NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

May 3, 2012

Computed Tomography Specialist's Factual Report

ERA-12-FA-056

A. INCIDENT

Operator:	Hendrick Motor Sports
Location:	Key West International Airport, Key West, FL
Date:	October 31, 2011
Time:	1945 EDT
Airplane:	Israel Aircraft Industries Gulfstream G150, N480JJ

B. GROUP

Computed Tomography Specialist:	Scott Warren National Transportation Safety Board Washington, D.C.

C. SUMMARY

On October 31, 2011, at about 1940 eastern daylight time, an Israel Aircraft Industries G150, N480JJ, went off the end of the runway on landing roll out. The nose landing gear collapsed and the airframe sustained structural damage. Visual meteorological conditions prevailed and an instrument flight rules (IFR) flight plan was filed. The certificated airline transport rated pilot-in-command (PIC), airline transport rated co-pilot and one passenger reported minor injuries. One passenger sustained serious injuries. The flight departed from Witham Field Airport (SUA) Stuart, Florida at 1900 edt. The flight was conducted on the provisions of 14 Code of Federal Regulations Part 91 as a personal flight.

Examination of the crash site revealed the airplane departed the runway, crossed a 600 foot overrun, impacted the far side of a ditch, crossed a dirt road, cleared another ditch, and came to a stop 820 feet from the departure end of the runway.

Radiographic studies were done on January 9-12, 2012 in Chicago, Illinois to examine and document the internal configuration of the power brake valve. The power brake valve was documented using a combination of computed tomography (CT) scans and digital radiography. The valve was imaged using a total of 8 digital radiographs (DR) and 604 CT slices.

There were no anomalies noted within the power brake valve on either the DR or CT images.

D. DETAILS OF THE INVESTIGATION

1.0 General

The power brake valve was subjected to x-ray computed tomography (CT) and digital radiography scanning to document the internal conditions of the valve. The scanning for power brake valve was conducted from January 10-11, 2012. The scans were performed by Varian Medical Systems, Inc (formerly Bio-Imaging Research, Inc. (BIR)) under the direction of the NTSB.

To conduct the scans, Varian used an ACTIS 800/450-225 CT system with a maximum source strength of 450 kV using an x-ray source strength of 440 kV and 2 mA. The system recorded the x-ray attenuation information using a 250D linear array detector system.

For the CT scans, the power brake valve was loaded into the imaging unit and placed on a turntable. The assembly was then rotated in front of the x-ray source, and the x-rays were captured by a detector after they went through the assembly. The x-ray source produced a collimated fan beam of x-rays, and the portion of the assembly imaged by this fan beam was adjusted slightly after each scan was

completed until the entire assembly was scanned. The x-ray energy levels captured by the detector were recorded at 1,800 different points during each rotation, and this information was converted into slice images using reconstruction algorithms.

The CT work resulted in 604 slices, and each slice was 2,048 x 2,048 pixels wide and had a resulting image file size of slightly over 8 megabytes (Mb). The slices were created with a thickness of 0.50 mm at a spacing of 0.40 mm with a cross sectional pixel dimension within each slice of approximately 0.115 mm x 0.115 mm.

For the digital radiograph (DR) images, the assembly was subjected to a process similar to a conventional x-ray. The image was gathered using the same detector used for the CT scans, but the assembly did not rotate, and the images contain elements superimposed on each other. Each individual valve within the power brake valve was imaged, and the pivot pin was imaged separately.

Each data set of CT slice images was evaluated using the VGStudio Max software package to either view the individual slices in detail or to create a three-dimensional reconstructed image of the component. As part of the evaluation, some sections of the power brake valve were digitally removed to allow closer observation of interior parts.

The images of the power brake valve were examined for any signs of missing or damaged parts, contamination, or any other anomalies. Specific results (including example images) are presented in subsequent sections of this report.

2.0 Digital Radiograph Results

Digital radiograph images of the power brake valve are shown in figures 1 through 4. No particles or other defects were noted in any of the digital radiographs. Some of the digital radiographs have had their window and level values[1] adjusted to make internal portions of the power brake valve more distinct.

[1] The images captured for this report consist of approximately 65,000 different shades of gray (gray levels). Since the human eye can only distinguish, at most, a few hundred shades of gray, determining which gray levels to display in an image composes a major part of radiographic image analysis. The range of gray levels displayed in the image is called the “window width”, and the midpoint of the range is called the “window level”. The process of adjusting the window width and window level is called “windowing and leveling”. Adjusting the window width and level allows for items of different gray values to be displayed with different contrast levels.

