IBM CONFIDENTIAL

VOLUME - 1

Project Notebook

COPY NO. 69

MANNED ORBITING LABORATORY PROGRAM

Wm B Dixon

MOL PROJECT DIRECTOR

INTERNATIONAL BUSINESS MACHINES CORPORATION

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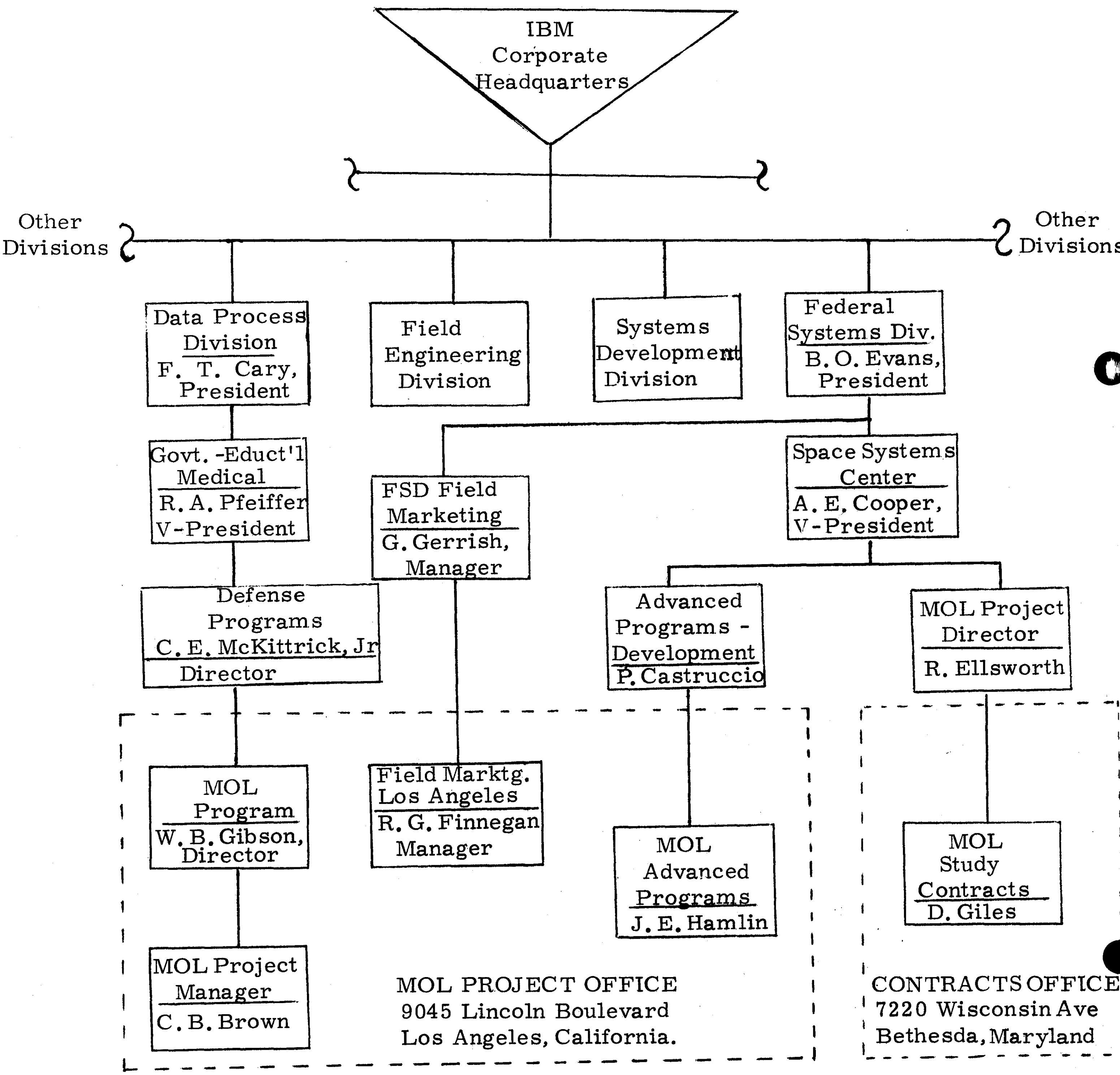
MOL PROGRAM ORGANIZATION CHART

November 15, 1965



FOREWORD

The Manned Orbiting Laboratory (MOL) Program was announced by President Johnson on August 25, 1965. This program represents the initial effort by the Department of Defense to determine the military effectiveness of man in space,as compared to previous programs by NASA, which have been oriented toward civilian scientific achievements and that man could abide in space.

The scope of the MOL Program is such that it is known to involve three regions, eight districts and nineteen branch offices, where IBM has either contractors and/or Governmental groups which have a part of or influence on the systems and equipment decisions. In addition, the Federal Systems Division (FSD) has major study contracts and implementation capabilities in both the space and ground-based areas. The anticipated special systems requirements will place heavy loads on the Systems Development Division, while unique maintenance responsibilities will require close Field Engineering (FE) Division attention.

A MOL Project Office has been established within the DP Division, in order to provide major assistance and guidance in DP's sale and installation of ground-based computer systems, as well as to provide a common Data Processing Division interface to FSD, SDD and FED. The project reports to Mr. C. E. McKittrick in the IBM Federal Region and may be addressed to:

MOL Project
IBM Corporation
9045 Lincoln Boulevard
Los Angeles, California 90045

Representatives of the various IBM Divisions, working in the MOL area, will all be located in a central office area. This joint effort will serve to optimize the IBM Corporation's response to MOL's requirements.

The purpose of this notebook is to communicate with the various IBM locations concerned with MOL. Prompt and timely information and action is essential. The project notebook will be updated weekly. Your constant inputs and corrections are essential if IBM is to make maximum use of its resources. You will be asked to make sales calls to check/verify/sample sales and technical problem areas for other IBM locations. Others will do the same for you, if you ask via the Project Notebook.

W. B. Gibson, Director,
MOL Program.

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SALES STATUS SUMMARY

Satellite Control Facility, Space Systems Division, U.S. Air Force

All sources of information at SSD have told us the RFP is written, signed and ready for release. Latest indications are that it will be released on or about August 1.

Shared memory Model 44's will be bid for the Remote Sites, and the 9020 still appears to be the best system for the Bird Buffer area. A final determination cannot be made on the Bird Buffer, however, until the RFP is received.

Mission Simulator

The Model 65 with a front-end 44 has been selected for the Mission Simulator. Originally, only one copy will be ordered for installation at Douglas. The decision to order a second copy for installation at the Western Test Range will be delayed until later this year, pending resolution of funding problems.

Airborne Computer

IBM has been selected to furnish a 4 Pi computer compatible with the 360 Model 44 for the on-board computer. A 360 Model 44 is being shipped to General Electric, Valley Forge, Pennsylvania, in September for their use in developing programs for MOL experiments.

Western Test Range

The Consolidated Telemetry Control Center proposal was delivered July 18, with a price of 1.933 million dollars. The system consisted of four FSD-built pre-processors (AMCS) tied into a 360 Model 44. We consider this proposal very responsive technically; however, it is roughly $250,000 greater in price than the customer has programmed for this system. There are five other competitors who submitted bids; however, we have not been able to determine equipments nor prices proposed.

Martin

The proposal was delivered July 5 to Martin-Denver for a System/360 Model 44 and two FSD-built pre-processors (AMCS). Martin is currently involved in a study funded by the Air Force to define a more active checkout system than DIMAC. This effort is going on in parallel with the evaluation of the proposals received for DIMAC. A decision will be made within approximately 30 days whether to contract for DIMAC or issue another RFP for this more active system.

ESTIMATED DELIVERY REQUIREMENTS

Est. Customer Delivery Date Required	Project Name	Equipment Type	DPOW Status
9/66	Airborne Computer Support	Model 44	FSD arranged
4 Q 66	SCF Checkout	Model 40 & 2250	Sub. 3/66
7/67	SCF Remote Sites	Duplexed Mod. 44's	Sub. 3/66
12/67	SCF Remote Sites	Duplexed Mod. 44's	Sub. 3/66
1/68	SCF Remote Sites	Duplexed Mod. 44's	Sub. 3/66
4/68	SCF Remote Sites	Duplexed Mod. 44's	Sub. 3/66
5/68	SCF Remote Sites	Triplexed Mod. 44's	Sub. 3/66
6/68	SCF Remote Sites	Triplexed Mod. 44's	Sub. 3/66
6/68	SCF Remote Sites	Triplexed Mod. 44's	Sub. 3/66
7/68	SCF Remote Sites	Duplexed Mod. 44's	Sub. 3/66
2 Q 67	SCF Bird Buffer	Triplex 9020	Sub. 3/66
4/67	Douglas Mission Simulator (Alternate to 2 Mod. 65's:	Two Model 65's One Model 75)	Sub. 3/66
4/67	Douglas Mission Simulator	One Model 44	Sub. 3/66
11/67	Second Increment Mission Sim.	One Model 44 & Two Model 65's	Sub. 3/66
2 Q 67	WTR Range Control	Model 65	Not Sub't.
2 Q 67	WTR Range Control	Three 1800's	Not Sub't.
4 Q 67	WTR Range Control	Two Model 65's	Not Sub't.
2/67	WTR Consolidated Telemetry Checkout System	One Model 44	
2/67	WTR Consolidated Telemetry Checkout System	Four FSD AMCS	
2 Q 67	Martin Vehicle Checkout	One Model 44	Not Sub't.
2 Q 67	Martin Vehicle Checkout	Three FSD AMCS	

OAR To Use Own Vehicles for OV Shots

Low batting average in program to date underscores risk of launching satellites as secondary payloads; eleven launchings planned for 1966

by Rex Pay

EL SEGUNDO, CALIF.—When *Titan III-C* failed to insert *Orbiting Vehicle 2-3* into orbit it lowered the Air Force Office of Aerospace Research ratio of successful orbital missions from one in four to one in five in 1965—and drove home the fact that it is risky to launch satellites as secondary payloads on booster development flights.

This year the situation is expected to change. OAR will make greater use of its own satellite launchers starting with the twin *OV1* satellite launch scheduled for Jan. 20.

Five types of *Orbiting Vehicles* are used in the Aerospace Research Satellite Program, which provides Air Force laboratories with a low-cost means of carrying instruments into space. In 1965, ARSP supported launching of 139 sounding rockets, seven space probes carried by *Scouts* and *Atlas* ICBM's, and five satellites. In 1966, 11 satellites are planned. Total OAR budget is about $10 million per year.

Vandenberg MOL Rumor Discounted

Air Force spokesmen say there is no truth to rumors at Cape Kennedy that the budget squeeze on the *Manned Orbiting Laboratory* (*MOL*) (M/R, Dec. 13, p. 7) will upset launch complex construction at Vandenberg AFB, resulting in an increase in the number of launches planned from the Cape. Speculation was that the Air Force had agreed to accept some polar orbit or payload weight restrictions rather than delay the entire program. This was denied. Air Force says, however, that it still plans to launch at least the first one or two *MOL* flights from the Cape, beginning late this year (M/R, Jan. 3, p. 7).

UTC Awaits New 120-in. Awards

United Technology Center still is awaiting further contracts for its 120-in. solid motor. Two 120-in. programs are planned, but neither has been given the go-ahead. One is for the seven-segment motor to be used in West Coast launches of the *Manned Orbiting Laboratory*. The other is for a two, or possibly three, segment strap-on for *Titan III-D*. Meanwhile, UTC has been forced to lay off another 200 workers. This brings employment down to less than 1,500 from 3,100 some 18 months ago.

Decision on Titan Launch Expected

AN AIR FORCE decision is expected within the next two weeks regarding the future launch schedule of the *Titan III-C*.

The booster's third stage—the Transtage—and attitude-control system (ACS) have both experienced malfunctions in the past two flights which have resulted in failure of the launch vehicle to complete those missions that come close to demonstrating *Titan's* full capability (M/R, Jan. 3, p. 14).

Both failures have occurred in the final phase of the mission, when the Transtage was to place payloads into a near-synchronous altitude (18,200 n. mi.) orbit.

The most recent failure, during the Dec. 21 flight, has now been traced to faulty valve operation associated with operation of the N5 rocket in the Transtage ACS.

The valve, according to the Air Force, leaked either fuel or oxidizer, resulting in complete loss of one of these fluids. The ACS then became inoperative, causing the stage to tumble and rendering the guidance system ineffective. As of late last week, the Air Force still had not pinpointed the cause of the valve failure.

During the past week, *Titan III-C* program officials met on the West Coast to attempt to determine the extent of the *Titan's* problems and generate a recommendation regarding the next scheduled launch, which is to place the first eight satellites of the Initial Defense Satellite Communications Program into the same 18,200-n. mi. orbit. The flight was originally set for mid-March.

While the Air Force recommendation is still awaited, sources close to the IDSCP program told MISSILES AND ROCKETS that it is "probably not wise to gamble with the entire IDSCP payload until a complete success has been achieved, including the near-synchronous altitude maneuver." This involves the transfer by the Transtage from Earth orbit to the 18,200-n. mi. altitude and circularization of the orbit at that altitude with a change in the orbital plane of about 26 degrees to a position over the equator.

Program sources say a compromise solution may be reached involving use of a laboratory qualification model of the IDSCP satellite dispenser aboard the next *Titan III-C*, carrying perhaps a smaller number of satellites. It is still expected that the launch will come this spring.

AVIATION WEEK
1/24/66

> ▹ International Business Machines has been selected to develop the data managment subsystem for USAF's manned orbiting laboratory, based on a recent proposal evaluation by Douglas Aircraft, prime laboratory contractor. Sperry Rand's Univac Div. ran a close second in the evaluation.

1/28/66:

This is unverified and unapproved as yet by the Air Force. However, if FSD win can be consolidated with the Air Force, this will be of significant assistance in getting the ground-based business.

2/4/66:

Late evening, Friday, January 28, FSD was notified by the Air Force that there was to be a further three-month competitive evaluation between IBM and Sperry Rand. This is to commence immediately and each party will be funded for approximately $400,000.

LOS ANGELES TIMES
approx. 1/15/66

U.S. SATELLITE PLAN FOR A-DEFENSE TOLD

WASHINGTON (AP) — Defense officials plan to use high-flying communications satellites in case of nuclear attack, senators learned Tuesday.

Lt. Gen. Alfred D. Starbird, director of the Defense Communications Agency, provided details for the Senate Space Committee behind closed doors.

Secrecy surrounds much of the military satellite program but a censored version of Starbird's testimony was made available outside the hearing.

Starbird said work is under way on an advanced defense communications system "coming into being about 1970."

Its circuits, he said, will be designed "for vital command and control functions under a situation of nuclear attack." He said such a system would have "a higher guarantee of survivability" than other means.

MISSILES AND ROCKETS
January 10, 1966

Republic Back on MOL Team

Republic Aviation Div. of Fairchild Hiller Corp., one of the original members of the General Electric team which bid on the Air Force *Manned Orbiting Laboratory,* is back on the project. GE, which is responsible for *MOL* experiments, has retained Republic for technical consulting services on planning of the experiments.

FY '67 Defense Budget May Remain $60 Billion

REQUEST FOR an additional $12-13 billion in Fiscal Year 1966 to cover the cost of the war in Vietnam does not mean, in the view of Dept. of Defense officials, that the FY '67 DOD budget request will now be less than the $60-billion program which has been anticipated.

Reasoning behind this stems from the fact that the actual annual cost of the war is now tagged at at least $10 billion by both DOD and Congressional observers, and that the FY '67 defense request, if the specific Vietnam costs could be set aside for accounting purposes, would still total about $50 billion.

The DOD caution against assuming that the larger-than-expected FY '66 supplemental request will mean a smaller-than-expected FY '67 budget is viewed suspiciously by some veteran political observers, particularly on the Republican side. It is felt by some that the Administration would like very much to prepare the people and the Congress for a $60-billion budget and then come in with something smaller that will have smoother sailing through the Congress.

It had been widely held that the supplemental would fall in the area of $5-7.5 billion, an assessment mostly based upon refinements of estimates made originally by Sen. John Stennis (D-Miss.), of the Senate Armed Services Committee. Actually, Stennis, along with Sens. Russell (D-Ga.) and Saltonstall (R-Mass.) predicted last August that the cost of the war in Vietnam would hit the $10-billion-a-year level, and that the Administration would have to present the bill for this in January in the form of a second FY '66 supplemental. The Senators made their remarks while openly critical of DOD's failure to submit a bill for the whole figure at that time, rather than just the initial $1.7-billion bill which easily passed.

Separate treatment—As matters now stand, most observers believe the supplemental will go to the Congress during the first week of the session, which begins Jan. 10, and not as a package along with the FY '67 budget, which is still expected to be presented on Jan. 24 or 25. Submission of the supplemental prior to the budget is also apt to drain off some of the attacks Congressmen are certain to make upon the preparedness and fiscal posture of the DOD in connection with the FY '67 budget.

Funds coming from the new supplemental will finance a wide range of DOD projects; however, the largest items are expected to be for conventional munitions, helicopters, and tactical aircraft. The press on munitions manufacturers, accustomed to a much slower pace until this year, is enormous, according to industry spokesmen. Orders are not going to firms other than those who are already in the business and are producing.

As of late last week, DOD officials said that the final version of the FY '67 defense budget still had not been decided. The casualty list because of the rising war costs is, however, expected to include both *Nike-X* and the AF's *Manned Orbiting Laboratory* programs. *Nike-X* has reportedly been stripped of all production money and will continue at the R&D level, and *MOL* funding is now believed to be less than half of that requested by the Air Force. ■

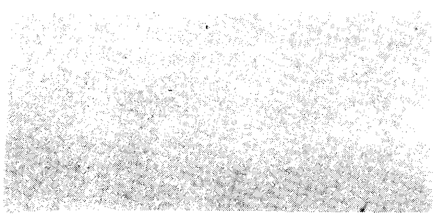
Section: IBM Management Summary

[redacted]
2/4/66

editorial . . .

