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CORONA
TECHNICAL
INFORMATION

VOLUME 1

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INTRODUCTION

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HISTORY

1954

When the U-2 High Altitude Photographic Reconnaissance Aircraft was under development, it was anticipated that the Soviets would be able to counter with a surface-to-air missile within 1 to 1½ years. This was an overestimation since a U-2 was not destroyed until 1960.

March 1958

Awareness of the U-2 vulnerability and the growing concern over the failures in the SAMOS Program prompted the CIA to begin exploring the possibility of employing a recoverable capsule to return film from an orbiting reconnaissance satellite.

15 April 1958

The White House approved the development of a camera and recoverable capsule, thus marking the beginning of the CORONA Reconnaissance Program. Simultaneously, the SENTRY Program was cancelled.

19 August 1960

The first film recovered from orbit was obtained by an air catch. The camera was a C model built by Fairchild while the lens was fabricated by Itek. It was a single, vertical panoramic camera and returned photography with a ground resolution of approximately 25 feet. The orbital life of the photographic mission was 1 day. Ten of these cameras were launched with one successful recovery.

7 December 1960

The second mission launched that returned usable film employed a C′ camera which had minor mechanical improvement. The orbital life of this photographic mission was 3 days. A total of 10 of these cameras were launched; film was recovered from 4.

30 August 1961

The first C''' camera launched returned usable film. This camera, built by Itek, employed an improved lens and the camera supported the film with rails rather than by a platen. The instrument had the same basic characteristics; it was a single, vertical-looking, panoramic, fixed slit/filter camera. These missions were 3 days long and a total of six cameras were launched with four returning usable film.

27 February 1962

The first stereo panoramic cameras, designated Mural (M) and built by Itek, were essentially two C''' cameras mounted at a 30-degree convergence angle. The useful mission lifetime was usually 4 to 5 days. A total of 26 units were launched with 20 returning usable film.

24 August 1963

The J-1 series of CORONA cameras was basically configured like the M units but it returned twice the coverage by using two recovery vehicles. The ground resolution was generally 10 feet, and the useful mission lifetime was 4 to 5 days for each mission segment. By the end of 1969, 52 systems (total of series) were launched with all but three returning usable film.

15 September 1967

This date marked the launch of the improved CORONA camera system, J-3. Substantial improvements afforded additional photographic flexibility through a multiple exposure/filtration mechanism and increased dynamic stability due to constant rotation of the instrument. The design goal of 7-foot ground resolution has been achieved with some photographic recording of ground resolved distances of 5 feet.

ANECDOTES

In the beginning of 1959, the first of the Discoverer series, an Agena with no payload, aborted on the launch pad. Due to a vehicle sneak circuit, the separation retro rockets and explosive bolts fired when a hydraulic motor was exercised at T-60 minutes. Initiation ceremonies for the program were thus celebrated with a brilliant pyrotechnic display.

The second Agena (Discoverer I) achieved orbit in later February, although in radio silence. Speculation was that the protective nose cone over the antennas was ejected just before the Agena firing; such that the Agena then rammed into the nose cone, damaging the antennas. Orbit was confirmed by radar skin-track.

The third Agena launched a biomedical purpose capsule (Discoverer II) housing a life support cell. Four "mechanical mice" consisting of transitorized multivibrators were installed to give a T/M readout. This capsule achieved orbit in April 1959, but due to an incorrect setting of a timing device in the Agena, it was ejected within hours over the North Pole and came down in the snow near Spitzbergen, Norway. Opinion was that the recovery functions occurred; but the capsule was never retrieved — by the United States team. A few years later, the movie, "Ice Station Zebra," was enjoyed by the box office public.

The next go was a more ambitious biomedical experiment because the life support cell carried four live black mice. Just before the first try at launch, telemetry indicated a lack of mouse activity. At first it was thought that the little fellas were asleep, so a cherrypicker was sent up with a technician who banged on the side of the vehicle in an attempt to wake them up. Catcalls and meows were used to no avail. It was then found that the mouse cage had been sprayed with krylon to make it smooth; but that the krylon had chipped off the screen, the mice had found it tasty — and that was that. Several days later, the second try at this launch was almost aborted when the capsule life-cell humidity sensor suddenly indicated 100 percent RH, out-of-band on T/M. The panic button was pushed and trouble-shooters were dispatched. They soon

realized that since the humidity sensor was located directly under the cage with the vehicle in a verticle position, it reacted in accordance with nature when a mouse decided to do his thing. But after a while the wetness dried out, all was forgiven and the vehicle was launched — into a 100 percent moisture environment (the Pacific Ocean).

This same payload was also distinguished by a unique fairing attachment. It was desired to develop a system whereby the payload doors could be hidden from inquisitive eyes during pad time. The fairings were covered with paper, under which were two piano wires tipped with ping-pong balls. It was supposed that the wind caused by lift-off would blow the ping-pong balls to the rear and the wire would tear the paper off, exposing the fairing. The automatic strip-away system was tested by mounting a test fairing on a sports car and the unit was driven up and down the Bayshore Freeway at 90 miles per hour. For some reason this activity attracted attention, including that of the local Gendarmes, who ticketed the driver. However, the test data indicated a "go" situation, and at 2 a.m. on a foggy cold morning under a blaze of searchlights, paper, piano wire, and ping-pong balls were attached to a million dollar satellite. But because test conditions do not always perfectly simulate operational conditions, the paper never did come off the fairing during lift-off. For all we know, the ping-pong balls are still in orbit.

During this initial period of unsuccessful missions, "witch hunts" were conducted to isolate and remedy certain problems. One such problem was to devise a cooler for the fairing interface which was heating up during ascent. A water receptacle was installed around the leading edge of the fairing, the idea being that the water would boil during ascent and the steam would carry away the heat. In order to contain the water and prevent sloshing, something absorbent, soft, and easy to work with was required. Kotex fulfilled these requirements. The reservoir was to be filled using a large hypodermic needle poked through the small holes in the water receptacle, and then each hole was to be sealed with wax. This unit became part of a display rigged for some visiting VIP's so as to satisfy their desire to come in contact with the hardware. Standing around the display, the moment came for the hypodermic needle loading action. The water was squirted in through one hole and squirted right out again through another hole, to the embarrassed surprise of a drenched VIP.

At least he did realize intimate contact with the hardware; and as it turned out, the Kotex and wax cooling system actually did work in flight.

Although Discoverer XIV is credited as being the first successful mission, Discoverer X actually had launch and payload recovery previously. Lift-off was perfect, but then the Thor began to fishtail and was destructed at 10,000 feet. The payload came down about a mile from Pad 5 and was located by helicopter, which landed payload people to guard it and render the pyrotechnics safe. Recovery was then made inauspiciously by Jeep. Something of a first.

In order to test the SRV sink valve under in-house conditions, an old four-legged tub was brought into the test facility. The sink valve, a metal plug filled with compressed salt, is designed to dissolve at a controlled rate. To provide sufficient sea water of proper salinity for operation "test tub," repeated trips to Half Moon Bay in a pick-up truck with a 50 gallon drum were required. The sea water was at first conveniently loaded from a wooden dock extending into the bay. But soon the owner put an end to this wholesale pilfering of sea water by chasing the thieves the hell out. Not to be frustrated in their mission, the salt water acquisition team courageously obtained access via a steep and twisting natural path along the cliffs of the bay. Carrying a 50 gallon drum of sea water up this path required spirit and dedication. During one of the many decents, the barrel carrier slipped and tumbled head over heels into the sea. This is a fine example of how project people sometimes throw themselves into their work.

Discoverer XIII is famous. It was a diagnostic capsule and it worked all the way. This capsule, picked up from the ocean on 11 August 1960, now reposes in the Smithsonian Institute, Washington, D.C., as the first object to be recovered from orbit. A principal factor in this success was the inauguration (in the previous mission) of the cold-gas spin and despin system. Earlier capsules on their re-entry from orbit were being destroyed by explosions of the small rockets used for spin and despin. Pictures of the lift-off from Vandenberg AFB on the 10th, the recovery ship, Haiti Victory, and the capsule in the Pacific Ocean 330 miles northwest of Honolulu, as well as close-ups of the capsule with Air Force personnel were published in the Illustrated London News, page 314, on the 20th.

Well into the program of evolving systems, an SRV recovery (mission 1005) was made that was a no-no. In June of 1964, a full bucket descended gracefully under its colorful canopy against the soft blue sky of northern South America. Unnoticed, the SRV crash landed on Guaramito Farm No. 35 owned by Pablo García. For over a month the payload lay neglected on the nearly deserted mountainous terrain of La Fría, Táchira, Venezuela, 2 kilometers from the Columbian border. Then, on July 7, 14 year old Eladio Becerra and 40 year old Gabino Mora stumbled upon the mysterious object. Excited by the glimmering gold, the two campesinos reported the treasure to their boss, Facundo Albarracin, who immediately got the thing moved 100 meters to his own property, Farm No. 36; then sent out word in an attempt to sell it. But the demand for space vehicles in Táchira is limited. He could not even get a worthwhile offer to smuggle it to Columbia. Intent on benefiting from this heavenly gift, the campesino and his family let loose on the SRV with hammer and machéte. La señora cut up the parachute and made it into clothing. Facundo claimed its nylon shrouds and fashioned some fine fancy reins for his horse. Odd pieces from the radio transmitter and take-up assembly became kitchen utensils and wonderful toys for the children. Word finally got around to the city, and people were making the scene to take a look. One of these, Leonardo Davila, a commercial photographer, telephoned the U.S. Embassy in Caracas on 1 August to report that he had photographed a fallen space satellite. The remains of the bucket were carried out of its locale on foot by the campesinos, taken over by the Venezuelan Defense Ministry and flown to Caracas. The local newspapers had a hay day. Diario Católico, San Cristóbal, for example, along with a lengthly report, published three pictures of the SRV revealing the rolls of film. There was great interest in the three curious "mascots": two quarters and a buffalo nickel. The most common hypothesis was that the thing was a Ranger probe from Cape Kennedy gone astray. The Daily Journal staff got a little playful when they wrote a sequel to Longfellow's verse:

> I shot an arrow into the air,
> It fell to earth, I know not where.
>
> Cape Kennedy signalled: "Where is it at you are?"
> Responded the rocket: "La Fria, Táchira."

