP OF RICH SHOWING A PLOT ON THE COMPUTER SCREEN WHERE  
THE LEAK IS EVIDENT

Audio

RICH KELLEY: We did another check over here as well. This step here from this low level, which is almost zero up to here is our leak, that's the real solid indication.

Video

CLIPS OF THE XRS DEWAR  
KEVIN OC

Audio

KEVIN: We had a very small leak; it's so small that is almost impossible to see at room temperature. It was only when you made the system very cold, that the leak would get big enough that you could see the helium coming out.

Video

RICH OC

Audio

RICH: That has a couple of implications, first of all, obviously is we have an extremely tight schedule, delivery schedule, so this now, potentially jeopardizes the delivery schedule.

Video

CLIPS OF WORK IN THE CRIF  
RICH OC

Audio

RICH: All of the instruments that we build for use in space are one of a kind, very unique instruments. So we allocate some time in our schedule to deal with problems and unexpected things. In this particular case we're dealing with something that's really difficult - we have a very, very small leak that we can only detect when the instrument is cold. And therefore it's going to take a lot of effort and really heroic effort on the part of the team to try to find this problem, fix it and get the instrument back together and to Japan when we said we would.

Video

CLIPS OF WORK IN THE CRIF

## **Chapter 4, part 2: Testing the XRT Foils and Building the Mirror Assembly**

Video

CLIP OF THE EXTERIOR OF BUILDING 2  
TEXT: METROLOGY LAB: MIRROR INSPECTION; BUILDING 2, NASA GSFC

Audio

NARRATOR: As the XRS team prepares to tackle the helium leak and hopefully beat the clock – the x-ray telescope manufacturing process enters another phase – testing.

Video

CLIPS OF THE MIRROR FOILS

Audio

CURTIS: We now have foils that have the front surface we want and it goes into the Metrology lab where the foil is inspected.

Video

CLIPS OF THE MIRROR FOIL IN A PROFILOMETER  
TEXT: VOICE OF DR. JOHN LEHAN, XRT SCIENTIST  
CLIPS SHOWING A MAP OF THE SURFACE OF A MIRROR FOIL ON A COMPUTER SCREEN

Audio

JOHN LEHAN: A Wiko Profilometer measures using light so it's a non-contact method. It uses visible light to actually measure the roughness of the surface. As far as x-rays go these are pretty close to mountains, but these are very short

mountains being only about 1/1000th the height of a human hair. So we would like to have them a small a difference between the maximum and minimum as practical.

Video

CLIPS OF MIRROR FOILS IN THE LAB

Audio

CURTIS: So then they are graded. Some are rejected, some are what we call flight and some are put in a small class of “usable if you have to get yourself out of a jam.”

NARRATOR: All the parts are ready

Video

CURTIS OC

CLIPS OF MIRROR HOUSE WITH ONE FOIL

Audio

CURTIS: So we are going to start building up a telescope, and we do this one quadrant at a time. After you’ve put the bars in, you put one foil in the middle of the housing somewhere, and you put it on an alignment fixture

Video

CLIPS OF MIRROR HOUSE WITH ONE FOIL

CURTIS OC

CLIPS OF THE TELESCOPE HOUSING FULL OF FOILS

Audio

CURTIS: The alignment bars are the ones that create the angle and perfectly position the foils in the housing and make it so that we can stick one housing on top of another and have 175 concentric nesting line up perfectly with 175 below.

### **Chapter 4, part 3: Another Problem with the XRS**

Video

CLIPS OF WORK IN THE CRIF

Audio

NARRATOR: After spending days in an exhausting effort to fix the helium leak and stay on schedule, the XRS team now faces an even more serious problem.

Video

CLIP OF KEVIN SHOWING THE TEST DEWAR

ANIMATION OF THE TEST DEWAR DAMAGE

Audio

KEVIN: There was a leak, which turned out to be in the vent line and we found that with this leak detector. We were able to patch it and repair it, but unfortunately what happened was during the repair – during the testing of the repair – we got an ice plug in the helium fill and vent lines for the test Dewar and

that actually ruptured and caused some damage – this of course has set us back quite a bit.