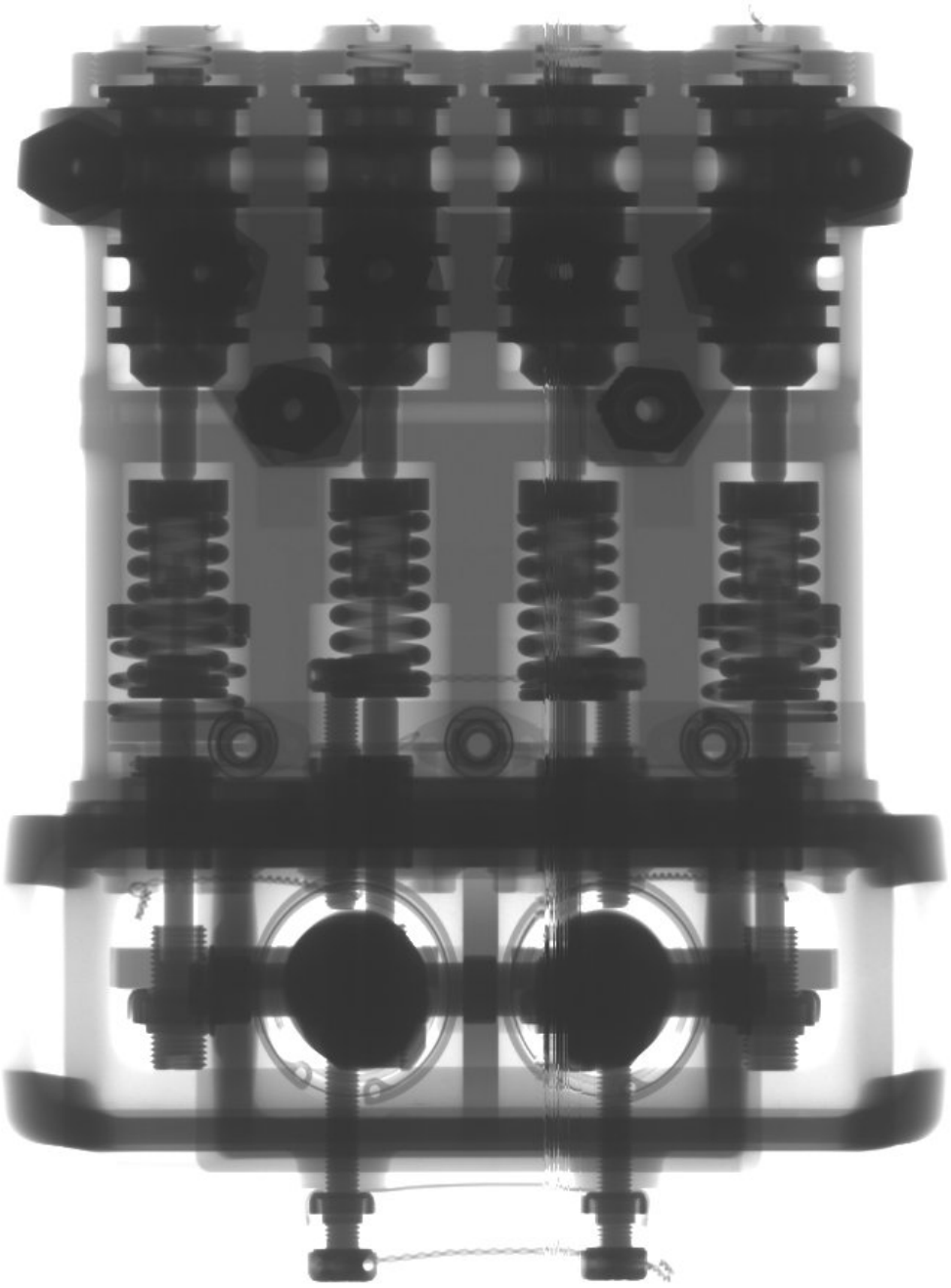

Figure 1
Digital Radiograph – Power brake valve, overall view

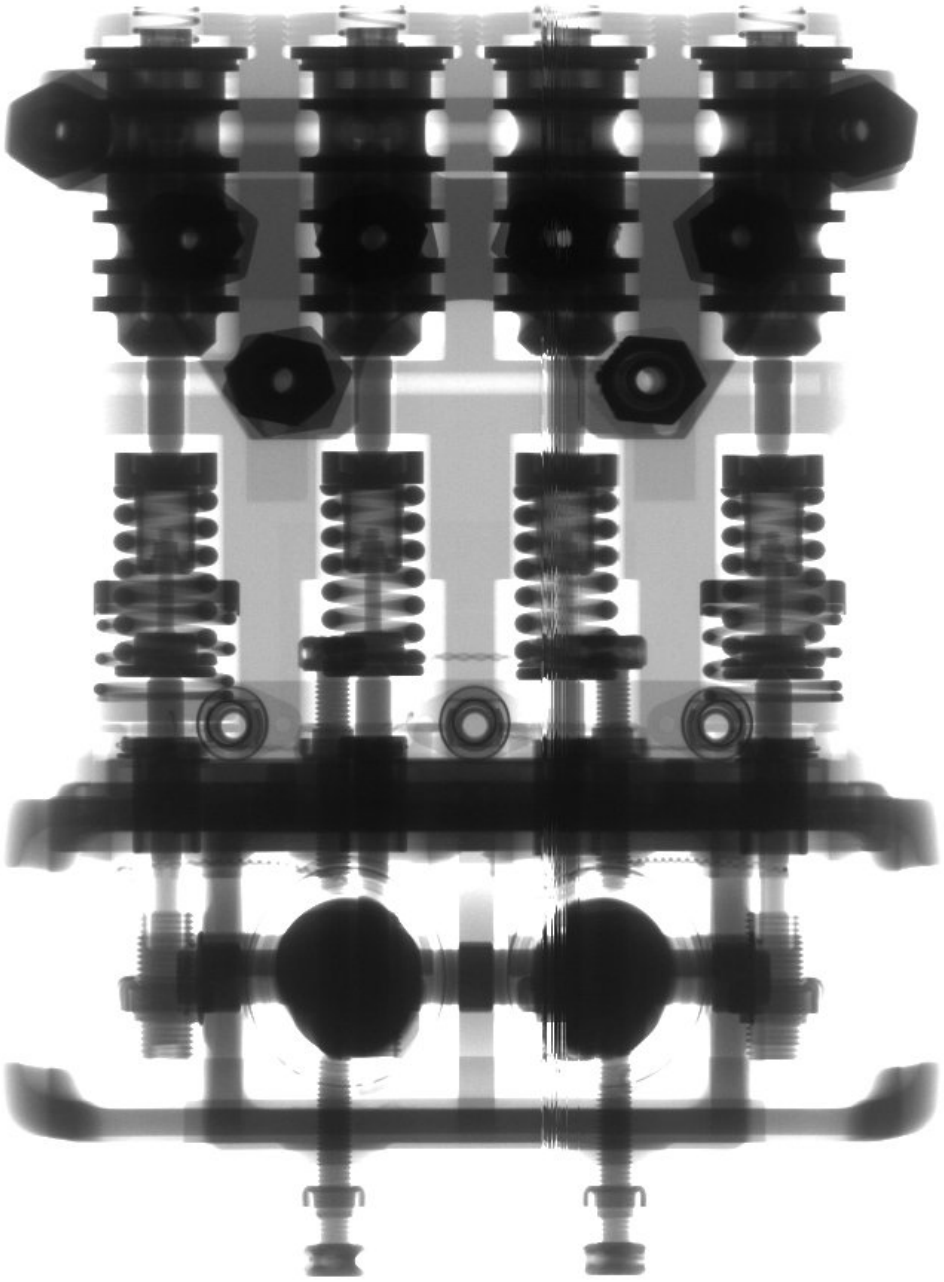

Figure 2
Digital Radiograph – Power brake valve, overall view

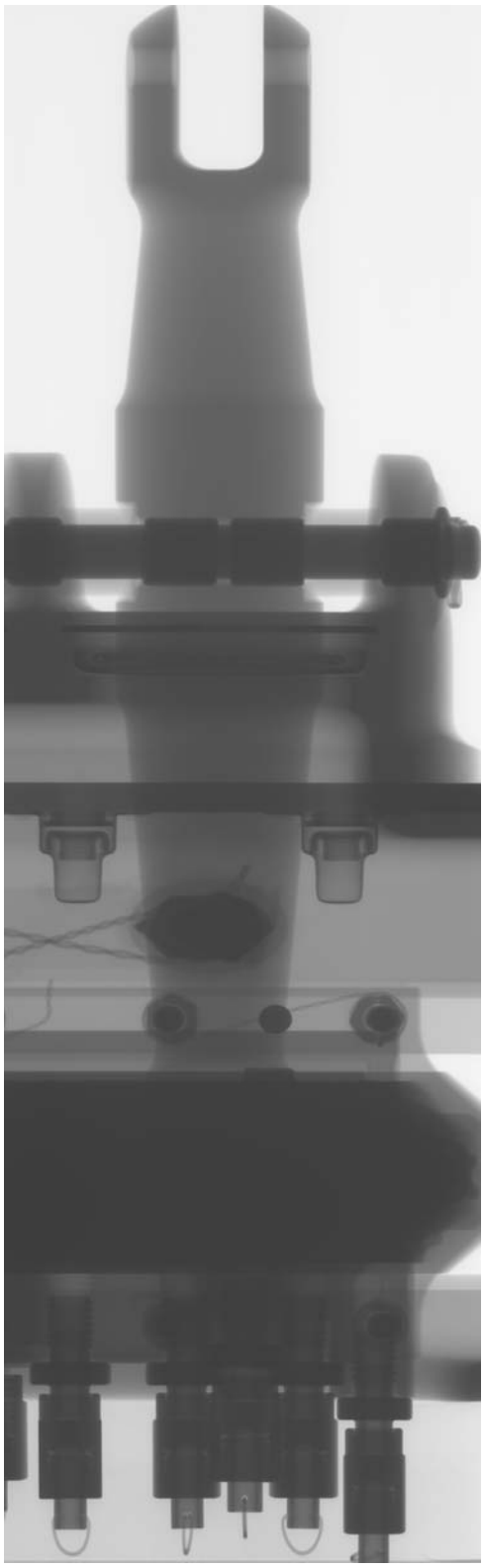

Figure 3
Digital Radiograph – Pivot pin and input rod, left system

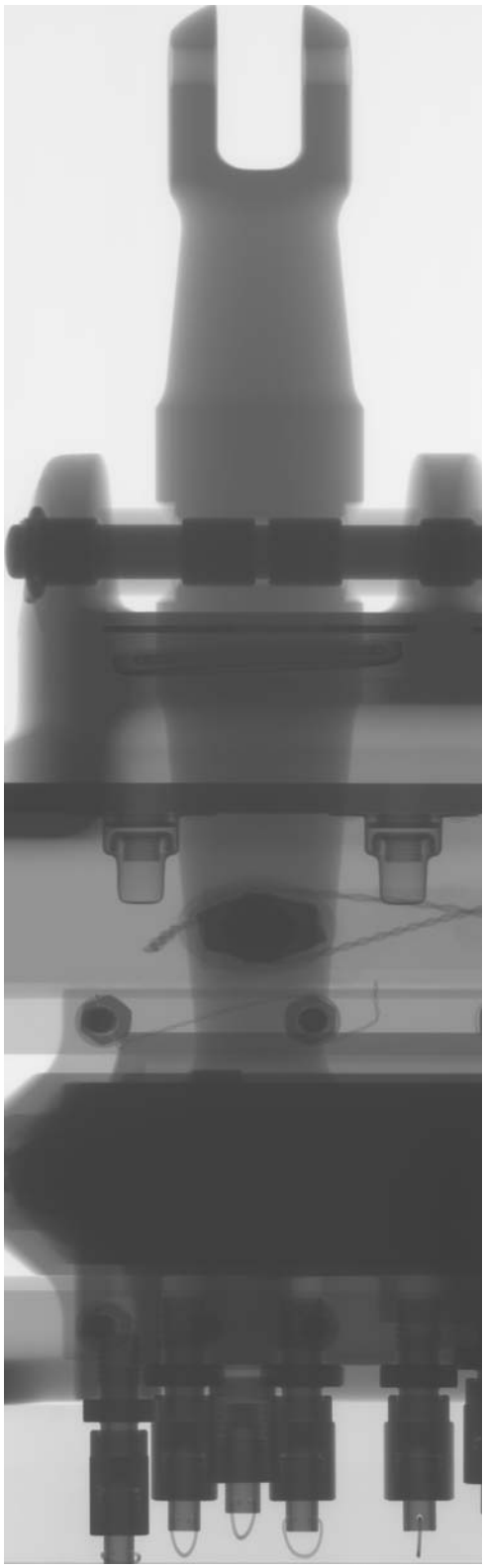

Figure 4
Digital Radiograph – Pivot pin and input rod, right system

3.0 Computed Tomography Results

The computed tomography (CT) results for the power brake valve are shown in figures 5 through 10. The internal dimensions of the internal components of each valve were noted as were the relative positions of those components within the valve.

When the pivot pin was examined, an artifact was noted that caused the pin to appear to be tapered on the ends when viewed in an axial slice (but not in the frontal slice images). This artifact, called long path beam starvation, resulted from the fact that when scanning this section of the part, the x-rays traveled down the full length of the pin during each rotation. In general, when there is not quite enough x-ray energy to fully penetrate a long object like the pivot pin, the ends of the object turn out to be very bright and sharp, and the middle of the object turns out to be darker, the edges get much less distinct, and the middle appears to expand. The reason it occurred in only the axial view was due to the fact that this view was how the actual image slices were being captured, so it had the artifact present. The frontal view of the pivot pin (without the distortion) was created by the software by stacking the axial slices on top of each other. Since each of these slices was the same thickness, there was no distortion as they were stacked on one another, and the pin looked square with no distortion.

Note that the brake systems associated with each valve are shown in figure 5, and they are the same for each image.