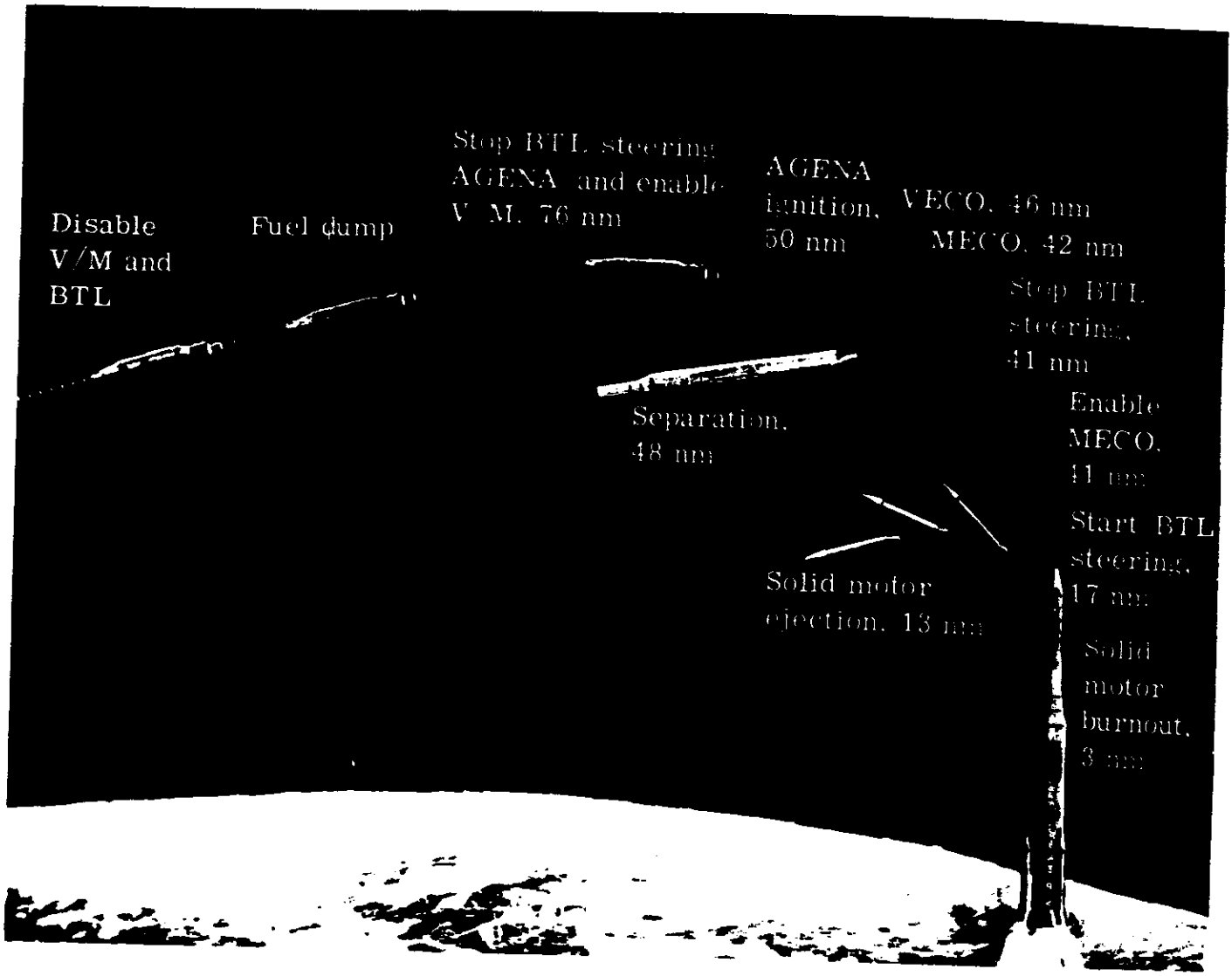
The Venezuelan government finally sold the crumpled specimen, along with all the fragments that could be collected, to the USAF, who quietly dismissed public attention from the unimportant NASA scientific instrumentation.

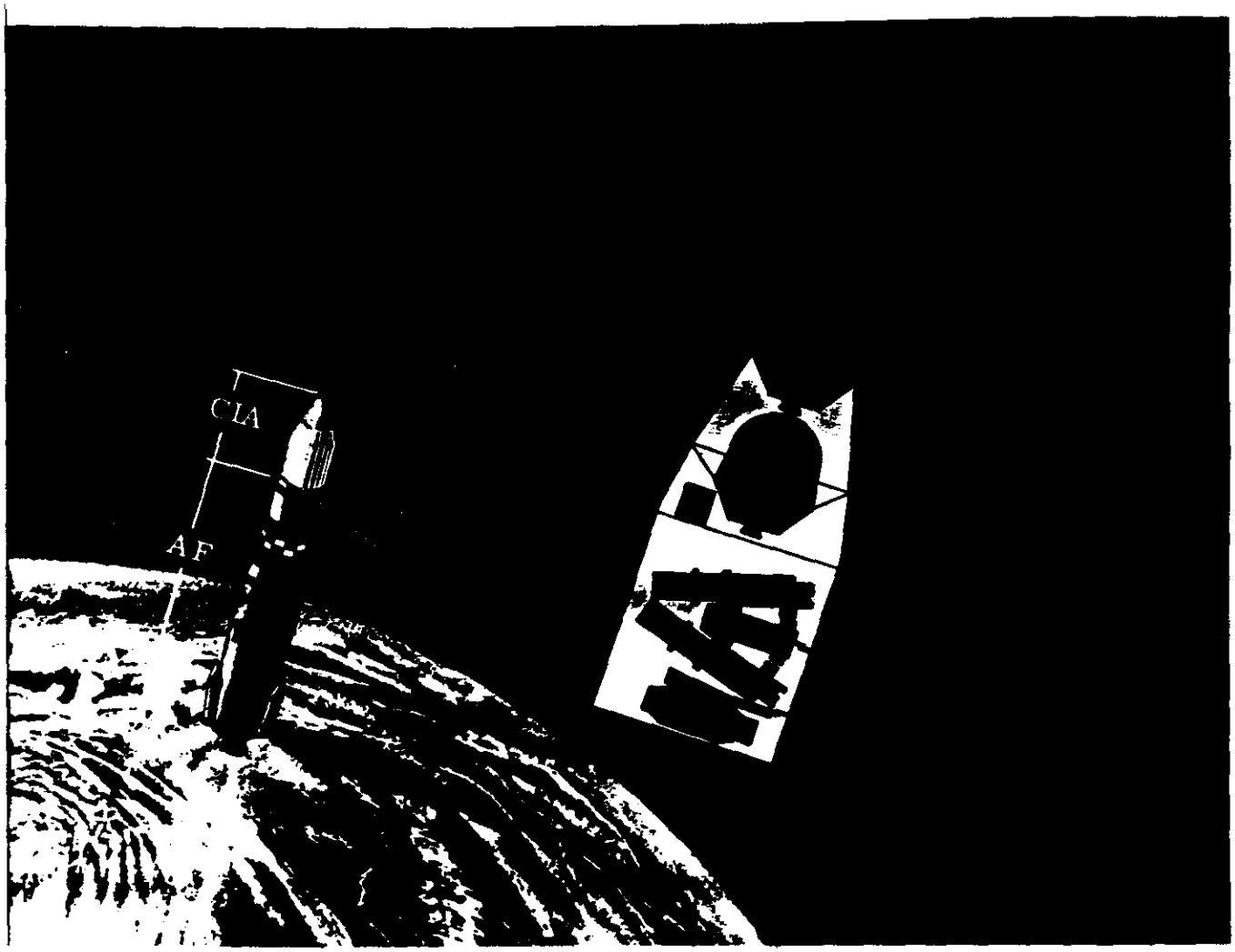
COMPUTER PROGRAM DEFINITIONS

CALICO	Determines camera operations and displays operations information.
CACTUS	Advance listing of target locations for photointerpretation.
CLICK	The original GE target acquisition program developed for ADIC. Predecessor to CACTUS/CALICO.
COMET	Better preflight orbit selections.
CORONA	[redacted]
LETHAL	The digital storage register command generation software used in the satellite control facility for automatic command and control.

[redacted]

