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HISTORY

CORONA PROGRAM

GOVERNMENT CONTROL

In 1954, when the U-2 Program first got underway, it was anticipated that in one to one and one-half years the Soviets would be able to counter with a surface-to-air missile. By early 1958 the CIA was well aware of U-2 vulnerability and there was growing concern that the U.S. would have no capability for aerial surveillance. In March 1958, the White House approved the development of a satellite-borne camera and recoverable capsule, the beginning of the CORONA Reconnaissance Program.

Administratively, the CORONA Program was carried out under the authority of the Advanced Research Projects Agency (ARPA) and the CIA, with support of the Air Force. Proposal work in early feasibility investigations had been performed earlier as part of Air Force Weapons System 117L (Sentry). The CIA was charged with the development of the reconnaissance equipment, security, cover, and covert procurement. The Air Force contracted and directed the detailed procurements on the overt side. These included the booster, the AGENA 2nd stage, control networks, launch facilities, and the basic recovery vehicle development, under the Biomedical Program auspices.

There is disagreement as to exactly who did the detailed supervision of the cameras and associated equipment. A small group in the Ballistic Missiles Division in Los Angeles, basically charged with the photo systems under 117-L, believed they had much of this responsibility, a belief not shared by the CIA people concerned. Col. Lee Battle of the Space Systems Division was the official program director of the DISCOVERER Program, including both the Biomedical Program (cover program) and the operational flights. The CIA, under the director of Mr. Bissell, the DDP, was in formal charge of the technical direction of the payload, and represented Project Headquarters.

In February 1959 an inert THOR-AGENA was launched, followed by two non-camera-bearing test vehicles. The first camera was flown in June of 1959 but did not orbit. In November 1959, the ARPA responsibility was transferred to the Air Force under direction of the Secretary of Defense. Up to this time there had been no successful camera operations in orbit nor recoveries. By April 1960 camera operation had been accomplished, primarily because of a change from acetate based to polyester based film. A recovery system diagnostic program was instituted, culminating in August of 1960 with the first successful recovery from orbit. Later that month, a camera system was flown and film was

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recovered. During this period, and for several years thereafter, CORONA was looked on as a short-term back-up for the developing SAMOS Reconnaissance System,a spotting (point target) photographic system. Attachment A summarizes all CORONA flights from the DISCOVERER series and Programs [redacted] and [redacted] which were USAF cover numbers for the CORONA Program.

The original CORONA Program was extended without major system modifications (the C'), and the C''' was first flown in August 1961. Also in that year Dr. Charyk, the Under Secretary of the Air Force, authorized the development of a dual camera stereo configuration, known as "C MURAL". The SAMOS E-6 system was concurrently under development. A Configuration Control Board was established. The CCB consisted of a representative from Col. Battle's office, the CIA Operations Officer at Palo Alto, and a CIA Project Headquarters representative. A member of the NRO Staff joined the Board shortly thereafter. The first CORONA/MURAL System was flown in February 1962.

Rather early in the program, when several technical difficulties (electrostatic discharge fogging and radiation fogging) were encountered, a high-level team of government officers were assigned responsibility for problem solving. The committee known as the "Autumn Leaves Committee", was headed by Mr. Kiefer of CIA.

Direction of the program proceeded under the Configuration Control Board until early in 1964. In late 1963 and early 1964, however, the Director, NRO played an increasingly strong role; and, in January 1964, specifically directed that all changes to the payload system be approved by himself, following review by the CCB. The CCB was not formally dissolved, but has not met since approximately March 1964.

From the inception of the program until 1963, the day-by-day technical direction of all contractors was under the general supervision of Col. Lee Battle, first in Ballistic Missiles Division (BMD) and later in Space Systems Division (SSD). Col. Battle responded directly to Washington authorities, Mr. Bissell, Dr. Charyk, et al. The program was generally assigned (under the NRO) to Director, Program "B", in CIA. Battle's successor, Col. Worthington, responded somewhat to [redacted] reporting directly to the Under Secretary of the Air Force (Director, NRO).

Early in 1964, the CORONA Program was transferred to a new office, directly under and reporting to [redacted] had earlier been in charge of several photographic systems under SAMOS, most recently E-6. Thereafter, [redacted] took an increasingly strong role in the program, not using the CCB or associate mechanisms, and reporting to Washington office only through [redacted]

Dr. Flax was named D/NRO vice Dr. McMillan in October 1965. Following much debate and deliberation between CIA, A/F, and NRO, the EXCOM approved a CORONA Management and Organizational Plan on 26 April 1966. This plan was formalized and became effective 22 June 1966. It provided that CIA, in addition to being responsible for the development of the improved sensor, be given the responsibility for the total payload and the contracting and technical direction associated with obtaining the cameras, recovery vehicles, providing the payload housing and structure and the functional activities of assembly, test, integration, checkout, and certification of the payload for launch. Additionally, CIA was delegated the responsibility for mission planning, on-orbit camera operations, on-orbit diagnostics of payload, and post-mission analysis and evaluation. The plan continues in force through November 1967. Col. Murphy relieved [redacted] as the [redacted] Deputy Director for CORONA and [redacted] at Palo Alto assumed duties as Chief of the CIA Payload Sub-Assembly Project Office.

CORONA CONFIGURATIONS AND CONTRACTUAL OBLIGATIONS

As a result of discussions held early in 1958 with representatives of the Government for the development and production of a photo-reconnaissance system, (then referred to as the CORONA (C) Program) LMSC set up an internal organization. This organization was then known as Advanced Engineering Test Organization, later known as Advanced Projects (A/P), whose function was to handle the covert side of such a photo-reconnaissance system.

That section of the reconnaissance systems to be under the cognizance of A/P was determined to be the photographic payload system to be boosted into orbit by an AGENA vehicle with planned recovery of the nose cone containing photographic information. The photographic payload system was to include the following subsystems:

(a) One Satellite Recovery Vehicle subsystem (SRV)
(b) One reconnaissance camera subsystem
(c) All other structures and electrical subsystems necessary for the housing, controlling and interfacing with the recovery and camera subsystems.

In contemplation of the covert effort to be expended by A/P under the C Program, LMSC entered into arrangements, as of 1 April 1958, [redacted]

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[redacted]

CORONA "C"

The Lockheed Corp. (Missiles and Space Div.) was given a charter, as Prime Contractor, to develop the payload section and camera system. Lockheed in turn, selected the Itek Corp. as subcontractor to develop and manufacture the camera system. At this time Itek was primarily a lens producing company, consequently, they subcontracted most of the manufacturing work on the C camera to Fairchild.