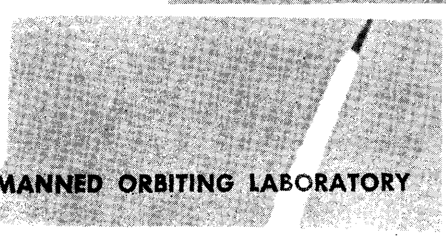
A Big, Risky Budget

TAKE FIRST THE CASE of the *Manned Orbiting Laboratory*. A year ago, we were assured enthusiastically that *MOL* finally was getting under way as a major Air Force project, one which had been determined to be important to the nation's welfare and which would receive substantial funding. Now, a high defense official cautions us of the technical difficulties inherent in *MOL* and advises "prudence" in proceeding with it. *MOL* funding therefore will not go up as planned but will remain at the same level. The fact is that *MOL* is so far within the state of the art that by next year the state of the art may be out of sight and *MOL*, as designed, will be as obsolescent as *Dyna-Soar*.



FISCAL '67 BUDGET:

PROGRAMS AT A GLANCE



DEFENSE

MANNED ORBITING LABORATORY

FY '67 funds of $150 million for development are far below original plan; stretchout likely; new construction funds provided for Vandenberg AFB.

Special Report: FY 1967 Budget

$30.03 Billion for the Industry

Actual DOD and NASA expenditures will be $1.741 billion above total for FY 1966, although obligational authority will decline

Manned Orbiting Laboratory, a budget casualty, will have to get along with about the same amount of funding for FY '67 as in FY '66 instead of an anticipated increase. Carry-over funds, however, will make it possible to actually spend some $250 million on *MOL* in FY '67. ■

missiles and rockets, January 31, 1966

Missiles Gain, Space Suffers at DOD

While *MOL* authorizations will remain the same, actual expenditures in FY '67 will increase substantially.

The remainder of the military space expenditure is for construction, which does include funds for *MOL* work at Vandenberg AFB, ancillary costs, and probably for the unpublicized procurement and RDT&E on military reconnaissance satellites.

The space spending will also include RDT&E funds for the replenishment launch of the initial military communications satellite system to be in service in 1967 and for a start on the more advanced system (see special report—p. 58).

Construction—Included within the new military construction program request are Army funds for additional *Nike-X* construction at various Pacific island radar and missile sites, *MOL* construction at Vandenberg AFB, additional silo construction for the *Minuteman* force and "for increasing the reliability and survivability of ballistic missile facilities." The Navy is also requesting construction funds for new missile development facilities at Patrick AFB, Fla. ■

missiles and rockets, January 31, 1966

AAP/MOL Cooperation Studied

A NASA—DOD coordinating group, set up to handle NASA's *Apollo* Applications program and the Air Force's *Manned Orbiting Laboratory*, is working on identification of experiments for the two space programs and mutual use of facilities.

Dr. John S. Foster, director of Defense Research and Engineering, is co-chairman of the six-member manned space flight policy committee, along with NASA Deputy Administrator Dr. Robert Seamans. Other members are Dr. Dan Fink, director of strategic systems at DDR&E, Alexander Flax, assistant secretary of the Air Force for R&D, Dr. Homer E. Newell, NASA associate administrator for space science and applications, and Dr. George Mueller, NASA associate administrator for manned space flight.

In testimony before the House Military Operations subcommittee, Foster said that contract definition on the *Manned Orbiting Laboratory* is expected in May. One of the facilities which NASA may elect to use if it exceeds the unified S-band system, Foster told the committee, is DOD's Space Ground Link System. Development and installation of the system is expected to cost $32 million.

missiles and rockets, February 7, 1966

WASHINGTON CLOSE-UP

Johnson Alters Funding Emphasis

By WILLIAM HINES

Ever since "The Miracle Worker" began a spectacular off-Broadway run at 1600 Pennsylvania Ave., ancient and hallowed notions of what is politically feasible have been dropping by the wayside. The latest to go — a victim of the budget for fiscal year 1967 —relates to the interchangeability of funding for federal projects.

When the space effort came of age in May 1961, with President Kennedy's call for men on the moon "before this decade is out," a certain opposition arose against the idea of lavishing billions on anything so tenuously connected to the general welfare. This opposition to a moon project was not absolute but relative; its partisans felt that while it would be nice to learn about the color of lunar rocks, other things back home on earth needed doing more urgently.

Some political realists— notably Space Administrator James E. Webb—were quick to emphasize that the $20 billion or so for Project Apollo would not be poured out onto the lunar surface but would be spent on earth, ultimately benefiting the American economy through a sort of bootstrapping operation whose cumulative effect is greater than the sum of its parts.

Other partisans of the moon program took a different tack. Conceding the desirability of solving problems at home as well as exploring the moon, they explained that there simply wasn't enough money to do everything and the moon had priority.

All right, the opponents rejoined, why not change priorities and defer the exploration of space until needs on earth are fulfilled? Here is where the doctine of non-interchangeability came in—a point of view that says you can get Congress to hold still for some expenditures but not for others.

In the budget for fiscal 1967, President Johnson flouts this doctrine and outlines a drastic change of emphasis in funding. Where the space race had top priority (next to national defense considerations) in the early '60s, that position has been usurped by the President's wide-ranging social plans. Officials in charge of major space projects acknowledge more or less frankly that they have been called on to pay their dues in the Great Society.

One of the most surprising cutbacks came in funding of the Manned Oribiting Laboratory (MOL), which was announced with much fanfare by Johnson himself last August. Because of the President's personal identification with MOL, many observers expected that this billion-dollar Air Force project would be treated gently by the budgeteers.

Not so; unless appearances are entirely deceiving, the Defense Department anteed up a significant chunk of planned 1967 spending on MOL as its share of the Great Society kitty. The first manned flight of five in the experimental program has been delayed from 1968 to 1969 at the earliest. Some pessimists already speculate that MOL is headed the way of its predecessor, Dyna-Soar, into limbo.

On the civilian side of the space effort, things are no cheerier. Voyager, the one big project authorized for the years after the first Apollo manned moon landing, has been downgraded to the status of "definition program," which means roughly, "Let's think about it." A delay in the first unmanned Voyager Mars flight from 1971 to 1973 was announced even before the budget was published; a close look at funding figures for fiscal '67 makes further postponement appear likely.

This is not all. A big rocket project for deep-space applications in the mid-1970s has been officially killed after having been stunned a year ago. Another propulsion program is dying from the administrative version of the Chinese torture of 1,000 cuts. The fate of an atomic rocket development program into which the space agency and the Atomic Energy Commission have jointly invested $1 billion now seemingly hangs in the balance. There are no new starts on post-Apollo manned projects.

This leaves at least two questions open. What, if anything, is planned in space for the years after the first astronauts land on the moon? And if space is destined to taper off as an important outlet for American scientific and technological energies (as seems entirely possible), what is to take its place?

These are questions of considerable importance for the Great Society of the future. A tremendous intellectual and productive capacity was built up in the last decade in aid of exploration of space. The President may have overturned the doctrine of non-interchangeability as far as funding is concerned. Still unsolved, however, is the problem of redirecting highly specialized know-how.

Section: IBM Management Summary

[redacted]

2/18/66

AVIATION WEEK & SPACE TECHNOLOGY - January 31, 1966

▶ **New Titan 3 Computer Going Competitive**—Selection of a new, more powerful guidance computer for the Titan 3, capable of satisfying expanding mission requirements for the Air Force space booster, will be thrown open to industry competition soon. The present IBM computer, originally designed for the Titan 2 (AW&ST Dec. 13, 1965, p. 23), will not meet all the demands imposed on it despite modifications from its basic missile guidance configuration. The impending competition for a new computer will be conducted by AC Electronics, guidance contractor for the space booster.

Although not attacking McNamara, the full House space committee this week will call Gen. Bernard A. Schriever, head of Air Force Systems Command, to testify on the status of the manned orbiting laboratory (MOL). Any disadvantages the Air Force sees from reduced MOL funding in Fiscal 1967 will be cited by those in Congress building a case against McNamara. The committee is expected to focus on why it is taking so long to define the MOL system.

• MOL received new money totaling $140 million. With carryover funds from previous years, this program will have $250 million available. However, there seems to be a growing disinclination in the Defense Dept. to spend this money.

Section: IBM Management Summary

[redacted]

2/18/66

Florida Fights to Keep Space Orbiting Lab

WASHINGTON (UPI)—A Florida congressman has asked the Governor of Florida to join him in a battle to keep the Defense Department's Manned Orbiting Laboratory program from being based in California.

Rep. Edward J. Gurney (R-Fla.) wrote Gov. Haydon Burns urging his active support for basing the program at Cape Kennedy, Fla., instead of at Vandenberg Air Force Base, Calif.

Gurney said the Air Force had invested nearly $150 million on a launch complex for Titan III rockets at Cape Kennedy. He said an Air Force proposal to duplicate the facilities at Vandenberg for MOL would be a "complete waste of tax money."

"The Los Angeles Times"
Saturday, February 12, 1966

INDUSTRY OBSERVER

► Dr. John S. Foster, director of Defense research and engineering, told both the House and Senate in closed committee sessions that the principal justification for the manned orbiting laboratory (MOL) is military reconnaissance. He said that if the program progresses to the point where it can use more than the $250 million it has available during the remainder of Fiscal 1966 and in Fiscal 1967, he will not hesitate to request more funding.

► National Aeronautics and Space Administration has entered the MOL program indirectly by offering to sell Defense Dept. six Saturn 1B launch vehicles which the agency guarantees will put the MOL payload into polar orbit from Cape Kennedy. This could put the Titan 3 vehicle in further jeopardy and also could hamper Air Force's efforts to build Titan 3/MOL launch facilities at Western Test Range.

AVIATION WEEK & SPACE TECHNOLOGY, February 7, 1966

MOL Data Studies

International Business Machines Corp. and Sperry Rand's Univac Div., began parallel, Air Force-directed studies Jan. 31 of the data management subsystem for USAF's manned orbiting laboratory (MOL).

The decision to conduct two studies after a prolonged and close competition effectively delays until mid-May final selection of a contractor to develop this key computer-oriented subsystem. The two companies were very close in the proposal evaluation by Douglas Aircraft Co., USAF's prime contractor for MOL with IBM holding a slight lead. Aerospace Corp. and USAF overruled Douglas' recommendation of IBM.

Douglas previously picked Honeywell (AW&ST Nov. 29, 1965, p. 24) and a Collins-TRW Systems team (AW&ST Nov. 22, 1965, p. 32) to develop the MOL attitude control and communications subsystems, respectively. The three subsystems complete the primary selections at present for the manned laboratory.

National Aeronautics and Space Administration soon will disclose plans for large 25-30 man space stations that would be used both for laboratories and bases for manned planetary expeditions. The agency appears to have made a fundamental decision to emphasize the large station rather than the six-astronaut manned orbital research laboratory (MORL).

AVIATION WEEK & SPACE TECHNOLOGY, February 7, 1966

MOL Hardware Contracts Due in Summer

Washington—Air Force will award full-scale hardware development contracts for the manned orbiting laboratory (MOL) this summer, Defense Secretary Robert S. McNamara last week told a joint session of the Senate Armed Services Committee and the Senate defense appropriations subcommittee.

McNamara said the MOL hardware phase will begin after design definition, system integration, specification development and determination of firm costs, all of which are to be completed in the summer.

In his posture statement, McNamara said MOL will be the largest single military space project, in terms of cost, in the Fiscal 1967 budget. MOL is a $159-million line item in this budget, and approximately $90 million remains unspent from the Fiscal 1966 MOL budget request of $150 million.

In testimony released after the closed session, McNamara identified space programs valued at $775 million. The total military space budget request is $1.62 billion, and presumably those programs not identified cover surveillance and reconnaissance satellite operations and procurement of launch vehicles for these missions.

Other space programs and their costs given by McNamara were:

- Spacecraft projects—defense communications satellite, $62 million; Navy's Transit navigational satellite, $21 million; Vela nuclear detection satellite, $8 million; Army's geodetic satellite program, including ground station operations under cognizance of the Navy, $7 million, and experiments for National Aeronautics and Space Administration's Gemini program, $2 million.
- Development programs—Titan 3, $66 million; spacecraft technology and advanced re-entry tests (START), $41 million; advanced liquid engines, $15 million; advanced space guidance, $2 million, and solid propulsion motors, $2 million.
- Supporting programs—USAF's Spacetrack, $33 million, and Navy's Spasur, $3 million. Both are elements of the U.S. satellite, detection and control network. Also in this category is $59 million for satellite control facilities.
- Exploratory development—$158 million for Air Force programs to improve photographic and infrared sensors and over-the-horizon radars, and for advancements in guidance, spaceborne computers, navigation sensors, missile target identification, terminal guidance, secure telemetry, and rocket engine technology.

Major effort under the START program is the $16-million maneuverable, recoverable PRIME re-entry vehicle. It is expected that these capsules will be used for controlled recovery of data capsules from reconnaissance and other sensor satellites. PRIME funding in Fiscal 1967 will cover launching of four models as Atlas payloads from Western Test Range to the vicinity of Kwajelein Island.

In the Titan 3 program, $40 million will be spent to continue development launches and the remaining $26 million will be spent to complete development of the seven-segment, 120-in.-dia. solid propulsion strap-on stage. McNamara said the total Titan 3 development cost through Fiscal 1967 is $995 million, including $84 million for launch facilities at Eastern and Western Test Ranges.

AVIATION WEEK & SPACE TECHNOLOGY, February 28, 1966

Current Status of U.S. Missile and Space Programs

satellites and spacecraft

ADVANCED ORBITING SOLAR OBSERVATORY (NASA)
Republic, prime. DESCRIPTION: 1,250-lb. spacecraft to make detailed measurements of Sun's radiation; greater pointing accuracy (5 arc sec) than OSO; launch vehicle, THRUST AUGMENTED THOR-AGENA. STATUS: Program cancelled because of tight FY '67 budget; may be resurrected later.

APPLICATIONS TECHNOLOGY SATELLITE (NASA)
Hughes, prime; GE, gradient stabilization. DESCRIPTION: Five-satellite program to test communication and meteorological equipment in medium and synchronous orbit; test bed for gravity gradient communications and meteorological experiments; weight, 780 lbs.; launch vehicle, ATLAS-AGENA. STATUS: Development; first flight scheduled for late 1966.

APOLLO (NASA)
North American, Command & Service modules, systems integration; Grumman, Lunar Excursion Module (LEM); MIT, guidance development; AC Spark Plug, guidance prime; Collins Radio, telecommunications; Honeywell, stabilization & control; AiResearch, environmental control; Northrop-Ventura, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction controls; IBM, realtime computer complex; Westinghouse, power conversion equipment. Lunar Excursion Module, prime, Grumman; descent engine, TRW Systems Group; ascent engine, Bell Aerosystems; environmental control, Hamilton Standard; reaction control thruster, Marquardt; guidance, MIT; radar & communications instruments, RCA; TMC, telemetry, Radiation Inc.; fuel cell, Pratt & Whitney; external visual display, Forand Optical; GE, acceptance checkout reliability; rendezvous optical system, Hughes. DESCRIPTION: Three-man spacecraft for Earth-orbital, lunar-orbital and lunar-landing missions. Boosters: SATURN I and SATURN IB for Earth orbits; SATURN V for lunar rendezvous and landing missions; 3-modular spacecraft: Command Module weight, 5-1/2 tons; Service Module, 25 tons; Lunar Excursion Module, 15 tons; total weight, 95,000 lbs. STATUS: First of a series of unmanned orbital tests began with a boilerplate model launch of SA-7, Sept. 18, 1964; LITTLE JOE II unmanned abort test successful, Dec. 8, 1964; first flight-rated spacecraft to be launched January 1966; lunar orbits scheduled 1968; lunar landing by 1970; first manned orbital flight due last half of 1966.

APOLLO APPLICATIONS (NASA)
No contractors named. DESCRIPTION: APOLLO spacecraft would be modified to provide extended life support and battery capability; two tanks would be removed from the Service Module propulsion section to provide room for additional consumable supplies; ascent stage of Lunar Excursion Module for extended operations in lunar orbit and on the lunar surface; many experimental payloads have been proposed, including orbiting telescopes, survey, mapping communications and many others. Boosters: SATURN IB and SATURN V. STATUS: RFP for preliminary program definition for the payload integration work is expected to be issued early in 1966; about 20 flights are planned beginning in late 1968.

ATHENA (Air Force)
Atlantic Research, prime; Honeywell, guidance. DESCRIPTION: 17,500-lb. four-stage re-entry vehicle, attains apogees from 600,000 to 1,000,000 ft.; last two stages drive vehicle and payload earthward at near-ICBM velocities; major diameter, 32 in.; velocity package diameter, 28 in.; length, 51 ft. First-stage engine, Castor XM33 (Thiokol); second stage, either X261 (Thiokol) or X259 (Naval Propellant Plant); third stage, 30KS 8000(Aerojet); fourth stage, Ranger Retro BE3, Hercules. STATUS: Engaged in sub-scale testing of advanced re-entry concepts; 77 launches scheduled; last flight Dec. 10; 13 of last 16 successful; advanced version proposed to AF for 450-lb. payload.

BIOSATELLITE (NASA)
GE, prime. DESCRIPTION: 1,000-lb. satellites to test effects of space environment on plants, animals (primates) and other biological specimens; launch vehicle, THRUST-AUGMENTED DELTA. STATUS: Six flight models to be built; first flight in mid-1966; others to follow at three-month intervals; 14 experiments selected for first flight.

COMSAT CORP. SATELLITE PROGRAM
TRW picked for contract negotiations for advanced worldwide satellite system; spacecraft would have capacity of some 1,200 two-way voice circuits and be launched into either medium-altitude or synchronous orbits; decision on type of system expected six months after contract signing, with delivery of first six satellites 24 months after signing; up to 24 satellites may be bought; launch vehicle not yet selected; Sylvania Electric Products to provide antenna systems at Washington State, Hawaii Earth stations, with delivery to start May 1, 1966; corporation also working on system for use with APOLLO program and commercial communications; Hughes aircraft awarded contract for four synchronous satellites, with two to be orbited probably by late next summer; Page Communications Engineers to provide transportable Earth stations; EARLY BIRD, experimental/operational satellite built by Hughes, launched April 6 and now in synchronous orbit over Atlantic, transmitting between U. S. and Europe.