ASCENT SEQUENCE

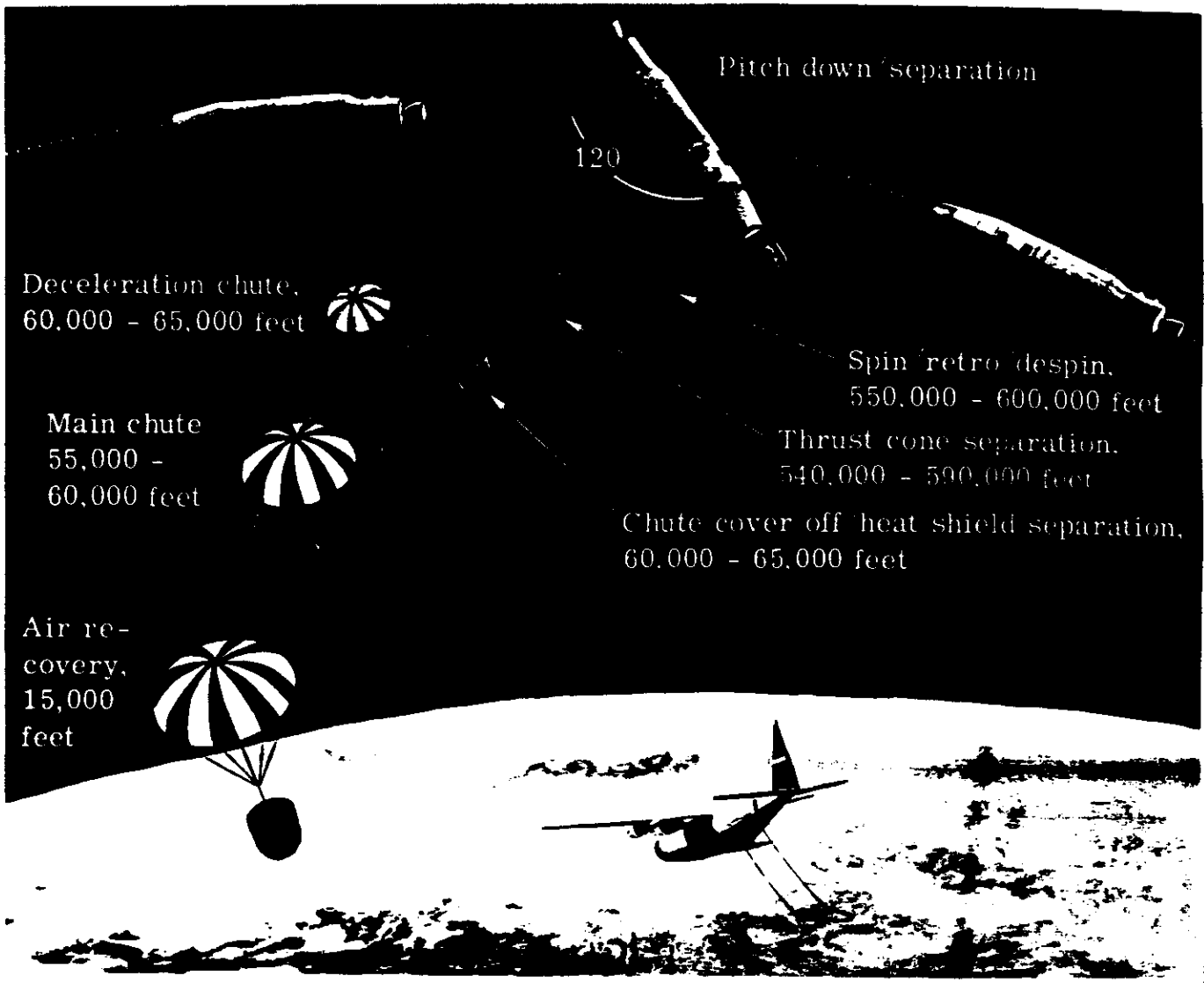




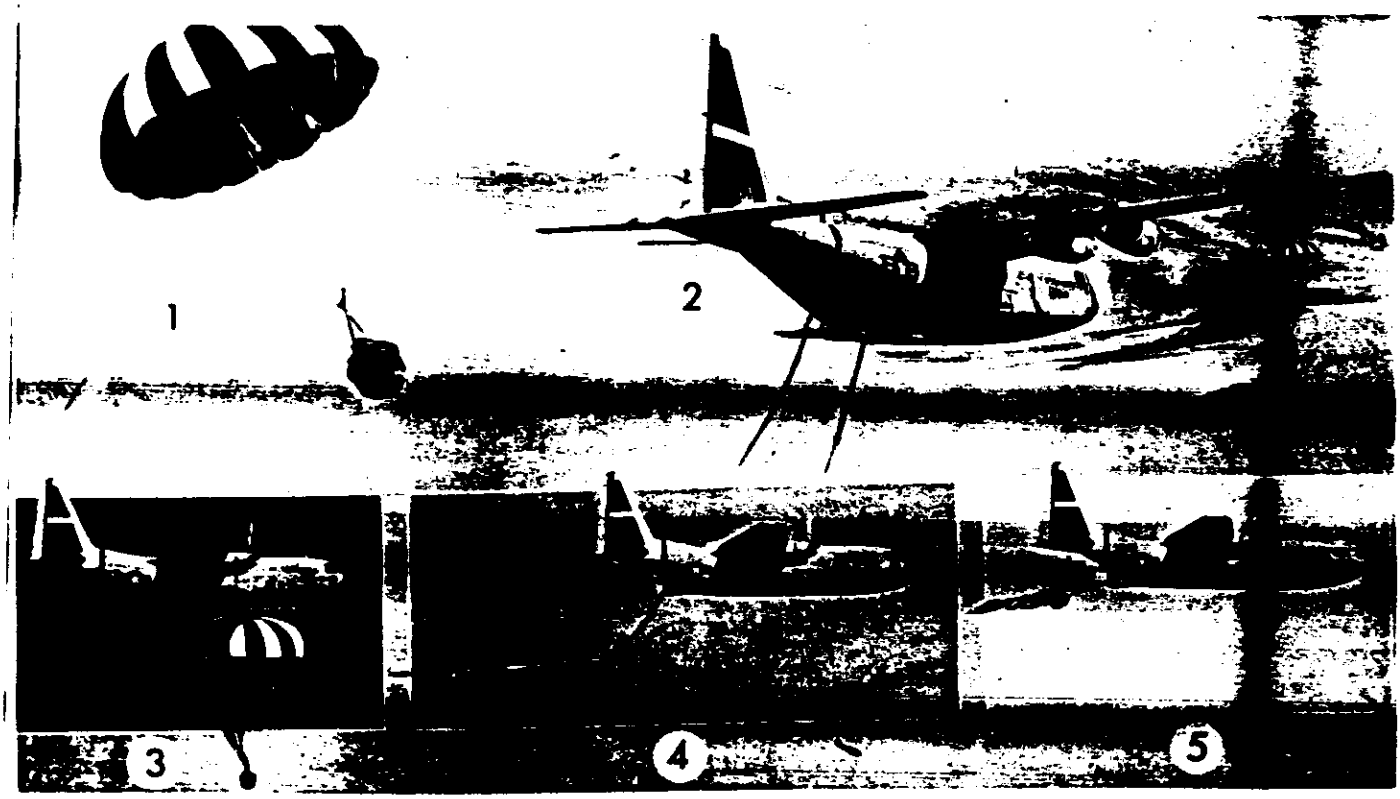
10M sq. nm coverage thin base film
15M sq. nm coverage ultra-thin base film
Mission life — 15 to 18 days dual recovery
Altitude — 80 to 100 nm
Features — selectable filter (2 per camera)
Coverage based on 100 nm mean altitude

[redacted]