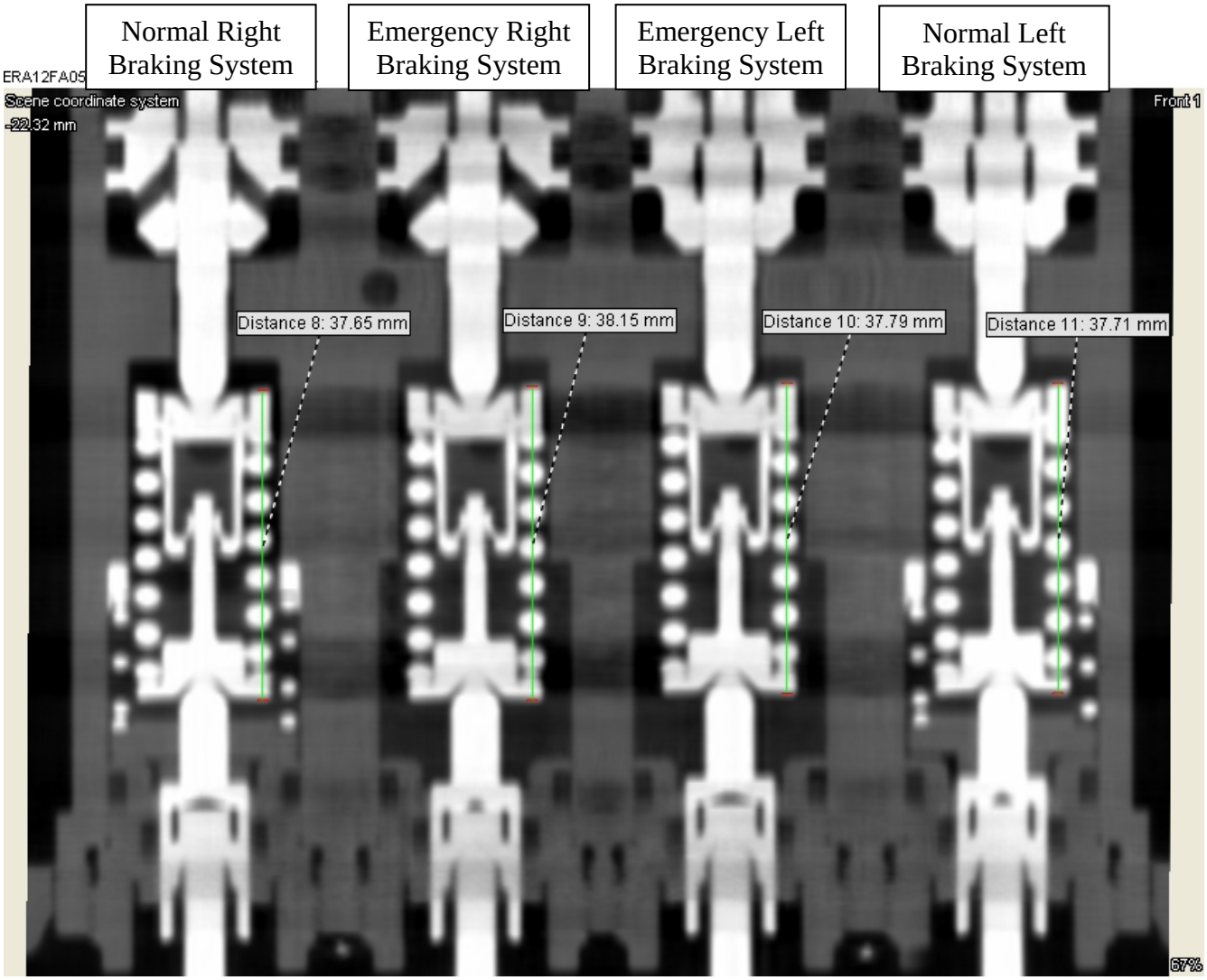

Figure 5
Frontal Cross Section – Power brake valve – Overall cross section showing all valves with measurements for spring lengths shown

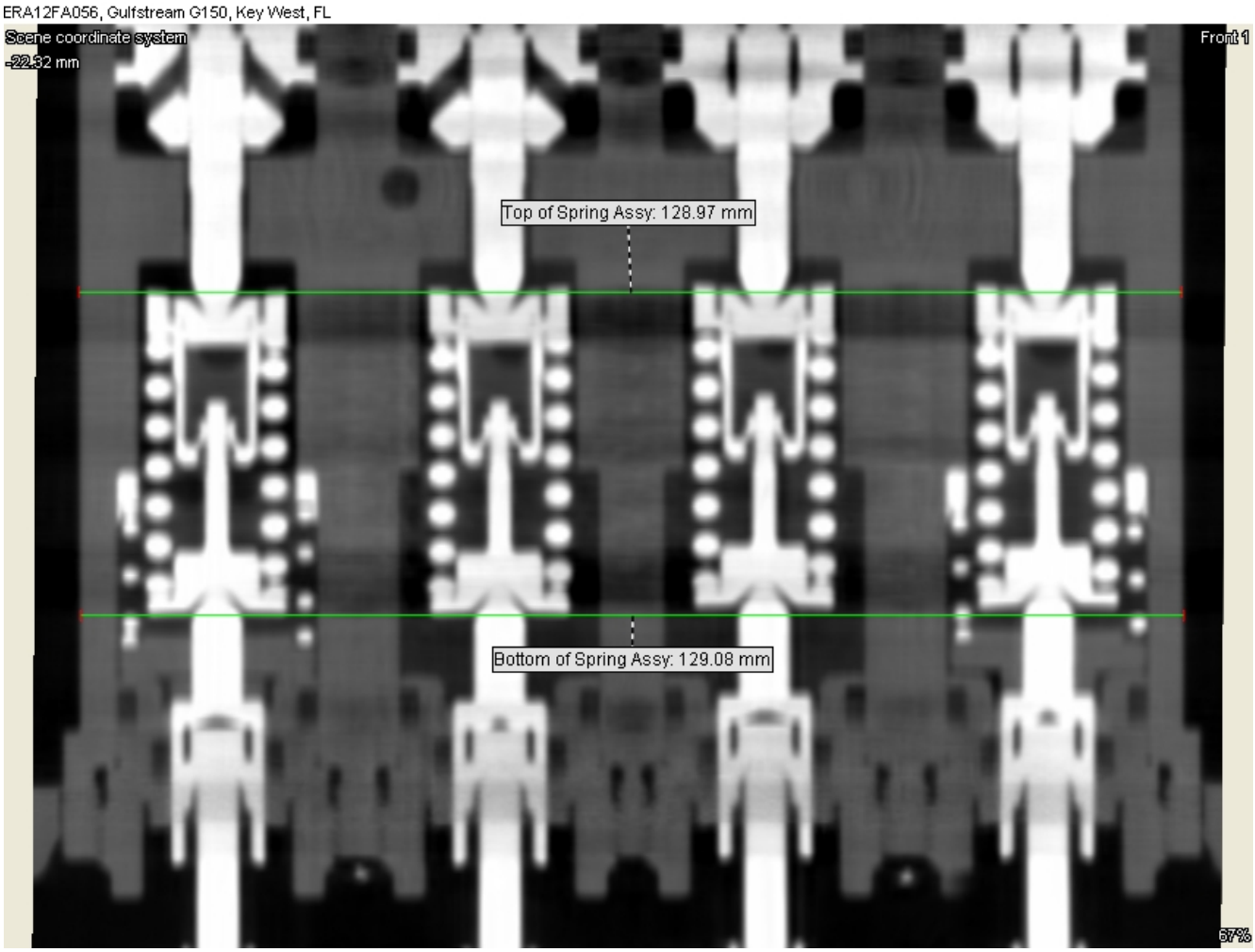

Figure 6
Frontal Cross Section – Power brake valve – Overall cross section showing all valves with comparison lines showing the relative positions of the top and bottom levels for the spring assemblies. (Note: Dimensions contained in the labels for each line are for the length of each green line only)