The Air Force was assigned the responsibility for development and procurement of the booster, the second stage, the Recovery Vehicle, launch facilities and ground control network. The Air Force assigned this effort to AFBSD (Air Force Ballistics Systems Div.) under Col. L. Battle. AFBSD selected the Lockheed Missiles & Space Co. (then Division) to develop the second stage (AGENA) and Recovery Vehicle. Lockheed in turn issued a subcontract to the General Electric Co. to develop and manufacture the Recovery Vehicles. The Recovery Vehicle was to be developed and manufactured under the cover of the Biomedical Program. The Douglas "THOR" was selected for the booster because of availability and capability.

This organizational structure (See. Fig. 1), was retained through the C, C' and C''' Systems.

The C camera was a scanning panoramic instrument with an oscillating lens cell. 70mm film was fed from a supply spool through suitable drive mechanisms to a curved platen area where it was exposed. The exposed film was then fed into a take-up spool in the recovery system. Camera rate and hence velocity over height (V/h) ratio was fixed and prelaunch selected. Image motion control was fixed mechanically to the V/h ratio. Two horizon cameras were used for attitude determination.

The main lens was a 24" focal length f 5.0 high acuity optical system suitable for a 70 mm slit format. Exposure time was preset at 1/500, 1/1000 or 1/200 sec. Time was recorded on the film by photographing the numbers displayed on a system clock known as a Digitote.

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[redacted]

The structure was of a thermally shielded conic fairing with 3 pyro activated ejectable photographic doors, light tight boots, and harnesses as required. The recovery system used Mark IIA SRV with single parachute, spin rockets, chaff radar detection, and seawater dye marker and were capable of retrieving 20 pounds of film.

The AGENA A served as the second stage and orbital stable platform and the THOR served as the booster.

The C system was designed for an altitude of 100 n.m. with a duration of mission of 1 day. The ground resolution goal was 20-25 feet.

The C Program contract was awarded to A/P for twelve flight systems and two spares on 25 April 1958, retroactively effective 15 March 1958. Two of the flight camera subsystems were delivered to the Government for storage. The hardware structures for these two flight systems were transferred to Sunnyvale and expended on diagnostic flights. The other ten flight systems were launched with the following results:

Four failed to achieve orbit.
Four failed on orbit and no separations took place.
One capsule separated but was not recovered.
One capsule was successfully recovered.

The first C flight system was launched on 25 June 1959 and the tenth on 13 September 1960.

CORONA "C Prime"

The C Prime camera system was an upgrading of the original C configuration. The changes involved the incorporation of a more capable V/h compensation system and several modifications to the recovery system.

The mission duration was extended to two days, and the SRV's now carried a load of 40 lbs. of film, and redesignated the Mark IV configuration.

The C Prime (C') Program contract was awarded to A/P as of 26 July 1959 for eight flight systems as developed under the C Program with design improvements to increase reliability and photo quality. The quantity of flight systems was later contractually increased from eight to eleven. The subcontract arrangements under the C' Program were the same as those under the C Program. One of the

C' flight systems was delivered to the Government for storage. The other ten flight systems were launched with the following results:

Four failed to achieve orbit.
One capsule separated but was not recovered.
Five capsules were recovered.

The first flight system was launched on 26 October 1960 and the tenth on 15 November 1961.

ARGON

The ARGON System was administered completely through [redacted] inasmuch as it was a mapping rather than a reconnaissance system. [redacted] awarded Lockheed a prime contract for the development and procurement of the payload subsystems including the cameras and SRV. The cameras were subcontracted to Fairchild and the SRV subcontracted to General Electric (See Fig. 2).

General Electric became as Associate Contractor in early 1961 and Fairchild was issued an associate contract (middle of 1963) for the A21 through A24 payloads. Of these four systems, two were flown and two were put into Government storage. The last ARGON System was flown in August of 1964.

This system consisted of a pressurized mapping camera composed of a terrain lens and a stellar lens. Film was fed from the supply spool through suitable drive mechanisms to the terrain and stellar platens where it was exposed. The film was then fed through a pressurized film chute to the SRV take-up cassette. 40 pounds of unperforated thin base 3.0 mil mylar, 5 inch film of type EK SO 102 was used.

The terrain portion of the camera consisted of a Geocon 3 inch focal length f/2.5 lens with a Wratten #12 filter. Exposure time was set at 1/500 second. The stellar portion consisted of a 3 inch focal length f/2.0 lens with an exposure time of 2 seconds. The two exposure times were synchronized to within .001 second of the mid points of their times.

Time was recorded on the film by illumination of lights powered by a Digital Time Interval Recording Clock. Other data information was recorded on the film such as pitch attitude, roll attitude, direction of flight indicators, shrinkage markers, optical fiducials, camera system number, and vacuum-to-platen status indication.

An AGENA served as the second stage and orbital stable platform and a THOR served as the booster stage.

Gross vehicle attitude was determined by the pitch and roll signals received from the AGENA, then recorded on film.

The payload structure was a thermally shielded conic fairing housing the camera system, light tight boots, pressurized film chute, harnesses, and other instrumentation. There were two optical doors that were blown off during ascent.

The recovery system was a Mark V SRV, dual parachute, cold gas spin systems.

This system was designed to function at an altitude of 165 nautical miles to a duration of six days. Resolution of 40 lines per millimeter for the terrain and stellar lens was the design goal.

CORONA (C''')

It should be noted at this point that the camera subsystems utilized under the C, C', C''' and A Programs were single camera subsystems which furnished only monoscopic photography. Under the M and J Programs, hereinafter discussed, dual camera subsystems were utilized by which stereoscopic photography was obtained.

The C''' camera was a single scanning panoramic instrument with an oscillating element in the optical system. Film was fed from a lightweight supply spool through suitable drive and metering mechanisms to a curved "rail" structure where it remained stationary during exposure. The lens cell scanned to present the image on the film. The film was then fed to a take-up cassette in the recovery subsystem. Image Motion Compensation was accomplished mechanically by causing the lens system to move opposite to the direction of flight during scan and then returned for the next cycle. Two horizon cameras with 90 mm focal length and shutter speed of 1/200 second were used for attitude determination. Velocity over height (V/h) input to the camera was accomplished by a motorized potentiometer which had 10 start and stop levels that were selectable by real time command.

Unperforated thin base 3.5 mil mylar 70 mm film of Type EK SO 221 and 8402 were used. The supply consisted of 40 pounds of film.