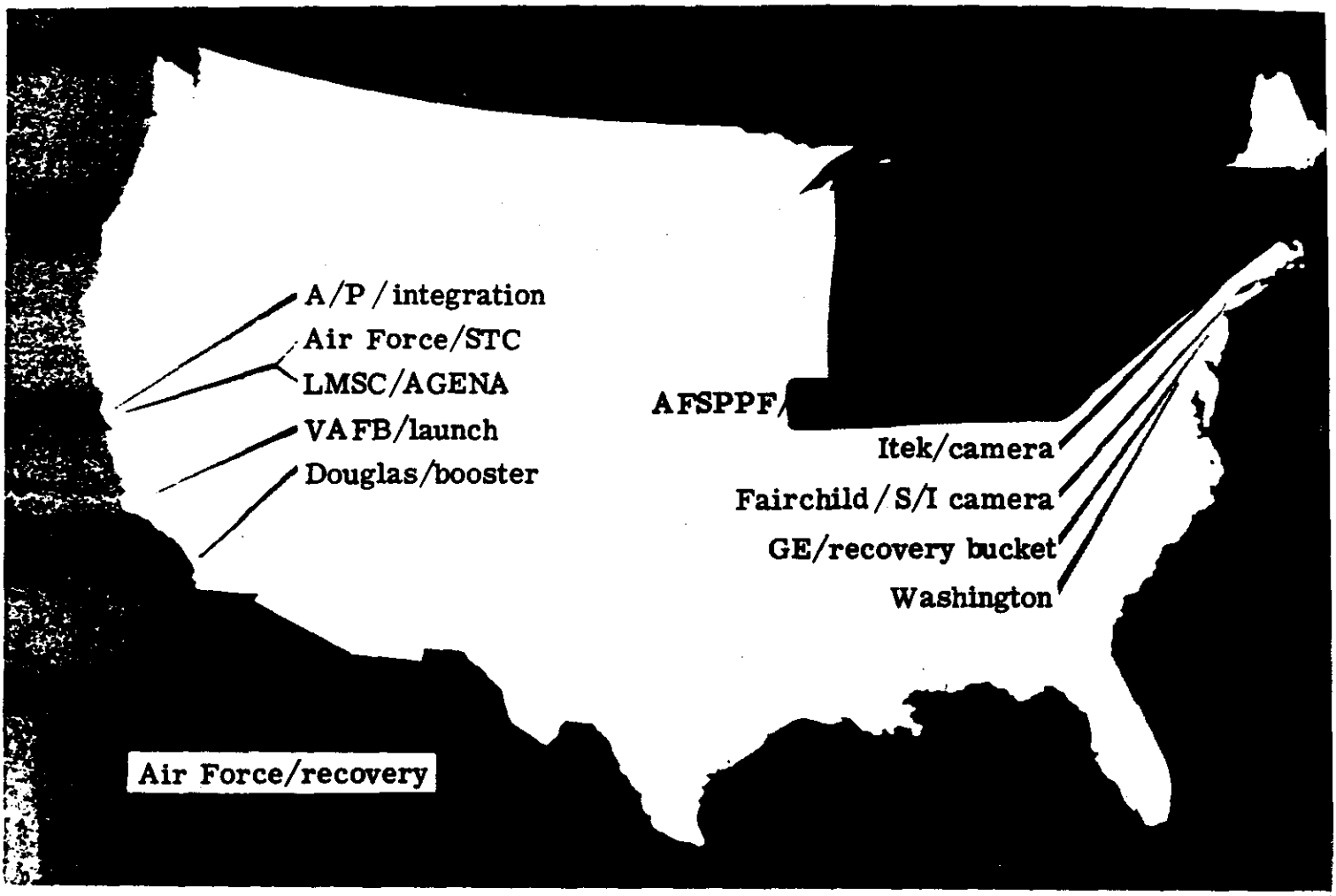
RECOVERY SEQUENCE



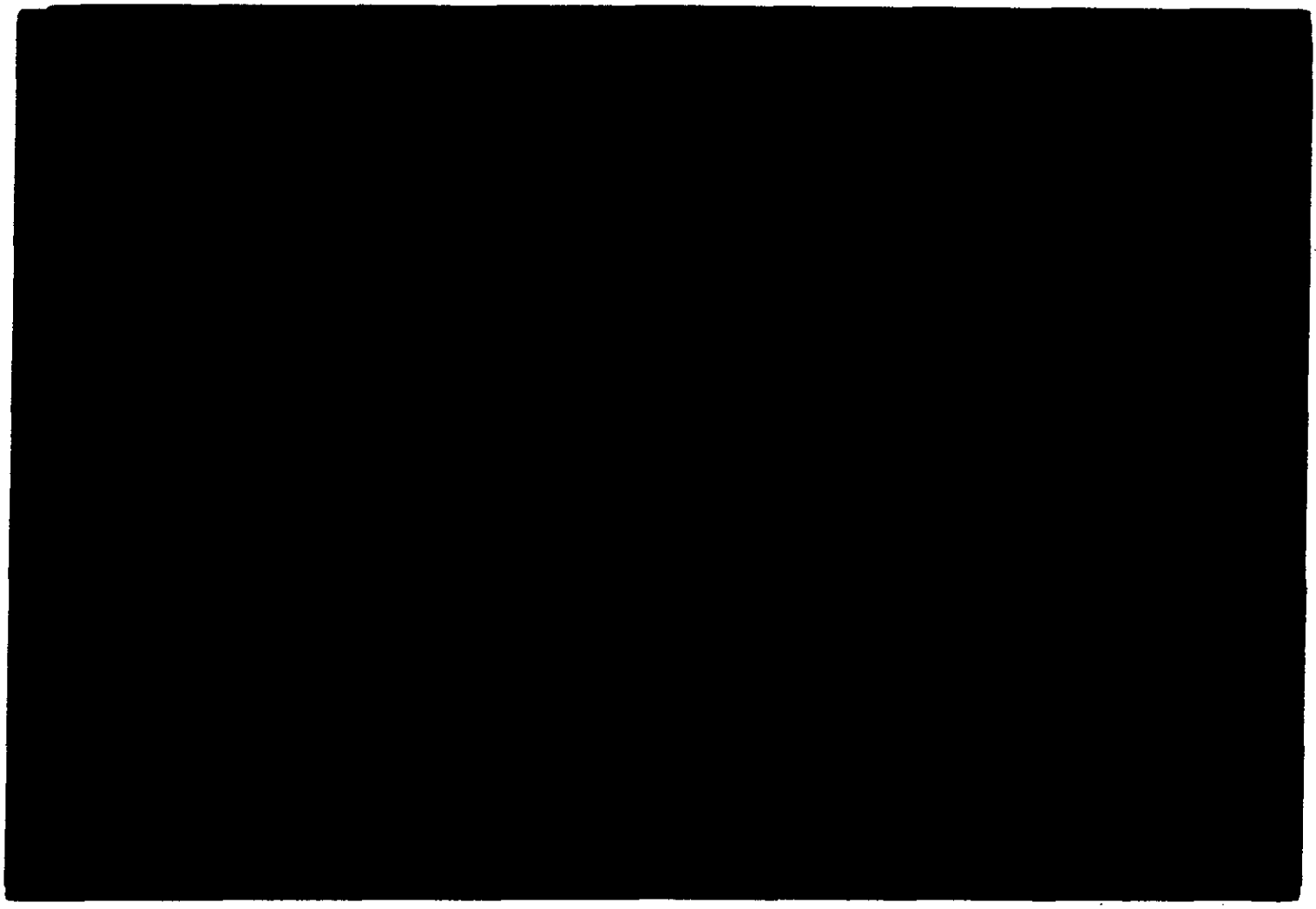
AERIAL RECOVERY OF CAPSULE



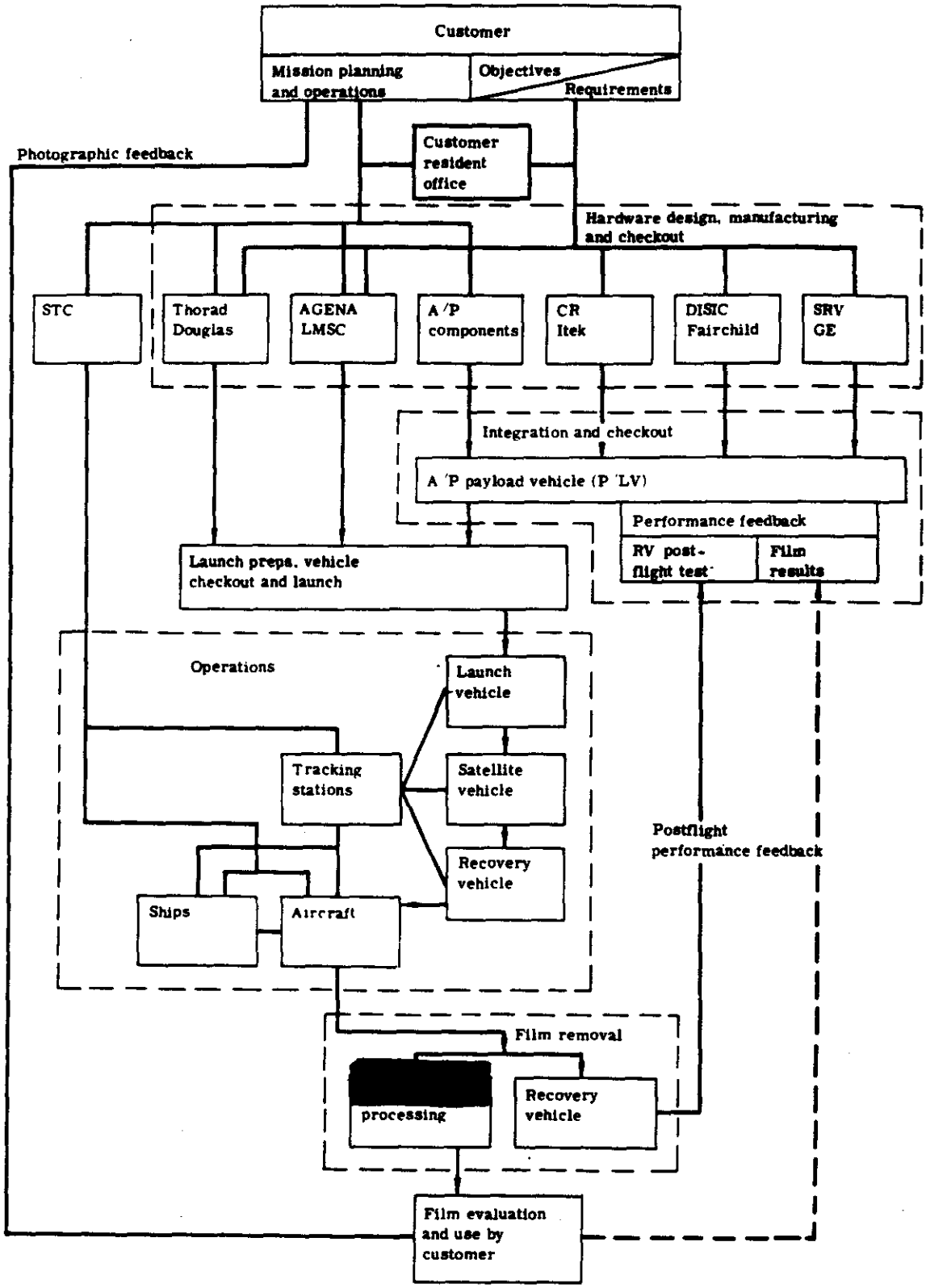
FACILITY LOCATIONS



TRACKING STATIONS



COMPOSITE ORGANIZATION CHART AND HARDWARE FLOW



AVERAGE SHIPMENT, TRANSFER, AND PROCESSING TIME OF CORONA MATERIAL (PRIORITY 1 DUPES ONLY)

Event	Average Time Required, hours
Air catch to Hawaii	1½
Transfer to Air Force Jet Transport at Hickham AFB	1
Hickham AFB to Travis AFB	5
Delay — Travis AFB — crew change*	1
Travis [redacted]	5
[redacted]	1½
In [redacted] — out	77
[redacted] to Andrews AFB — OSA Project A/C	3
Andrews AFB to NPIC	1
Total	96

*When defilming is accomplished at AP, add 3 additional hours.

EVOLUTION

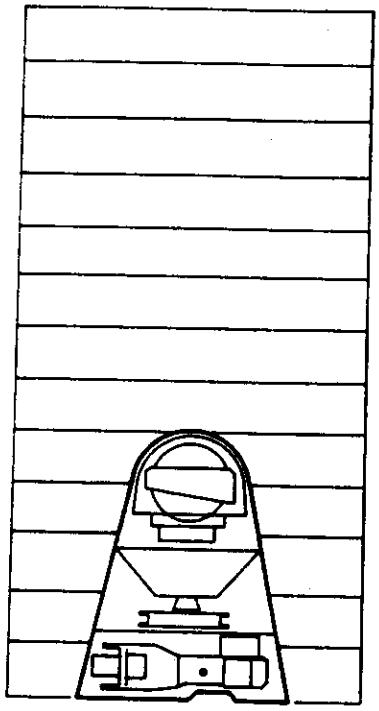
EVOLUTION OF CORONA SYSTEM CHARACTERISTICS

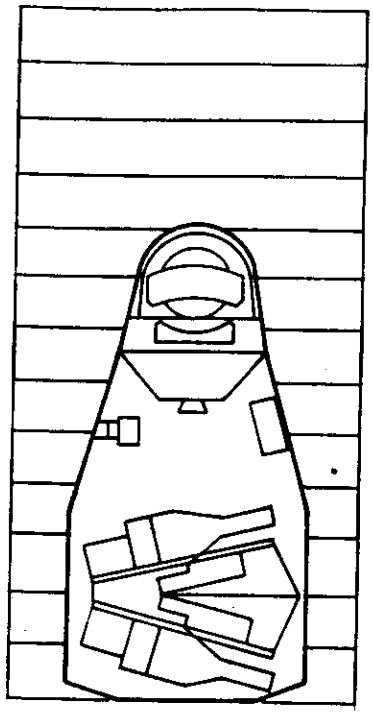
	C	C′	C‴	M	J1	J3
Camera manufacturer	Fairchild	Fairchild	Itek	Itek	Itek	Itek
Units built	10	10	6	26	52	17
Lens manufacturer	Itek	Itek	Itek	Itek	Itek	Itek
Design type	Tessar, 24-inch, f/5.0	Tessar, 24-inch, f/5.0	Petzval, 24-inch, f/3.5	Petzval, 24-inch, f/3.5	Petzval, 24-inch, f/3.5	Petzval, 24-inch, f/3.5
Camera type	70° pan, vertical, recipro-cating	70° pan, vertical, recipro-cating	70° pan, vertical, recipro-cating	70° pan, 30° stereo, recipro-cating	70° pan, 30° stereo, recipro-cating	70° pan, 30° stereo, rotating
Exposure control	Fixed	Fixed	Fixed	Fixed	Fixed	(4) selectable
Filter control	Fixed	Fixed	Fixed	Fixed	Fixed	(2) selectable
Primary film/base	1213/ acetate	1221/ polyester	4404/ polyester	4404/ polyester	3404/ polyester	3404;3414 polyester
Recovery vehicles	1	1	1	1	2	2
S/I subsystem	0/0	0/1	0/1	1/1	2/2	2/1
Time period	1959-1960	1960-1961	1961-1962	1962-1963	1964-1969	1967-1971

[redacted]

