AMCHITKA BIOENVIRONMENTAL PROGRAM
AERIAL AND GROUND-TRUTH PHOTOGRAPHY FOR ENVIRONMENTAL
SURVEILLANCE OF AMCHITKA ISLAND, ALASKA

ANNUAL PROGRESS REPORT

July 1, 1970 - June 30, 1971

by

Joachim G. Stephan

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

May, 1972

Prepared for the U. S. Atomic Energy Commission
under Contract No. AT(26-1)-171

BATTELLE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	1
BACKGROUND	1
PREVIOUS EFFORTS	2
TASK SCOPE FOR FY-71	3
Additional Photography	3
EQUIPMENT	3
PHOTOGRAPHIC SURVEYS	6
Sea Otter Surveys	6
Milrow Postevent and Cannikin Preevent Surveys	7
Additional Photography	7
RESULTS	8
Sea Otter Surveys	8
Milrow Postsurvey and Cannikin Preevent Photography	10
CONCLUSIONS AND RECOMMENDATIONS	15
REFERENCES	16

APPENDIX

INVENTORY OF AERIAL AND TERRESTRIAL PHOTOGRAPHY AMCHITKA ISLAND, OCTOBER, 1970	A-1
---	-----

LIST OF FIGURES

	<u>Page</u>
Figure 1. Milrow and Cannikin SZ Areas Covered by 70 mm Format, Color and IR Color Photography	4
Figure 2. Flight Path During Oblique Infrared Color Photography of Cliffides and Sea Stacks	4
Figure 3. Photographic Coverage by 240 mm Format, Black and White Photography, and Oblique Color Photography.	4
Figure 4. Multispectral Camera Mounting Configuration	5
Figure 5. Approximate Flight Path During October 1970 Census in Which 2, 773 Sea Otter were Counted	9
Figure 6. Milrow SZ Area with Heart Lake and Upper and Lower Twin Lake, October 1970	11
Figure 7. Milrow SZ Area with Heart Lake and Lower Twin Lake, October 1969 (D+13)	12
Figure 8. Milrow SZ Area with Upper and Lower Twin Lake, October 1969 (D+13)	13
Figure 9. Cannikin SZ Area, October 1970	14

AERIAL AND GROUND-TRUTH PHOTOGRAPHY FOR ENVIRONMENTAL SURVEILLANCE OF AMCHITKA ISLAND, ALASKA

by

Joachim G. Stephan

ABSTRACT

A photographic aerial survey was conducted over the site of the underground nuclear test Milrow (October, 1969) to record potential long-term changes to the bioenvironment. An aerial survey was also made over the Cannikin test site to document preshot bioenvironmental conditions. Color, infrared color, and black and white films were used to record an area up to 80 square kilometers. Multispectral photography was taken over selected areas to test its applicability to the bioenvironmental program.

Three photographic sea otter surveys were conducted in the nearshore waters off Amchitka Island, but sea otters were counted in only one. Adjusting the count for this one survey so that the estimated number will be comparable to previous annual estimates gives an estimate of 3300 sea otters during October, 1970, an increase of 500 sea otters since 1969 and an increase of about 130 over the 1968 estimate.

Because the principal investigators for marine ecology, freshwater ecology, plant ecology, limnology, geomorphology, avian ecology, and other studies plan to report the results of photointerpretations in their fields, this report does not contain a comprehensive analysis of the photographs.

BACKGROUND

Battelle's Columbus Laboratories (BCL), under contract with the United States Atomic Energy Commission, Nevada Operations Office (USAEC-NVOO), is conducting a bioenvironmental research program on Amchitka Island, Alaska. Amchitka Island is part of the Rat Island Group and is located some 2,200 km from Anchorage, Alaska. Amchitka was selected as the site for certain underground nuclear tests. Two such tests have already taken place - Project Longshot (1965) and Milrow (1969). Since 1967 BCL has been involved in a series of bioenvironmental studies to predict, evaluate, and document the effects of nuclear tests on the biota and the environment.