The main camera lens was a 24 inch focal length f/3.5 Petzval type system suitable of covering a 70 mm slit format. A Wratten 12 filter was used. Preset slit width exposure times were provided.

Time was recorded on the film by photographing the numbers displayed from the system clock. Time marks of 160 cps were also recorded on the film. Other data information such as fiducials, camera serial number, center of format marker, and shrinkage markers were recorded on the film.

Commands to the camera were stored on-off commands, stored V/h step commands, real time V/h program command, real time and stored recovery commands. Telemetry information consisted of signals as V/h readout, voltage, film footage, light leak sensors, temperature and other operational and diagnostic information.

The payload structure was a thermally shielded conic fairing housing the camera, film supply, light tight boots, harnesses, and instrumentation. There were three optical doors that were blown off during ascent. The SRV was attached to the fairing.

A single recovery system was used, the Mark IV SRV with a dual parachute and a cold gas spin system.

An AGENA served as the second stage and orbital stable platform and a THOR served as the booster stage.

This system was designed to operate at an altitude of 100-110 nautical miles for a duration of four days. Resolution of 130 lines per millimeter was the design goal.

The C Triple Prime (C''') Program contract was awarded to A/P as of 27 June 1960, retroactively effective 7 June 1960, for six flight systems as developed under the C Program with design improvements to increase reliability and photographic quality. The six flight systems were launched with the following results:

One failed to achieve orbit.
One failed on orbit.
Four capsules were recovered.

The first C''' flight system was launched on 30 August 1961 and the sixth on 13 January 1962.

CORONA "Mural"

The Mural (M) Program contract was awarded to A/P as of 9 August 1961, retroactively effective 20 March 1961, for six Photographic Reconnaissance Satellite Systems with dual C''' type camera systems, capable of furnishing stereoscopic photography.

With the advent of the "C Mural" Program, the contractual arrangement was revised such that Lockheed, Itek and General Electric became associate contractors on their respective subsystems. Additionally, all responsibility for the Payload section (forward of the AGENA/Payload interface) became a CIA responsibility (see Fig. 3). A "Systems Engineering and Technical Direction" (SETD) contract, administered by [redacted] (formally AFBSD) was established with Lockheed. The primary purpose of the SETD organization was to guarantee an optimized total system design.

In November 1962, the SETD contract under [redacted] was terminated and a "Systems Engineering" (SE) contract issued under the CIA (see Fig. 4). This SE contract continued through August 1964, at which time the development work had been completed on the M, L, and J Systems.

The "M" camera system was a pair of 24 inch focal length panoramic instruments mounted in a 30 degree convergent stereo angle. 70 mm film was fed from a double spool film supply cassette (capacity 80 pounds of film) with one of two film webs going to each instrument through a suitable drive system, rollers, and clamps. The film was panoramically exposed through 70 degrees of lens cell assembly rotation and then fed to a double spool take-up cassette in an SRV. Simultaneous operation of both instruments was required for stereo photography.

Prime attitude information was provided by one Stellar/Index camera utilizing 70 mm film with a 1.5" focal length f 4.5 lens for index (terrain) information and 35 mm film with an 85 mm focal length f 1.8 lens for attitude information. The back-up attitude information is provided by the horizon cameras with a 90 mm focal length f 6.8 lens.

The system was designed for nominal altitudes of 110 nautical miles with mission duration up to 4 days. Dynamic resolution was 80 to 110 lines per millimeter.

The quantity of flight systems to be furnished under the contract was later increased to twenty-two. The twenty-two flight systems were launched with the following results:

> One failed to achieve orbit.
> Three capsules separated but were not recovered.
> Eighteen capsules were recovered.

The first M flight system was launched on 27 February 1962 and the twenty-second on 26 June 1963.

CORONA "Lanyard"

The Lanyard (L) Program contract was awarded on 2 August 1962 retroactively effective 22 February 1962, for five Satellite Photographic Reconnaissance Systems (with stereoscopic photographic capabilities) with the camera subsystems to be furnished as GFE by Itek as an Associate Contractor and with the SRV's to be furnished by G.E. also as an Associate Contractor (see Fig. 4). Such contract also provided that A/P should furnish Systems Engineering for the Government through August 1963. The number of flight systems to be furnished was later contractually increased from five to eight and the Systems Engineering period of performance amended to be from 22 February 1962 through 31 October 1962.

Commands consisted of recovery commands plus stored and real time commands to operate a decoder in the "L" system. The decoder selected operate programs and controlled the roll joint. Telemetry consisted of continuous and commutated channels transmitting diagnostic and operational data.

The "L" was a panoramic spotting camera with an oscillating lens cell viewing a large mirror which was aimed at a 45° angle toward the earth. Movement of the mirror enabled the system to produce stereo or mono photography. The 5" film was fed from a supply spool (capacity 8000 feet or 80 pounds of film) to the platen for exposure and thence to a take-up cassette in the recovery system. Suitable servo controlled drive rollers effected the film movement. Because of the limited scan angle of the lens, a roll joint was incorporated in the structure to increase the scan capability. The effective focal length of the optical system was 66".

Time was recorded on the film by means of a data head driven by the digital recording clock generator. Other bits in the data head recorded attitude, roll steering and rate data.

The system included a Stellar/Index camera to provide pitch and roll information and to provide panoramic terrain correlation.

Payload structure consisted of a 60" barrel and a fairing. On the aft end of the barrel was a counter balanced roll joint enabling the entire payload to rotate to the various angles upon command. All structures were thermally shielded.

The recovery system used a modified Mark VA SRV with double parachute and cold gas spin system.

The AGENA D served as the second stage and orbital stable platform and the Thrust Augmented THOR (TAT) served as the booster.

The system was designed for a 112 n.m. altitude with a mission duration of 4 days. The ground resolution was 4 to 5 feet as a design goal.

On 23 October 1963 the contract was partially terminated and the number of flight systems was reduced from eight to those already launched, viz. three, which had had the following results:

> The first, launched on 18 March 1963, failed to achieve orbit.
>
> The second was launched on 18 May 1963 and the capsule was recovered.
>
> The third and final was launched on 30 July 1963 and the capsule was recovered.

<u>CORONA "J" and M Follow-On</u>

A contract was awarded on 18 March 1963, retroactively effective 1 July 1962, for the development and production of twenty Photographic Reconnaissance Satellite Systems under the CORONA/J Program. The contractual organization remained as shown in Fig. 4. The major difference between the J Program and predecessor C Programs was that the J System included two-re-entry capsule subsystems instead of one. These two SRV's increased the film capacity to 160 pounds or 16000 feet. The system was designed to be "deactivated" or stored on orbit in a passive mode for up to 21 days. The goal was to expose the film supply and load the recovery vehicle at two different time spans for a single launch.