Video

CLIPS OF WORK IN THE CRIF AND THE SCHEDULES FOR WORK

Audio

NARRATOR: The XRS Team goes into crunch-mode with shifts working around the clock to fix the damage, test the system and get back on schedule. It's becomes the most grueling, the most trying few weeks the XRS team has had to go through. Tension strains the team, testing nerves and patience.

Video

CLIP WITH RICH SHOWING A "STRESS CHECK CARD"

Audio

MIKE MCCLARE (OFF CAMERA): That's not a joke??  
KEVIN: No, it's actually a Goddard thing.  
RICH: I'm calm.

#### **Chapter 4, part 4: Testing the XRTs**

Video

CLIP OF EXTERIOR OF BUILDING 2  
CURTIS OC  
CLIPS OF THE MIRROR HOUSING ASSEMBLY

Audio

CURTIS: The mirror team had its share of problems too. Early on we had some structural problems. In a couple of cases mirror assemblies did not past vibration testing, which simulates the rigors of launch. We went in and made repairs to the assemblies and retested successfully.

Video

CLIP OF XRT MIRROR QUADRANT

Audio

NARRATOR: The x-ray telescope quadrants are ready for more testing and final assemblies.

Video

CLIP OF CURTIS HOLDING AN XRT MIRROR QUADRANT

Audio

CURTIS: You're seeing the edges of the foils in many, many arcs like that. That's the 175 nestings.

Video

CLIPS OF THE XRT MIRROR QUADRANT IN THE TESING EQUIPMENT

Audio

CURTIS: So then you've got a quadrant, now we're going to do some optical testing with that, then we start doing x-ray testing.

Video

CLIP OF X-RAY TEST CHAMBER  
CLIP OF COMPUTER SCREEN SHOWING X-RAY TESTS

Audio

CURTIS: So what we are looking for is to contain the photons in as small a circle as possible

Video

CLIP OF COMPUTER SCREEN SHOWING X-RAY TESTS

Audio

NARRATOR: The better the focus, the more photons will arrive onto the XRS.

Video

CLIPS OF THE XRT MIRRORS IN THE TESTING EQUIPMENT

Audio

CURTIS: So the process is done again in optical – in white light - by putting the 4 quadrants on the ring and then looking at where each quadrant projects it's image – and adjusting these until they all project to the same spot.

Video

CLIPS OF PACKING THE MIRRORS

Audio

NARRATIVE: With the assemblies complete, the telescopes can be packed and sent to Japan for further testing and final assembly onto the spacecraft.

## **Chapter 4, part 5: Back on Schedule with the XRS**

Video

CLIPS OF WORK IN THE CRIF

Audio

NARRATIVE: It's been a tough few weeks for the XRS team. But Their determination and drive to stay on schedule pays off.

Video

CLIP OF SCOTT PORTER SHOWING WHERE THE TEAM IS ON THE SCHEDULE

TEXT: F. SCOTT PORTER INFO

Audio

SCOTT: We are going to integrate the FEA ADR this morning. We should be done in about an hour and a half. Then that ends this series and then we are on to the cryostat integration. Back where we should be.

Video

KEVIN OC

TEXT: KEVIN'S INFO

CLIPS OF WORK ON THE XRS IN THE CLEAN ROOM

Audio

KEVIN: People are a little happier than they have been over the past few weeks. We made a new schedule after we had the accident, the damage to the test Dewar, we made a new schedule and it looked like if we really worked hard we could get done in time to deliver in mid-March, which is when we need to deliver in order to launch on time. We've actually gained on that schedule – we are six days ahead of that schedule right now. So that has some slack in the schedule as well. So we've got a little bit of room now to breath. So everybody is feeling a little bit happier, it's really nice to be done with the calibration – this interim calibration – and going back into the real flight unit.