Since inception of the program, scores of scientists, including marine ecologists, freshwater ecologists, plant ecologists, limnologists, geomorphologists, avian ecologists, and others, have participated in the various research activities. To aid many of these activities, BCL provided a program of photographic surveillance. This report describes those photogrammetric tasks conducted on Amchitka Island during FY71 in support of BCL's Amchitka Bioenvironmental Program.

PREVIOUS EFFORTS

Conditions for aerial photography on Amchitka Island are rarely ideal. Smith (1968) describes the western Aleutian chain in which Amchitka is located as having at most one day per month favorable for aerial photography. Most of the time Amchitka weather is characterized by overcast skies, fog, and rain. Therefore, it was necessary to develop reliable photogrammetric techniques for marginal weather conditions.

The initial task was to determine which film emulsions worked best in the Amchitka environment. Four types of films were tested in May, 1969 - Panchromatic, infrared black and white, color, and infrared color. Tests were sometimes conducted in drizzly to moderate rain. It was quickly determined that infrared color film depicts Amchitka terrain features better than the other films. Infrared color film is also superior in detecting and identifying Amchitka's marine mammals, especially the valuable sea otter which abounds in the Island's nearshore waters (Stephan, 1968, 1969).

Color and black and white film were also used on Amchitka. However, the rather monotone landscape and nearshore environment required that these films be used in conjunction with infrared color film. Infrared color film is sensitive in the near-infrared range of the electromagnetic spectrum (3500-9000 Å). When properly exposed and processed, the film depicts healthy vegetation in hues of pink to bright red, diseased or dying foliage appears brown. Color film was used to record vegetation as it appears to the natural eye and to record fresh rock falls along the Amchitka shoreline. Infrared color film and color photographs, usually taken from an oblique angle, covered a maximum amount of terrain with a minimum number of photographs. Oblique photography also provided most principal investigators with a natural view that required minimum interpretation on their part. Vertical, panchromatic photographs provide certain principal investigators with economical large-scale photography. Since it overlapped 60 percent from photograph to photograph, it could be viewed stereographically.

The second task was to determine the most likely mission profiles to be flown during the various types of photographic missions. For best results, typical sea otter census missions called for altitudes between 30 to 100 m, because sea otter surveys were typically conducted with overcast skies, some drizzly to moderate rain and zero to moderate wind action. Typical cloud ceilings during "good" days on Amchitka are at 300 to 400 m; therefore, all photo flights for recording the terrain were planned accordingly.

The third task was to determine the type of cameras to be used during photo flights. The Fairchild K-17 camera with 152 and 304-mm focal lengths was chosen. Cameras were carried on a special mount on the outside of an S-55 Sikorsky helicopter. This configuration, successfully tested in July, 1969, was applied in a number of photo flights prior to and after Milrow (September/October, 1969).

The primary purpose of the FY 1970 photography was to (1) provide a sea otter census of Amchitka and (2) record the Amchitka environment in a 3-1/2 to 8 km radius of Milrow SZ, prior to and after the test. The successful completion of that effort is described by Stephan (1971, 1972).

Additional Milrow postsurvey photography and preevent Cannikin photography were obtained during FY 1971 as described in the following sections.

TASK SCOPE FOR FY-71

Specifically requested photogrammetric tasks were conducted on Amchitka during FY 71 as follows:

- (1) A sea otter census using already developed aerial photographic techniques to produce a total population estimate.
- (2) Large-scale photography of the area within a 1600-m radius of Milrow SZ to provide posttest documentation (Figure 1).
- (3) Large-scale photography of the area within a 3200-m radius of Cannikin SZ to provide pretest documentation (Figure 1).
- (4) Large-scale, oblique photography along the Bering Sea coastline from Cyril Cove to Sea Otter Point, and along the Pacific coast from Rifle Range Point to Mex Island to provide pretest documentation (Figure 2).

Additional Photography

In conjunction with the specifically requested photography over the described areas, additional photographs were taken, some for experimental purposes, others to assure that principal investigators would have available, if desired, coverage in areas beyond the immediate Milrow and Cannikin test sites.