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Major redesign of the command and control subsystems was required to accommodate the expanded operational requirements. The V/h programmer capability was also greatly expanded.

As of 23 January 1962, six M systems were added to this contract and, as of 14 June 1965, two of these M systems (M27 and M28) were transferred in an "as is" condition to a follow-on J Program for conversion to the J System configuration. The contracting arrangements under this contract were the same as those under the M Program (Fig. 4). The twenty J systems (forty capsules) were launched with results as follows:

One system (two capsules) failed to achieve orbit.
Six capsules were not recovered.
Thirty-two capsules were successfully recovered.

The first J system was launched on 24 August 1963 and the twentieth on 9 June 1965.

The four follow-on M systems (single capsules) were launched with results as follows:

One failed to achieve orbit.
One failed on orbit.
Two capsules were successfully recovered.

The first of the four follow-on M systems was launched on 18 July 1963 and the fourth on 21 December 1963.

System Engineering (SE)

A follow-on Systems Engineering contract was awarded to A/P as of 1 July 1963, and, by its terms, expired 17 August 1964.

A Follow-on

A follow-on A Program contract was awarded on 23 September 1963, retroactively effective 15 July 1963, for four A systems. Under this contract the camera systems were furnished by Fairchild Camera and Instrument Company as an Associate Contractor; the SRV's were furnished by G. E. also as an Associate Contractor and A/P furnished electrical boxes and acted as integrating contractor. The first of these follow-on systems was launched on 19 June 1964 and the capsule was successfully recovered. The second was launched on 21 August 1964 and the capsule was also successfully recovered. The first of the other two systems was sold to the Government in an "as is" condition on 4 September 1964 and the second was sold to the Government in an "as is" condition on 22 September 1964. Both of these systems were returned by the Government to A/P and were packed and shipped to Government storage.

L Follow-on

A follow-on L Program contract was awarded on 27 September 1963, retroactively effective 17 July 1963, for five L systems. However, this contract was terminated as of 23 October 1963 before any systems were produced.

Improved Stellar Index (ISI)

A contract was awarded to A/P as of 14 August 1964 to provide equipment and services to integrate an Improved Stellar Index Camera (ISI) as a part of the CORONA J Program. The ISI was furnished by Fairchild Camera and Instrument Company as GFE and after completion of testing, it was returned to Fairchild. The contract was completed in October 1965.

Systems Engineering

A contract for Systems Engineering was awarded to A/P by [redacted] as of 18 August 1964 and by its terms expired 30 April 1966. As of 1 May 1966 LMSC was awarded a small level-of-effort System Integration contract by [redacted]

A follow-on contract for nineteen additional J systems and for the conversion of M27 and M28 to the J configuration as JX 27 and JX 28 was awarded on 23 November 1964, retroactively effective 3 March 1964. Fig. 4 shows the contractual organization. As of the close of business 30 June 1966, the uncompleted efforts of A/P's Operations and Analysis and Payload Integration under the follow-on J Program were transferred to a separate level-of-effort contract under the CIA. This contract is planned to be renegotiated on an annual basis. The nineteen follow-on J systems and JX 27 and JX28 (forty-two capsules in all) were launched with results as follows:

One system (two capsules) failed to achieve orbit
Forty capsules were successfully recovered.

The first of the follow-on J systems were launched on 18 May 1965 and the twenty-first on 16 June 1967.

In April 1965, Itek commenced work under contract to provide a Pan-Geometry capability for the J-1 cameras. This would allow the mapping and charting community a means to more accurately determine geographic location of targets on the CORONA photography. P.G. consisted of providing rail holes with appropriate lamps so that a reseau could be determined and an IMC trace would be imaged on the pan camera film. Using calibrated data from the cameras, the cartographic community would be able to reconstruct the internal geometry of the camera system. A design goal would be to have the accuracy to provide maps in 1 to 50,000 scale range.

In September 1966 the first CORONA PG Mission was flown. The results were generally favorable but the anomalies present were sufficient not to allow the using community to conduct an evaluation as to PG useability. The second PG flight in November 1966 gave sufficient data on which to base a user evaluation. The results of which were mixed pro and con PG. There has been no agreed upon DIA position on the useability of PG for mapping and charting purposes to this date. The J-3 system still retains a PG capability should it be required.

A second follow-on contract for eleven additional J systems was awarded on 21 September 1966 under the contractual organization of Fig. 4. As of this date (15 November 1967) three of these systems (six capsules) have been launched and successfully recovered. The first of the second follow-on systems was launched on 9 May 1967.

CORONA "J-3"

In July 1965, Itek was awarded a contract for thirteen and one half J-3 camera subsystems and in June 1966 A/P and G.E. were awarded contracts, (retroactively effective 23 March 1966) for thirteen J-3 photographic reconnaissance satellite systems and SRV's, respectively. One of these systems was launched on 15 September 1967 with both capsules successfully recovered.

On 25 July 1967 A/P, G. E., and Itek received telegraphic awards for four additional J-3 systems.

The CIA retains the management responsibility for the J-3 Payload Space Structures, Pan Cameras, SRV, Integration responsibility for the Dual-Looking Improved Stellar Index Camera (DISIC) into the payload, payload software and on orbit payload commanding. [redacted] retained the management of the Booster, AGENA and launch facilities and ground control network as well as adding the responsibility of developing and procuring the DISIC. [redacted] assigned a contract (associate) to Fairchild Camera and Instrument Company to develop and manufacture the "DISIC" (See Fig. 5).

J-3 Camera System

The J-3 camera system is a pair of panoramic instruments, mounted in a 30 degree convergent stereo angle; each with a constant rotating lens cell. Film is fed from a double spool film supply (160 pounds, 16,000 feet capacity) with one of two film webs going to each instrument through a suitable drive system, rollers, and clamps. The 70 mm film is panoramically exposed through 70 degrees of lens cell assembly rotation and then fed to a double spool take-up cassette in one of two SRV's. Simultaneous operation of both instruments is required for stereo photography. IMC is provided by a "Nodding" cam and is proportional to the scan rate. The scan period is proportional to V/h and a V/h programmer provides an in-flight adjustable sinusoidal voltage to assure the correct scan periods. The J-3 camera subsystems retains the capability for panoramic geometry for mapping and charting. One DISIC system provides prime attitude information plus cartographic capability. Two horizon cameras on each instrument provide back-up attitude information.