DISCOVERER (Air Force Program 622A)
Lockheed, prime; GE, re-entry vehicle. DESCRIPTION: THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems. STATUS: All data on program classified as part of DOD information policy; however, indications are that program has been cut back or ended as more economical vehicles have come into use.

ECHO (NASA)
Langley Research Center, prime. DESCRIPTION: ECHO I,135-ft. inflatable sphere in 700- to 805-mi. orbit; passive communication satellite; booster, THOR for ballistic tests; THOR-AGENA for orbital. STATUS: Program complete; ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful; ECHO II launched from Vandenberg Jan. 27, 1964; U.S.-USSR conducting experiments using ECHO.

GEMINI (NASA)
McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Honeywell, guidance; Westinghouse, rendezvous radar; AiResearch, environment. DESCRIPTION: Bigger and heavier MERCURY-type capsule to carry two men for up to two weeks; TITAN II used as booster; ATLAS-launched AGENA will be used for rendezvous missions; 15 spacecraft will be produced. STATUS: Development; 12 flights planned; will be used to determine feasibility of rendezvous for lunar mission and long-duration manned flight; first unmanned flight, April, 1964, successful; second unmanned orbital flight, January, 1965, successful; first manned flight successful March 23; second flight successful, June 3-7, 1965, including first extravehicular activity; eight-day GEMINI 5 flight, Aug. 21-29; successful; GT-7 flight, launched Dec. 4, set world record for manned spaceflight duration (14 days); GT-6 launched Dec. 15 after two previous attempts scrubbed; first space rendezvous achieved Dec. 15 during 14-day GEMINI 7 flight when GEMINI 6 on one-day mission came within one foot of sister craft; five more flights planned in 1966; AF participating in program, and will modify GEMINI capsule for MOL.

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GEOS (NASA)
Applied Physics Laboratory, prime. DESCRIPTION: 350-lb. geodetic satellite (similar to ANNA) to carry flashing-light beacons, electronic beacons and optical and radar reflectors; launch vehicle, IMPROVED DELTA; 700-900-mi. orbit at a 59-degree inclination. STATUS: First flight launched successfully Nov. 6, 1965; PAGEOS passive satellite developed by Langley Research Center will also be launched first half of 1966.

HYPERSONIC RESEARCH VEHICLE (AF, NASA)
No contracrors announced. DESCRIPTION: Manned hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, Mach 0-3; ramjet, Mach 3-8 or 10 (oxygen collected and liquefied during this cycle); Mach 8-10 orbital speeds, LH_2-LOX rocket. STATUS: Joint NASA-AF research program approved; NASA funding $5 million in FY '66; AF has advanced technology program in six pertinent areas (mostly engine developments) in FY '65. GE, Pratt & Whitney and Marquardt selected for conceptual and preliminary design of a research engine; engine flight test planned for early 1968.

ICBM ALARM (Formerly MIDAS) (Air Force Program 239A)
Lockheed, prime; Aerojet, IR detector system. DESCRIPTION: Early-warning random-orbit satellite; detect ICBM launchings by IR; two flights conducted in 1963 detected solid and liquid missile launches; satellites are launched piggy-back on various AF boosters. STATUS: Development; no decision on deployment; reportedly competing with over-the-horizon radar; Air Force is currently studying requirements for a new, multi-function satellite, combining the functions of MIDAS and SAMOS.

INTERPLANETARY MONITORING PLATFORM (NASA)
Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit; BTL/Univac, guidance. DESCRIPTION: 131 to 181-lb. satellite launched into cislunar-space orbit with an apogee of more than 100,000 mi.; will measure radiation and solar flare hazards in advance of Project APOLLO; launched by DELTA and THRUST-AUGMENTED DELTA boosters from AMR. STATUS: IMP-I launched in December, 1963; IMP-II launched Oct. 3, 1965; five more satellites are planned, two to be placed in lunar orbit; later flights will use a nuclear power unit as replacement for solar cells; designation, IMP-I is EXPLORER XVIII; IMP-II is EXPLORER XXI.

ISIS (Canada, U.S.)
Canadian Defense Research Board, satellite; NASA, launch vehicle. DESCRIPTION: Three-satellite follow-on program to ALOUETTE to continue ionospheric studies. STATUS: Design of ISIS A began in 1964 with launch planned in 1967; B and C to be launched in 1968, 1969; launch vehicle, THOR-AGENA.

LES (Air Force)
M. I. T. Lincoln Laboratory, prime; consulting support, TRW Systems Group. DESCRIPTION: a series of Lincoln Experimental Satellites carried as TITAN III-A and III-C "bonus" payloads to test military comsat devices and techniques. STATUS: First launch Feb. 11 failed; second, May 6, achieved orbit; LES-3 and 4 launched Dec. 21 are operating but in wrong orbit because of TITAN Control failure.

LUNAR LOGISTICS SYSTEM (NASA)
Studies have been conducted by Grumman, TRW Systems Group and Northrop. DESCRIPTION: Spacecraft to carry support payloads to the Moon. Two designs under study—LEM truck with 7,000-lb. payload and logistics spacecraft with 25,000 to 30,000-lb. payload; booster, SATURN V. STATUS: Program definition of the LEM truck planned in FY '67; program would cost about $1 billion; first step will be to extend lunar stay-time up to two weeks.

LUNAR ORBITER PHOTO CRAFT (NASA)
Boeing, prime; RCA, power and communications; Eastman Kodak, cameras; Marquardt, maneuvering engine. DESCRIPTION: 800-lb. spacecraft launched by ATLAS-AGENA will orbit Moon, taking pictures of lunar surface; radioactive and geodetic measurements will also be taken. STATUS: Five flights scheduled beginning in mid-1966.

MANNED ORBITING LABORATORY (Air Force)
Douglas Aircraft Co., prime; GE, on-board experiments; Aerospace Corp., technical management. DESCRIPTION: Two-man spacecraft to establish military usefulness of man in space; booster, TITAN III-C; GEMINI-X capsule atop 10-ft.-dia., 41-ft.-long canister lab; total weight about 25,000 lbs., orbit below 350 mi.; flights of 30 days in shirt-sleeve environment planned. STATUS: Six-launch program now planned; 30-day missions; 60-90 day missions under study; $150 million in FY '66 funding; unmanned GEMINI canister launch, late 1966 or 1967; manned GEMINI canister launch, 1968; rendezvous and ferry capability possible; Honeywell and Collins Radio reported winners of attitude control and communications subsystems.

MARINER (NASA)
Jet Propulsion Laboratory, prime. DESCRIPTION: 570-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA. STATUS: First scheduled Venus fly-by, August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus, Dec. 14; two Mars fly-by spacecraft launched in November, 1964; first on Nov. 5 failed due to shroud malfunction; MARINER IV launched Nov. 28, flew by Mars July 14, 1965, and transmitted the first closeup photos of the planet; MARINER flight to Venus in mid-1967, and two flights to Mars in 1969 are planned.

MILITARY COMMUNICATIONS SATELLITE (Prog. 369) (AF,DCA,Army)
Aerospace Corp., systems engineering & technical direction; Philco, prime. DESCRIPTION: Multiple-launch, random, active repeater comsat; 24 satellites launched in groups of 8 satellites in 18,300-n.mi. polar orbits; weight about 100 lbs.; TITAN III-C booster. STATUS: Full-scale development as an "interim" system which is to be in operation in 1966. DCA has contracted industry studies on a longer-lived Advanced Communication Satellite system; FY 1968 operational status planned; tactical system also likely.

NATIONAL ORBITING SPACE STATION (NASA, AF)
Many studies awarded. DESCRIPTION: Manned space station with orbital lifetime of one to five years for testing components and techniques in the space environment; weight ranges under study vary from 15,000-20,000 up to 200,000 lbs. STATUS: Decision not expected for two to four years. MANNED ORBITING RESEARCH LABORATORY and LARGE ORBITING RESEARCH LABORATORY being considered.

NIMBUS (NASA)
Goddard Space Flight Center, prime; GE, integration and testing; RCA, vidicon cameras. DESCRIPTION: 900-1,100-lb. second-generation weather satellite; Earth-stabilized polar orbiting; TV cameras and IR scanners in payload; THRUST-AUGMENTED THOR-AGENA B booster. STATUS: First launching successful Aug. 28, 1964; picture & IR quality good in spite of satellite's elliptical orbit; satellite quit transmitting Sept. 23, 1965; second scheduled in 1966, third in 1967 and fourth in 1968-69.

NUCLEAR DETECTION SATELLITES (Formerly Vela) (ARPA)
TRW Systems Group, prime; Los Alamos Scientific Lab/Aerospace Corp., payload. DESCRIPTION: 20-sided, 485-lb. satellite for detection of nuclear explosions in space; 50,000-mi. orbit; booster, ATLAS-AGENA; launched in pairs. STATUS: First pair successfully launched in October, 1963; second pair successfully launched July 17, 1964; three pairs remain; next pair aboard TITAN III-C next fall.

ORBITAL VEHICLE (AF)
Series of vehicles under OAR project to orbit small scientific experiments at low cost; first two satellites, OV1-1 and -3, both failed, first due to separation mechanism in flight and second due to launch vehicle explosion; first flight was first known attempt to launch satellite from an ATLAS-ABRES vehicle on ballistic trajectory; OV2-1, developed by Northrop, also fell victim to faulty Titan III-C Transtage Oct. 15; OV2-3 also failed due to Dec. 21 TITAN III-C Control malfunction; space General at work on OV3; OV-1 was successfully launched Oct. 5 aboard an ATLAS-D.

ORBITING ASTRONOMICAL OBSERVATORY (NASA)
Grumman, prime; Westinghouse, ground station, components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage; Hughes and Avco, communications equipment. DESCRIPTION: 3,600-lb. orbiting astronomical satellite to study ultraviolet spectrum from approximately 1,200 Å to 4,000 Å; four major experiments selected; one piggyback; booster, ATLAS-AGENA D. STATUS: Three flights beginning in early 1966.

ORBITING GEOPHYSICAL OBSERVATORY (NASA)
TRW Systems Group, prime; DESCRIPTION: 1,000-lb. satellite with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry more than 20 experiments; ATLAS-AGENA, THRUST-AUGMENTED THOR, booster. STATUS: First launch Sept. 4, 1964, partially successful; 16 of 20 experiments working; OGO II launched Oct. 14, 1965 ceased operation Oct. 24, when electrical power failed.

ORBITING SOLAR OBSERVATORY (NASA)
Ball Brothers, prime. DESCRIPTION: OSO I, 458-lb. orbiting solar observatory; OSO II, 535-lbs.; booster, DELTA; S-16 early version; S-17 and S-57 advanced versions. STATUS: First flight March 7, 1962, highly successful; second flight, Feb. 27, 1965, successful. Third satellite, launched Aug. 25, failed to achieve orbit because of premature third-stage ignition, six more flights planned, with next flight in first half of 1966.

PEGASUS (NASA)
Fairchild Hiller, prime. DESCRIPTION: 3,400-lb. meteoroid-detection satellite employing two 50 x 15 ft. extendable detector wings; Earth orbit 300 to 800 mi.; booster, SATURN I. STATUS: Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch successful in February; PEGASUS B, May 25, 1965, and PEGASUS C, July 30, 1965, also successrul. No more launches planned; formerly known as METEORIOD DETECTION SATELLITE.

PIONEER (NASA)
TRW Systems Group, prime. DESCRIPTION: 130-lb. spin-stabilized solar probe; AUGMENTED DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; four outrigger booms for stabilization; five experiments, 60 to 90-million-mi. communication capability. STATUS: Seven launches in program; first spacecraft launched successfully Dec. 16, 1965; EXTENDED PIONEER under study.

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PROJECT SCANNER (NASA)
Honeywell, fabrication and integration; Baird-Atomic, star-mapper telescope; Santa Barbara Research Center, dual radiometers. DESCRIPTION: Unmanned scientific satellite to measure natural radiation gradients of Earth's horizon to determine utility of spacecraft horizon sensors. STATUS: Flights to begin in 1966.

RADIO ASTRONOMY EXPLORER (NASA)
Goddard, prime for first two spacecraft with industry to build remaining four. DESCRIPTION: 270-lb. satellite which will have four 750-ft. extendable antennas to pinpoint radio emissions in space. STATUS: Hardware funding approved in FY '65 & '66 budgets, with first launch by a THRUST-AUGMENTED DELTA in 1967.

RANGER (NASA)
JPL, prime; Hercules, retro-rocket; Northrop, support contractor; RCA, TV system. DESCRIPTION: Before impact, TV cameras take pictures of lunar surface; ATLAS-AGENA B booster. STATUS: RANGER VI launched Jan. 30, 1964; TV system failed; RANGER VII launched July 28, 1964, and impacted Moon after transmitting 4,316 pictures; RANGER VIII launched Feb. 17, 1965, impacted Moon Feb. 20, after transmitting more than 7,000 pictures; RANGER IX launched March 21; struck Moon March 24 after transmitting 5,814 photos; program now complete.

SAMOS (Air Force Program 720A)
Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco and Northrop Ventura. DESCRIPTION: Reconnaissance satellite; formerly SENTRY; R&D model weighs 4,100 lbs. with E-5 capsule (3,000 lbs. with E-6); booster, ATLAS-AGENA; 100-300-mi. circular polar orbit. STATUS: Operational; advanced SAMOS under development; a successor system, capable of changing orbital plane and altitude on command, is apparently being developed; this newer reconnaissance satellite would have up to six recoverable data capsules or cassettes with lifting-body characteristics, permitting data recovery without returning entire satellite to Earth; could be launched by the TITAN III-B booster now under development; FERRET version used for electronic intelligence and communications eavesdropping.

SATAR (Air Force)
General Dynamics, prime. DESCRIPTION: 300-lb. scientific satellite pod-mounted on side of ATLAS booster; length, 55 in.; diameter 27 in.; 200-lb. payload; orbits vary from 500 to 2,000 n. mi.; as re-entry vehicle, gains speeds up to 30,000 fps; guidance, strap-down system with three orthogonally mounted gyros; unstabilized when in orbit. STATUS: Development; seven vehicles being built under present contract; pods of SATAR type have been flown on 44 missions.

SATELLITE INSPECTOR (Air Force PROGRAM 706)
No contractors announced. DESCRIPTION: Satellite inspection system consisting of a spacecraft capable of co-orbital inspection of non-cooperative satellites. STATUS: Re-oriented from unmanned vehicle to manned satellite using GEMINI; conceptual studies under way.

SECOR (Army)
Cubic Corp., prime, transponder and ground stations; ITT Labs, satellite vehicle. DESCRIPTION: 40-lb. geodetic satellite; rectilinear, measuring 9 x 11 x 14 in.; can be carried piggyback on a variety of boosters; frequency, 162-324 mc for geodetic measurements; 54-216 mc for refraction studies. STATUS: Operational SECOR vehicles 1, 3, 2, 4 and 5 now in orbit, launched in order of mention. SECOR 5, launched Aug. 10, 1965, is the only non-rectilinear satellite in the series, being a 20-in. polished sphere; future SECORS will be rectilinear; expanded program at altitudes of 1,800 mi. is being considered.

SERT (NASA)
RCA, prime. DESCRIPTION: Spinning ballistic test vehicle carrying two electric-propulsion engines for environmental tests. STATUS: First flight July 20, 1964, from Wallops Island, Va., carried a Lewis electron bombardment engine and a Hughes contact ionization engine; the Lewis engine worked well while Hughes engine produced no thrust; follow-on flights cancelled since SERT I proved neutralization of an ion beam in space; SERT II now under study.

START (Air Force)
Award in only one of an expected 10-14 areas has been announced—Martin Co. for work on a vehicle related to the in-house SLV-5; Aerospace Corp., general systems engineering and technical direction. DESCRIPTION: A four-part experimental program, beginning with ASSET, to explore the materials, structures, flight regimes and other areas related to glide atmospheric entry. STATUS: Follow-on phases include PRIME, PILOT, and a high L/D ratio vehicle.

SURVEILLANCE CALIBRATION (Navy)
NRL designed and developed satellites for calibrating ground-based systems; 12 satellites launched to date; Latest Aug. 13; five satellites launched aboard single THOR ABLESTAR to check performance of Navy space surveillance system.

SURVEYOR (NASA)
Hughes, prime; Martin, SNAP device. DESCRIPTION: 2,150-lb. spacecraft for soft-landing 100-300 lbs. of instruments on Moon; nine 2,500-lb. spacecraft are also planned; booster, ATLAS-CENTAUR; SNAP nuclear generator optional. STATUS: First Moon flights May, 1966; seven engineering and three operational spacecraft planned.

SYNCOM (NASA)
Hughes, prime. DESCRIPTION: 24-hr.-orbit instantaneous narrow-band, active-repeater communications satellite; 28 in. in dia. and weighs about 63 lbs.; booster, DELTA; capable of accommodating one full duplex radio telephone channel. STATUS: First launch failed, Feb. 14, 1963; satellite believed to be in orbit but contact lost; SYNCOM II launched July 26, 1963, completely successful; third launch Aug. 19, 1964, successful; satellite positioned in stationary orbit over Pacific; DOD has taken over satellites for military traffic.

SMS (Synchronous Meteorological Satellite) (NASA)
Republic, RCA Astro-Electronics, Hughes, study contracts. DESCRIPTION: 24-hr. weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or -CENTAUR. STATUS: Studies to continue; development funds not included in FY '66 budget; ATS and TIROS expected to provide major inputs to the program.

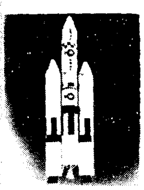
TIROS (NASA, Weather Bureau)
RCA, prime. DESCRIPTION: 285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (300-3,000 mi.). STATUS: R&D; 10 satellites launched; all successful; four more launches planned with TIROS wheel configuration (Earth-stabilized) to serve as an interim National Operational System.

TRANSIT (NAVY)
Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers. DESCRIPTION: Navigational satellite; R&D model over 250 lbs.; operational, 50 to 100 lbs.; operational system; four satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; ABLESTAR, SCOUT boosters. STATUS: Four-satellite system operational since July, 1964; system established for use by POLARIS subs and surface ships; two nuclear-powered (SNAP-9A) satellites launched in 1963; NASA studying commercial system.

