NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MSC APOLLO 13 INVESTIGATION TEAM

FINAL REPORT

PANEL 4

PHOTO HANDLING, PROCESSING, AND CATALOGUING

MAY 1970

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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MAY 18, 1970

JOHN R. BRINKMANN
Chairman

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MSC APOLLO 13 INVESTIGATION TEAM
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

REPLY TO ATTN OF: BL

May 18, 1970

MEMORANDUM TO: See list attached

FROM : BL/Chief, Photographic Technology Laboratory

SUBJECT : Panel #4 Final Report

Eleven rolls of Apollo 13 flight film arrived at the MSC Photographic Technology Laboratory (PTL) at 8:45 a.m. on April 19, 1970. While the film was being downloaded for processing, the radiation level was being checked by measuring the docimeter included in the film transportation box. Radiation level was less than .5 rads and considered satisfactory. There was no detectable effect of radiation on any of the processed film.

Priority processing proceeded on Magazine N (70mm. color film, type SO-368), Magazine R (70mm. black-and-white film, type 3400), and Magazine FF (16mm. color motion-picture film, type SO-368). These three magazines contained the only photography of the damaged service module in flight. The 70mm. color still photographs were shot by Astronaut Swigert using a Hasselblad camera with a 250mm. lens. Exposure was reported to be 1/250 second at f/8, but this exposure cannot be confirmed by the crew. The camera Swigert used was originally to be used in the command module but was taken to the lunar module by Swigert to photograph the damaged service module. The 70mm. black-and-white still photographs were shot by Astronaut Lovell using a Hasselblad camera with an 80mm. lens. Exposure was reported to be 1/250 second at f/8--again, unconfirmed by the crew. The 16mm. color motion-picture film was shot by Astronaut Haise using the data-acquisition camera with a 3-inch focal length lens. Exposure was reported to be 1/250 second at f/8 at a 12-frames-a-second rate. This exposure also was not confirmed by the crew.

The decision to use SO-368 color film and type 3400 black-and-white film to photograph the damaged service module in flight was made by a committee comprising Helmut Kuehnel (Missions Operations), James Peacock (Apollo System Engineer), John Brinkmann, Richard Underwood, and Mark Weinstein (PTL), and spacecraft designers.

The color SO-368 was selected because of the possibility of color stain on the service module which could help define the cause of the accident. The black-and-white type 3400 was chosen to give best resolution and latitude to record details and account for any exposure deviations.

When the film arrived at PTL, it was decided that the SO-368 would be processed normally so that correct color balance would be maintained. The SO-368 was processed first to determine spacecraft orientation, lighting, and validity of exposure used. Analysis showed that the color film had been slightly underexposed, and most of the critical areas were in shadow.

The black-and-white type 3400 film therefore was processed to gain as much film speed rating as possible to obtain maximum information available in the shadow areas. The process cycle selected produced the ultimate amount of shadow detail possible and yielded a high gamma product with a wide range of densities. With this high gamma original, the slower speed duplicating stock required a long exposure with low gamma processing employed to insure best shadow detail.

None of the resulting imagery was optimum with respect to sharpness or lighting. The lack of picture sharpness is attributed to the fact that the cameras were focused at approximately 100 feet by instruction from ground control and the actual distance of the service module was later estimated to be 269 meters for Magazine N and an average of 125 meters for Magazine R. With the longer focal length lenses on the color film cameras, the service module was apparently not within the acceptable limits of depth of field range. However, with the shorter focal length lens on the black-and-white film camera and the closer distance of the service module, the photography was more within the depth of field range and the images were fairly sharp.

The distance of the service module from the camera resulted in a very small image on all of the frames--both motion picture and still. The image on the 70mm. color frame was at a 1:1077 scale and on the 70mm. black-and-white frame averaged a 1:1500 scale. This meant that, in addition to lack of sharpness of focus, enlargement of the photographs resulted in image deterioration because of film grain structure.

Since image enhancement was obviously needed, 11 still photographs were selected from Magazines N and R for enhancement attempts. The 11 frames comprised frames 8462 and 8464 from Magazine N and frames 8500, 8501, 8510, 8511, 8512, 8513, 8530, 8531, and 8534 from Magazine R. Visual examination was made of the Magazine FF 16mm. color motion-picture film, and a determination was made to concentrate on still picture enhancement only since the motion-picture film had no additional information in it.

Further study resulted in the selection of two color 70mm. frames from Magazine N (frames 8462 and 8464) and two black-and-white 70mm. frames from Magazine R (frames 8500 and 8501) for concentrated enhancement attempts. The two black-and-white frames were usable as a stereo pair when properly oriented.

In addition to immediate in-house enhancement attempts, the two 70mm. black-and-white frames were reproduced to the best possible masters; and sets were sent for additional enhancement work to Data Corporation in Dayton, Ohio, McDonnell Douglas Astronautics in Huntington Beach, California, Jet Propulsion Laboratory in Pasadena, California, and LogEtronics, Incorporated, in Springfield, Virginia.