- (1) Panchromatic vertical photography of the terrain bounded by Kirilof Point, Sea Otter Point, Mex Island, and St. Makarius Point (Figure 3).
- (2) Oblique color photography of the same area (Figure 3).
- (3) Ground-truth (terrestrial) photography near Milrow SZ and Cannikin SZ.
- (4) Multispectral imagery over a test strip of lakes, terrain, and beach features.
- (5) Photography of selected test lakes with a special experimental minus-blue film emulsion supplied no charge by GAF Corporation to determine its capability to penetrate water.

EQUIPMENT

One of three photographic sensors used during aerial surveys was the 70-mm format Hasselblad camera. During vertical photography four Hasselblad cameras were mounted in a special configuration typically used for multispectral photography (Figure 4a). The cameras were aligned so that all four, simultaneously triggered by a master switch, photographed the same terrain. The cameras were equipped with 100-mm Zeiss Planar or 50-mm Zeiss Distagon lenses.

FIGURE 1. MILROW AND CANNIKIN SZ AREAS COVERED BY 70 MM FORMAT, COLOR AND IR COLOR PHOTOGRAPHY

FIGURE 2. FLIGHT PATH DURING OBLIQUE INFRARED COLOR PHOTOGRAPHY OF CLIFFSIDES AND SEA STACKS

FIGURE 3. PHOTOGRAPHIC COVERAGE BY 240 MM FORMAT, BLACK AND WHITE PHOTOGRAPHY, AND OBLIQUE COLOR PHOTOGRAPHY

a. Closeup of Camera Configuration

b. Fastened to HE-1100 Helicopter

FIGURE 4 MULTISPECTRAL CAMERA MOUNTING CONFIGURATION

During oblique photography one or two cameras were hand-held in a handle-bar grip. The photographic platform was an HE-1100 helicopter that, unlike the S-55 Sikorsky craft used during 1969 photo missions, proved to be very undesirable for photo missions (Figure 4b). Severe vibrations were common, making aiming with hand-held cameras difficult. Photography from the cockpit had to be performed through the plexiglass, which, though immaculately clean, caused image reflections, loss of resolution, and a change in the color balance of the infrared color film.

For black-and-white photography, a standard cartographic camera was used - the Fairchild K-17 with 152-mm focal length.

PHOTOGRAPHIC SURVEYS

Photographic surveys were flown between October 5 and 13. Photographic conditions as affected by the weather varied from fair to marginal.

Sea Otter Surveys

Surveys were conducted on October 7, 8, and 11. The first survey was conducted with dual Hasselblad cameras, one with a 50-mm lens, the other with a 250-mm lens. This arrangement was chosen to photograph a wide portion of the nearshore area ahead of the helicopter while simultaneously obtaining closeup photographs of groups of sea otter. The use of the 250-mm lens had to be abandoned almost immediately because the helicopter had a virtually continuous up-and-down motion. The survey was finished by using the 50-mm camera exclusively. Severe squalls experienced near the north end of the Island made continuous photography around the Island impossible.

The second survey was conducted in weather which ranged from overcast to sunny with brisk winds rippling the surface of the ocean on the Pacific Ocean side. Photography was taken continuously ahead of the helicopter all around the Island out 3 to 5 km seaward from the shore.

The third survey was conducted with a dual-camera arrangement. Hasselblad cameras, one with a 100-mm focal length lens and a second with a 50-mm lens, were mounted on a common handle-bar. This was done to obtain a wide photographic swath, and to simultaneously result in closeup photography of sea otter groups. The camera optical axes were then so inclined toward each other that they intersected at a point 100 m ahead of the flying aircraft. The result was multiscale stereophotography that the BCL-stationed Richardson Interpretation Module readily accommodates. Stereophotographs were expected to increase the photointerpreters' identification and detection capability of the sea otter.