TRS (Air Force)
TRW Systems Group, prime. DESCRIPTION: 3-lb. scientific satellite to measure radiation; four-sided, measuring 9 in. on a side. STATUS: Operational; first launched piggyback on DOD payload Oct. 17, 1963.

VOYAGER (NASA)
Either Boeing, GE, or TRW Systems Group will be selected for spacecraft program definition in about a year. DESCRIPTION: Unmanned 7,000-11,000-lb. MARINER follow-on spacecraft bus/lander to orbit Mars and eject a capsule to the surface. STATUS: Development expected to begin in late 1966 or early 1967; lander design to be studied in 1967; program definition funded in FY '66; first launch delayed until 1973; spacecraft to be launched by SATURN V, and will be used to explore other planets through 1970's.

X-15 (NASA, AF, NAVY)
North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Honeywell, adaptive flight control electronics. DESCRIPTION: Manned rocket plane capable of 4,000-mph-plus flight at edge of space; single rocket engine develops 57,000 lbs. thrust. STATUS: Powered flights in progress; unofficial records set—altitude 354,200 ft. and speed 4,104 mph; hypersonic propulsion research program should run through 1968; more than 100 flights have been made; ramjet (X-15A2) flights scheduled for 1968.



space vehicles

ABLESTAR (Air Force)
Space-General, prime; Aerojet, propulsion; Space-General/Bell Telephone, guidance. DESCRIPTION: 2,000-lb. upper stage; 9.5 ft. long; 55 in. dia.; radio command guidance; propellants, UDMH/IRFNA; restart capability. STATUS: Used in TRANSIT and other military programs; THOR booster.

ATLAS-AGENA D (Air Force)
General Dynamics/Convair (ATLAS); Lockheed (AGENA); TRW Systems Group, AGENA B; Honeywell, inertial reference. DESCRIPTION: 275,000-lb. booster; payload capability, 5,000 lbs., in 345-mi. orbit, 750 lbs. to escape; length, 102 ft.; base diameter, 10 ft.; liquid propulsion; modified ATLAS D with 360,000-lb. thrust; AGENA B with 15,000-lb. thrust; restart capability. STATUS: Operational; used in RANGER, DISCOVERER, MILITARY COMSAT, MARINER, LUNAR ORBITER, OAO, SAMOS and other programs. ATLAS Standard Launch

Vehicle developed for AF space programs; ATLAS launches from WTR being used in conjunction with ATHENA launches at Green River, Utah, in an effort to develop scaling laws for re-entry bodies (Advanced Ballistic Re-entry Systems program).

AGENA D (Air Force)
Lockheed, prime; Honeywell, guidance; Bell, propulsion. DESCRIPTION: 1,700-lb. upper stage; 25 ft. long; 5 ft. dia.; all-inertial guidance; propellants, UDMH/IRFNA; multiple re-start capability; ATLAS, THOR and AUGMENTED THOR boosters. STATUS: Used in DISCOVERER, SAMOS and other military programs as well as a variety of NASA programs; e.g., MARINER, RANGER, OAO and OGO.

CENTAUR (NASA)
Lewis, program management; General Dynamics/Convair, prime; Pratt & Whitney, propulsion; Honeywell, guidance. DESCRIPTION: High-energy upper stage using a pair of RL-10 LOX/liquid hydrogen engines; 30,000 lbs. total thrust; 30 ft. long; 10 ft. dia.; ATLAS D booster; capable of orbiting 8,500 lbs.; 2,300 lbs. to escape; 1,300 lbs. on planetary flights. STATUS: Development; first flight failed; second launch Nov. 27, 1963, successful; third, June 20, 1964, partially successful; fourth flight Dec. 11, 1964, successful; fifth flight Mar. 2 failed when ATLAS-CENTAUR exploded on pad; CENTAUR 6, Aug. 11, 1965, successful; CENTAUR 8 flight scheduled for first quarter 1966 will be first attempt to restart engine in orbit; first SURVEYOR flight also scheduled for second quarter 1966.

DELTA (NASA)
Douglas, prime; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/ Allegany Ballistics Laboratory, propulsion. DESCRIPTION: Successor to THOR-ABLE; upper-stage guidance; three-stage vehicle; 800-lb. payload capability in 100-mi. orbit; THRUST-AUGMENTED DELTA payload capability, 1,500-plus lbs. in 100-mi. orbit; THOR missile comprises first stage. STATUS: Launch vehicle for TIROS, EXPLORER, OSO, BIOS, ECHO; TAD used for SYNCOM & PIONEER; 26 previously on order augmented by AF order for 21 more for NASA; THRUST-AUGMENTED DELTA with three solid motor strap-ons also being used.

LITTLE JOE II (NASA)
General Dynamics/Convair, prime. DESCRIPTION: Solid-propelled vehicle with 800,000-lb. thrust; launch vehicles for APOLLO suborbital flights. STATUS: Three launches: Aug. 28, 1963; May 13, 1964; Dec. 8, 1964, successful; May 19, 1965, launch unsuccessful; June 29, 1965 launch successful; last flight scheduled January, 1966.

POST-SATURN V LAUNCH VEHICLE (NASA)
Under study. DESCRIPTION: No firm concept but will be significant improvement over SATURN V (20-30 million-lb.-thrust first-stage large solid motors, and nuclear upper stage under consideration). STATUS: Study to determine characteristics; operational target date post-1975.

ROVER (NASA, AEC)
Los Alamos Scientific Labs, ROVER prime; Aerojet, NERVA prime; Westinghouse, propulsion. DESCRIPTION: First nuclear rocket; tests of Kiwi, prototype of NERVA engine, under way. STATUS: Kiwi tests completed this year; NERVA tests highly successful; full systems tests of engine now set for fall, 1965—12 months ahead of schedule; development of Phoebus reactor initiated; no flight test program funded at present.

SATURN I (NASA)
Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas. DESCRIPTION: Two-stage vehicle for early boilerplate tests of APOLLO and PEGASUS; first stage: eight Rocketdyne H-1 engines; second stage: six Pratt & Whitney RL-10-A3 engines; 22,500 lbs. into 345-mi. orbit. STATUS: Four flight tests of first stage successful; all flights with inert upper stage; first flight with live upper stage successfully launched Jan. 27, putting 37,700 lbs. in low Earth orbit; SA-6 May 28, 1964 and SA-7 Sept. 18, 1964, also successful; SA-9 on Feb. 16 put PEGASUS satellite into orbit; SA-8, May 25, and SA-10, July 30, 1965, also successful, completing R&D program.

SATURN IB (NASA)
Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas. DESCRIPTION: S-1, eight H-1 engines; S-IVB, one J-2 engine; payload capability, 35,000 lbs. in 105-mi. orbit. STATUS: Development; first flight in January or February, 1966; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; first manned flight in APOLLO program set for October, 1966; advanced version able to orbit 30 tons under consideration.

SATURN V (NASA)
Systems engineering, assembly and guidance, Marshall Space Flight Center; S-IC stage, Boeing; S-II, North American; S-IVB, Douglas; F-1 engine, North American; J-2, North American. DESCRIPTION: S-IC, five F-1 engines; S-11, five J-2 engines; S-IVB, J-2 engine; 140-ton payload in 105-mi. orbit; 95,000 lbs. to escape velocity; 30 tons for planetary missions. STATUS: R&D; first flight scheduled for 1967; prime booster for APOLLO missions; will be used to boost orbiting space station.

SCOUT (NASA)
LTV Aerospace Corp., prime; Honeywell, guidance; Aerojet/Thiokol/ Allegany Ballistic Laboratory, propulsion. DESCRIPTION: Solid propulsion four-stage satellite launcher; 72 ft. long; 3.3 ft. dia.; 240-lb. payload in 345-mi. orbit; 80 lbs. to escape. STATUS: Operational; used by NASA for EXPLORER and other small payloads; also procured by NASA for Air Force as BLUE SCOUT.

THOR-ABLESTAR (Air Force)
Douglas, prime; Bell Telephone Labs/Univac, guidance; Rocketdyne, first-stage propulsion; Space-General, second; DESCRIPTION: Two-stage vehicle with 181,900 lbs. total thrust; performance, 900 lbs. in 100-n.-mi. orbit; length, 55.9 ft., diameter, 8 ft., weight, 118,200 lbs., height, 79 ft.; guidance, radio command; STATUS: Operational; used in TRANSIT, GEOS and other military programs.

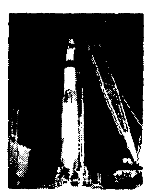
THOR-AGENA D (Air Force and NASA)
No prime; Douglas, THOR frame; Lockheed, AGENA D; Rocketdyne, propulsion. DESCRIPTION: Liquid-propulsion vehicle to put 1,600-lb. payload in 300-mi. orbit; length, 76 ft.; diameter, 8 ft.; launch weight, 123,000 lbs.; 172,000 lbs. thrust; THOR, radio guidance, AGENA, all-inertial. STATUS: Operational; used in AF space program, TELSTAR, Topside Sounder and other NASA programs; NASA has 11 launches scheduled.

THRUST-AUGMENTED DELTA (NASA)
Douglas, prime; Thiokol, solid propulsion. DESCRIPTION: DELTA launch vehicle with three strap-on solids; performance, 1,000 lbs. to Earth orbit; 150 lbs. to escape; propulsion, three XM-33 solid motors producing 55,000 lbs. thrust each. STATUS: Development; to be used for BIOSATELLITE, PIONEER, SYNCOM, TIROS, COMSAT programs; initial flight Aug. 19, 1964, successful.

THRUST-AUGMENTED THOR (Air Force/NASA)
No prime; Rocketdyne and Thiokol, propulsion. DESCRIPTION: THOR-AGENA with 3 strap-on solids; THOR liquid propulsion, 172,000 lbs. of thrust; each strap-on, 55,000 lbs. thrust; performance, 2,500 lbs. in 100-n.mi. orbit. STATUS: Operational; used for NIMBUS, POGO and other payloads too heavy for THOR, but not heavy enough for ATLAS.

TITAN II (GLV) (NASA)
Aerospace Corp., systems engineering & technical direction; Martin, prime. DESCRIPTION: Manned space booster; Essentially TITAN II with addition of redundant electrical power and flight control systems, malfunction detection system and radio command guidance. STATUS: Development; GT-2 (unmanned version) launched Jan. 19; GT-3 successful on March 23; GT-4, June 3, and GT-5, Aug. 21, also successful, as were GT-7 Dec. 4 and GT-6 Dec. 15.

TITAN III (Air Force Program 624A)
Aerospace Corp., systems engineering & technical direction; Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II portion; Aerojet-General, liquid engines (Transtage); Martin, standardized upper stage; AC Spark Plug, guidance. DESCRIPTION: Quick-reaction vehicle for military space missions; will be used to boost MOL/GEMINI-X; Zero stage, two 120-in. solid motors; first and second stages, TITAN II (storable propellants); third-stage is liquid Transtage; modified TITAN II guidance; payload, 25,000 lbs. in 100-n.mi. orbit, 2,100 lbs. to 22,300-mi. orbit; 5,000 lbs. to escape; STATUS: Development; first flight Sept. 1, 1964 (T-IIIA) achieved primary and secondary objectives, but failed to achieve orbit; second flight (T-IIIA) successful Dec. 10, 1964; first full TITAN III-C flight successful June 18, 1965; second flight Oct. 15, successful launch followed by partial Transtage failure; third launch Dec. 21 also had partial control failure; eight remaining III-C R&D flights; next three for IDSCP; development stretchout moves operational date to June, 1967; a non-man-rated version—TITAN III-B—being studied as more cost-effective booster for satellite launches; uses first two TITAN III-A stages and an AGENA upper stage; first launch, mid-1966; 24 vehicles planned as initial buy; 7-segment version of III-C expected to boost MOL.



missiles

ADVANCED SURFACE MISSILE SYSTEM (Navy)
Raytheon, Boeing, Sperry Rand, General Electric, Westinghouse, RCA & Hughes, pre-program definition contracts. DESCRIPTION: Fleet air-defense weapon for the 1970 time period; to have capability against aircraft and certain types of air-to-surface missiles; will replace the 3-T systems currently in the fleet. STATUS: Pre-program definition; further definition contracts expected before any development decision; commonality with Army's SAM-D has been studied; and Navy to participate in SAM-D development.

ALFA (RUR-4) (Navy)
Navy, prime; Avco, frame; Naval Propellant Plant, propulsion. DESCRIPTION: ASW, surface-to-underwater; weight, 500 lbs.; solid propulsion; H.E. depth charge; range, 1,000 yds.; guidance, free-flight. STATUS: Operational; deployed on destroyers and cruisers; being replaced by ASROC.

ANTI-SATELLITE WEAPON (Army/Air Force)
Boeing, AF program; Hughes, terminal guidance (IR), AF program; Douglas, THOR and ZEUS vehicles and support services; A. D. Little, operations analysis. DESCRIPTION: Consists of both NIKE-ZEUS and THOR-AGENA w/terminal stage programs; intercepts have been accomplished at "hundreds of miles," according to Secretary McNamara. STATUS: Operational, according to DOD.

ARM I (Navy)
No contractor announced. DESCRIPTION: Longer-range, smaller anti-radiation missile than SHRIKE for armament of F-111B and A-7A aircraft. STATUS: Advanced component development; decision on contract definition expected next year.

ASROC (RUR-5A) (Navy)
Honeywell, prime; Sangamo Electric, sonar; GE, torpedo; Librascope-General Precision, fire control. DESCRIPTION: ASW, surface-to-underwater; weight, 1,000 lbs.; solid propulsion; warhead, nuclear or conventional torpedo; range between 1,800 yds. and 8 mi.; guidance, unguided. STATUS: Operational on DE, DD, DLG, & heavy cruisers; one "live" weapon fired in 1962 Pacific nuclear tests; extended-range version in pre-program definition phase; version adaptable to TERRIER launchers being developed; FY 1966 procurement to complete Navy's stock needs.

BOMARC B (AIM-10B) (Air Force)
Boeing, prime; General Precision Aerospace/Westinghouse/IBM, guidance; Thiokol/Marquardt, propulsion. DESCRIPTION: Surface-to-air; weight, 16,000 lbs.; solid booster/ramjet propulsion; warhead, nuclear; range, more than 400 n.mi.; guidance, command via SAGE; speed, Mach 2.7. STATUS: Three bases operational; production completed; the 188 B models will be distributed among the eight bases after the A model is phased out; all A missiles at five bases operational in northeastern U.S. phased out by the end of FY 1965.

BULLPUP (AGM-12 B & C) (Navy-Air Force)
Martin, systems cognizance; Maxson Electronics Co., production; Thiokol, liquid and solid propulsion; Naval Propellant Plant, solid propulsion (motor loading). DESCRIPTION: Air-to-surface, range, 3-6 mi.; guidance (visual reference), radio-link command. BULLPUP A: Solid propulsion; warhead, 250-lb. H.E. BULLPUP B&C: pre-packaged liquid motor; warhead, 750-lb. H.E. STATUS: BULLPUP A deployed with Atlantic and Pacific Fleets; operational with U.S. Air Force & NATO units; training version (ATM-12) being procured by both services; being produced in Europe for NATO. Planned procurement of BULLPUP B cancelled in FY 1966.

CHAPARRAL (Army)
A surface-to-air adaptation of the Navy's air-to-air SIDEWINDER; mounted on vehicles, in a 4- or 6-missile configuration. Philco's Aeronutronic Div. is prime; CHAPARRAL will be an interim, fair-weather-only, solution to forward-area air defense; has been successfully fired; production award expected soon. (See: SIDEWINDER.)

CLOSE-SUPPORT ASSAULT WEAPON (Navy)
Navy Bureau of Weapons and Johns Hopkins Applied Physics Lab, prime; United Aircraft Norden Div., guidance. DESCRIPTION: Ship-to-shore; outside dimensions compatible with TERRIER shipboard installations; solid propulsion; warhead, H.E.; range, 30 mi. minimum; guidance, inertial and terminal. STATUS: Carried as a line item in FY '66 budget; gyro packages for flight test delivered by Norden; funding dependent on results of guidance system flight tests at WSMR aboard SERGEANT missiles in July.

CONDOR (AGM-53) (Navy)
In-house project, Naval Ordnance Test Station; North American Aviation, Columbus Div. and Northrop Norair Div. completed PDP studies. DESCRIPTION: Air-to-surface TV-guided, stand-off weapon; configuration classified; range, 40 mi. STATUS: Development; intended for use with Navy version of F-111 and on A-6 aircraft; decision on development expected in next few months.

DAVY CROCKETT (M-388) (Army)
In-house project directed by Army Weapons Command at Rock Island, Ill. DESCRIPTION: Surface-to-surface; solid propulsion, bazooka-launched; warhead, sub-kiloton nuclear; guidance, free flight; two launchers — vehicle-mounted or carried by two men. STATUS: Operational in Europe; $13 million provided in FY '64 budget; three per ROAD battalion.

ENTAC (MGM-32A) (Army)
Nord Aviation, prime. DESCRIPTION: Anti-tank; weight, 37 lbs. with launcher; solid propulsion; warhead, shaped-charge H.E.; range, 6,600 ft.; guidance, wire-guided; man-portable. STATUS: Operational; procurement complete; will be replaced by TOW.

FALCON (AIM-4A, C, E, F/26A/47A) (Air Force)
Hughes, prime; Hughes, guidance; Thiokol, AIM-4/26 propulsion; Lockheed Propulsion, AIM-47 propulsion. DESCRIPTION: Air-to-air; weight (AIM-4/47), more than 100 lbs. — (AIM-26), more than 200 lbs.; range 5 n.mi.; supersonic; solid propulsion; warhead, H.E. (except for AIM-26B, which carries nuclear warhead); AIM-4A, and 4E, active radar homing guidance; AIM-4C, and 4F, IR homing; AIM-26 model has nuclear warhead and hybrid IR radar homing. STATUS: Operational buy-out of 4E, 4F and 26 in FY '62; AIM-47 is the armament for YF-12A (A-11); several versions operational on F-101, F-102 and F-106.