The two color frames from Magazine N were studied in-house on optical instruments only because what little information there was beyond that already available on the black-and-white frames could not be reproduced.

The final results of all enhancement attempts have been received at MSC. All efforts to date, both in-house and out of house, have reached approximately the same level of enhancement; and all products have been shown to Board and Panel members for their evaluation and judgment.

The Photographic Analysis Group of Panel 1 reports that, considering the marginal characteristics of the original photography, the blowups are quite remarkable. The processing produced, on hardcopy, photographic information which previously could only be viewed on a transparency through a magnifier. However, obtaining this information required mentally combining the presentations of each of the three color layers. The process, of course, cannot duplicate the color acuity and flexibility of focus of the eye.

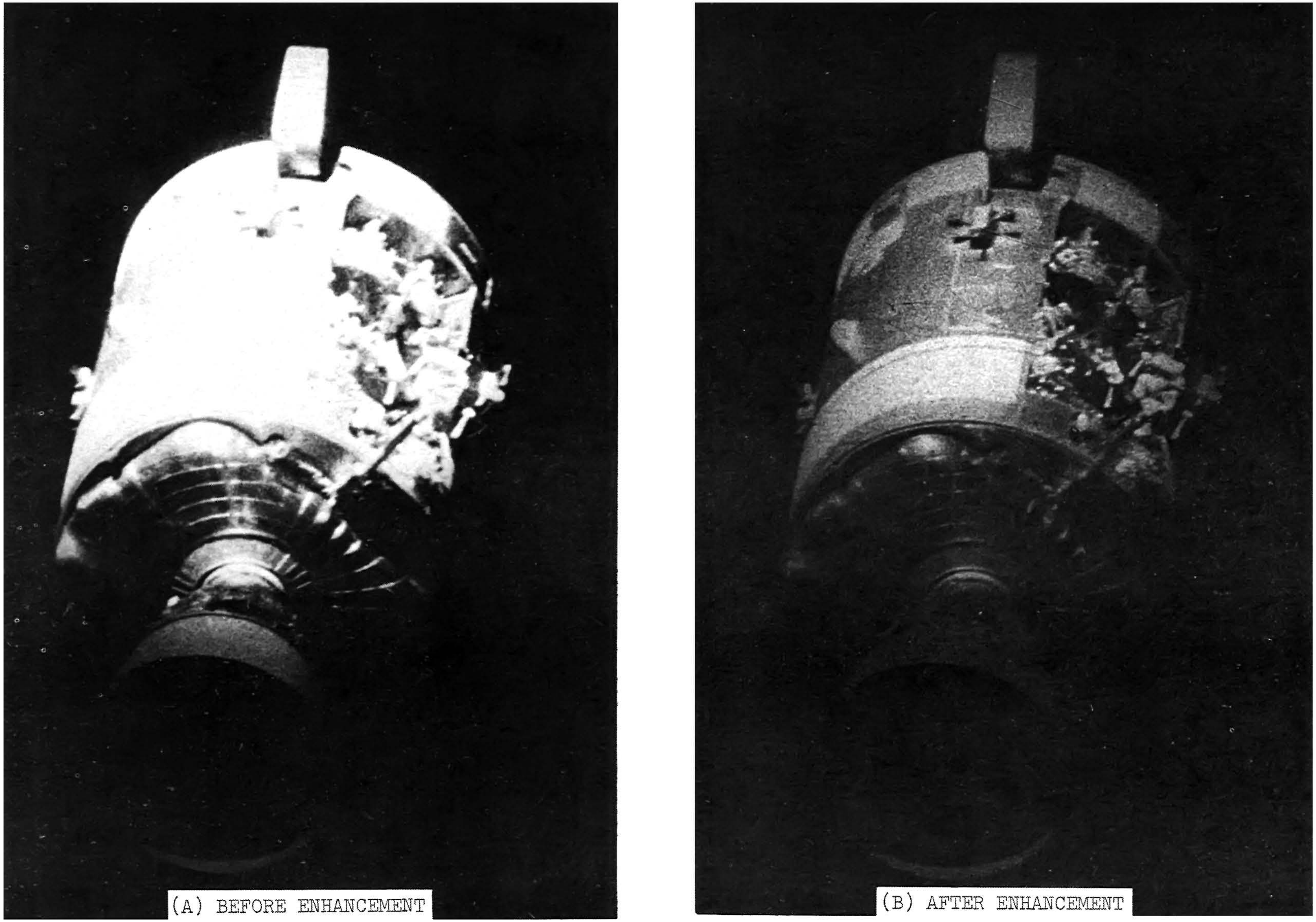
Additional information on exterior placement of the loosened mylar was more evident in the blue layer prints, more contrast in the red layer, and more interior definition with the green layer when compared with the blue and red. The processing did not provide a clear image of the #2 oxygen tank.