A cassette tape recorder was used to record conditions en route and to report where photographs of sea otter were taken. Photographic surveys lasted from 2-1/2 to 3 hours; the aircraft traveled typically at speeds of 100 to 130 km per hour. Each flight was uninterrupted; the cameras were reloaded in flight by an accompanying technician.

Milrow Postevent and Cannikin Preevent Surveys

The multispectral four-Hasselblad-camera arrangement was used for vertical photography of the Milrow and Cannikin test-site areas on October 6. The camera configuration was as follows:

- Camera 1: Lens type - 100-mm Planar
Film: Infrared color film (Kodak Ektachrome
Infrared SO 117)
Filter: Kodak No. 12 filter (yellow)
- Camera 2: Lens type - 50-mm Distagon
Film: Color (Kodak Ektachrome ER, Type 5257)
Filter: Haze
- Camera 3: Lens type - 100-mm Planar
Film: Panchromatic (Kodak Plus-X)
Filter: Kodak No. 25 (red)
- Camera 4: Lens type - 100-mm Planar
Film: Panchromatic (Kodak Plus-X)
Filter: Kodak No. 58 (green)

A fifth camera with 100-mm focal length lens was used to photograph obliquely out to the side and ahead of the aircraft with color film.

Vertical photographs were taken at an altitude of 920 m. Each vertical infrared and panchromatic photograph covered a ground area of 500 x 500 m. Each vertical color photograph covered a ground area of 1,000 x 1,000 m.

Oblique color and infrared color photographs were taken between Kirilof Point and Sea Otter Point on the Bering coast and St. Makarius Point and Mex Island on the Pacific coast. This was done with hand-held cameras at altitudes of 300 and 900 m.

Additional Photography

To provide photo coverage of terrain conditions in the area bounded by Kirilof Point, Sea Otter Point, Mex Island, and St. Makarius Point, vertical black-and-white photographs were taken from 920 m with a K-17 cartographic camera ($f = 152$ mm). Simultaneously, oblique photos were taken with handheld Hasselblad 70-mm cameras and color film. Approximately 4-1/2 passes were made to cover an area of roughly 75-80 square km.

An experimental flight was also made with the multispectral camera over a series of test lakes as required by freshwater ecologists to determine the applicability of certain film emulsions to water penetration. During these photo runs, photographs were also taken with the experimental film supplied by GAF Corporation. The film, which requires no minus-blue filter, has an ASA of 1,000.

Ground-truth photographs were taken with color film. A 70-mm camera was used to photograph vegetation types in the Cannikin test-site area. Vegetation plots were

photographed by pointing the camera vertically to the ground, then obliquely at the same spot, and then another high-oblique photo was taken of the surrounding area to orient the viewer in the terrain.

RESULTS

All photography was processed by the photographic facility of Pan American Airways at Jackass Flats, Nevada. An index of the photography has been provided in the Appendix of this report. All color and infrared color films were developed to positive transparencies. Prints were made from panchromatic photography only. The photography has been used for Cannikin preevent prediction by principal investigators of the bioenvironmental program.

Sea Otter Surveys

The second sea otter survey taken on October 8, 1970, resulted in almost continuous photo coverage around the Island. This photography was used for a count. On eight rolls of 70-mm infrared color film, 2,773 sea otter were counted (Figure 5). Applying the techniques of Spencer (1969) (he assumes that during the best count only 85 percent of all animals are observed), the estimated number of sea otter observed in October, 1970, was 3,300 (this figure included 30 sea otter which were missed by the camera man during reloading of the cameras). The figure represents an increase of some 500 sea otter over the estimated number in 1969 (2,800, September, 1969) (Stephan, 1971) and 130 more than the estimated number in 1968 (3,170, August/September, 1968) (Spencer, 1969).