GENIE (AIR-2A) (Air Force)
Douglas, prime; Aerojet-General, propulsion. DESCRIPTION: Air-to-air; weight 800 lbs.; unguided; solid propulsion; warhead, nuclear; range, 6 n.mi.; guidance, free flight; supersonic; proximity fuzing. STATUS: Procurement complete; operational on F-101B and F-106; improved version cancelled; launcher being developed by McDonnell for adaptation to F-4 aircraft.

HAWK (MIM-23A) (Army)
Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion. DESCRIPTION: Surface-to-air; weight, 1,275 lbs.; solid propulsion; warhead, H.E.; range, 22 mi.; guidance, semi-active radar homing; 100-45,000-ft. ceiling; provides defense against medium and low-flying aircraft and cruise-type missiles. STATUS: Operational, deployed in Europe, Panama, Okinawa, South Vietnam, U.S. (13 battalions); bought by Sweden and Israel; R&D being conducted to adapt selected HAWK units to an anti-tactical ballistic missile; NATO producing; Japan also plans buy; $34 million requested for equipment and $8 million for spares in FY '66; no further procurement in FY '66; $11 million improvement program aimed at limited anti-missile capability; self-propelled version also under development; large-scale buy by Saudi Arabia; sales to other Arab nations expected.

HIBEX (ARPA/Army)
Boeing, prime; Hercules and Aerojet, propulsion. DESCRIPTION: Experimental program in high-energy propellants; cone-shaped missile; performance classified; solid propulsion. STATUS: Development; accelerations of 800 to 1,000 g's goal; static test of motor successful November, 1964; flight test program of 10 vehicles being conducted at WSMR; third successful flight Oct. 28 was first from underground cell at WSMR; Up-Stage program started to add second stage and increase range.

HONEST JOHN (MGR-1A) (Army)
Douglas/Emerson Electric, prime; Hercules, propulsion. DESCRIPTION: Surface-to-surface; weight, 5,900 lbs.; single-stage solid propulsion; warhead, nuclear; range, 12 mi. (M-31), 20 mi. (M-50); unguided. STATUS: Operational; M-50 being deployed in Europe; to be replaced by LANCE; procurement complete.

HORNET (ZAGM-64A) (Air Force)
(Formerly known as ATGAR). Concept based on North American Aviation Columbus Div. unsolicited proposal, funded by AF. DESCRIPTION: Air-launched, anti-tank weapon, electro-optical guidance. STATUS: pre-development, AF procuring missiles for test at Eglin AFB; Army interested in potential use on helicopters; HORNET also used as demonstration vehicle for new NAA TV-guidance system for MAVERICK (AGM-65A), a new tactical air-to-surface missile for which the AF has asked for DOD approval.

HOUND DOG (AGM-28) (Air Force)
North American, prime; Autonetics, guidance; Pratt & Whitney, propulsion. DESCRIPTION: Air-breathing air-to-surface standoff missile; weight, 9,600 lbs.; turbojet propulsion; warhead, nuclear; range, about 600 n.mi.; guidance, all-inertial; ceiling in excess of 50,000 ft.; Mach 2+. STATUS: Operational; to be launched from B-52G intercontinental bombers; procurement complete.

LANCE (XMGM-52A) (Army)
LTV Aerospace, prime; Systron-Donner, guidance. DESCRIPTION: Highly mobile general-purpose missile; very light weight; pre-packaged storable liquid propellant; warhead, nuclear and H.E.; range, 3-30 mi.; guidance, Automet inertial, one missile per launcher. STATUS: Large-scale development. Tenth flight test, Oct. 10, 1965, from operational launcher; production decision depends on success of current flight tests; eventually will replace HONEST JOHN and LACROSSE and perhaps LITTLE JOHN; division support weapon; to use multi-system test equipment; Navy also studying shipboard version.

LITTLE JOHN (MGR-3A) (Army)
Emerson Electric, prime; Hercules Powder, propulsion. DESCRIPTION: Surface-to-surface; weight, 800 lbs.; solid propulsion; warhead, nuclear; range, 10 mi.; unguided; supplements medium and heavy artillery in airborne divisions and air-transportable commands. STATUS: Two battalions activated in 1961; each equipped with four launchers; air- and helicopter-transportable; may be replaced by LANCE.

MACE (MGM-13A, CGM-13B) (Air Force)
Martin, prime; Goodyear/AC Spark Plug, guidance, Thiokol/Allison, propulsion. DESCRIPTION: Air-breathing surface-to-surface; weight, 18,000 lbs.; turbojet and solid propulsion; warhead, nuclear and H.E.; range, over 650 n.mi. (Model A), over 1,200 n.mi. (Model B); guidance, map-matching (A), inertial (B). STATUS: Five MACE-A and one MACE-B squadrons (in hard sites) deployed in Europe; two MACE-B squadrons on Okinawa in hard sites.

MAW (Army)
McDonnell Aircraft Corp. and Army Missile Command, development of competitive approaches to Medium Anti-Tank/Assault Weapon requirement; Ford Instrument Co., gyro package for Army version. DESCRIPTION: Surface-to-surface; solid propellant; range, 500-1,500 yds.; shoulder-fired; McDonnell version wire-guided; Army version two-degree-of-freedom, free rotor gyro. STATUS: Exploratory development; competitive approaches have been fired against each other, using a ZUNI test vehicle; the best system will be allowed to proceed into full-scale development when evaluation is complete; MAC version completed test series with all 13 firings successful; AMC version fired successfully Oct. 20 using GPI guidance system.

MINUTEMAN (LGM-30) (Air Force)
TRW Systems Group, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance, Thiokol, first-stage propulsion; Aerojet, second-stage propulsion; Hercules, third-stage propulsion; Avco, re-entry vehicle; GE, MARK 12 re-entry vehicle, MINUTEMAN II. DESCRIPTION: 2nd-generation ICBM; weight, over 65,000 lbs.; solid propulsion; warhead, nuclear; 3 stages; range, 7,000 mi.; guidance, all-inertial, target selected in seconds; 32-sec. reaction time. STATUS: MINUTEMAN II flight-test program (36 shots planned) began Sept. 24, 1964; 800 MINUTEMAN I's now operational; 1,000 missiles through FY '65; advanced version can be fired by airborne command posts; deployed in hardened and dispersed silos; MINUTEMAN II expected operational early in 1966; all MINUTEMAN I missiles to be replaced by MINUTEMAN II in phased replacement program costing $1 billion and beginning in 1966; some of the II's replace earlier models; MMII has greater accuracy (nearly 8 times more) and range/payload than I version; 14 successful MINUTEMAN II launches now completed, with most recent launch Dec. 14, 1965; maneuverable re-entry vehicle under development; several modifications beyond MMII already made.

NIKE-HERCULES (MIM-14B) (Army)
Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe. DESCRIPTION: Surface-to-air, anti-aircraft, tactical; weight, 10,000 lbs.; solid propulsion; warhead, nuclear or H.E.; range, 75 mi.; guidance, command; Mach 3+; ceiling in excess of 150,000 ft. STATUS: Over 80 batteries deployed in U.S. being turned over to National Guard; over 10 N-H batteries deployed overseas; Japan plans additional procurement; being equipped with HIPAR, a high-power acquisition radar, and anti-tactical-ballistic-missile capabilities. Re-location of some HERCULES batteries under consideration by JCS.

NIKE-X/Zeus (XLIM-49A) (Army)
Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe. DESCRIPTION: Anti-missile missile, 3-stage; weight, 22,800 lbs.; solid propulsion; warhead, nuclear; range, 200-mi.; guidance, command; length, 48 ft.; diameter, 36 in.; fin span, 10 ft. STATUS: Missile is now part of NIKE-X missile "mix"; development, except as part of X, has ended; no intercept "failure" in more than a year of tests; $10 million requested for preliminary production engineering in FY 1966; advanced version of ZEUS (DM15X2) now under development reflects important breakthrough in long-range (400-mi.) ICBM interception.

NIKE-X (Army)
Western Electric, prime; Bell Telephone, guidance; Thiokol, ZEUS propulsion; Douglas, ZEUS airframe; Martin Marietta, SPRINT missile prime; Hercules and Lockheed, SPRINT propulsion. DESCRIPTION: Successor to ZEUS as an anti-ICBM system; uses a mix of ZEUS/SPRINT missiles and multi-function array radar (MAR). STATUS: Engineering development; funded at $400 million in FY '66 on accelerated development schedule, but deployment still deferred; GE will submit proposals on a hardened NIKE-X system. Tests to be conducted late this year with MAR at WSMR, N.M., could provide basis for deployment decision; deployment cost: $8-20 billion; key decision expected late this year.

PERSHING (MGM-31A) (Army)
Martin, prime; Bendix, guidance; Sperry Farragut, fuzing and aiming; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; two-stage solid propulsion; warhead, nuclear; range, approx. 400 n.mi.; guidance, inertial; transported on FMC M474 tracked vehicles; replaced REDSTONE. STATUS: Flight test program completed; troop firings from Ft. Wingate, N.M., to White Sands being conducted; number of missile-loaded launchers per unit to be increased; West Germany organizing two battalions; first U.S. PERSHING battalion deployed to Germany in April, 1964.

PHOENIX (AIM-54) (Navy)
Hughes Aircraft Co., prime; Rocketdyne, propulsion. DESCRIPTION: Air-to-air missile for use with the F-111B fighter aircraft; each aircraft will be able to carry six missiles. Missile control system designated AN/AWG-9; and missile/bomb launcher is MAU-48A. STATUS: Dedelopment; first flight test planned in March, 1966; $71 million in FY '66 funds.

POLARIS (UGM-27 A, B, C) (Navy)
Lockheed, prime; GE/MIT/Hughes/Honeywell/Raytheon, guidance and fire control; Aerojet-General/Hercules, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination and training; Systron-Donner, ignition programming. DESCRIPTION: Underwater- and surface-to-surface; weight, 30,000 lbs.; solid propulsion; warhead, nuclear; range, 1,200 n.mi. (A-1), 1,500 n.mi. (A-2), 2,500 n.mi. (A-3); guidance, all-inertial. STATUS: 24 subs operational each with 16 A-2 or A-3 missiles; all A-1's now retired; A-3, operational in August, 1964; going on subs 19-41; total of 41 POLARIS subs authorized; deployed in Atlantic and Mediterranean; Pacific deployment began in 1964; British to buy A-3 missiles from U.S. POSEIDON, follow-on FBM, about to go into full-scale development; same contractors as POLARIS except for propulsion; Hercules/Thiokol first stage; Hercules second stage; same range as A-3 with double payload and accuracy; 50-month development effort; may go aboard 19 subs; PenAids and warhead can be field-changed.

QUAIL (ADM-20C) (Air Force)
McDonnell, prime; McDonnell, electronics, guidance; GE, propulsion; TRW, Inc., ECM equipment. DESCRIPTION: ECM-carrying decoy, which simulates B-52 bomber, to enemy radar; turbojet powered; range, 250 mi.; guidance, gyroscopic autopilot. STATUS: Deployed at SAC bases; carried by B-52; procurement completed FY '61; advanced version with 400-mi. range has been flight tested.

REDEYE (XFIM-43B) (Army)
GD/Pomona, prime; Atlantic Research, propulsion; MPB, Inc., seeker optics. DESCRIPTION: Surface-to-air; weight, 28 lbs.; solid propulsion; warhead conventional; guidance, IR-homing; length 48 in.; diameter, 2.75 in. STATUS: Production; tests against helicopters and jets at NOTS successful.

REGULUS I (RGM-6) (Navy)
LTV Aerospace Corp., prime; Sperry, guidance; Allison, propulsion. DESCRIPTION: Surface-to-surface; weight, 14,000 lbs.; turbojet and solid propulsion; warhead, nuclear; range, 500 n.mi.; guidance, inertial; speed, about 600 mph; ceiling, approx. 40,000 ft. STATUS: Five REGULUS subs with 17 missiles are operational now; 3 subs (8 missiles) phased out in FY '65.

SAM-D (Formerly AADS-70) (Army)
Hughes/Douglas/FMC, RCA/Beech, competitive component development contracts. DESCRIPTION: Field army aircraft/missile defense system, mobile. STATUS: DOD approved Army go-ahead for CDP; RFP's for CDP expected early January; Engineering development expected in FY '67; missile will replace both HAWK and NIKE-HERCULES; production could cost more than $2 billion.

SERGEANT (MGM-29A) (Army)
Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; solid propulsion; warhead, nuclear; range, over 75 n.mi.; guidance, inertial; uses drag brakes. STATUS: Operational procurement complete; deployed in Europe; replacement for CORPORAL; West Germany buying system. $1.9 million requested in FY 1966 for warhead adaptation kits.

SHILLELAGH (MGM-51A) (Army)
Philco Aeronutronic, prime, Picatinny Arsenal/Amoco Chemicals Corp., propulsion; Aeronutronic, guidance. DESCRIPTION: Surface-to-surface; lightweight; solid propulsion; warhead, nuclear or H.E.; guidance, command; vehicle-mounted for use against field fortifications, armor and for close-in support of troops. STATUS: Production; initial procurement in FY '65; second-source procurement may come in FY '66; to use multi-system test equipment; to be installed on Gen. Sheridan assault vehicle; also being considered for use on helicopters; Philco has contract to adapt missile to Army's M-60 tank.

SHRIKE (AGM-45A) (Navy)
Naval Ordnance Test Station-China Lake, prime; Texas Instruments, guidance and control; North American Rocketdyne (McGregor), propulsion. DESCRIPTION: Air-to-surface, anti-radar; solid propulsion; guidance, passive radar homing. STATUS: Operational with Navy and Air Force; some reliability problems; advanced version under development.

SIDEWINDER I-C (AIM-9C&D) (Navy, Air Force)
Naval Ordnance Test Station, technical direction; Philco, IR guidance, Motorola, radar guidance; Naval Ammunition Depot, McAllister, motor loading; Rocketdyne (McGregor), propellant. DESCRIPTION: Air-to-air; weight, about 185 lbs.; solid propulsion; warhead, H.E.; range, more than 2 mi. STATUS: 1-A deployed with Navy and Air Force; 1-C version being procured as replacement for 1-A; NATO-built version now in production. (See CHAPARRAL).

SPARROW III-6B (AIM-7E) (Navy)
Raytheon, prime; Raytheon, airframe, control, guidance; Aerojet-General/North American Rocketdyne (McGregor), propulsion; McDonnell/Benrus Watch Co., launcher. DESCRIPTION: Air-to-air; weight, 350 lbs.; solid propulsion; warhead, conventional; range, 5-8 mi.; guidance, semi-active CW homing; Mach 2.5-3; ceiling, over 50,000 ft. STATUS: Earlier models operational with carrier aircraft; SPARROW III-6B prime armament for Phantom II (F-4B) and other high-performance interceptors; Italians buying NATO version for use of new F-104S; sales to West Germans and other NATO F-104 consortium members possible; Navy considering for air defense.

SPRINT (Army)
Martin-Orlando, prime; Hercules Powder/Lockheed Propulsion Co., propulsion; Bell Telephone Laboratories, guidance. DESCRIPTION: High-acceleration cone-shaped maneuverable missile for low-altitude interception of ballistic missiles; 4.5-ft. base diameter, 27 ft. long; two-stage; nuclear; missile will be popped out of silo before motor is ignited; to be part of the missile mix in a NIKE-X battery. STATUS: Development; first flight in March, 1965, tested vehicle aerodynamically; successfully tested from silo Nov. 17 at WSMR; extensive guidance tests underway; tests to move to Kwajalein in 12-18 months for use with NIKE-ZEUS and full radar system.

SRAM (Air Force)
Boeing and Martin Marietta won CDP awards of $2.75 million each. DESCRIPTION: Air-to-surface defense-suppression stand-off missile for use with the B-52, B-58, F-111 or the Advanced Manned Strategic Aircraft. STATUS: AF contracting feasibility tests for LASRM (Low-Altitude Supersonic Research Missile), aiming at doubling SRAM's range; Congress cut FY '66 budget request by $30.7 million; development decision not expected until August, 1966.

STANDARDIZED MISSILE (Navy)
No contractors. DESCRIPTION: Fleet air-defense missile to replace TARTAR-TERRIER and give Navy a single missile to perform both missions; longer-range targets (30+ miles) would be engaged by adding a booster to the shorter-range (10+ miles) weapon; similar to the homing TERRIER now being procured. STATUS: Development; expected to be procured initially in 1967-68; intended to work with new TARTAR-D digital fire control.

SUBROC (UUM-44A) (Navy)
Naval Ordnance Laboratory, technical direction; Goodyear, prime; General Precision Aerospace, guidance; Thiokol, propulsion; General Precision Librascope, fire control. DESCRIPTION: Underwater-air-underwater anti-submarine missile depth bomb; solid propulsion; warhead, nuclear; weight, 4,000 lbs.; length, 21 ft.; diameter, 21 in.; range, 25-30 mi.; guidance, inertial. STATUS: Production scheduled for installation in Thresher-class subs; operational evaluation under way.

SS-10 (MGM-21A) (Army)
Nord Aviation, prime. DESCRIPTION: Surface-to-surface, primarily anti-tank; weight, 33 lbs.; solid propulsion; warhead, conventional; range, 1,600 yards; wire-guided. STATUS: Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC.

SS-11 (AGM-22B) (Army)
Nord Aviation, prime. DESCRIPTION: Surface-to-surface anti-tank, also helicopter-to-surface; weight, 63 lbs.; solid propulsion; wire-guided; warhead, conventional; range, 3,800 yds. STATUS: Operational, used with airborne units and Army helicopters; AS-12 being considered by Navy for ASW aircraft.

TACTICAL PROBE (Navy)
Bendix, prime: DESCRIPTION: Surface-to-air; multiple, interchangeable payloads for each mission; booster, TERRIER or TALOS from shipboard installations; high-impulse second stage; range, 50-300 mi.; parachute descent. STATUS: Program definition; a new study has been authorized, and is under way, to evolve a cheaper program.