Normally 3404 type film is used but a design goal exists to utilize SO 180, (camouflage detection), SO 230 (high speed), SO 340 (night photographic), or SO 380 (ultra thin base). UTB is planned for use on CR-5 and above.

The main lens is a Petzval 24" focal length f 3.5 optical system. Exposure time is in-flight selectable to provide one of four slit widths, plus a "failsafe" capability.

Time recording on the film is accomplished by a silicon light pulser (solid state) data head driven by an electronic digital recording clock generator. Additional data is recorded by conditioning of conventional pulsing or switching circuits.

A recoverable tape recorder is used to provide "center of format" times for each frame and other system flight data.

Prime attitude information is provided on 35 mm film by the DISIC with dual side-looking 3" f1, f2.8 lenses and indexing or cartographic information is provided on 5" film with a 3" f1, f4.5 lens. Back-up attitude information is provided by the horizon cameras with a 55 mm focal length f6.8 lens system.

Commands consist of stored On-Off commands, Real Time Commands, and stored recovery commands. Later J-3 configurations will have a new command system utilizing a digital shift register for increased operational capability.

Telemetry consists of commutated, multiplexed, or continuous data transmitted by the AGENA TM system.

The payload structure consists of a 60 inch diameter instrument barrel DISIC conic section, and fairing. Pyro actuated doors, light tight boots, and miscellaneous items are provided as required.

The recovery systems are two G. E. Mark V SRV's with sink valves, water seals, parachute, beacon, flashing light, etc.

AGENA D serves as the second stage and provides a stable orbital platform for the payload. THORAD A serves as the booster.

The system is designed for altitudes of 80 to 200 nautical miles with a mission duration of up to 14 days (A plus B mission). Dynamic resolution of up to 180 lines per millimeter is expected (5 - 6 feet at 90 n.m. altitude).

Figure 6 shows the envelope for the CORONA configurations.

CORONA ACHIEVEMENTS

The fact that CORONA was the first successful operational photographic reconnaissance satellite program has naturally led to a number of "firsts" when the achievements of the total program are listed. Of greater significance however, are the contributions made from a technical and intelligence standpoint in challenging the unknown and advancing the "state-of-the-art" in photographic reconnaissance and interpretation from orbiting satellites. Starting with the basic substantiation of the feasibility of gathering, via satellite, useful intelligence and geodetic data to the polishing of the exploitation techniques, the CORONA Program has been instrumental in developing the baseline and then adding to the store of knowledge.

The basic unknowns of areas such as the effects of extended duration flights in the environment of space, the effects of space radiation, the behavior of materials and the suppression of electrical discharge were explored within the program. The operational control concepts developed for CORONA lead the way for more sophisticated and complex systems within and outside the program.

In more specific terms, 112 flights, containing 157 capsules have been launched on all phases of the CORONA and ARGON Programs. Of these flights 73 have been successful, recovering 118 of the capsules.

The reliability achieved by the Program particularly in the last four years has been truly outstanding. The reliability figure of .977 has been computed for the major payload system equipment.

The ARGON Program represents the prime source of photographic data gathered for cartographic and mapping purposes. While the early flights were disappointing, the last five flights produced useable material which became the baseline for geodetic control.

As an associated development, the techniques for stellar photography and reduction for attitude determination were part of the ARGON and CORONA Programs. This method is now the standard for obtaining high accuracy attitude data.

The recovery system used today represents an evolutionary process from the first design. It is today a highly reliable subsystem and is the basic system used in all of today's operational programs which require a recovery system.

In all aspects of the technical challenge, data has been gathered adding to the general fund of knowledge and thus permitting the advanced capability systems to proceed with greater confidence of achieving their objectives.

CORONA is, and has been, the "work horse" for photographic intelligence. Figure 7 is a CORONA flight summary showing capsule recoveries and useable coverage in millions of square miles by year.

CORONA MILESTONES

March 1958 - CORONA Program Go-Ahead

April 1960 - 1st Camera System Launched

August 1960 - 1st Successful Air Recovery with Film

April 1961 - 1st ARGON System Launched

August 1961 - 1st C''' Flight

February 1962 - 1st Stereo Flight (Mural)

August 1963 - 1st Dual Bucket (C_{J1})

February 1964 - 1st Successful Recovery of 2 Capsules from a single launch.

Sept. 1967 - 1st Constant Rotator Flight (C_{J3})

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ORIGINAL DISCOVERER ORGANIZATION (CONTRACTUALLY)