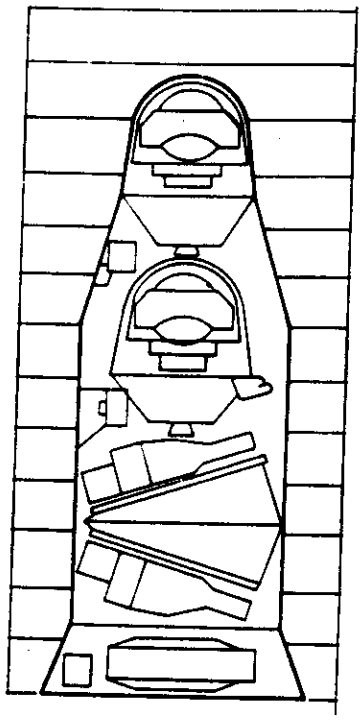
C, C′, C‴

M

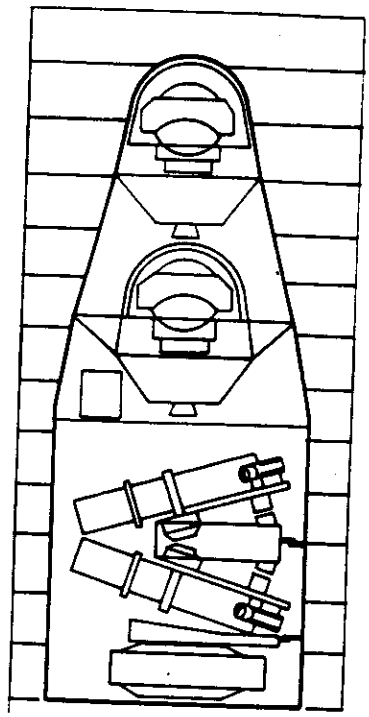




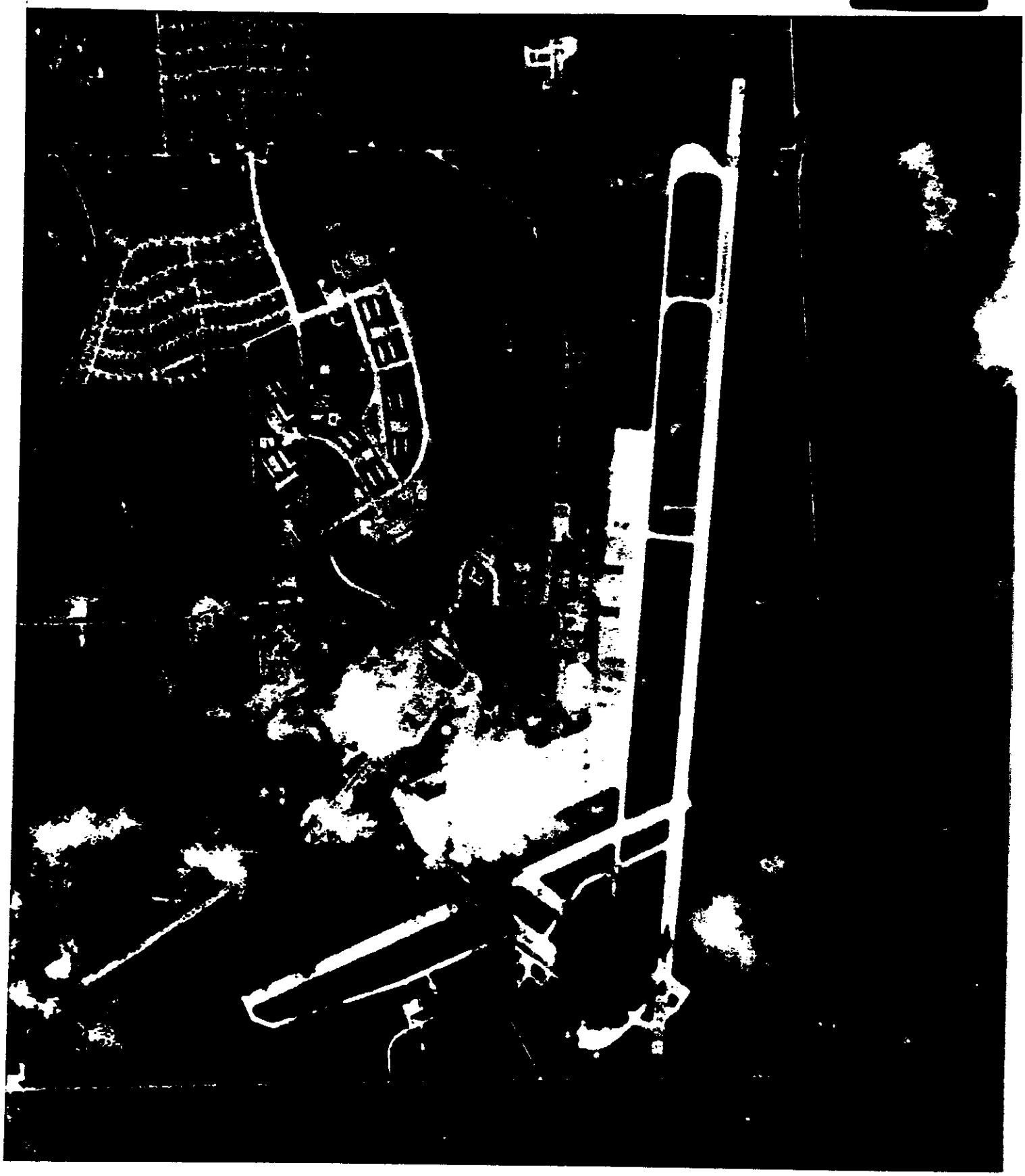
J-1



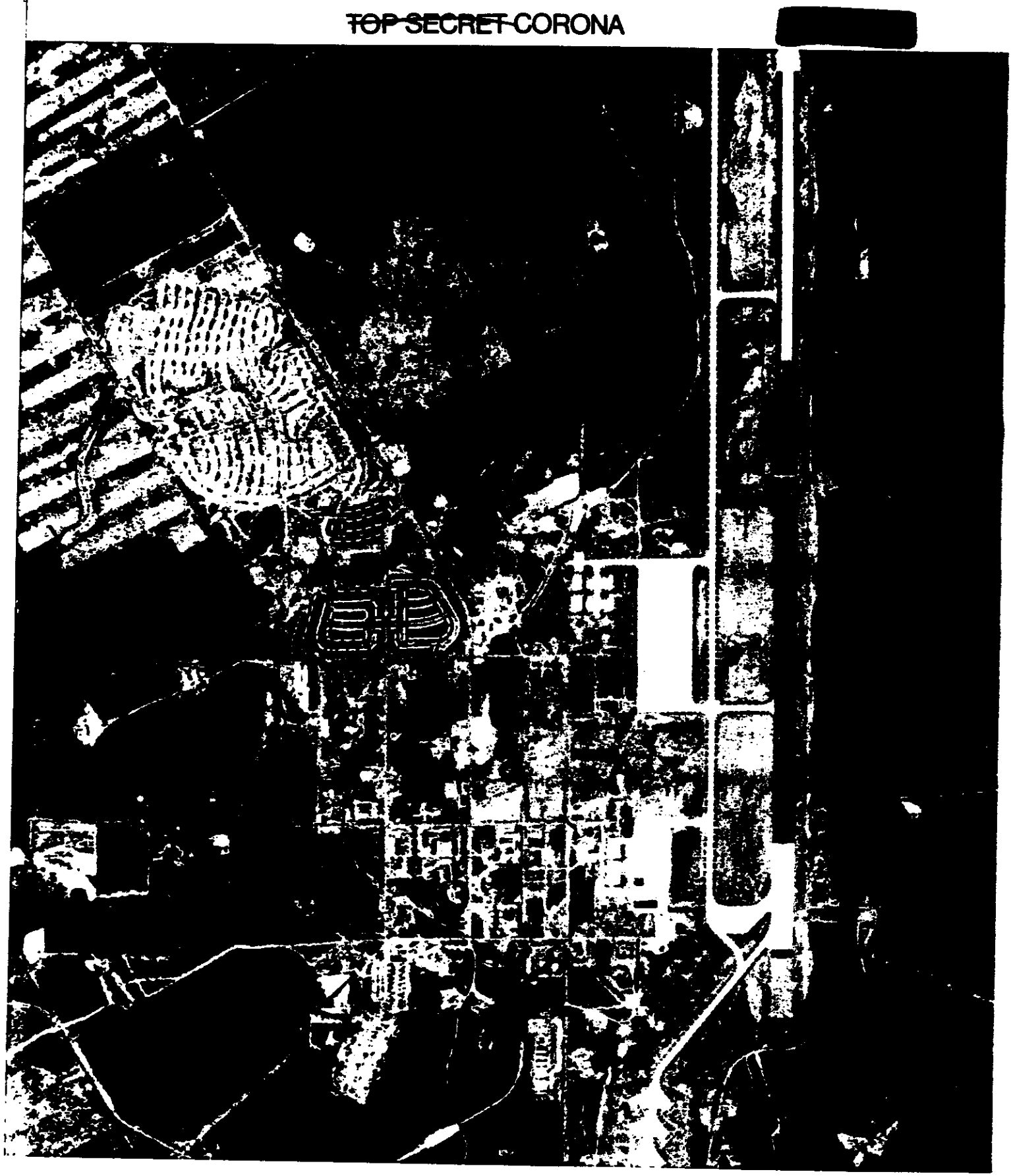
J-3



Mission	9009
Pass	14
Frame	29
Date	19 August 1960
Film	1188
Exposure time	1/1000
Filter	W-21
Latitude/longitude	39 N / 95 W
Scale	1:345,165
Altitude	114 nm
Solar altitude	63°
Enlargement	20×

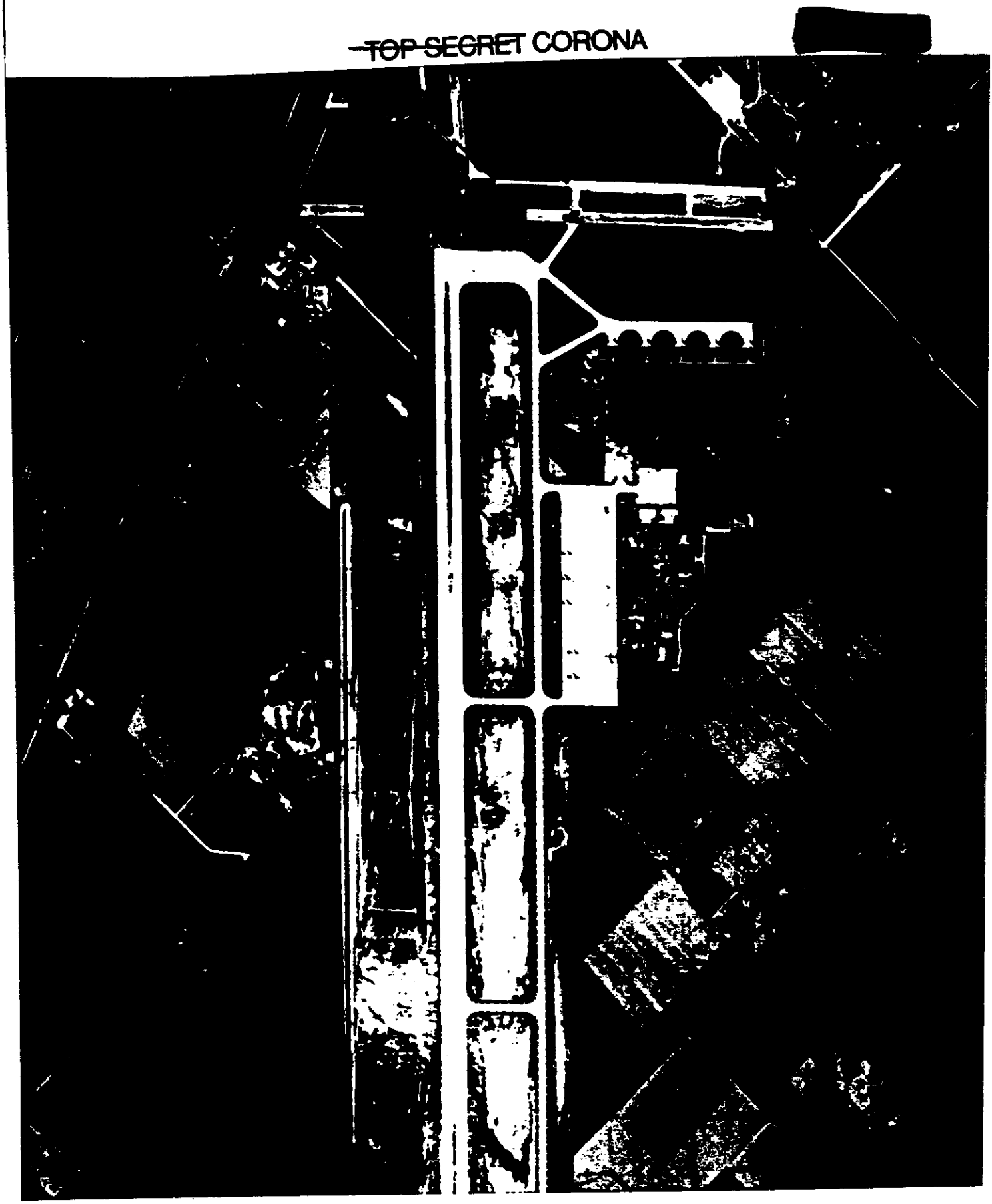


Mission	9017
Pass	15
Frame	3
Date	17 June 1961
Film	4400
Exposure time	1/500
Filter	W-21
Latitude/longitude	48 N / 106 W
Scale	1:427,384
Altitude	141 nm
Solar altitude	49°
Enlargement	20×



Mission	9022
Pass	1
Frame	12
Date	12 December 1961
Film	4404
Exposure time	1/250
Filter	W-21
Latitude/longitude	61 N / 150 W
Scale	1:431,225
Altitude	142 nm
Solar altitude	33°
Enlargement	20×