TALOS (RIM-8E) (Navy)
Bendix, prime; Vitro, systems engineering; McDonnell/Hercules Allegany Ballistics Lab., propulsion; Sperry, guidance; GE, launching gear. DESCRIPTION: Ship-to-air; weight, 7,000 lbs.; solid and ramjet propulsion; warhead, nuclear; range, 65 n.mi.; guidance, radar beam riding/semi-active homing; Mach 2.5. STATUS: Operational aboard cruisers Galveston, Little Rock & Oklahoma City and three Albany-class DEG's; Long Beach, nuclear-powered cruiser, has advanced TALOS; "3-T" get-well program increasing reliability; procurement continuing.

TARTAR (RIM-24B) (Navy)
Vitro, systems coordination engineering; Applied Physics Lab, design and development; GD/Pomona, Aerojet-General, propulsion; Sperry Farragut, fuze (target detection device). DESCRIPTION: Ship-to-air; weight, 1,500 lbs.; solid dual-thrust motor; warhead, conventional; range, 10 n.mi.; guidance, semi-active homing; Mach 2. STATUS: Operational; installed aboard 23 guided missile destroyers and three cruisers equipped with TALOS; get-well program progressing satisfactorily; CVA Kennedy will also have TARTAR.

TERRIER (RIM-2E) (Navy)
Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; Hercules Allegany Ballistics Laboratory, propulsion; Northern Ordnance, launching gear. DESCRIPTION: Ship-to-air; weight, 3,000 lbs.; 27 ft. long; solid propulsion; warhead, conventional; range 10 n.mi.; guidance, radar beam-riding or homing; Mach 2.5. STATUS: Operational aboard two attack carriers, 6 cruisers, and 12 missile frigates; get-well program progressing satisfactorily; being used in test firings against surplus REDSTONE missiles.

TITAN II (LGM-25C) (Air Force)
Martin, prime; TRW Systems Group, systems engineering and technica direction; AC Spark Plug, guidance; Aerojet-General, propulsion; GE, re-entry vehicle. DESCRIPTION: ICBM; weight, 330,000 lbs.; N_2O_4 and Aerozine-50 storable fuels; warhead, nuclear; range, over 5,000 mi.; guidance, inertial; 115 ft. long; 2 stages; greatest payload and range of any U.S. ICBM, basic core vehicle for TITAN III booster. STATUS: All 54 missiles operational in 18-missile squadrons at Davis-Monthan AFB, McConnell AFB, and Little Rock AFB.

TMRBM (Air Force)
No contractors announced, but probably would be same team producing the second and third stages of MINUTEMAN II. DESCRIPTION: A transportable mid-range missile to fill the gap left by cancellation of MMRBM; it would use the top two stages of MM II and the MM II guidance system; would weigh more and be less mobile than MMRBM, but could be developed for approximately one-third the cost; reaction time also less than MMRBM's; employment concept much the same as that of the Russian-deployed missiles in Cuba in 1962. STATUS: Study by the Air Force at DDR&E direction; not likely to be developed due to a lack of mission.

TOW (XMGM-71A) (Army)
Hughes, prime. DESCRIPTION: Anti-tank; weight, 160 lbs.; solid propulsion; warhead, H.E.; wire-guided; optically tracked; tube-launched. STATUS: Development; follow-on to ENTAC; successful firings have been conducted; helicopter use planned.

WALLEYE (Navy)
NOTS development; TV-guided glide bomb with good stand-off range; Martin reported winner of production competition; large buy expected; smaller version, called SNIPE, under NOTS development for Army helicopters.

ZUNI (Navy)
Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion. DESCRIPTION: air-to-surface; weight, 107 lbs.; solid propulsion; warhead, conventional; range, 5 n.mi.; unguided; STATUS: Operational; designed for use on jet fighter and attack aircraft; big increase in orders because of Vietnam war.

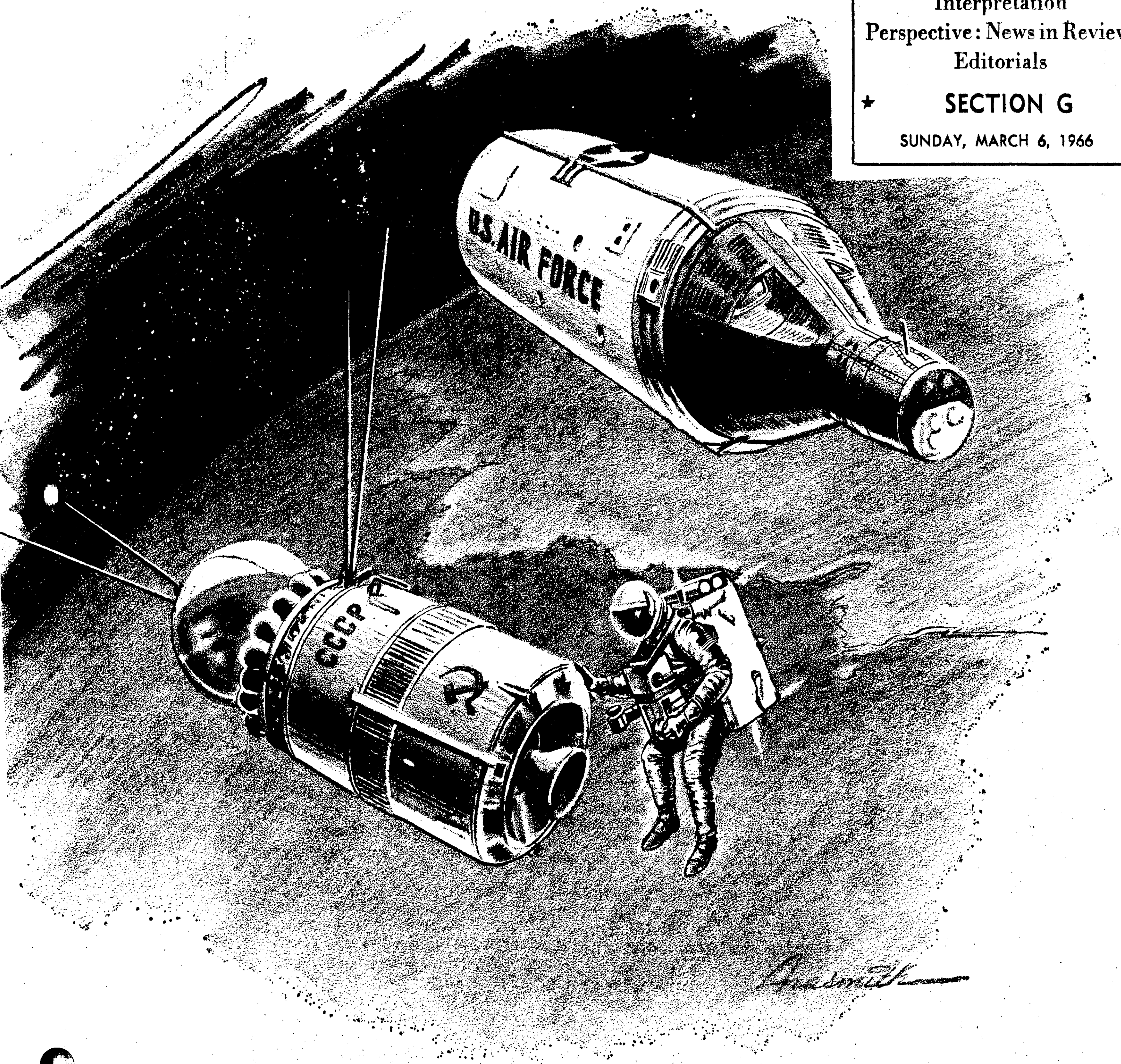
Los Angeles Times

Opinion

Interpretation
Perspective: News in Review
Editorials

★ SECTION G

SUNDAY, MARCH 6, 1966



Secrecy Over MOL---A 'Gentlemen's Agreement' to Avoid Arms Race?

MARVIN MILES

The United States, it appears, will once again attempt to preserve the fiction that this nation does not engage in space reconnaissance and has no special interest in satellite inspection or the possibilities of future space combat.

Nervous secrecy already shrouds the Air Force's Manned Orbiting Laboratory (MOL) program announced by President Johnson last August, even to generalities of the public information policy that will go with it.

Billed as a project to evaluate the role of military man in space, MOL, scheduled for orbit in 1968, gives the Defense Department its first share in the nation's manned space effort after long and bitter controversy within the government.

Marvin Miles is aerospace editor of The Times.

It represents belated agreement that the United States can no longer delay exploring the military values of the vacuum above the atmosphere lest the balance of power be tipped suddenly by Russia where all space programs are militarily oriented.

And on MOL's performance—and that of its two-man crews—will ride the space future of the Air Force.

Information Problem

Once a decision was reached on the $1.5 billion MOL program ($2 billion is more likely) the Defense Department was confronted with the problem of a public information policy. To what extent should MOL be publicized?

Air Force planners were in a tough quandary.

On one hand, MOL will involve month-long overflights of every nation on earth with a wide range of secret military capabilities, including space reconnaissance from advanced photography to electromagnetic ferreting of alien radar installations and eavesdropping on foreign communications channels.

On the other hand, it will involve men in space, an area of intense interest to Americans who are thoroughly familiar with the extraordinary public information job accomplished by the National Aeronautics and Space Administration in reporting to the nation on such civilian programs as Mercury, Gemini and Apollo.

To the credit of Air Force planners—some of whom scoff at NASA information efforts as "dog and pony shows," an effort was made to establish a sensible public information policy for MOL.

Basic Facts Unhidden

They reasoned that while military projects demanding strict secrecy are involved, the basic facts of MOL cannot be hidden from the Soviet Union, the American public or the world at large.

Hence they recommended a policy that would give the public a deserved share of information on the program — details that would become known in any case—while holding in understandable secrecy the vital military operational and experimental areas that are the heart of the program.

But this reasonable approach was rejected—by the Defense Department? the State Department? the Joint Chiefs of Staff? the White House?—and it appears MOL will be shrouded with the same cloak of secrecy that has for years mantled our Samos and Midas satellites.

These unmanned military orbiters —Samos for space reconnaissance and Midas for early warning of hostile missile launches—were, in the beginning, well publicized by the Air Force. Newsmen were invited to watch launches from Vandenberg Air Force Base and provided with information releases.

Then a national policy decision screened the two programs with a secrecy curtain. The satellites still fly regularly, but they are identified only as "classified payloads." Air Force officers are forbidden to mention the names Samos and Midas and information once handed out so freely is now classified.

Khrushchev's Boast

Not that the Russians don't know about the so-called spies in the sky. Soviet leaders occasionally mention Samos and Midas and Nikita Khrushchev once boasted of Russian satellite operations over the United States and offered to swap space photographs with the United States.

In an article entitled "Pentagon Grasps for Outer Space," the Soviet newspaper Izvestia last year had this to say about Samos:

"Two years ago two types of Samos reconnaissance satellites, one light and one heavy, entered the (U.S.) arsenal. Their job is to conduct photographic and radiotechnical reconnaissance.

"The light ones are launched to take rough photographs, to provide small-scale terrain pictures.

"The heavy satellites (up to two tons) are launched with better-developed photographic equipment, making possible the detection of various objects with linear dimensions of 16 to 20 meters.

"Samos is also used for radio technical intelligence, taking fixes on electromagnetic radiation of diverse origin and intercepting information traveling along radio communications lines.

"The Pentagon wants to know where rocket launching sites and strategic airports are located, where ships and submarines are based and where various objectives of military significance have been built and also to see what is going out on the airwaves of a number of countries."

Two Possibilities

The Russians are no less conversant with MOL and it potentialities as a manned extension of America's unmanned spies in the sky. Why, then, the rigorous secrecy? Certainly it is not based on the hope of keeping the Soviet from learning of the flights and assessing their significance.

This leaves two possibilities:

First, the United States hopes to preserve the international image that this nation is devoted entirely to the peaceful uses of space and fears that an investigation of space defense potentiality might be misinterpreted as an abrogation of this posture.

Second—and more likely—is that high government authority, perhaps the State Department or even the White House, had determined, as in the case of Samos and Midas, that discretion calls for secrecy even if no secret is involved.

The latter possibility implies a "gentleman's agreement." Since both the United States and Russia have overflight capability, each will be allowed to conduct its missions unmolested as long as each abides by the international agreement not to place weapons of mass destruction in orbit.

The rationale as far as the United States is concerned could be that it has more to gain by overflight reconnaissance, manned or unmanned, than the Soviets and to publicize its missions would place Russia in an untenable position, forcing her into reprisals to save face before the world.

No Intercept Actions

Those who believe this explanation of the curious situation point out that with a constant stream of Samos and Midas satellites launched by the United States and overflights of this country by Russian satellites, manned and unmanned, there have been no intercept actions by either side.

They note also that the United States for some time has had the capability, with special Thor and Nike X launch batteries, to knock down alien satellites, if desired. They add that Russia undoubtedly has acquired the same defense technology which is simpler than intercepting incoming ballistic missile warheads.

Proponents of MOL say the spacecraft can serve to maintain peace by discovering any covert move toward the massive buildup of arms and thwart it by returning proof for disclosure before the world.

Opponents fear MOL may bring an extension of the arms race by spurring Russia to attain equal capability and lead eventually to competition for more effective manned military orbiters that would fly as strike systems, loaded with nuclear weapons.

The civilian space agency's Mercury flights and more importantly the two-man Gemini missions have contributed much to the future of military space operations by demonstrating maneuverability, prolonged flight, space walking, orbital rendezvous and, soon, docking aloft.

Military Experiments

And along with these major accomplishments, including proof that man can live and function in orbit for as long as two weeks, Gemini has provided a test vehicle for a series of announced military experiments and probably some that have never been disclosed.

MOL flights with a laboratory 41 feet long and 10 feet in diameter will carry much more specialized equipment than Gemini and thoroughly test man's ability to extend the efficiency of reconnaissance systems with human decision and analysis and real-time reports on changing situations.

But MOL represents more than an advanced reconnaissance spacecraft. Undoubtedly it will be the forerunner of future satellite inspection systems, of military command posts in space and perhaps a step toward the space combat vehicles envisioned by many.

The Air Force will not discuss such possibilities today, even in general terms unrelated to MOL. Quite obviously these areas are too sensitive now that the USAF has a foot in the manned space door with a chance to expand its penetration.

But certainly satellite inspection, for example, will be an area investigated in the program, for the United States must have the capability to check out suspicious orbiters and determine if they carry nuclear weapons aboard.

Feasibility of Checkout

The Gemini 6 and 7 rendezvous last December proved the feasibility of checkout. A military operation could include nudging the target craft to determine its mass as a clue to the nature of its payload.

It could involve investigation by a space-walking astronaut wearing a self-contained maneuvering unit the Air Force has developed for use without a tether line. Or inspection could be accomplished remotely, in a dangerous situation, by controlled devices guided outward from MOL.

Methods of neutralizing a menacing satellite would vary, according to assessment of the threat, but it could involve no more than destroying its antennas to block off command communications or blacking out its sensors and fouling its thrusters to disrupt attitude control.

And MOL could be the forerunner of space combat vehicles, although some deny such a possibility.

Others feel that the Gemini rendezvous last December opened the path for pursuit and interception by opposing manned spacecraft.

"What happens, even in a cold war situation," they ask, "when manned spacecraft of rival nations seek to check each other out? And what happens if such encounters take place in a hot war?"

Their contention is that space combat techniques may stand unwittingly today in almost the same evolutionary stage of development as the first rickety little aircraft encounters early in World War I before air fighting became an art.

It's food for thought.

# # #

House Committee Urges AAP Merger into MOL Program

by Heather M. David

THE HOUSE GOVERNMENT Operations Committee has recommended that NASA participate in the Air Force's *Manned Orbiting Laboratory* program rather than embark upon a separate *Apollo* Applications Program of its own.

A report prepared by the Subcommittee on Military Operations, which investigated missile and space ground-support operations, and adopted by the full committee, urged priority for the military needs of the *MOL*—with satisfaction of the objectives of the AAP handled as a sideline of *MOL*.

The report stated that while AAP is not yet an approved program, both Air Force and NASA are nearing a point-of-no-return where "separate and largely duplicating" programs cannot be avoided.

"Inasmuch as both programs are still research and development programs without definitive operational missions, there is reason to expect that with earnest effort both agencies could get together on a joint program incorporating both unique and similar experiments of each agency," the committee stated.

It also noted that such a plan would give each agency the necessary experience and information to plan larger space stations, for which NASA at least has stated a potential future need.

The committee, which last year made a widely circulated recommendation for immediate action on the *MOL*, said that a merger between *MOL* and AAP should be "effected within the existing scale of priorities which accords to the military experiments greater urgency."

MOL ground support—The Dept. of Defense was urged to make maximum use of existing DOD and NASA facilities for the *MOL* rather than build new ones.

However, while DOD has said that no new development support resources on the scale of NASA facilities will be necessary because Douglas Aircraft Co., *MOL* prime contractor, has extensive new facilities, the committee questioned whether Douglas facilities can handle all phases of *MOL* development support.

One of the items it questioned was whether Douglas's vacuum chambers and simulators were large enough to accommodate the projected size of the *MOL* spacecraft. The group recommended use of existing simulation and test facilities, such as those at NASA's Manned Spacecraft Center and the Air Force's Arnold Engineering Development Center, should this be necessary.

Tracking systems—NASA and DOD passed up "big savings" by going to different tracking systems, the committee said, since about $25 million will be spent by NASA for the Unified S-Band system, and $32 million by DOD for the Space-to-Ground Link Subsystem (SGLS).

The group urged a vigorous effort towards standardization of existing or future instrumentation equipment, but acknowledged that the time is now past when a choice could be made between one or the other system.

It may be possible to use the USB equipment on the converted instrument ships for the ascent stage of *MOL*, and this could obviate additional investments in instrumentation ships, the report noted. However, the equipment does not have the degree of compatibility permitting its use for all on-orbit *MOL* support if that could not be met by current SCF stations, which will be equipped with SGLS equipment.

It will nevertheless take a concentrated effort to avoid expansion of the instrumentation fleet, the committee observed. The problem both agencies face is the conflict between two high-priority programs, involving the need to make compatible the deployment and scheduling of the ships for both *MOL* and the *Apollo* lunar-landing mission, with launches from different coasts.