The 70-mm photography taken in October, 1970, was quite inferior in resolution and color balance to the 240-mm photography taken the previous year during the sea otter surveys. Thus, the advantages gained through a more economic film format and a much smaller and lighter camera system were considerably offset by the difficulty in making a photographic count. In 1969, photography taken with the 240-mm format, sea otter are identifiable by a layman with little training; 70-mm photography taken in 1970 must be analyzed by an interpreter who is very familiar with photointerpretation and sea otter census work on Amchitka. The advantage of having a helicopter from which the camera can be pointed ahead is unquestionable. Only 30 otter were visually counted; all others were recorded on the film. (The previous year, the available helicopter required aiming of the cameras out of a side door, thus calling for an extra visual observer who sat beside the pilot during flight.)

The survey determined a marked decrease of sea otter at points where large concentration in pods had been observed previously. The nearshore area of East Cape, once teaming with pods of floating and feeding sea otter, were almost devoid of otter. However, many more sea otter were at the north end of Amchitka than were observed there in 1969.

Photographing sea otter against a coastal background enables relating their location within at least 100 m of their actual location at the time of photographic exposure.

FIGURE 5. APPROXIMATE FLIGHT PATH DURING OCTOBER 1970 CENSUS IN WHICH 2,773 SEA OTTER WERE COUNTED

Milrow Postsurvey and Cannikin Preevent Photography

Average photographic scales for the vertical photography are as follows:

IR color	1:9200
Color	1:18,400
B&W (70 mm)	1:9200
B&W (240 mm)	1:6000

Photographic scales taken obliquely vary, of course, over the entire picture format, and depend on the angle of photography, focal length, and altitude at the time of exposure.

A brief comparison of photography obtained in October 1969 (post Milrow) and the photography taken in October 1970 reveals little changes in the terrain of the Milrow sites. Figure 6 is a vertical photograph of the Milrow GZ area taken in October 1970 from an altitude of 900 m. It shows the two lakes which underwent the most dramatic changes after Milrow: Heart Lake (nearest to SZ) and Lower Twin Lake. Figures 7 and 8 show the same area as it was photographed in October 15, 1969, from an altitude of 600 m. The 1969 photography shows that Heat Lake near Milrow SZ contained 40 percent of the water on D+13 that it had pretest. A crack 180 m long now cuts through its lower lobe. Lower Twin Lake, 360 m from SZ, contained only 30 percent of its former water content. Comparison of the photography reveals very little, if any, additional change in these or adjacent terrain features. The sharp break in the crack surfaces has weathered somewhat (the highest vertical displacement along the crack interface being 1.2 m).

Figure 9 is a vertical photograph taken at 900 m over the Cannikin test site. It shows that operational activities resulted in a displacement of 11.5 hectares (28 acres) of vegetational cover at the immediate Cannikin test site versus 5.9 hectares (14.5 acres) at the immediate Milrow test site.

Oblique photographs of the cliffsides and sea stacks show that fresh rock falls photographed after the 1969 test have weathered over. These rockfalls had been quite apparent by the bright yellow-to-orange color of the rock. Now, they can no longer be distinguished from earlier rock falls. Tundra and soil slides have also weathered over. The cliffside photography resolves objects roughly the size of a man's fist. It has been used satisfactorily by geologists on the program for post-Milrow and pre-Cannikin analysis.

The usage of the multispectral photography taken over Amchitka has not proved its worth on this program. However, the color and IR color photos have been used to identify vegetational zones, lake features, hydrological pattern, and for other uses. Ideally, multispectral photography is viewed on special viewers that permit enhancement and discrimination of a particular terrain feature or change thereof. Such viewers had not been available until March, 1971, when the first "on-the-shelf" model was displayed at the annual meeting of the American Society for Photogrammetry (ASP) in Washington, D. C. As they have not been available on the Bioenvironmental Safety Program, an intensive analysis or evaluation of such multispectral imagery was precluded.