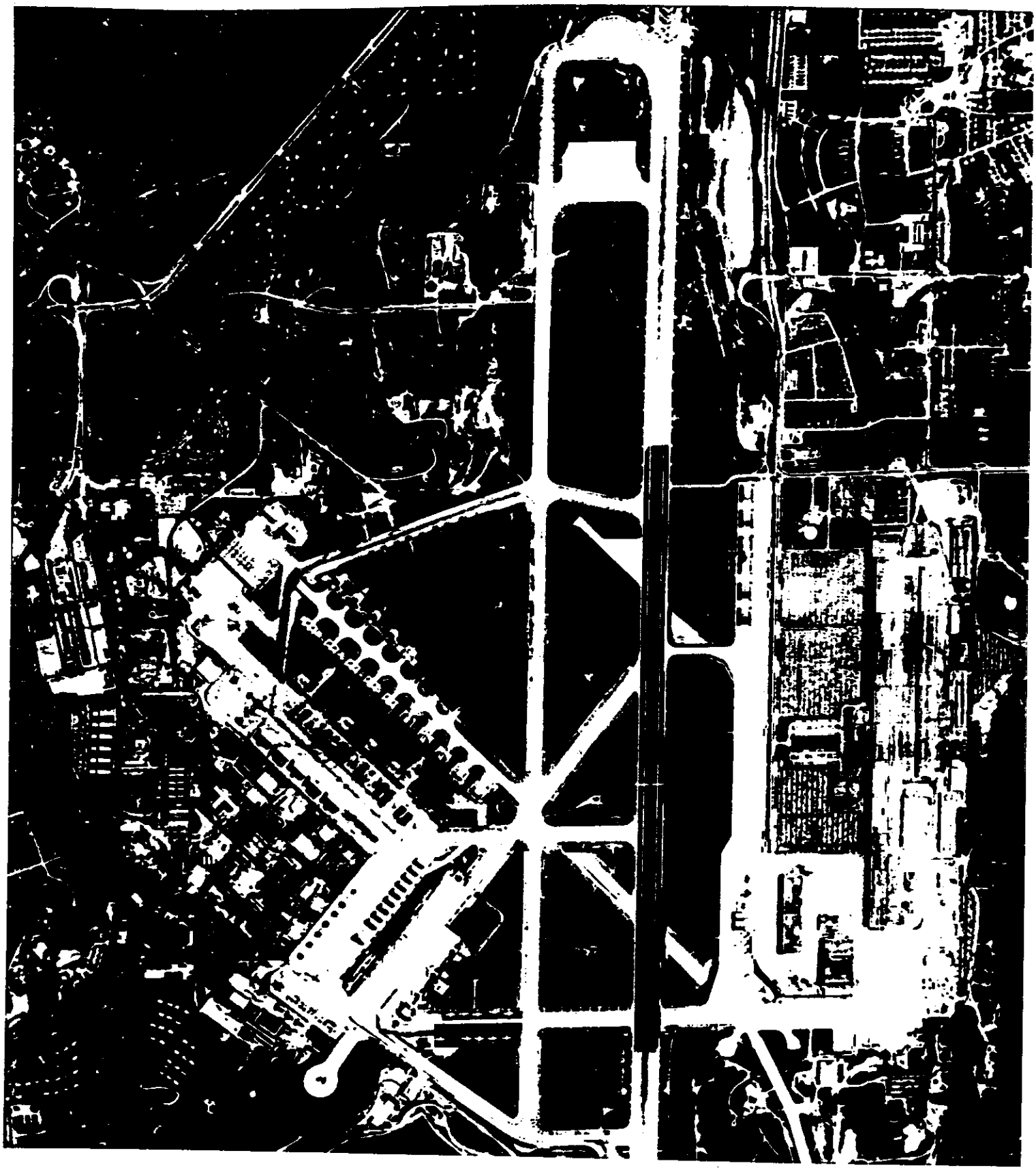
Mission	9037
Pass	31
Frame	17 AFT
Date	25 June 1964
Film	4404
Exposure time	1/270
Filter	W-21
Latitude/longitude	36 N / 103 W
Scale	1:348,388
Altitude	115 nm
Solar altitude	36°
Enlargement	20×



[redacted]

J-1 SYSTEM

Mission	1006
Pass	78
Frame	19 AFT
Date	9 June 1964
Film	4404
Exposure time	1/339
Filter	W-21
Latitude/longitude	33 N / 97 W
Scale	1:329,000
Altitude	105 nm
Solar altitude	58°
Enlargement	20×



Mission	1104
Pass	127
Frame	15 AFT
Date	15 August 1968
Film	3404
Exposure time	1/549
Filter	W-21
Latitude/longitude	42 N / 72 W
Scale	1:261,300
Altitude	83 nm
Solar altitude	61°
Enlargement	20×

CORONA FILM RECOVERY BUCKETS LAUNCHED, ORBITED, AND RECOVERED PER YEAR

		1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
C	Launched	5	5								
	Orbited	3	3								
	Recovered	0	1								
C′	Launched		3	7							
	Orbital		2	4							
	Recovered		2	3							
C‴	Launched			5	1						
	Orbited			5	0						
	Recovered			4	0						
M	Launched				17	9					
	Orbited				17	7					
	Recovered				14	6					
J-1	Launched					4	26	26	18	14	8
	Orbited					4	24	26	16	14	8
	Recovered					2	21	25	16	14	8
J-3	Launched									4	8
	Orbited									4	8
	Recovered									4	8
Total	Launched	5	8	12	18	13	26	26	18	18	16
	Orbited	3	5	9	17	11	24	26	16	18	16
	Recovered	0	3	7	14	8	21	25	16	18	16

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY (Concl.

Mission	Camera	Launch	Recovery	Comments
[redacted]				
1052	J-46	22 Sept 1969	(-1) 29 Sept 1969	Last J-1
			(-2) 7 Oct 1969	Successful
[redacted]				
1108	CR-9	4 Dec 1969	(-1) 11 Dec 1969	Successful
			(-2) 21 Dec 1969	Successful
[redacted]				
1109	CR-10	4 Mar 1970	(-1) 12 Mar 1970	Successful
			(-2) 23 Mar 1970	Successful
[redacted]				
1110	CR-11	20 May 1970	(-1) 31 May 1970	Successful
			(-2) 8 June 1970	Successful
[redacted]				
1111	CR-12	23 July 1970	(-1) 30 July 1970	Successful
			(-2) 10 Aug 1970	Successful
[redacted]				
1112	QR-2	18 Nov 1970	(-1) 27 Nov 1970	Successful
			(-2) 7 Dec 1970	One camera failed

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY (Cont.)

Mission	Camera	Launch	Recovery	Comments
[redacted]				
1046	J-48	14 Mar 1968	(-1) 22 Mar 1968	Successful
			(-2) 30 Mar 1968	Successful
[redacted]				
1103	CR-3	1 May 1968	(-1) 8 May 1968	Successful
			(-2) 15 May 1968	Successful
[redacted]				
1047	J-47	20 June 1968	(-1) 29 June 1968	Successful
			(-2) 5 July 1968	Successful
[redacted]				
1104	CR-4	7 Aug 1968	(-1) 15 Aug 1968	Successful
			(-2) 22 Aug 1968	Successful
[redacted]				
1048	J-49	18 Sept 1968	(-1) 28 Sept 1968	Successful
			(-2) 2 Oct 1968	One inst. failed
1105	CR-5	3 Nov 1968	(-1) 11 Nov 1968	Successful
			(-2) 21 Nov 1968	Successful
[redacted]				
1049	J-50	12 Dec 1968	(-1) 19 Dec 1968	Successful
			(-2) 23 Dec 1968	Successful
[redacted]				
1106	CR-6	5 Feb 1969	(-1) 10 Feb 1969	Successful
			(-2) 14 Feb 1969	Successful
[redacted]				
1050	J-43	19 Mar 1969	(-1) 22 Mar 1969	Unstable after
			(-2) 23 Mar 1969	rev 22
[redacted]				
1051	J-44	2 May 1969	(-1) 9 May 1969	Successful
			(-2) 18 May 1969	Successful
[redacted]				
1107	CR-7	24 July 1969	(-1) 2 Aug 1969	FWD inst. failed on rev 1. All mono
			(-2) 12 Aug 1969	Successful

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY (Cont.)

Mission	Camera	Launch	Recovery	Comments
1037	J-38	8 Nov 1966	(-1) 12 Nov 1966	Successful
			(-2) 20 Nov 1966	Successful
[redacted]				
1038	J-34	14 Jan 1967	(-1) 19 Jan 1967	Westover process
			(-2) 26 Jan 1967	Successful
[redacted]				
1039	J-39	22 Feb 1967	(-1) 28 Feb 1967	Successful
			(-2) 5 Mar 1967	Successful
[redacted]				
1040	J-35	30 Mar 1967	(-1) 4 Apr 1967	Successful
			(-2) 8 Apr 1967	Successful
[redacted]				
1041	J-40	9 May 1967	(-1) 16 May 1967	Successful
			(-2) 24 May 1967	Successful
[redacted]				
1042	J-37	16 June 1967	(-1) 22 June 1967	Successful
			(-2) 1 July 1967	Water recovery
[redacted]				
1043	J-42	7 Aug 1967	(-1) 14 Aug 1967	Successful
			(-2) 22 Aug 1967	Successful
[redacted]				
1101	CR-1	15 Sept 1967	(-1) 21 Sept 1967	Successful
			(-2) 28 Sept 1967	Successful
[redacted]				
1044	J-41	2 Nov 1967	(-1) 9 Nov 1967	Successful
			(-2) 11 Nov 1967	Successful
1102	CR-2	9 Dec 1967	(-1) 15 Dec 1967	Successful
			(-2) 23 Dec 1967	Successful
[redacted]				
1045	J-45	24 Jan 1968	(-1) 1 Feb 1968	Successful
			(-2) 8 Feb 1968	Successful

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY (Cont.)

Mission	Camera	Launch	Recovery	Comments
1026	J-25	28 Oct 1965	(-1) 3 Nov 1965	Successful
			(-2) 7 Nov 1965	Successful
[redacted]				
1027	JX-27	9 Dec 1965	(-1) 10 Dec 1965	D-timer failure
			(-2) 11 Dec 1965	Successful
1028	J-26	24 Dec 1965	(-1) 29 Dec 1965	Successful
			(-2) 2 Jan 1966	Successful
[redacted]				
1029	J-27	2 Feb 1966	(-1) 8 Feb 1966	Successful
			(-2) 12 Feb 1966	Successful
[redacted]				
1030	J-29	9 Mar 1966	(-1) 15 Mar 1966	Successful
			(-2) 19 Mar 1966	Successful
[redacted]				
1031	J-30	7 April 1966	(-1) 14 April 1966	Successful
			(-2) 18 April 1966	One inst. failed
[redacted]				
1032	J-28	3 May 1966		No orbit
[redacted]				
1033	J-33	24 May 1966	(-1) 29 May 1966	Successful
			(-2) 4 June 1966	Successful
[redacted]				
1034	J-31	21 June 1966	(-1) 26 June 1966	Successful
			(-2) 1 July 1966	Successful
[redacted]				
1036	J-32	9 Aug 1966	(-1) 17 Aug 1966	Successful
			(-2) 23 Aug 1966	Successful
[redacted]				
1035	J-36	20 Sept 1966	(-1) 26 Sept 1966	Successful
			(-2) 30 Sept 1966	Successful
[redacted]				

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY (Cont.)

Mission	Camera	Launch	Recovery	Comments
1013	J-15	2 Nov 1964	(-1) 6 Nov 1964	Successful
			(-2) 8 Nov 1964	Inst. failed rev. 52
1014	J-16	18 Nov 1964	(-1) 23 Nov 1964	Successful
			(-2) 27 Nov 1964	Successful
[redacted]				
1015	J-17	19 Dec 1964	(-1) 24 Dec 1964	Successful
			(-2) 30 Dec 1964	Successful
1016	J-18	15 Jan 1965	(-1) 20 Jan 1965	Successful
			(-2) 25 Jan 1965	Successful
[redacted]				
1017	J-14	25 Feb 1965	(-1) 2 Mar 1965	Successful
			(-2) 6 Mar 1965	Successful
[redacted]				
1018	J-19	25 Mar 1965	(-1) 29 Mar 1965	Successful
			(-2) 31 Mar 1965	Successful
[redacted]				
1019	J-4	29 April 1965	(-1) 4 May 1965	Successful
			(-2) Not recovered	Command failure
1021	J-21	18 May 1965	(-1) 23 May 1965	Successful
			(-2) 28 May 1965	One inst. failed
[redacted]				
1020	J-20	9 June 1965	(-1) 15 June 1965	Successful
			(-2) 16 June 1965	Successful
[redacted]				
1022	J-22	19 July 1965	(-1) 24 July 1965	Successful
			(-2) 28 July 1965	Successful
[redacted]				
1023	J-23	17 Aug 1965	(-1) 22 Aug 1965	Successful
			(-2) 26 Aug 1965	Successful
1024	J-24	22 Sept 1965	(-1) 27 Sept 1965	Successful
			(-2) 2 Oct 1965	Successful
[redacted]				
1025	JX-28	5 Oct 1965	(-1) 10 Oct 1965	Successful
			(-2) 15 Oct 1965	Successful

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY (Cont.)