Photographs are attached showing the result of image enhancement attempts and the service module mockup photographed with lighting duplicating in-flight condition.

John R. Brinkmann

Enclosures 2

BL6:AMSea:bjb 5-18-70

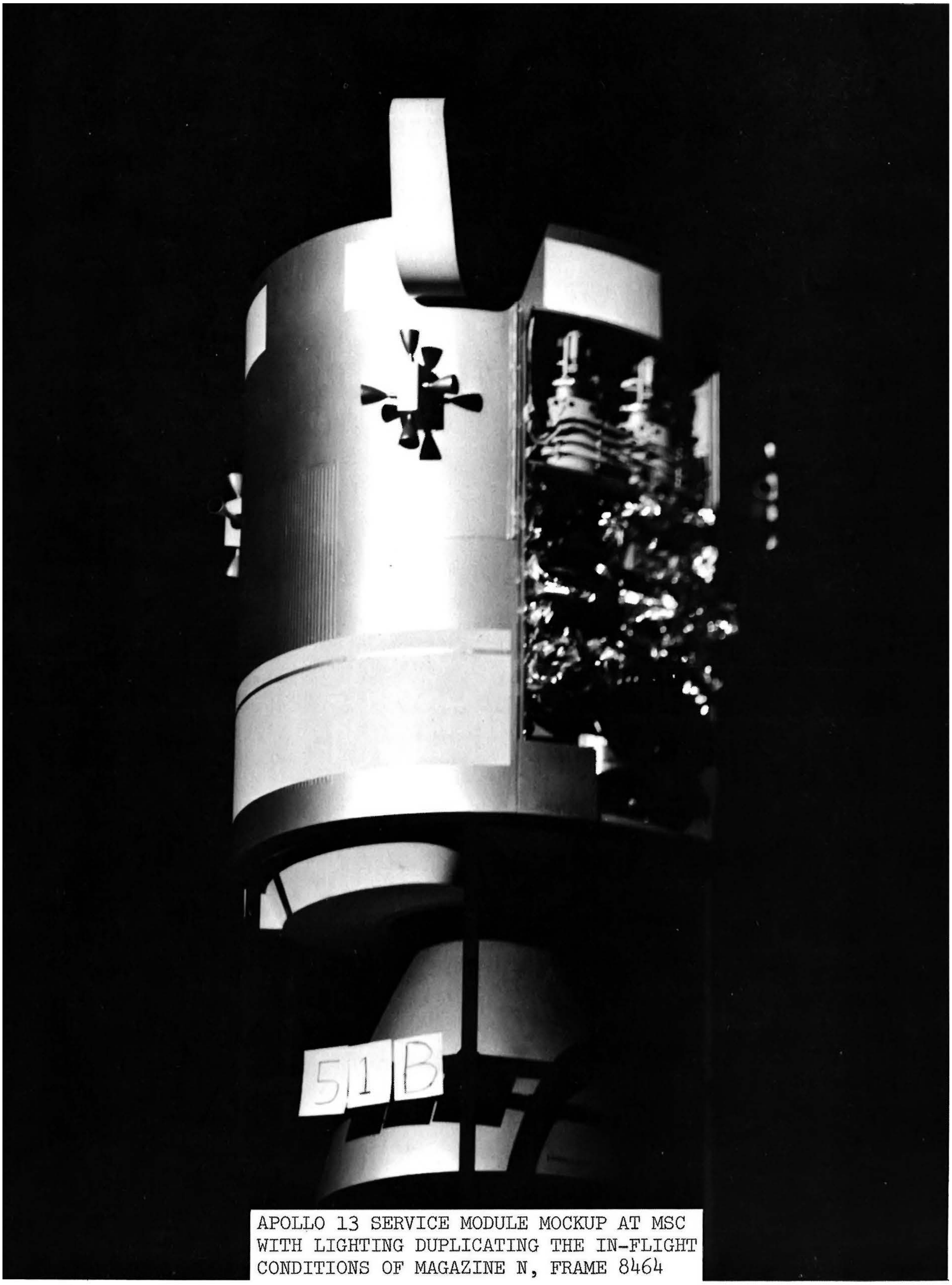


(A) BEFORE ENHANCEMENT

(B) AFTER ENHANCEMENT

APOLLO 13 SERVICE MODULE PHOTOGRAPH
(MAGAZINE R, FRAME 8500)

APOLLO 13 SERVICE MODULE INFLIGHT,
MAGAZINE N, FRAME 8464



APOLLO 13 SERVICE MODULE MOCKUP AT MSC
WITH LIGHTING DUPLICATING THE IN-FLIGHT
CONDITIONS OF MAGAZINE N, FRAME 8464

APOLLO 13 INVESTIGATION TEAM

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