FIGURE 6. MILROW SZ AREA WITH HEART LAKE AND UPPER AND LOWER TWIN LAKE, OCTOBER, 1970 (Scale 1:6000 Average Scale 1:5800)

FIGURE 7. MILROW SZ AREA WITH HEART LAKE AND LOWER TWIN LAKE,
OCTOBER, 1969 (D+13) (Scale 1:4000)

FIGURE 8. MILROW SZ AREA WITH UPPER AND LOWER TWIN LAKE,
OCTOBER, 1969 (D+13) (Scale 1:4000)

FIGURE 9. CANNIKIN SZ AREA, OCTOBER 1970 (Scale 1:6000)

The photography taken with the special Anscochrome (GAF) film with an ASA rating of 1000 and without a blue emulsion layer, is helpful in photographically penetrating water. Features on the bottom of lakes 0.3 to 1 m deep can be identified. The disadvantage of the film is that it renders all features in rather monotone colors. The film could be used in conjunction with standard color film during future surveys.

The ground-survey photography is of excellent quality and will be helpful in determining plant species. This photography may be used in conjunction with aerial photography to (1) identify the type of vegetation in the selected test plots, and (2) determine their presence and extent of the vegetation in the test areas.

CONCLUSIONS AND RECOMMENDATIONS

The primary motive for the extensive use of 70-mm photography during FY 71 was economy, the ease of handling a light-weight camera, and use of a multispectral camera configuration which is highly in vogue today for environmental-surveillance purposes. Such photography is very desirable to a photointerpreter. However, within the Bioenvironmental Safety Program, it has become apparent that most principal investigators desire photography that shows greater detail than is possible to obtain with 70-mm photography. No single mode of photography is suitable to meet the diverse requirement of all the principal investigators; some prefer only oblique photography, others only vertical photography, and most prefer resolutions such that features recognized on the ground are just as recognizable on the photograph, with a minimum of interpreting. For example, researchers on the program want to identify plant species, determine the presence of plants under the surface of the water, count and identify dead floating fish near the surface of the water, study caving of stream banks, map near-shore algae, etc.

These needs are best met by the large-format cameras used in 1969, using exclusively color and infrared color films.

REFERENCES

- Smith, J. T., ed. 1968. Manual of Color Aerial Photography. American Society of Photogrammetry, Falls Church, Va. 550 pp.
- Spencer, D. L. 1969. Amchitka Bioenvironmental Program. Sea otter surveys, Amchitka Island, Alaska; interim report. Battelle Memorial Institute, Columbus Laboratories, U. S. AEC report BMI-171-120. 7 pp.
- Stephan, J. G. 1968. Amchitka Bioenvironmental Program. The feasibility test to determine the Amchitka sea otter population through photogrammetric techniques. Battelle Memorial Institute, Columbus Laboratories, U. S. AEC report BMI-171-108. 19 pp.
- Stephan, J. G. 1969. Amchitka Bioenvironmental Program. Evaluation of photogrammetric techniques for censusing sea otters; interim report for FY 1969. Battelle Memorial Institute, Columbus Laboratories, U. S. AEC report BMI-171-119. 21 pp.
- Stephan, J. G. 1971. Ecological surveillance employing photogrammetric techniques. *BioScience* 21(12): 677-682.
- Stephan, J. G. 1972. Amchitka Bioenvironmental Program. Application of photogrammetric techniques for environmental surveillance of Amchitka Island, Alaska. Annual progress report, July 1, 1969 - June 30, 1970. Battelle Memorial Institute, Columbus Laboratories, U. S. AEC report BMI-171-135. 43 pp.

APPENDIX

INVENTORY OF AERIAL AND TERRESTRIAL PHOTOGRAPHY
AMCHITKA ISLAND, OCTOBER, 1970

APPENDIX

INVENTORY OF AERIAL AND TERRESTRIAL PHOTOGRAPHY
AMCHITKA ISLAND, OCTOBER, 1970

Sea Otter Census Photography

25 rolls of 70 mm x 4.5 m infrared color film (Kodak Ektachrome Infrared SO 117)

Coverage: Intermittent to continuous coverage of Amchitka coastline

Type of Photography: Forward oblique

Altitude: 30-90 m

Time: 1:00-4:00 p.m.