Mission	Camera	Launch	Recovery	Comments
9059	A-6	29 Oct 1963	3 Nov 1963	Successful
9060	M-24	9 Nov 1963		No orbit
9061	M-25	27 Nov 1963	Not recovered	Faulty separation
[redacted]				
9062	M-26	21 Dec 1963	26 Dec 1963	Successful
1004	J-5	15 Feb 1964	(-1) 18 Feb 1964	Successful
			(-2) 22 Feb 1964	Successful
[redacted]				
1003	J-6	24 Mar 1964		No orbit
[redacted]				
1005	J-8	27 April 1964	(-1) Not recovered	Power failure
			(-2) Not recovered	Power failure
[redacted]				
1006	J-9	5 June 1964	(-1) 8 June 1964	Successful
			(-2) 12 June 1964	Successful
9065	A-21	13 June 1964	19 June 1964	Successful
1007	J-7	19 June 1964	(-1) 24 June 1964	Successful
			(-2) 28 June 1964	Successful
[redacted]				
1008	J-10	10 July 1964	(-1) 14 July 1964	Successful
			(-2) 18 July 1964	Successful
1009	J-12	5 Aug 1964	(-1) 9 Aug 1964	Successful
			(-2) 14 Aug 1964	Successful
[redacted]				
9066	A-22	21 Aug 1964	27 Aug 1964	Successful
1010	J-11	14 Sept 1964	(-1) 19 Sept 1964	Successful
			(-2) 24 Sept 1964	Successful
[redacted]				
1011	J-3	5 Oct 1964	(-1) 9 Oct 1964	Successful
			(-2) Not recovered	Battery failure
[redacted]				
1012	J-13	17 Oct 1964	(-1) 20 Oct 1964	Successful
			(-2) 23 Oct 1964	Water recovery
[redacted]				

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY (Cont.)

Mission	Camera	Launch	Recovery	Comments
9034	A-5	15 May 1962	19 May 1962	Timer failure
9035	M-4	30 May 1962	2 June 1962	Successful
9036	M-5	1 June 1962	Not recovered	SRV sank
9037	M-6	23 June 1962	26 June 1962	Successful
9038	M-7	28 June 1962	2 July 1962	Successful
9039	M-8	20 July 1962	22 July 1962	Timer failure
9040	M-9	28 July 1962	31 July 1962	Successful
9041	M-10	2 Aug 1962	6 Aug 1962	Successful
9044	M-11	28 Aug 1962	1 Sept 1962	Successful
9042	A-10	1 Sept 1962	Not recovered	SRV sank
9043	M-12	18 Sept 1962	19 Sept 1962	Successful
9045	M-13	30 Sept 1962	2 Oct 1962	Successful
9046	A-9	9 Oct 1962	13 Oct 1962	Shutter timer failure
9047	M-14	5 Nov 1962	9 Nov 1962	Successful
9048	M-15	24 Nov 1962	29 Nov 1962	Successful
9049	M-16	4 Dec 1962	Not recovered	SRV sank
9050	M-17	15 Dec 1962	17 Dec 1962	Successful
9051	M-18	8 Jan 1963	11 Jan 1963	Water recovery
9052	M-20	28 Feb 1963		No orbit
8001	L-1	18 Mar 1963		No orbit
9053	M-19	2 April 1963	4 April 1963	Successful
9055	A-12	26 April 1963		No orbit
8002	L-2	18 May 1963	20 May 1963	Decoder failure
9054	M-21	13 June 1963	16 June 1963	Successful
9056	M-22	27 June 1963	30 June 1963	Successful
[redacted]				
9057	M-23	19 July 1963	22 July 1963	Successful
8003	L-3	30 July 1963	1 Aug 1963	Successful
1001	J-1	25 Sept 1963	(-1) 29 Sept 1963	Successful
			(-2) Not recovered	Inverter failure
9058	A-11	29 Aug 1963	2 Sept 1963	Successful
[redacted]				
1002	J-2	23 Oct 1963	(-1) 26 Oct 1963	Successful
			(-2) Not recovered	Decoder failure
[redacted]				

SATELLITE PHOTOGRAPHIC RECONNAISSANCE FLIGHT SUMMARY

Mission	Camera	Launch	Recovery	Comments
9001	C-1	25 June 1959		No orbit
9003	C-2	13 Aug 1959	Not recovered	Low temperatures
9002	C-3	19 Aug 1959	Not recovered	Retro failure
9004	C-4	7 Nov 1959		No orbit
9005	C-5	20 Nov 1959	Not recovered	Eccentric orbit
9006	C-6	4 Feb 1960		No orbit
9007	C-7	19 Feb 1960		No orbit
9008	C-8	15 April 1960	Not recovered	Spin-up failure
Diagnostic		29 June 1960		No orbit
Diagnostic		10 Aug 1960	11 Aug 1960	Water recovery
9009	C-9	18 Aug 1960	19 Aug 1960	First film recovered
9010	C-10	13 Sept 1960	Not recovered	Capsule sank
9011	C'-1	26 Oct 1960		No orbit
9012	C'-2	12 Nov 1960	14 Nov 1960	No film recovery
9013	C'-3	7 Dec 1960	10 Dec 1960	Successful
9014	A-1	17 Feb 1961	Not recovered	Programmer failure
9015	C'-4	30 Mar 1961		No orbit
9016	A-2	8 April 1961	Not recovered	Vehicle unstable
9018	A-3	8 June 1961		No orbit
9017	C'-5	16 June 1961	18 June 1961	Water recovery
9019	C'-6	7 July 1961	9 July 1961	Successful
9020	A-4	21 July 1961		No orbit
9021	C'-7	3 Aug 1961		No orbit
9023	C'''-1	30 Aug 1961	1 Sept 1961	Successful
9022	C'''-2	12 Sept 1961	14 Sept 1961	Successful
9024	C'''-3	17 Sept 1961	Not recovered	No separation
9025	C'''-4	13 Oct 1961	14 Oct 1961	Successful
9026	C'-8	23 Oct 1961		No orbit
9027	C'-9	5 Nov 1961	Not recovered	Vehicle unstable
9028	C'-10	15 Nov 1961	16 Nov 1961	Successful
9029	C'''-5	12 Dec 1961	16 Dec 1961	Successful
9030	C'''-6	13 Jan 1962		No orbit
9031	M-1	27 Feb 1962	3 Mar 1962	Successful
9032	M-2	18 April 1962	20 April 1962	Successful
9033	M-3	28 April 1962	Not recovered	No chute—SRV sank

PHOTOGRAPHIC SATELLITE SUMMARY

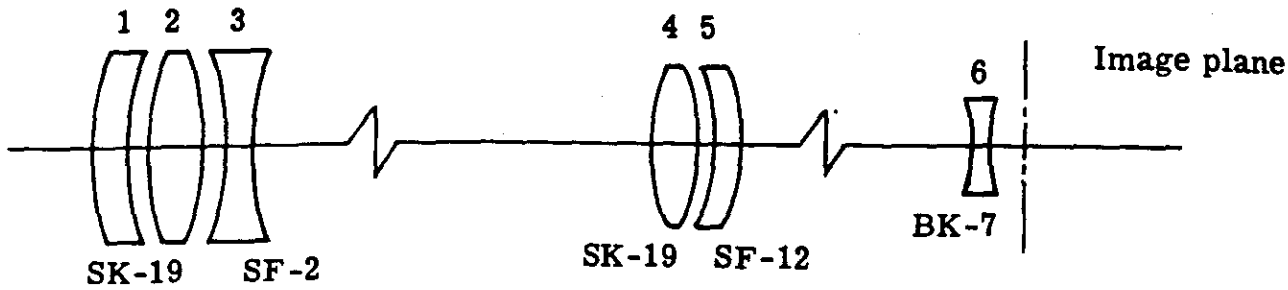
FILM RETURN HISTORY

Year	No. of Flights	System Ident.	Film Recovered, percent	Mission Flight Numbers
1959	5	C	0%	9001-9005
1960	5	C	20% 9009 1st recovery	9006-9010
	3	C′	33%	9011-9013
1961	7	C′	29%	9015, 17, 19, 21, 26-28
	5	C‴	66%	9022-25, 29
1962	1	C‴	0%	9030
	17	M	69%	9031-41, 43-45, 47-50
1963	9	M	66%	9051-54, 56, 57, 60-62
	2	J	50%	1001, 02
1964	13	J	73%	1003-15
1965	13	J	87.5%	1016-28
1966	9	J	87%	1029-37
1967	7	J	99%	1038-44
	2	CR	100%	1101, 02
1968	5	J	97%	1045-49
	3	CR	99%	1103-05
1969	3	J	94%	1050-52
	3	CR	83%	1106-08
1970	4	CR	94%	1109-12
1971	5	CR	Proposed flight schedule	1113-17

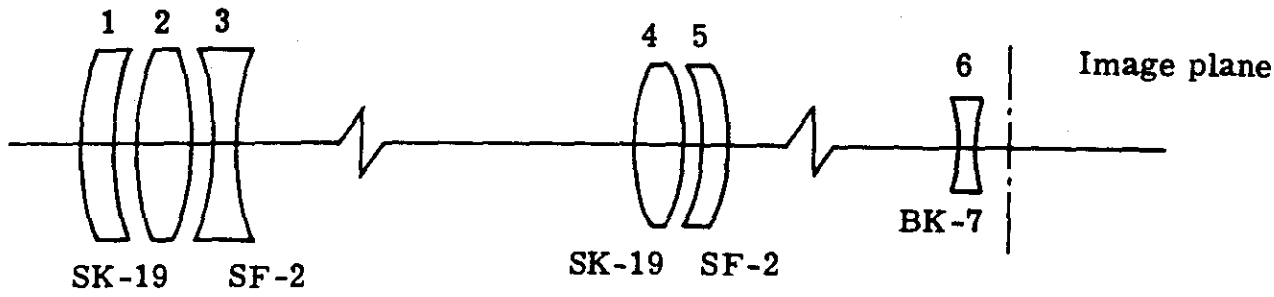
		Camera Type	Film Load
10	C	Mono Camera	40 lbs
10	C′	Mono Camera	40 lbs
6	C‴	Mono Camera	40 lbs
26	M	Stereo Camera	80 lbs
52	J	Stereo Camera/2 buckets	160 lbs
17	CR	Stereo Camera/2 buckets	160 lbs
121	Systems		