March 1958 - Apr. 1961 - C, C', C''' Systems

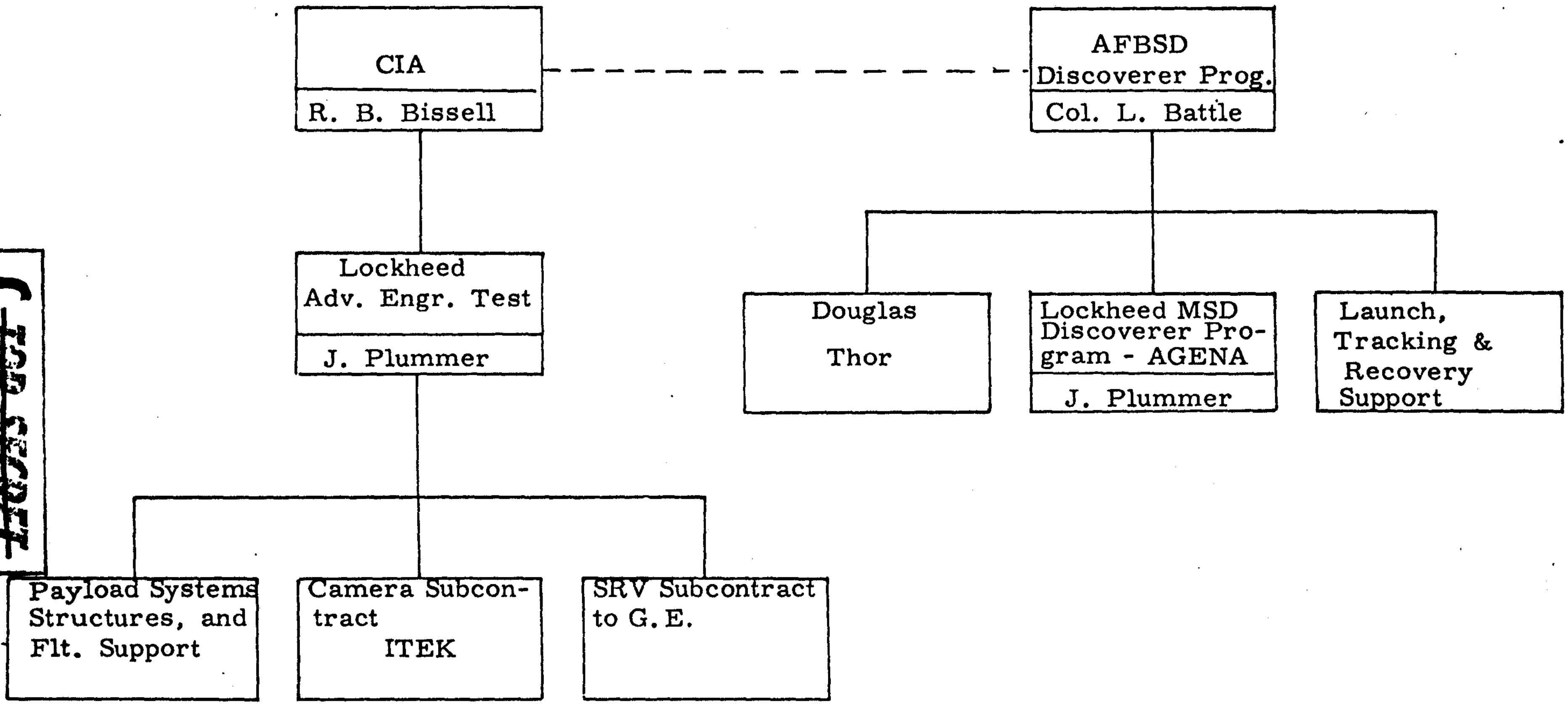
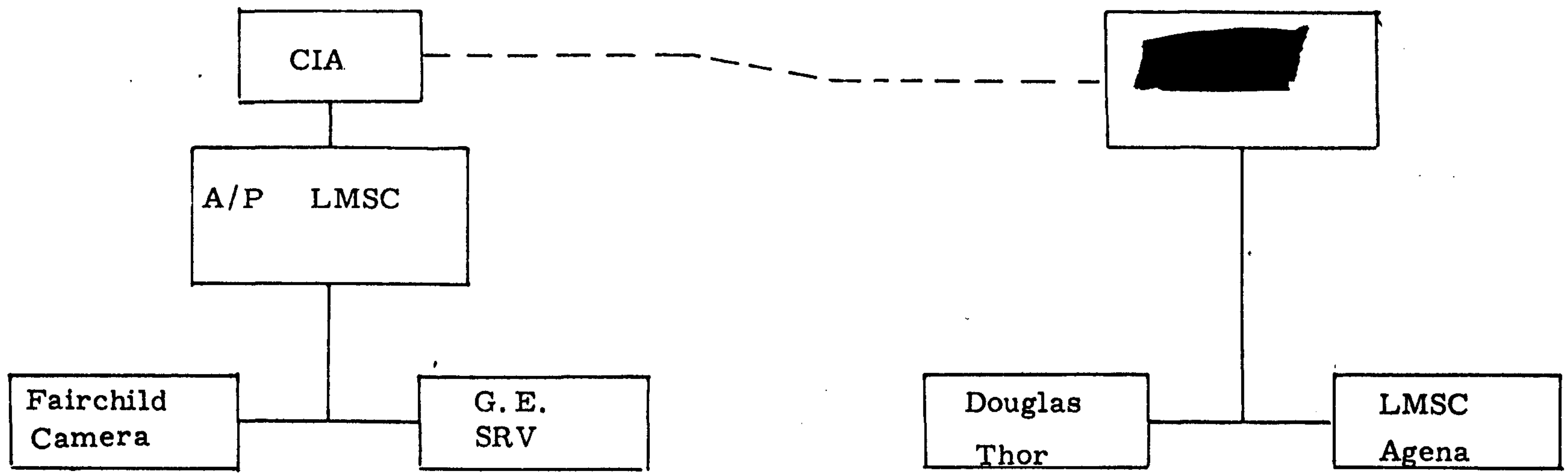


FIGURE 1

C ~~TOP SECRET~~ [redacted]

CONTRACTUAL ORGANIZATION - ARGON 1-12



CONTRACTUAL ORGANIZATION - ARGON 21-24

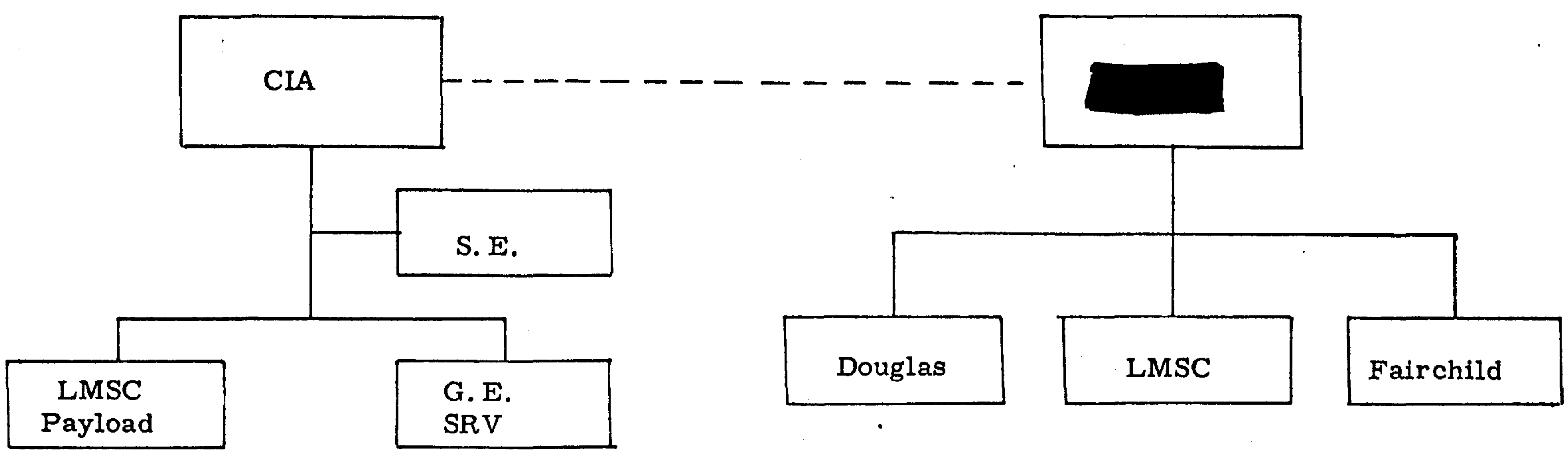


FIGURE 2

C ~~TOP SECRET~~ [redacted]