Purpose of Photography: To census Amchitka sea otter population

Quality of Photography: Fair to good

Approximate Number of Photographs per Survey (3 surveys): 580

Total Number of Photographs: 1,750

Post-Milrow and Pre-Cannikin Photography

(1) 2 rolls of 70 mm x 4.5 m Ektachrome color film (Kodak Ektachrome ER Type 5257)

(2) 2 rolls of 70 mm x 4.5 Ektachrome IR color film (Kodak Type SO 117)

Coverage: Area within 1-1/2 km of Milrow SZ and 3 km of Cannikin SZ

Type of Photography: Vertical, scale 1:18,400 and 1:9,200

Altitude: 920 m

Time: 1:00-3:00 p.m.

Purpose of Photography: Record terrain features after Milrow and prior to
Cannikin test

Quality of Photography: Fair to good

Approximate Number of Photographs: 250

(3) 1 roll of 240 mm x 70 m panchromatic (black and white) film (Kodak XX Aero-graphic Type 2405)

Coverage: Area bounded by Kirilloff Point, Sea Otter Point, Mex Island, and
St. Makarius Point

Type of Photography: Vertical, stereo (permits 3-dimensional viewing)

Altitude: 920 m (average scale: 1:6,000)

Time: 1:00-4:00 p.m.

Purpose of Photography: Record terrain features after Milrow and prior to Cannikin
test

Quality of Photography: Good

Number of Photographs: 285

(4) 5 rolls of 70 mm x 4.5 m Ektachrome color film (Kodak Ektachrome ER Type 5257)

Type of Photography: Forward and side oblique

Altitude: 920 m

Time: 1:00-4:00 p.m.

Purpose of Photography: To provide color photography in conjunction with photography
in (3) above

Quality of Photography: Good to excellent

Number of Photographs: 350

(5) 4 rolls of 70 mm x 4.5 m Ektachrome color and IR color film (Kodak ER Type 5257 and Kodak Type SO 117)

Coverage: Shoreline between Kirilloff Point to Sea Otter Point and St. Makarius Point to Mex Island

Altitude: 300 m

Time: 1:00-4:00 p.m.

Purpose of Photography: To record conditions of cliffsides and sea stacks

Quality of Photography: Good to excellent

Number of Photographs: 280

(6) 4 half rolls of 70 mm x 4.5 m Ektachrome color, IR color and panchromatic film

Coverage: Selected test lakes, terrain, and marine features

Type of Photography: Vertical, multispectral

Altitude: 100-300 m

Time: 1:00-4:00 p.m.

Purpose of Photography: To determine feasibility of multispectral imagery in bioenvironmental program

Quality of Photography: Excellent

Number of Photographs per Band: 30

Total Number of Photographs: 120

Terrestrial Photography

3 rolls of 70 mm x 4.5 Ektachrome color film (Kodak Ektachrome ER Type 5257)

Type of Photography: Close-up, ground based

Time: 1:00-4:00 p.m.

Purpose of Photography: To obtain close-up photographs of vegetation types and terrain conditions near Cannikin SZ and Bering Coastline adjacent to Cannikin SZ

Quality of Photography: Excellent

Number of Photographs: 210

Distribution

U. S. Atomic Energy Commission, Washington, D. C.

Major General E. B. Giller, Assistant General Manager for Military Application (6)
J. R. Totter, Director, Division of Biology and Medicine (3)
M. B. Biles, Director, Division of Operational Safety
R. F. Pigeon, Division of Technical Information
J. A. Harris, Jr., Director, Division of Public Information
J. J. Davis, Assistant Director, Division of Radiological and Environmental Protection
R. L. Ballard, Division of Radiological and Environmental Protection
J. J. DiNunno, Director, Office of Environmental Affairs