The committee also suggested that DOD should make a decision as to whether the ship pool should be manned under the Navy Military Sea Transportation Service (MSTS).

The Satellite Control Facility and the Air Force National Range Division should be linked more closely in the interest of achieving a global network, the report added.

Single management of instrumentation facilities was urged where possible, as were steps to halt the proliferation of stations by different networks and agencies in adjacent areas around the world.

Apollo communications—The committee saw a strong need for reappraisal in the management of negotiations for communications services, such as those recently carried out between NASA and the Communications Satellite Corp.

It pointed out that NASA will lay out about $150 million or more for *Apollo* communications over a three-year period, including the underwriting of most of the costs for a new satellite communications system to be built by Comsat, modifications of ship terminals and conventional backup communications.

Some $27.79 million of this is involved in the Comsat contract, but does not include charges to be paid for the use of the foreign ground stations, which are expected to raise the total price for the Government to about $40 million for three years.

DOD also may make use of this system, and discussions are under way between DOD and Comsat over use of the channels to be available from the satellite, which will be stationed over the Pacific Ocean, the committee revealed.

It is possible, therefore, that the Government will be providing 75% of Comsat's annual revenues for some period of time, a portion of which will accrue to the international consortium in accordance with the ownership shares of the participating nations.

The committee indicated that a review of all the negotiations which took place between NASA, Comsat and DOD turned up some apparent reservations about the agreement among officials who approved it.

To this end, the group reiterated its recommendation made a year ago that the Directorate of Telecommunications be reorganized to give it power to adjudicate and make policy on such matters, assume the responsibility of the Secretary of Defense for identifying and evaluating Government user requirements for communications, and undertake systematic planning so that these requirements can be met in an orderly and economical way.

While "notable" progress has been made generally in achieving coordination among the agencies in ground-support activities, the committee said it observed "disturbing trends" which could defeat the progress made to date, especially in the creation of more complex and specialized equipment and facilities, which the agencies "show no great willingness to resist."

It urged strengthening of existing coordination mechanisms such as the Aeronautics and Astronautics Coordinating Board and its Space Flight Ground Environment Panel, active participation by the National Aeronautics and Space Council, and greater reliance on—and official recognition of—the Range Commanders Council and its sub-groups. ■

Section: IBM Management Summary

4/1/66

ARMED FORCES MANAGEMENT
March, 1966

Spacecraft Mission Projects

The largest space mission project in terms of total program cost is the Manned Orbital Laboratory (MOL). Last August, President Johnson decided to proceed with its development at an estimated cost of about $1.5 billion. "We intend that the MOL development program should proceed on a deliberate and orderly schedule," Secretary McNamara said, "using the $150 million provided for FY 1966 and the $159 million requested for FY 1967.

"Design definition, system integration, development of specifications and determination of firm cost proposals are scheduled for completion during this coming spring and summer, after which contracts will be awarded for the full-scale development of hardware." Finn Larsen added, "MOL is now in an important definition stage. We can expect the direction of our advanced development to come from current work."

Douglas Lists Major MOL Subsystem Contractors

DOUGLAS AIRCRAFT CO., prime contractor for the Air Force's *Manned Orbiting Laboratory,* has announced award of six major subsystem contracts.

Hamilton-Standard Div. of United Aircraft has been chosen to develop the environmental control and life-support system.

Attitude control will be developed by Honeywell, Inc., (M/R, Dec. 20, p. 9).

Collins Radio Co. won the competition for the communications subsystem (M/R, Dec. 20, p. 9). TRW Systems, Inc., will work with Collins as a subcontractor to supply some components and aid in systems engineering.

United Aircraft will also share in another subsystem development through selection of the Pratt & Whitney Div.'s fuel cell for *MOL.*

Douglas has also selected both the Federal Systems Div. of IBM and the Univac Div. of Sperry Rand for continued definition work on the *MOL* data-management system. The firm says the decision on a final single contractor for the system will be made only after this additional definition phase work is completed.

The winners were named March 30.

The effort to develop the environmental-control and life-support system is aimed at providing the *MOL* crews with "shirtsleeve" living conditions during extended missions of possibly 30 days duration. The system controls cabin pressure, temperature, humidity, and composition of the artificial atmosphere. The system will also eliminate atmosphere contaminants.

Douglas reports that work in this area will include a study on the choice between oxygen-helium and oxygen-nitrogen gas combinations for the laboratory atmosphere. Hamilton-Standard was chosen after earlier competition with the AiResearch Div. of Garrett Corp.

Honeywell was selected from three firms competing for the *MOL's* attitude-control system.

Collins Radio's efforts involve both the radio voice links between the *MOL* crew and ground stations and the flow of telemetry and other command data.

Unsuccessful bidders on the fuel cell, which will supply prime electrical power for all lab needs, were Allis-Chalmers and General Electric. ◘

ELECTRONIC NEWS, MONDAY, APRIL 18, 1966

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AFSC Report Recommends Nonprofit Firm Reforms

By BILL HICKMAN

WASHINGTON. — Air Force-supported nonprofit corporations have survived another probe, but this one will make a dent in fees and salaries.

The long awaited AF Systems Command board of visitors report — sometimes called the Johnson or O'Neill report, for its chairman and co-chairman — was released Saturday.

The board — after praising Aerospace Corp., Mitre Corp. and Systems Development Corp. for contributions to AF programs — recommended the corporations not be increased in size; fees be controlled; salaries and benefits to employes watched and in some cases changed; assets held at a minimum, and the AF be the exclusive customer.

It also charged Aerospace had been too ambitious and not sufficiently responsive to AF needs. A blue ribbon panel to oversee the corporations was recommended, but AF Secretary Harold Brown rejected this.

The corporation's greatest fear—that of being turned into in-house AF laboratories — was not mentioned in the cases of Aerospace or Mitre, or in the comments by Secretary Brown and Gen. B. A. Schriever, commander of AF Systems Command, which accompany the report. The question was left open concerning Systems Development.

Aerospace Corp. was held up as the worst culprit. In addition to the charge that the firm was overcompensating its professional employes, the report said its drive for complete independence from the AF was a fundamental problem.

It charged the corporation with ignoring the military chain of command in dealing with the AF. Aerospace often goes directly to the secretary, rather than to the divisions and contracting officers, the report said.

Mitre Corp., consultant to AFSC Electronics Systems Division, stood high in the board's view and was chided only for its "conservative" approach.

Systems Development, the leading "soft wear" (computer programming) organization, is at the point where it should become either a Government installation or a private, profit-making organization, the board contended.

Secretary Brown ordered AFSC to "try out" the weighted guideline articles of the Armed Services Procurement Regulations "as a general framework for fee negotiations." He conceded the guidelines would require adjustments.

In any case, Dr. Brown said, a "fee substantially lower than at present is in order."

General Schriever said the corporations' fixed assets, or facilities, should be owned by them but controlled by the AF. On this point he differed with the board, which had recommended either Government ownership or an arrangement for retention.

On the controversial point of independent corporation research, General Schriever said 10 per cent of contract values should be handled entirely by the corporations, the Government footing the bill.

But the AF should have access to all research results, he said.

Contracts

AIR FORCE

$7,568,000—**Martin Marietta Corp.**, Denver, Colo., increment to an existing contract for design, development, fabrication and delivery of a *Titan III* space booster and associated equipment.

$3,500,000—**Avco Corp.**, New York City, first segment of a $63,585,300 contract for development and production of Mark 17 re-entry vehicles.

$3,200,000—**Lear Siegler, Inc.**, Santa Monica, Calif., for production of attitude reference and bombing computer systems for use aboard the F-4, Phantom II aircraft.

$2,000,000—**McDonnell Aircraft Corp.**, St. Louis, Mo., increment to a previously awarded contract for work on the *Manned Orbiting Laboratory*.

$1,249,845—**F&M Systems Co.**, Dallas, to provide two mobile, air-transportable, closed-circuit-television recording facilities for tactical use by the Air Photographic and Charting Service.

$1,200,000—**TRW, Inc.**, Redondo Beach, Calif., initial increment to a $3,000,000 contract for production of airborne tactical reconnaissance equipment.

$540,000—**Sperry Rand Corp.**, Gainesville, Fla., for microwave tubes.

$127,755—**Clevite Corp.**, Cleveland, Ohio, for work on a material used in rocket nozzles.

missiles and rockets, April 18, 1966

New Titan III-C Procurement Planned

by Michael Getler

WASHINGTON—Air Force and Defense Department are preparing a follow-on production plan for additional *Titan III-C* launch vehicles, according to Dr. John S. Foster, Jr., Director of Defense Research and Engineering.

Foster reports that the vehicles will be used primarily to launch new military communications satellites associated with the Advanced Defense Communications Satellite Program (ADCSP) and tactical communications satellite programs.

Consideration is also being given, Foster reports, to additional *Titan III-C* vehicles for future replenishment launchings of satellites for the Initial Defense Communications Satellite Program (IDSCP) beyond those already planned and for more flights of *Nuclear Detection Satellites* and new multiple-engineering payloads.

Air Force sources say current studies of additional *Titan III-C* procurement are to be completed this fall in time for inclusion in the Fiscal Year 1968 budget request. Various procurement plans are being studied, initially involving three to eight new boosters, according to Air Force officers.

The number of boosters is tied to DOD approval of some of the follow-on satellite programs, such as the tactical comsat network (M/R, Jan. 31, p. 58), and the individual cost is linked to both the launch and production rates. Officers estimate cost of the individual *Titan III-C's* at between $13 and $20 million each, including launch costs.

The new launch vehicles will be in addition to the remaining 10 *Titan III-C* R&D boosters still in the Air Force inventory and already committed to launch assignments. All of the *Titan III-C* launchings will be from the Eastern Test Range (ETR).

Foster made his remarks before the Senate Committee on Aeronautical and Space Sciences in a special hearing called to investigate the Air Force's decision to build new launch facilities for the *Manned Orbiting Laboratory* (*MOL*) program at the Western Test Range (WTR) rather than expand the existing *Titan III-C* facilities at Cape Kennedy to handle the larger seven-segment version of *Titan*, which will launch the *MOL*.

The hearings were called at the request of Sen. Spessard L. Holland (D-Fla.), a member of the committee.

Critics quashed—In defending the launch area decision against charges, mostly from Florida-based interests, of costly duplication of facilities (M/R, Jan. 17, p. 9; Feb. 21, p. 9), of juggling payload figures and orbital requirements, and of Air Force skulduggery in moving the *MOL* project behind the much more secure confines of Vandenberg AFB complex, both Foster and Dr. Robert C. Seamans, Jr., Deputy NASA Administrator, strongly backed the Air Force.

Foster stated flatly that "the program requires that the vehicle be launched into a polar orbit," that "land overflight during the launch phase must be avoided," and that "the seven-segment *Titan III-C* cannot deliver the required payload weight from ETR using a 'dog leg' trajectory."

The dog leg, in this case, would be achieved by launching eastward from the Cape and then turning the vehicle south during ascent. This pattern, while cutting the useful payload that could be lofted into polar orbit with a direct launch due south from the Cape, avoids an overflight of the heavily populated southern Florida area.

However, even with the dog leg to avoid the Florida coast, the *MOL* would still pass over Cuba and Central America during the pre-orbital stage. DOD, the Air Force, and the State Department say that the risk of losing a highly classified payload and astronauts over these areas is not worth taking.

The estimated *MOL* payload weight is about 30,000 lbs., and it is this weight that the seven-segment version of *Titan* is designed to lift from WTR into polar orbit. Capability of the same booster from ETR with the requirement for a dog-leg maneuver is said to be about 27,000 lbs.

Support from Seamans—Dr. Seamans told the committee that the *Saturn IB* booster, including payload increases achieved through vehicle refinements in the past year, would deliver "a maximum of 28,000 lbs. for a polar orbit with a dog-leg maneuver." Seamans said "that compares very closely with the *Titan III* seven segment solid."

Seamans also said that "it does not appear that either the *Titan* or the *Saturn IB* could place the *MOL* payload into polar orbit from Cape Kennedy." The NASA scientist added that "NASA headquarters have not only supported the *MOL* program and its importance, but we have also supported the necessity of the *MOL's* launching from WTR."

Comparative costs of the two boosters revealed at the hearings indicated an $18.2-million price tag on each of the seven-segmented *Titan III* vehicles, including launch costs, based on production of six per year. Seamans said that *Saturn IB*, assuming a production rate of six per year, would cost about $35 million each. Both scientists pointed out differences in accounting procedures between agencies, and in the case of the NASA figure, cost was also linked with production rates on the larger *Saturn V* vehicle.

The hearings also pinpointed present cost estimates for the *MOL* building program at WTR, which currently involves only a single assemble-on-pad facility but which eventually will probably be expanded into an integrate-transfer-launch complex.

Cost of the WTR facility is tagged at $114 million, including roughly $80 million for ground support equipment and at least $4 million for acquisition of the Sudden Ranch property adjacent to the Vandenberg site (M/R, Jan. 10, p. 35).

Development schedules—Foster also placed the development time for the *Titan* seven-segment solid version as "a little over 2½ years" and the time needed for base facility development to "about 2½ years." Foster told the committee that facilities were not the pacing item in the project.

Ground breaking for the WTR site is expected to take place very soon. It's reported that questions of rights if not of cost, involved in the Sudden Ranch property have now been settled.

Contract for solid motor development for the larger version of *Titan* has still not been let, although it has been expected for several months.

A spokesman for Sen. Holland told MISSILES AND ROCKETS that the Senator was apparently satisfied with the explanations offered in the hearing and that no further hearings were scheduled on the matter.

MOL Flight Slips into '69

The first flight of an unmanned version of the Air Force's *Manned Orbiting Laboratory* (*MOL*) has slipped its schedule into early 1969, high-level Dept. of Defense sources told MISSILES AND ROCKETS.

The first flight, one of seven now planned for MOL through 1970, was scheduled for the last quarter of 1968 in recent DOD plans. The first two flights in the program will be unmanned, with the following five flights all carrying crews into polar orbit. Slippage of the lead-off flight is also expected to push the first manned shot beyond the mid-1969 estimate recently stated by DOD.

DATA
April, 1966

Reconnaissance And Surveillance:

A Year Of Progress And Planning

mac.. on c the s op- erationa. copy is to be deliv .ed by Lockheed shortly.

The Defense Department, while pulling the reins on manned recon satellites, did approve funds to get the PRIME portion of the START program underway, thus assuring a reliable means of delivering data capsules from MOL and from unmanned recon satellites to selected points on earth without the present hit-or-miss mid-air snags.

Before going into detail on the major developments of the past year and before exploring plans for the near future, it is appr riate to ex- ine the sta of recon surveillar as descr by the r one y go in D . (D \pril 1 15: ie F f A co e v;" D

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As progressive and promising as the past year has been, aerial recon and surveillance is still the future's child. Governments and their military departments are becoming increasingly aware that world stability rests on accurate knowledge of other parties' activities. There is no room for error in evaluating a potential enemy's intentions on the basis of haphazard, gap-filled information. U.S. military budgets in recent years have shown clearly that the Pentagon and White House fully subscribe to this belief. The budget and importance attached to all aspects of reconnaissance have generally increased. This year, the budget for Fiscal 1967 and the traditional "Posture Statement" that analyzes it, are no exception.

Among the highlights of the intelligence-recon budget are initiation of PRIME which will return data capsules, new Army surveillance aircraft, additional work on VELA nuclear detection satellites, improvement of IR and photographic sensors and a major expansion of effort on recon satellites.

A breakdown by categories is presented in a box within the tex .

THE FY 1967 BUDGET FOR RECONNAISSANCE AND SURVEILLANCE

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gram. from ailable .ds in F 06 ana .5 m. is req .ed i. FY 7 b et. . pro. .ion decisio.. on this aircraft is required at this time.

RESEARCH AND DEVELOPMENT

Vehicles, Engine and Component Developments—The current principal effort under the START (Spacecraft Technology and Advanced Re-entry Tests) program is project PRIME for which we included $16 million in the FY 1967 budget. This is a feasibility demonstration of returning a data capsule from orbit using maneuvering during re-entry . . .

Many other items . . . are now well along in development. In orde to make hem av lable for use in Vi nam t the iest ssible ne, have takε new e cal ec VC Pri Rese ment is not that we cannot afford it—there is no question in my mind that the U.S. can—but that having spent this money we may not be able to change our policies in any particular way. It may not add to deterrence. It may not make it easier for us to exercise our power anywhere else in the world. . . ."

Pro-Nike—"The argument for the ABM is obvious," Brown continued. "If the war does happen, it is worth quite a lot to reduce casualties from 120 million to 60 million. It could also add to deterrence, though I don't particularly believe in that argument."

Air Force Chief of Staff Gen. John P. McConnell told the committee: "In my mind, there is quite a difference between the loss of 100 million and 60 million Americans. I think we ought to have this system." ◘

missiles and rockets, May 9, 1966

First Manned MOL Flight May Slip Into Early 1970

WASHINGTON—Addition of $80 million to the Air Force's Fiscal Year 1967 budget request is aimed at preventing slippage of the first manned flight in the *Manned Orbiting Laboratory* program into 1970.

The additional funds for the program were voted by the House Armed Services Committee last week.

Clear indication of a further *MOL* slippage unless more funds are made available by mid-summer was given by Air Force Secretary Dr. Harold Brown in testimony before the committee. The testimony was made public last week.

The *MOL* development and flight test schedule has already slipped nine months (M/R, April 18, p. 14) behind the timetable laid out for the program last year.

Request slashed—Brown reported before the committtee, that the Air Force had originally asked Secretary of Defense Robert S. McNamara for $395 million for *MOL* in FY '67, but that this figure had been cut by McNamara to $159 million ($150 million for RDT&E and $9 million in military construction allotments).

Brown admitted that after the original request for just under $400 million, a re-examination of the *MOL* schedule —taking into account the nine-month slippage and approximately $40 million carried over from FY '66—revealed a need of $230 to 240 million for FY '67.

"That is what I finally asked the Secretary of Defense for," Brown told the committtee. "We received $150 million. We were told that if we asked for $395 million first and then could only justify $230 million we could not calculate very well. That is a justified criticism, but I believe our calculation of $230-240 million is correct, and I am quite sure that we can obligate justifiably and profitably that much money in FY '67. That amount is necessary to keep the program on schedule."