CONTRACTUAL ORGANIZATION (CORONA MURAL)

April 1961 - Oct. 1962

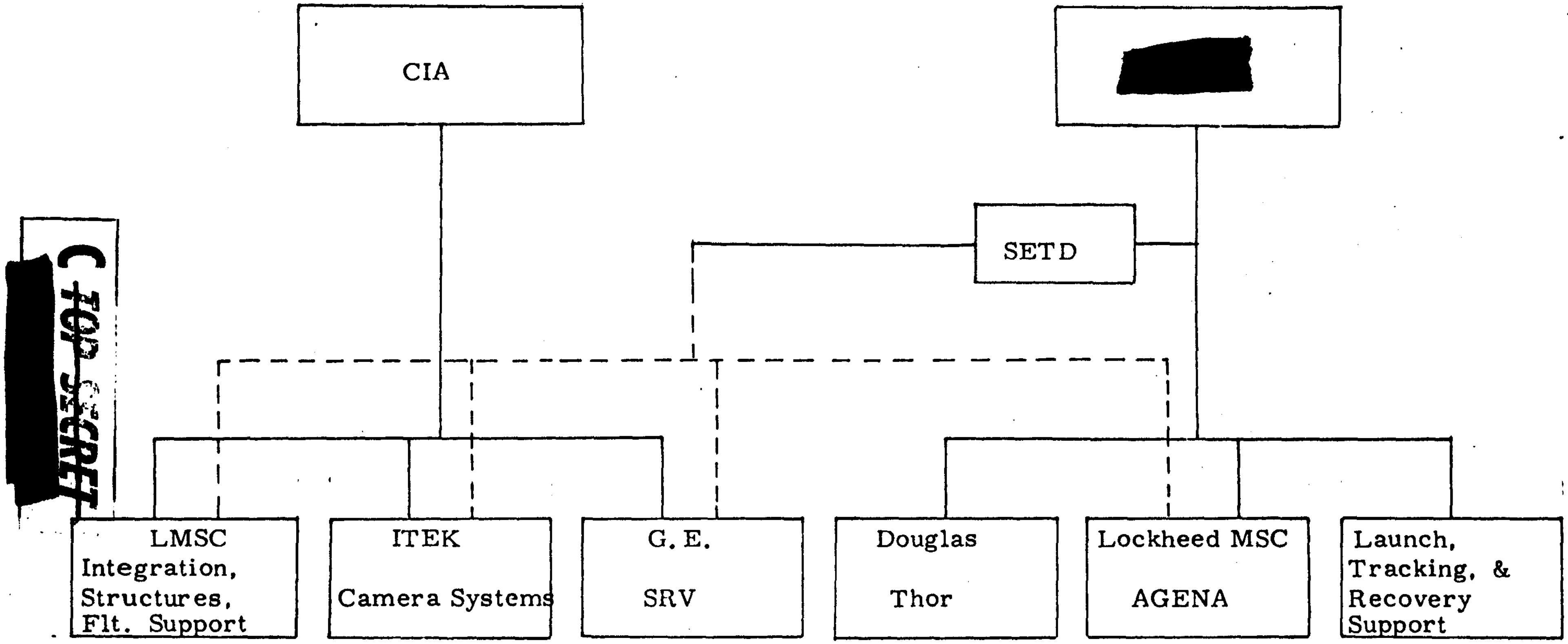


FIGURE 3

CONTRACTUAL ORGANIZATION (M, L, J Programs)

November 1962 - August 1964

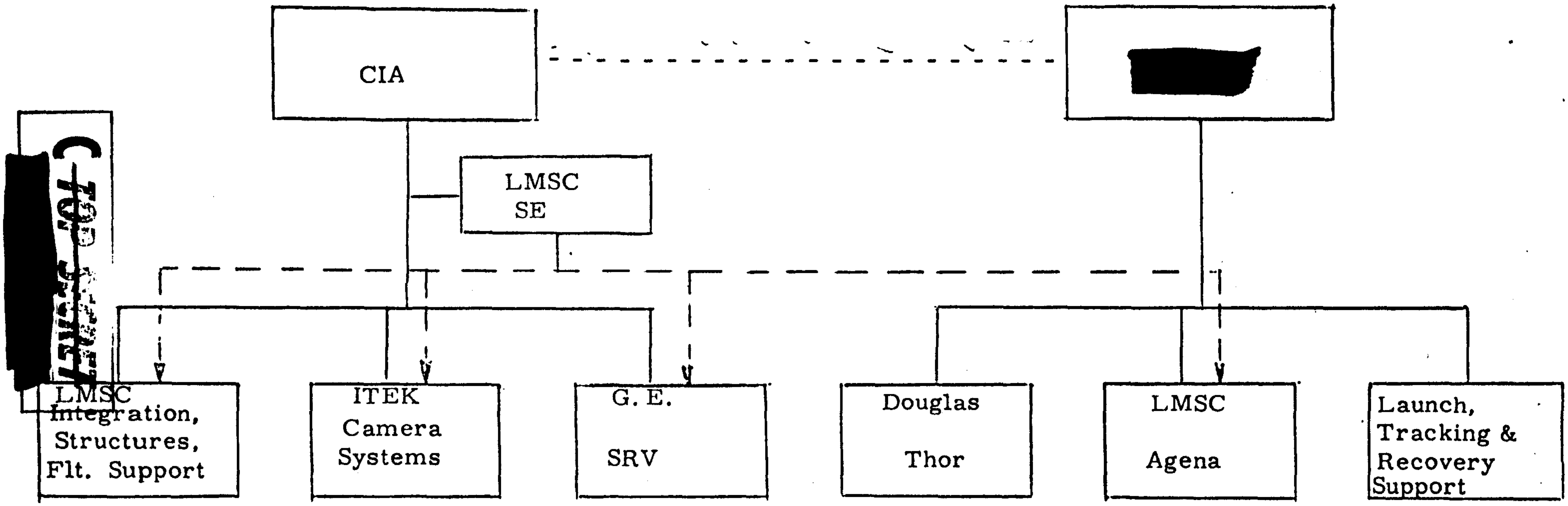
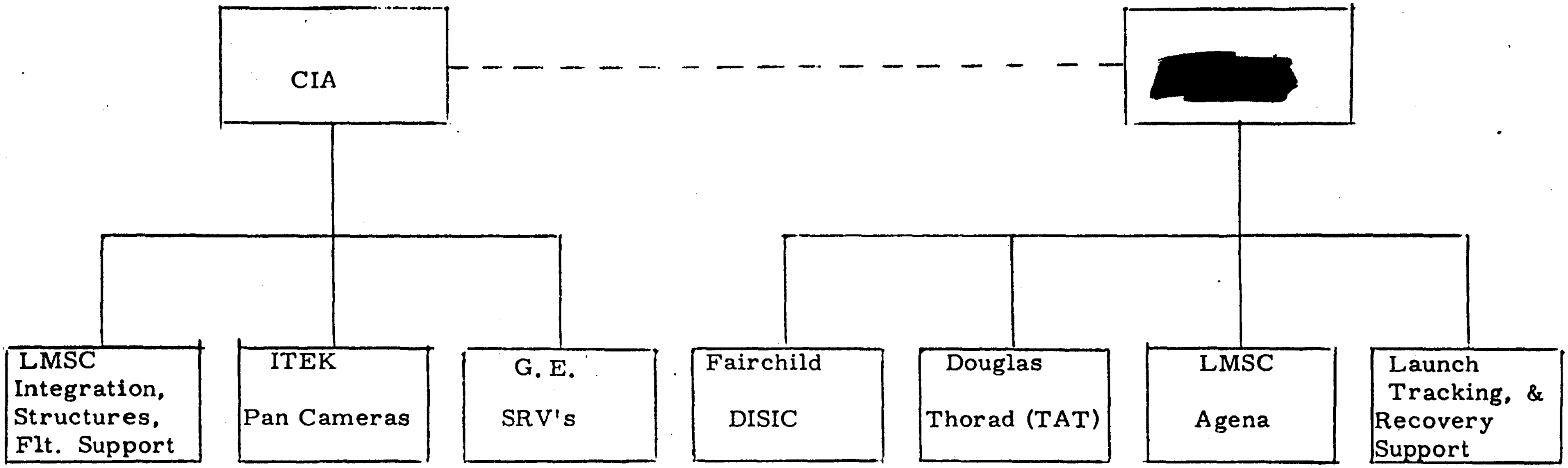