PETZVAL LENS DIAGRAMS

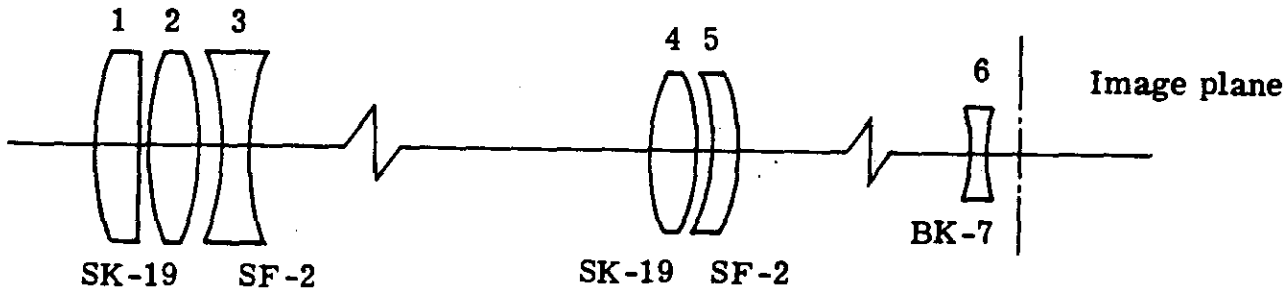
J-1, J-3, Type I



J-3, Type II



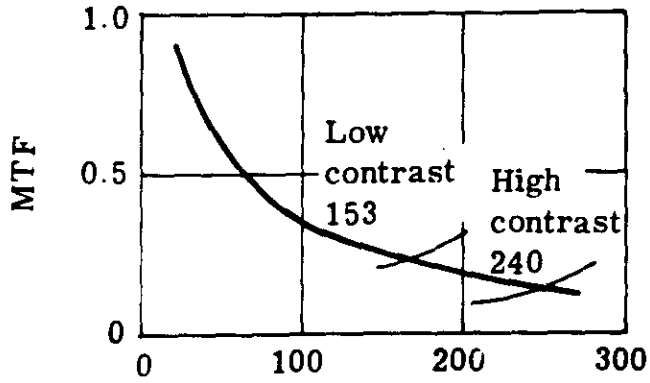
J-3, Type III, Type IV



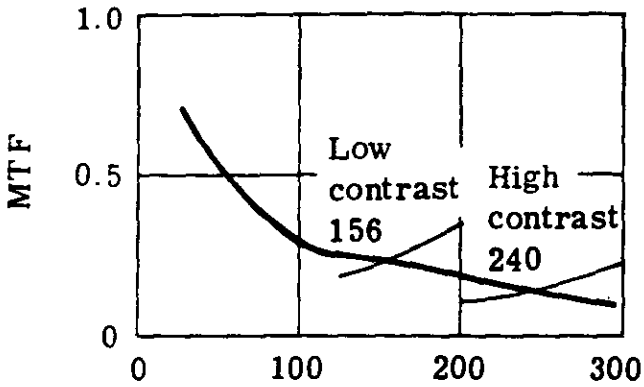
PETZVAL LENS

Design MTF

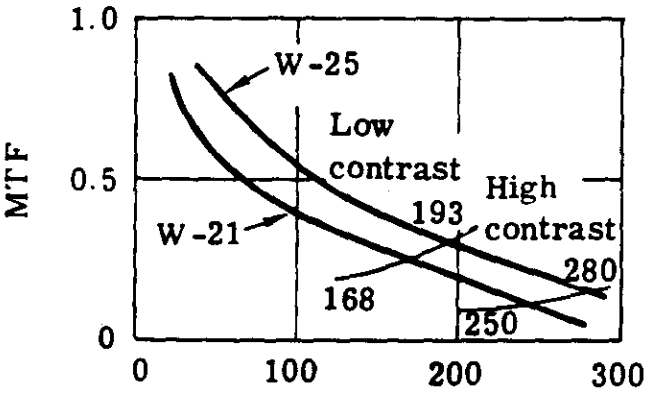
J-1, J-3, Type I



J-3, Type II



J-3, Type III, Type IV



Resolution, cycles per millimeter

Static Resolution Specifications

Filter	Resolution EK 3404 at 2:1	Resolution EK 3404 at 1,000
W-21	140 l/mm	240 l/m
W-25	None	None

Filter	Resolution EK 3404 at 2:1	Resolution EK 3404 at 1,000
W-21	140 l/mm	240 l/m
W-25	None	None

	Filter	Resolution EK 3404 at 2:1	Resolution EK 3404 at 1,000
Type III	W-21	150 l/mm	240 l/mm
	W-25	175 l/mm	240 l/mm
Type IV	W-21	160 l/mm	240 l/mm
	W-25	185 l/mm	240 l/mm

System	Comments
J-1	• Elements 1 and 3 relatively thin; fabrication problem • Element 3 undersize in diameter • Normal quality glass used • Loss of resolution with Wratten 25 filter
J-3 Type I	• Same characteristics as J-1 lens
J-3 Type II	• First three elements same diameter, alignment improved • Astronomical objective quality glass used, more homogeneous • Elements 1, 3, and 4 thickened for structural integrity • SF-2 (more readily available) replaces SF-12 in element 5
J-3 Type III	• Design central wavelength raised to 0.6500 micron to improve performance with Wratten 25 filter • Improved performance with Wratten 21 filter • Same glass types, glass quality, element thickness as Type II lens • Slightly different radii, airspaces
J-3 Type IV	• Same nominal design as Type III lens • PH-3, select precision quality for improved homogeneity, reduced optical path difference at image plane • Tighter tolerances and improved material for hardware used to mount optics • Surface quality of optical elements improved

PETZVAL LENS CHARACTERISTICS

System	Year	Approximate Glass Weight, pounds	Glass Quality	Design Wavelengths, microns (lower, central upper)
J-1	1964-1969	15	Normal (Schott RQ)	0.5461, 0.6200, 0.6900
J-3 Type I	1967-1969	15	Normal (Schott RQ)	0.5461, 0.6200, 0.6900
J-3 Type II	1967-1970	17	Precision (Schott AO)	0.5461, 0.6200, 0.6900
J-3 Type III	1968-1971	17	Precision (Schott AO)	0.6000, 0.6500, 0.7100
J-3 Type IV	1971	17	Select precision (Schott PH-3)	0.6000, 0.6500, 0.7100

CORONA LENS EVOLUTION

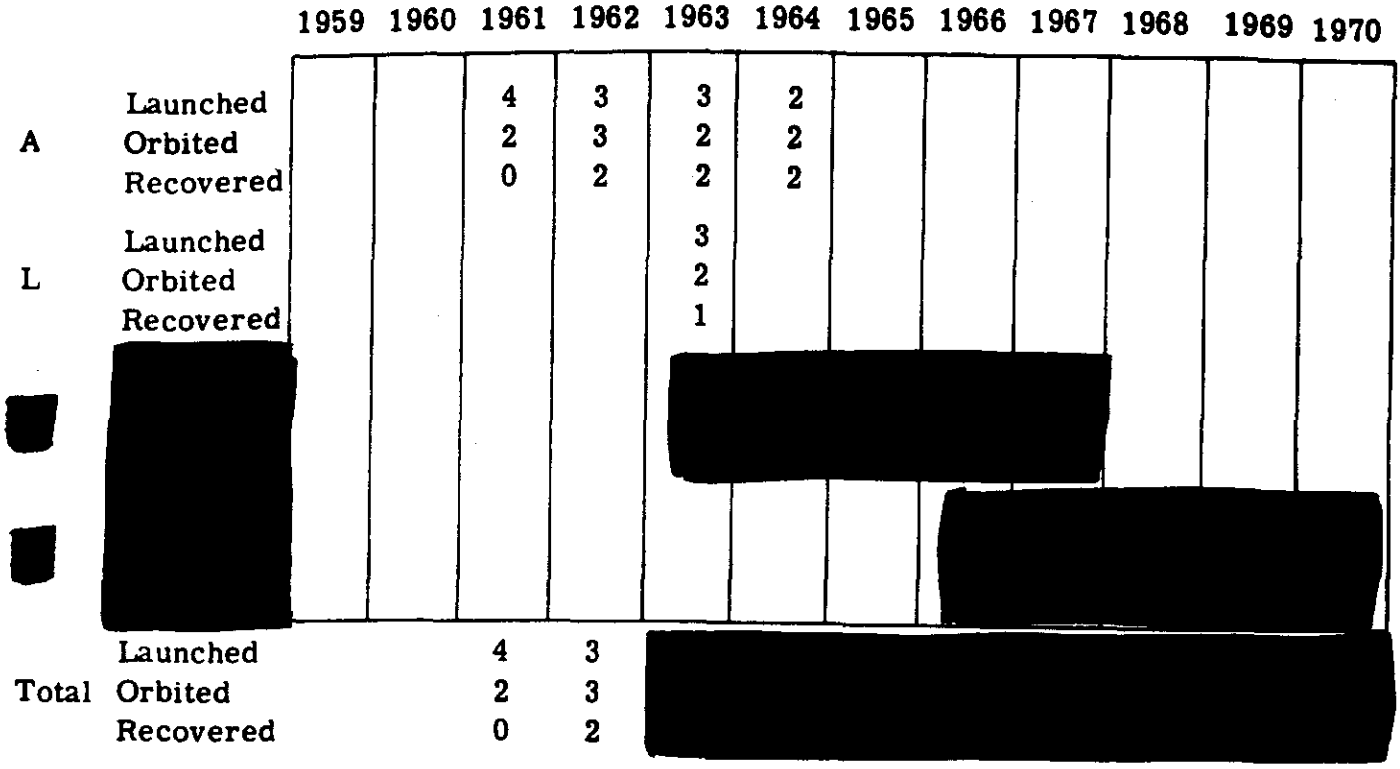
The first CORONA missions employed a Tessar lens design with a relative aperture of f/5.0. These lenses were fabricated by Itek and integrated into the C and C′ cameras by Fairchild. The C′′′ and subsequent camera systems were built entirely by Itek and employed a Petzval lens design with a relative aperture of f/3.5. All of these lenses were 24-inch focal length.

The physical characteristics of the Itek Petzval lenses have remained virtually unchanged through J-3. Performance of the lenses, however, has been continually upgraded from 1964 through present systems while necessitating no changes in either camera or vehicle interface. This was accomplished by taking advantage of improvements in materials, Itek computer programs, and improved fabrication and test techniques, coupled with an overall tightening of lens tolerances. The result of these upgradings from the J-1 through J-3 type IV lenses is a 15 percent improvement in low contrast resolution with a Wratten no. 21 filter and a 30 percent improvement in low contrast resolution with a Wratten no. 25 filter.

CORONA FILM RECOVERY BUCKETS LAUNCHED, ORBITED, AND RECOVERED PER YEAR

		1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
C	Launched	5	5										
	Orbited	3	3										
	Recovered	0	1										
C′	Launched		3	7									
	Orbital		2	4									
	Recovered		2	3									
C‴	Launched			5	1								
	Orbited			5	0								
	Recovered			4	0								
M	Launched				17	9							
	Orbited				17	7							
	Recovered				14	6							
J-1	Launched					4	26	26	18	14	8	6	
	Orbited					4	24	26	16	14	8	6	
	Recovered					2	21	25	16	14	8	6	
J-3	Launched									4	8	6	8
	Orbited									4	8	6	8
	Recovered									4	8	6	8
Total	Launched	5	8	12	18	13	26	26	18	18	16	12	8
	Orbited	3	5	9	17	11	24	26	16	18	16	12	8
	Recovered	0	3	7	14	8	21	25	16	18	16	12	8

ARGON, LANYARD, [redacted] AND [redacted] FILM RECOVERY BUCKETS LAUNCHED, ORBITED, AND RECOVERED PER YEAR



CORONA PERFORMANCE