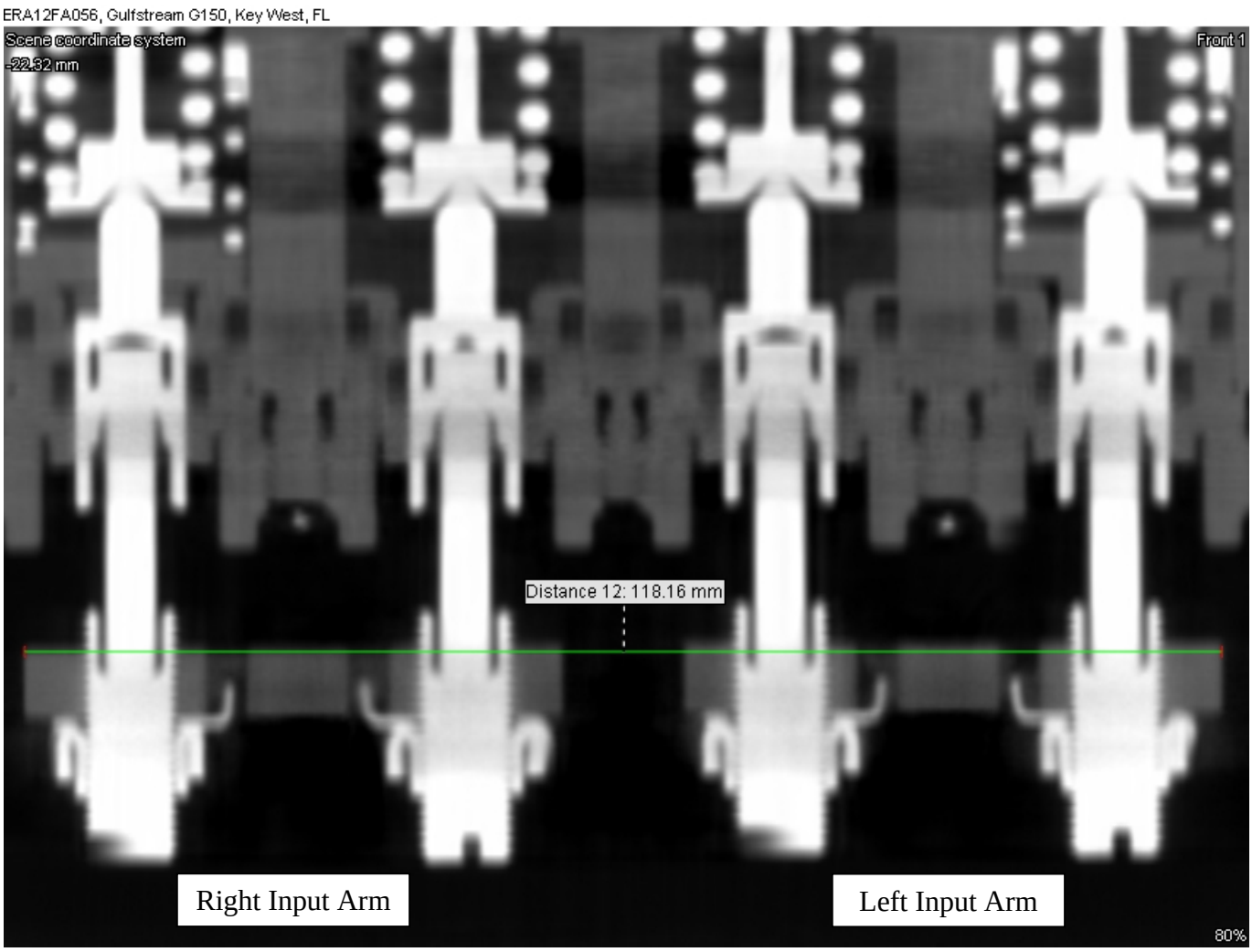

Figure 7
Frontal Cross Section – Power brake valve – Overall cross section showing input arm assemblies with a comparison line showing the relative positions of the left and right input arms. (Note: Dimension contained in the label for the line is for the length of the green line only)