FIGURE 4

CONTRACTUAL ORGANIZATION (J-3 Program)

July 1965



C ~~TOP SECRET~~ [redacted]

FIGURE 5

INBOARD PROFILES

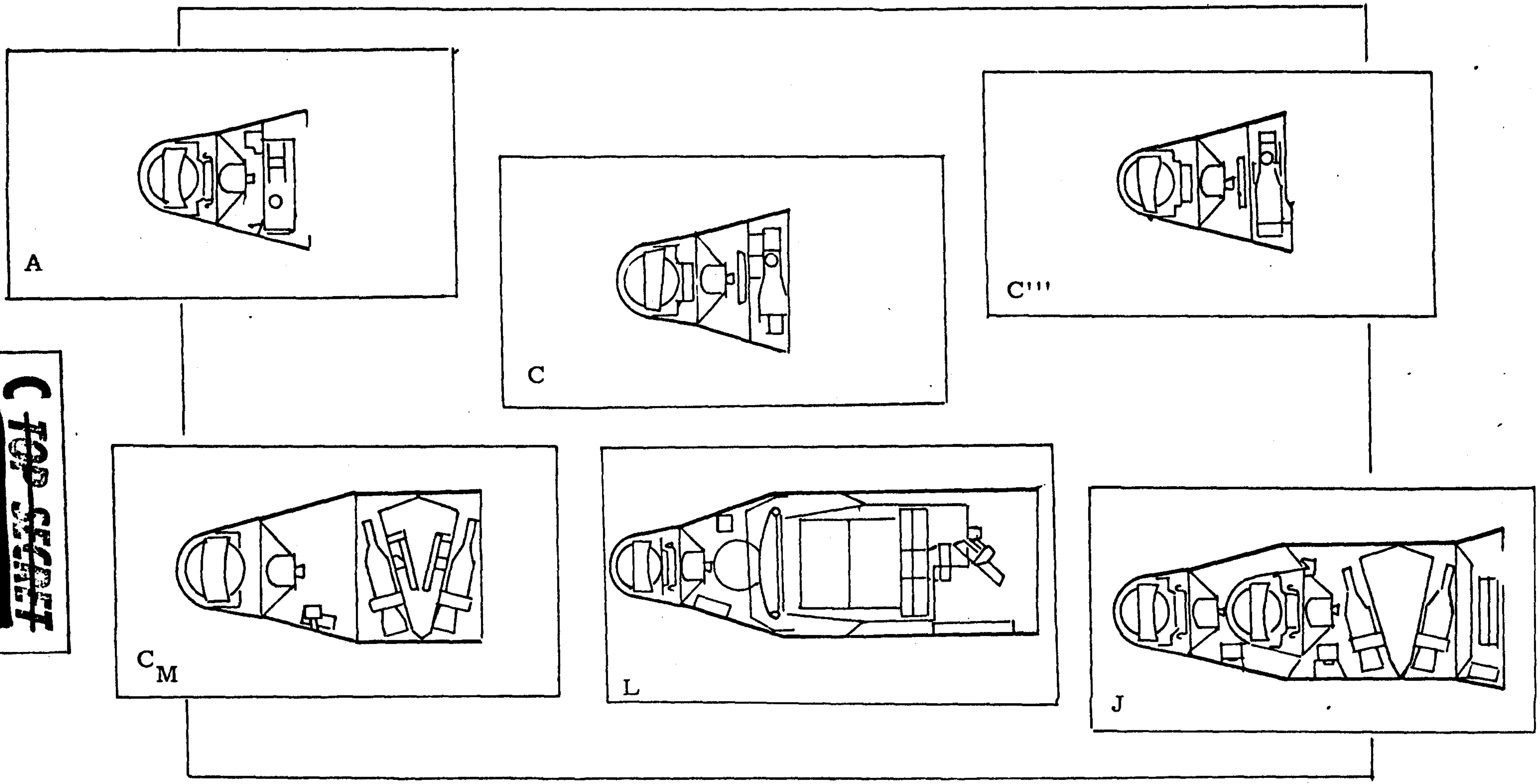


FIGURE 6

CORONA FLIGHT SUMMARY*

	1959	1960	1961	1962	1963	1964	1965	1966	1967
C	5	5							
C'		3	7						
C'''			5	1					
M				17	9				
J Capsules					4	26	26	18	16
Capsules Recovered	0	3	7	14	8	21	25	17	16
Useable Coverage N.M.^{2} x 10^6	0	2	12	59	40	85	96	68	64

* Less ARGON and LANYARD Flights

Figure 7