U. S. Atomic Energy Commission, Nevada Operations Office, Las Vegas, Nevada

R. E. Miller, Manager
R. H. Thalgott, Test Manager
E. M. Douthett, Office of Effects Evaluation
H. G. Vermillion, Office of Public Affairs (25)
W. D. Smith, Jr., Assistant Manager for Engineering and Logistics
W. R. Cooper/R. W. Taft, Office of Assistant Manager for Plans and Budgets
R. R. Loux, Technical Information Branch (20)
D. M. Hamel, Technical Library (20)
D. W. Hendricks, Radiological Operations Division (3)
E. D. Campbell, Bioenvironmental Branch (20)
Roger Ray, Assistant Manager for Operations
P. N. Halstead, Seismology Branch
T. M. Humphrey, Geology/Hydrology Branch

U. S. Atomic Energy Commission, Oak Ridge, Tennessee

Division of Technical Information Extension (2)

U. S. Atomic Energy Commission, Amchitka, Alaska

Site Manager

U. S. Department of Commerce, National Oceanic and Atmospheric Association

P. M. Roedel, Director, National Marine Fisheries Service, Washington, D. C.
T. R. Merrell, Jr., National Marine Fisheries Service, Auke Bay, Alaska
H. L. Rietze, National Marine Fisheries Service, Juneau, Alaska
G. Y. Harry, Jr., National Marine Fisheries Service, Seattle, Washington
H. F. Mueller, Air Resources Laboratory, Las Vegas, Nevada (2)

U. S. Department of the Interior

Assistant Secretary, National Park Service, Washington, D. C.
Director, Bureau of Sport Fisheries and Wildlife, Washington, D. C.
R. E. Johnson, Bureau of Sport Fisheries and Wildlife Service, Washington, D. C.
G. W. Watson, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Anchorage, Alaska (3)
C. E. Abegglen, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Anchorage, Alaska
D. L. Spencer, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Anchorage, Alaska
Ed Bailey, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Cold Bay, Alaska
J. D. Findlay, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Portland, Oregon
W. S. Twenhofel, Geological Survey, Denver, Colorado (2)
H. T. Shacklette, Geological Survey, Denver, Colorado

U. S. Army Corps of Engineers, Anchorage, Alaska

District Engineer

U. S. Environmental Protection Agency

Regional Director, Pollution Control Administration, Portland, Oregon

M. W. Carter, Director, Western Environmental Research Laboratory, Las Vegas,
Nevada (5)

Advanced Research Projects Agency, Washington, D. C.

S. R. Ruby

Alaska Cooperative Wildlife Research Unit, College, Alaska

D. R. Klein

Alaska Department of Fish and Game, Juneau, Alaska

W. H. Noerenberg (2)

Battelle Memorial Institute, Las Vegas, Nevada

R. G. Fuller

Eberline Instrument Corporation, Santa Fe, New Mexico

W. S. Johnson (2)

A. E. Doles (2)

Los Alamos Scientific Laboratory, Los Alamos, New Mexico

W. E. Ogle (2)

Sandia Laboratories, Albuquerque, New Mexico

M. L. Merritt

C. F. Bild

Smithsonian Institution, Chesapeake Bay Center for Field Biology, Edgewater, Maryland

F. S. L. Williamson

The Ohio State University, Institute of Polar Studies, Columbus, Ohio

K. R. Everett

Brigham Young University, Department of Zoology and Entomology, Provo, Utah

C. M. White

University of Arizona, Tucson, Arizona

N. S. Smith

University of California, Davis, Radiobiology Laboratory, Davis, California

L. K. Bustad, Director

University of California, Berkeley, Lawrence Livermore Laboratory, Livermore,
California

R. E. Batzel

J. E. Carothers

P. E. Coyle

B. W. Shore

University of Nevada, Desert Research Institute, Reno, Nevada

P. R. Fenske

University of Tennessee, Graduate Program in Ecology, Knoxville, Tennessee

C. C. Amundsen

University of Washington, Seattle, Washington

R. L. Burgner, Fisheries Research Institute

A. H. Seymour, Laboratory of Radiation Ecology

Utah State University, Logan, Utah

J. M. Neuhold, Center of Ecology (2)

D. D. Koob, Department of Wildlife Resources

Washington State University, Department of Zoology, Pullman, Washington

V. Schultz