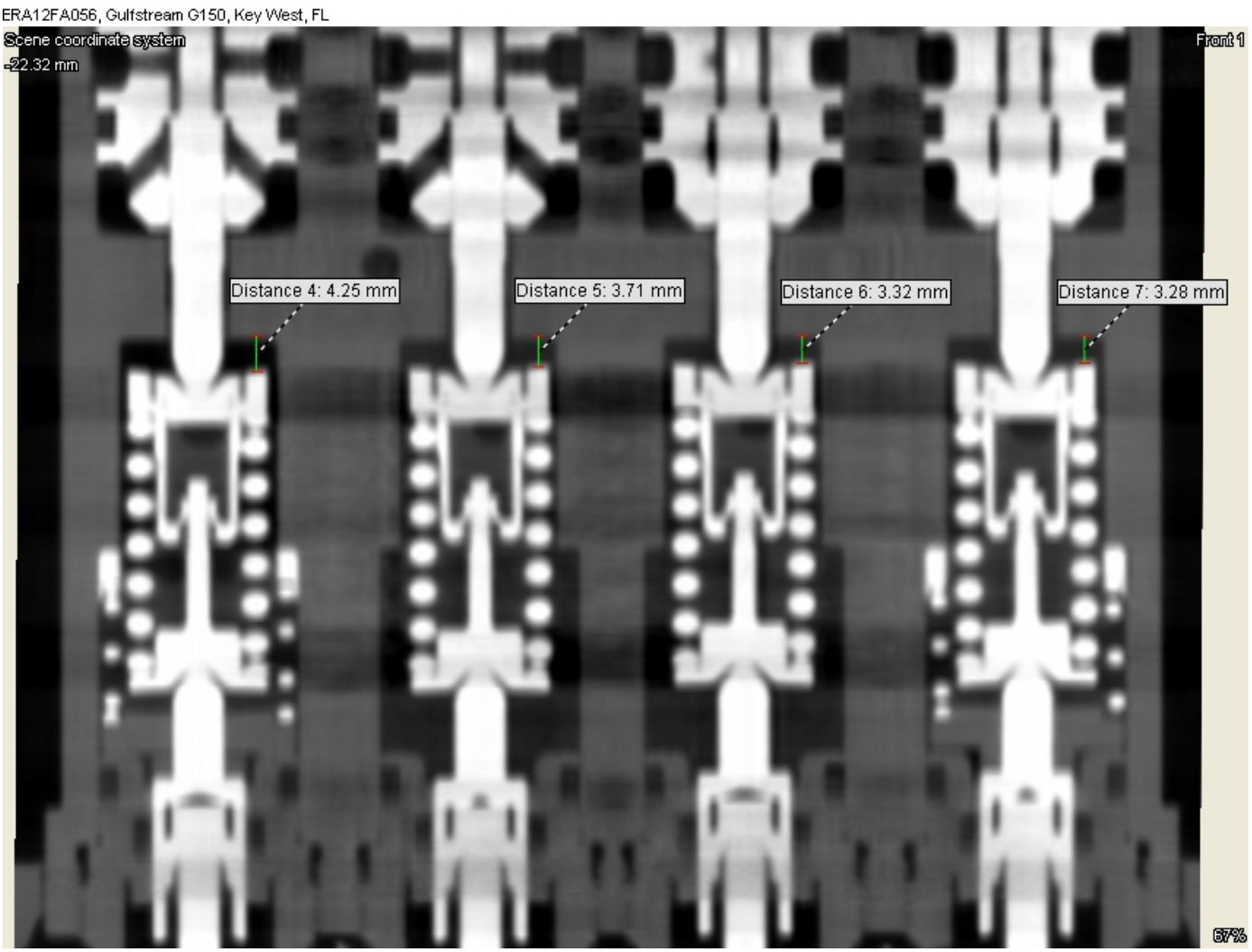

Figure 8
Frontal Cross Section – Power brake valve – Overall cross section showing all valves and the measurements for the clearance between the top of the spring assembly and the spring assembly cavity

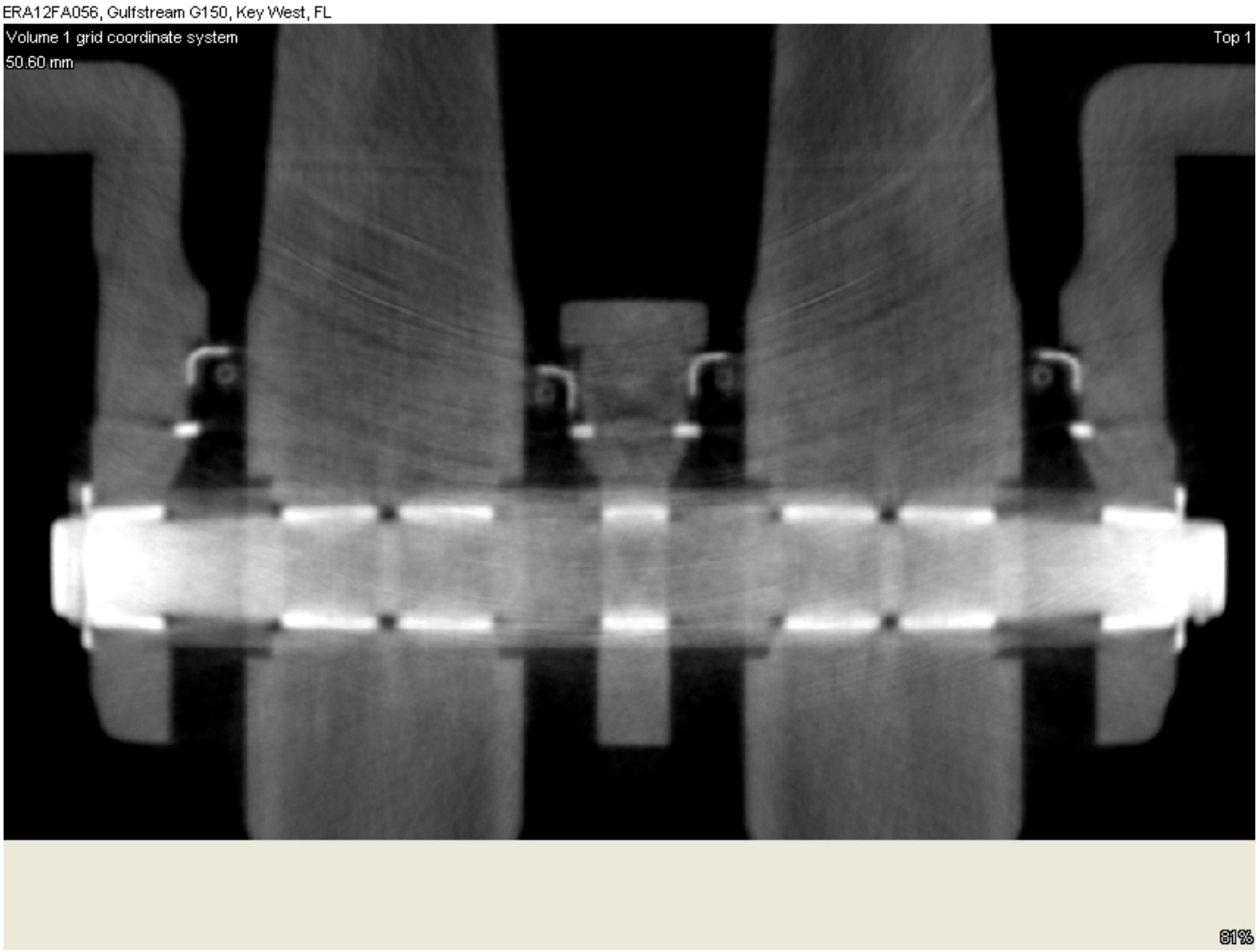

Figure 9
Axial Cross Section – Power brake valve – Pivot pin cross section showing apparent tapering of the pin at the ends

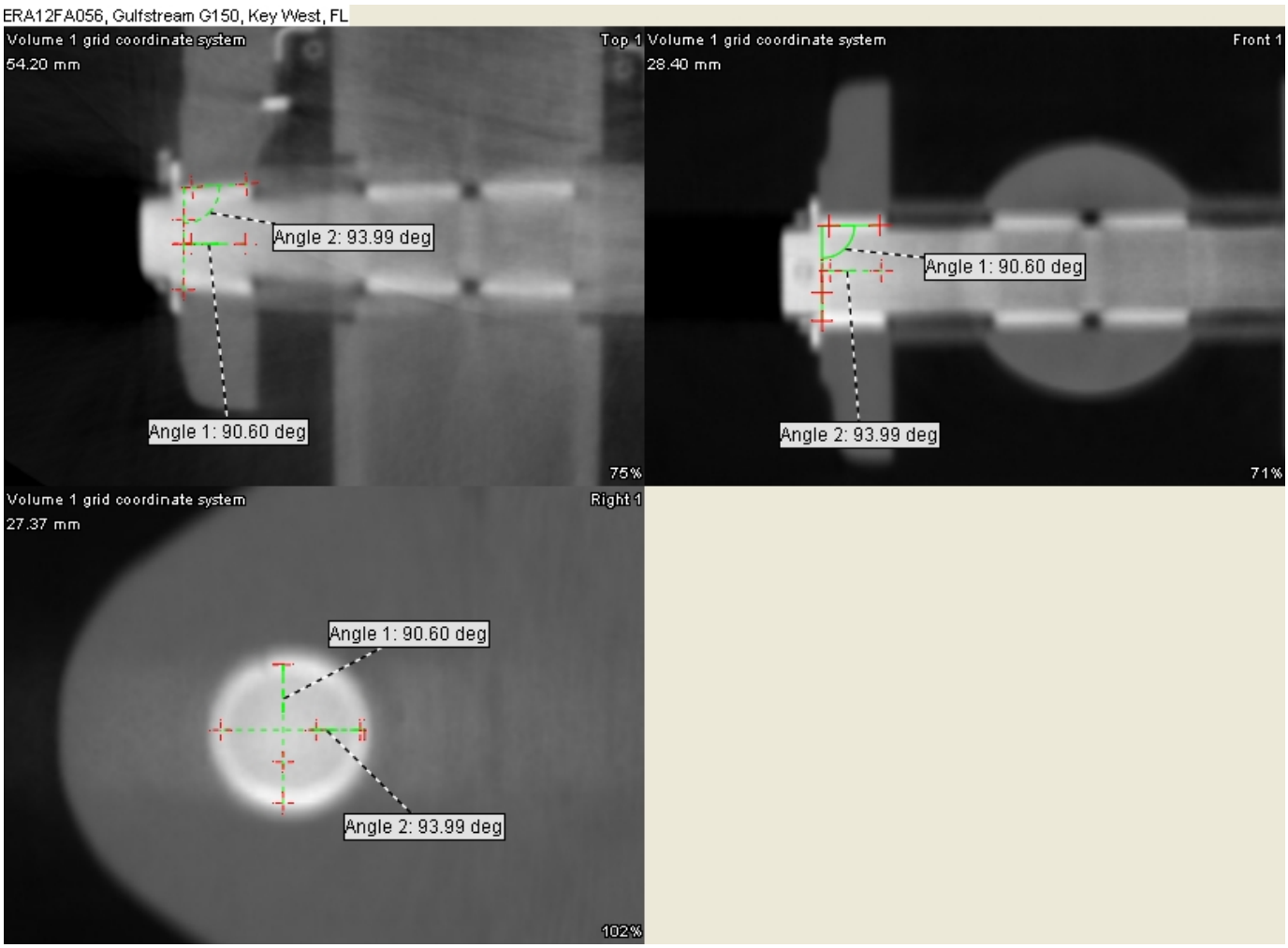

Figure 10
Multiple Cross Sections – Power brake valve – Pivot pin cross sections showing apparent tapering of the pin at the ends (upper left, axial cross section image) and showing no apparent tapering of the pin (upper right, frontal cross section image). The approximate angular dimensions of the pin geometry are shown in each image.

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