Reprogramming possible—Brown reported McNamara as indicating that "if we still believed the $240-million figure and could prove it next July, he would let us reprogram the money.

"I don't know where we will reprogram the money from," Brown quickly added. "I don't think we have it."

A spokesman for the Armed Services Committee told MISSILES AND ROCKETS that the committee's action seeks to ensure that those funds are in the Air Force budget from the start and are clearly earmarked for *MOL*. He stated that the add-on was also intended to emphasize the committee's support for the *MOL* program.

During the hearings, Brown told the committee that the best current estimate "is that the first manned *MOL* flight will not occur prior to mid-1969, which is a slip of about nine months from what we stated last year.

"Without the additional money," Brown said, "I am sure there will be additional slippage. Whether it is six months or what, I cannot say." Brown did say that no specific schedule delay could be related to the funding cut in FY '67 until later this month, when the Air Force completes its evaluation of the *MOL* contractors' cost submissions.

Brown also said that the additional funds would provide reasonable assurance that a laboratory vehicle qualification test could be made in mid-1969.

Cost estimates from each of the *MOL* contractors were due at Air Force *MOL* headquarters early this month.

McNamara's justification—Earlier in the hearings, Secretary McNamara responded to Congressional questioning on *MOL*.

"Are there grounds for serious concern about progress?" asked Congressman Robert L. F. Sikes (D-Fla). "Time is passing and we have not pushed this program very rapidly, if it is contrasted with space progress generally."

McNamara pointed to the large carryover of unspent FY '66 *MOL* funds and said "this simply illustrates that fact we overestimated the rate of technical progress . . . and asked for more than we needed. I wanted to avoid this mistake twice. That is why I cut back the FY '67 request," the Secretary stated, "not because of any shortage of funds." This conflicts with Brown's later statement that the program would slip unless more funds are forthcoming by mid-summer.

"I think the Defense Department has, on many occasions in the past two decades, expended funds faster than was justified by technical progress," he added.

Specifically, McNamara pointed to the costly failures associated with the now cancelled Sugar Grove radio telescope project, which cost $70 million, and the *Dynasoar* project, which cost some $400 million before its cancellation in December, 1963.

Non-Profit SDC Expands Market Base

by James L. Trainor

SANTA MONICA, CALIF.—System Development Corp. President Wesley S. Melahn is confident that, even with termination of the not-for-profit's special relationship with the Air Force, the company will be able to prosper.

"We have no great ambitions to get any larger," the SDC president told MISSILES AND ROCKETS, "but we do think that we will be able to compete. Our salaries are comparable to those in industry and our overhead is also competitive."

While the Air Force provides 82.5% of SDC's revenue and the Defense Department as a whole 96.5%, Melahn sees the company's future as an effective contributor "to a wide range of worthwhile projects in such fields as education, law enforcement, regional planning and in assisting state and local governments in the solution of important problems."

He also expects a continuing military business based on the company's experience and demonstrated competence, particularly in air defense, where the company has worked in a privileged position on the Semi-Automatic Ground Environment (SAGE) and the Back-Up Interceptor Control (BUIC) systems.

Need established—In turning to other governmental, state and local organizations for future business, Melahn cites three factors as decisive in establishing the need of these organizations for the computer systems design competence of SDC:

—Reduction in the cost of computer hardware, which allows many more potential users to buy hardware tailored to their needs.

—Development of time-sharing concepts (in which SDC and Massachusetts Institute of Technology's Project MAC did pioneering work) in which many users have access to a central computer. This brings the cost to the user down by another order of magnitude.

—Military work in the computer field has clearly demonstrated that computers are useful, thus melting much of the resistance of people not experienced in computer uses.

Citing SDC's work over a wide range of information sciences and technology and for a wide range of clients (more than 90), Melahn explained the company's role as providing these organizations "with highly qualified technical assistance, which will contribute to the solution of important public problems. This assistance takes the form of design and development of computer-based information-management systems, the design and implementation of training programs and the application of such techniques as systems analysis, simulation and computer programming."

The phrase "important public programs" is an important one to SDC officials, and one they stress repeatedly. The company does not intend to compete for normal commercial business (although Melahn admits that this could change at some time in the future), but will deliberately restrict its set of customers to public organizations or non-profits, such as hospitals, which can use the specialized services the firm can provide.

This restriction is so severe at present that if SDC were asked to take a subcontractor role to a major hardware manufacturer on a public program, the company would reject the contract. The reasoning, Melahn says, is that SDC must enjoy a close, unfettered relationship with the client in order to advise him most effectively.

"The prime naturally wants to sell his hardware and so he would tend to act as a buffer between ourselves and the customer. In this case, this is something we would have to work out with the customer.

Not a snap decision—Although the change in SDC status was first brought to public attention last month in the report of the *ad hoc* group of the Air Force System's Command's Board of Visitors on Air Force relations with the not-for-profit corporations (M/R, April 25, p. 14), both parties were aware that a change was needed.

"Several years ago the Air Force and we took a look at the future Air Defense Command programming needs and came to the conclusion that by 1967 the workload would have dropped off substantially and there was nothing coming along to take up the slack," an SDC executive explained.

The impetus for this examination appears to have been provided by a special committee created by the Secretary of the Air Force in 1964 to examine the overall AF relationship with SDC including the possibility of merging SDC and Mitre Corp. Such a merger, it was felt, would create an organization with "the size and depth of competence and specialized position to accomplish the systems engineering and intersystems integration needed to create a cohesive national command/control system."

Chaired by Bert Goodwin of the General Counsel's office, the committee instead was instrumental in the issuance of a Secretary of the Air Force memorandum recognizing SDC's unique character and exempting it from an earlier policy memo which equated it with the systems engineering/technical direction (SE/TD) roles played by Mitre and Aerospace Corps. It was a victory for the company in that it recognized SDC's independent status and supported the not-for-profit's contention that it differed from the SE/TD, single-customer organizations chartered with Air Force sponsorship.

"This sponsorship has always been an implied Air Force attitude," Melahn says, "but we've always considered ourselves an independent entity, a private organization. We're not like Aerospace and Mitre. We've always been different, although unfortunately people have tended to lump us together. We've never had the single-customer relationship with the Air Force that they have. Almost from the start, we have had a number of customers."

Fade away or branch out—With recognition of the diminishing character of the air defense business, SDC's board of trustees "thought very hard" over the past several years of what the company's future should be. Melahn says alternatives were considered ranging from becoming a profit-maker to dissolving the company.

On the latter point, the board concluded that SDC represented a good capability for which there is a continuing need and with which its customers were pleased. Also, they felt the SDC team was "worth more as a unit" than it would be spread throughout the industry.

On the question of becoming a profit-maker, the board decided that it should remain an independent not-for-profit as long as there is a need and this "continues to be an honorable existence."

The *ad hoc* committee report has worried aloud that "if the corporation is turned loose, the fact that the Government permits the action might place in jeopardy the capabilities of Mitre and Aerospace. If this is a portent of the future of all non-profits, industry may no longer desire to share its proprietary data with the sponsored corporations."

The report then admits the differing character of SDC and the firm's contention that it is not an Air Force-sponsored non-profit. The committee's final recommendation, concurred in by Gen. B. A. Schriever, AFSC commander, and Secretary of the Air Force Harold Brown, is that "Air Force relations with System Development Corporation should now be placed on a normal Air Force/contractor basis. There should be a public withdrawal of the Air Force policy statement of 1964, without prejudice to the corporation. There should be no special privileges or considerations regarding research planning or new business with SDC."

A sponsored monopoly—Melahn emphasizes "that this recognition of SDC's role as an independent non-profit organization does not mean that SDC will be any less concerned with continuing to serve the needs of our Air Force customers. Neither do I believe that it means that the Air Force is less interested in having SDC continue to serve its needs."

In fact, the 1964 policy statement on SDC has placed the company in a good position to compete for military business. That memo directed contracting with SDC on a task-by-task basis, taking into account "the benefits that derive from SDC's status as a non-profit, non-hardware producer, in terms of close working arrangements, objectivity and protection of sensitive information. The decisive factor, however, must be SDC's capabilities to perform the specific task at hand. Tasks that can be performed as well by industrial firms should be competed among them, if not performed in-house."

Thus, most of SDC's contracts with the Air Force are sole-source. Justification for these awards is expected to be valid even under the company's change in status. The only tasks Melahn feels the company will be ineligible for are small planning jobs the company has done for Electronic Systems Div. in the past.

Major military tasks being done by SDC that contributed to its $50 million Fiscal Year 1965 budget:

—Provision of operational, maintenance and training support for ADC in updating the SAGE computer programs and providing computerized system training to keep ADC in a state of emergency readiness ($18 million in FY '65).

—BUIC program ($6.5 million in FY '65).

—NORAD command operation center software and updating the NORAD space track programs ($4 million).

—System training programs for other Air Force commands and the Army, as well as military assistance countries ($4 million).

—Support of Space Systems Div./Aerospace Corp. through maintenance and operation of a computerized library of satellite trajectory information for operational research and for use in operational launch and in-orbit control by the Air Force Satellite Control Facility ($6.5 million).

SDC has also had contracts with the Navy, the Office of Civil Defense and ARPA, the Advanced Research Projects Agency. The ARPA contract is the experiment in developing time-sharing techniques.

In the civilian world—Already considerably experienced in the application of information processing to civilian needs, SDC has designed automatic information processing and retrieval systems for school districts in New York's Rockland County and for Quebec's Ministry of Education. It also has an extensive program covering the spectrum of computer-aided education.

In law enforcement, it has designed New York State's identification and intelligence system and a computer-based information system for the Los Angeles Police Dept.

SDC is a planning and technical support contractor for the Appalachian Regional Commission, part of the War on Poverty. It has also aided and advised the State of California and designed an information system for the Job Corps.

The company is engaged in several projects related to the development planning of a national information retrieval system. Having already studied the problem from the viewpoint of the Federal Council for Science and Technology, SDC is now working under a National Science Foundation contract to study the abstracting and indexing services performed by the national scientific and technical document handling system.

SDC's Melahn summarizes the company's position in these words, "it has a distinctive competence in information sciences and technologies provided by a large technical staff with extensive training and broad varied experience.

"Since its incorporation in 1956, SDC has played a key role in the significant developments in the information sciences and computer technology. These include pioneering efforts in the first real-time information systems, higher-order programming languages, simulation, computer time-sharing, natural language research and development of user-oriented systems." ◘

missiles and rockets, May 23, 1966

Contracts

AIR FORCE

$3,115,200—Martin, Co., Denver, Colo., segment of previously awarded contract for *Manned Orbiting Laboratory* requirements study.

$2,359,000—Oakland Construction Co., Mark B. Garff Co., Ryberg and Garff Construction Co., Salt Lake City, Utah, a joint contract for construction of missile training facilities at the following bases: Malmstrom AFB, Mont., ($594,000); Ellsworth AFB, S.D., ($566,000); Whiteman AFB, Mo., ($578,000); Grand Forks AFB, N.D., ($621,000).

$1,500,000—Douglas Aircraft Co., Inc., for conversion of *Thor* missiles to standard launch space boosters.

$107,650—Avco Corp., Avco-Everett Research Laboratory, Everett, Mass., for research in plasma propulsion.

$89,250—Lockheed Aircraft Corp., Lockheed Propulsion Co., Redlands, Calif., for Hydoc rocket motors.

$70,505—Mithras, Inc., Cambridge, Mass., for development of theoretical models to explain radio frequency efforts associated with missile passage through the atmosphere.

$50,000—Massachusetts Institute of Technology, Cambridge, Mass., for research directed toward development of a method of objective forecasting of solar flare phenomena.

$30,466—Texas Instruments, Inc., Dallas, Tex., for the Advanced Research Projects Agency Project Vela research.

$28,339—General Dynamics Corp., Convair Div., San Diego, Calif., for continuation of research on ionizing fronts in plasma accelerators and generators.

NASA Experts To Help Manage MOL

HOUSTON—Top-ranking NASA officials will be assigned temporarily to the Defense Dept. to aid the Air Force in technical management of its *Manned Orbiting Laboratory (MOL)* program.

The officials at the civil service grade levels of GS-15 will come primarily from the *Gemini* division of the Manned Spacecraft Center here.

It is believed that Air Force Space Systems Div. has asked the space agency to provide initially five or six technical managers.

In addition to those requested for the *MOL* program, the Air Force has also asked that two other officials —with at least one coming from NASA headquarters—be assigned to Holloman AFB, N.M. The latter two will be used to aid the Air Force in its study of advanced manned space missions. One major area of interest in which the NASA personnel will be assigned is in the study of reusable boosters, reliable sources reported.

Transfer of the NASA personnel to the Air Force is part of an agreement announced last year in which the space agency consented to make some of its personnel available to DOD if needed. Some 330 DOD officers are now on duty with NASA.

Only one NASA employee, Michael Yaromovitch, is now on duty at DOD. He serves as special advisor on the *MOL* at Air Force Systems Command headquarters, Andrews AFB, Md.

The request for the relatively highly placed officials reflects the important role they are likely to play in the *MOL* program. Only the very highest program managers of the space agency, such as the overall director of the *Gemini* program here, receive salaries in the GS-16 to 18 range.

It is also believed that as *MOL* moves further into the design and development phase, the Air Force may request more NASA officials.

One of the major positions a NASA employee will fill is assistant to the *Gemini-B* program director at SSD. He is expected to be a top-ranking official in the Manned Spacecraft Center's *Gemini* spacecraft design office.

Another will fill the job of assistant director of the *MOL* engineering division. The person selected—if he accepts—is expected to come from MSC's reliability group.

One major job the Air Force would like NASA to fill is that of special assistant to the chief of flight operations for *MOL*. The NASA official is expected to come from the mission control group at MSC.

SPACE MEDICINE

Air Force Rules Out Space Diet in Test

New coatings for bite-size foods must be developed before an all-bite-size feeding system can be recommended for manned spaceflight, Air Force doctors conclude. Reporting a recent two-month simulated space voyage at the Air Force School of Aerospace Medicine, researchers said that the fat coatings presently used to maintain the integrity of bite-size foods are poorly utilized and may be responsible for elimination frequency. Intestinal cramps and abdominal pains, so severe on several occasions as to keep crew members from performing efficiently, were attributed to certain beverages used as supplements to the diet.

Future Programs Considered Hinged to MOL Performance

by Hal Taylor

WASHINGTON—Defense Department officials do not believe a decision on the need for an advanced manned military spaceflight program will have to be made for at least three years.

Their position is based on the belief that a new program should not be initiated until *Manned Orbiting Laboratory* astronauts have proved that man can add to this country's military space capability in Earth orbit.

This view is not shared by some Air Force officers who feel that plans for advanced programs do not necessarily have to wait until early systems have been proved in flight tests. But it is clear, following talks with both DOD and the Air Force, that no one in the defense establishment is pushing very hard for an advanced manned program beyond *MOL*, with the possible exception of a reuseable spacecraft for logistics and ferry purposes.

This is not true, however, as far as an operational *MOL* program is concerned. A high-ranking Air Force official reports that though there is no approved *MOL* program beyond the planned seven-flight R&D effort, "we wouldn't have started the program if we didn't have plans for an operational system."

Where the action is—While consideration of a new, large post-*MOL* manned program is currently in limbo, there is activity in other areas of the manned military space program:

—The Directorate of Defense Research and Engineering expects to issue requests for proposals in about six months to industry for development of a space rescue capability.

Within DDR&E, the preponderance of opinion holds that the best hope of developing such a capability lies in providing Earth-orbiting astronauts with an escape capability that will allow them to leave their spacecraft and return to Earth on their own rather than having rescue spacecraft launched from the Earth.

—The Air Force envisions the need for a lifting body resupply vehicle in the mid-1970's. As a result, development of such a vehicle may be initiated in the late 1960's. DOD officials generally concur in the need for this vehicle. They are now attempting to pull together much of the on-going work and develop a schedule for further orderly development.

—The Air Force has asked NASA to provide two more spacecraft from its *Gemini* program for use in unmanned *MOL* missions. This brings the total to four spacecraft transferred from the space agency to DOD.

One of the new spacecraft will be used in a pad abort test. The Air Force, M/R has learned, is experimenting with a new escape system in which the spacecraft's retro-rockets could be used for pulling the capsule clear of the launch vehicle in case of a pad abort, with the pilots then using the ejection seats.

The other will be used as the payload on an R&D flight test of the seven-segment *Titan III-C* launch vehicle.

—Air Force officers have reported that, to the greatest extent possible, subsystems developed in the *Gemini* and *Apollo* programs will be used in *MOL*. The latest to be incorporated into the program is the extravehicular space suit used by *Gemini* astronauts.

Though the Air Force will use existing life-support systems in its early manned program, it is pushing for technological improvements to meet its own needs. One example is modification of the *Apollo* Lunar Excursion Module (LEM) environmental controls system, developed by Hamilton Standard, to make it a two-gas system, and the study of helium as a diluent gas for possible weight savings.

—Studies will begin in Fiscal Year 1967 on advanced subsystems for manned spacecraft. Initially, DOD officials say, attention will be focused on integration of advanced space power systems with new guidance and control technology within the overall spacecraft system.

MOL plans—The Air Force is negotiating with NASA for the acquisition of two more *Gemini* spacecraft. An official announcement is expected later this summer or fall.

The Air Force wants the *Gemini 9* capsule, which is scheduled for a three-day mission this week, and *Gemini 10,* which is scheduled for launch later this summer, probably because these craft have the latest technical changes —including a switch that can shut down all 16 thrusters in the orbital attitude maneuvering system (OAMS).

After the spacecraft are turned over to DOD, it is expected that the McDonnell Aircraft Corp. will receive a contract to refurbish them. The pad abort test and the launch vehicle flight test are expected to follow the heat shield flight test, using *Gemini 2,* which will be the first launch in the program.

Two unmanned flight tests using *Gemini-B* spacecraft—built for the *MOL* program by McDonnell—and five manned flights, will then be made.

It now appears that the first unmanned flight has slipped into 1969 (M/R, April 18, p. 14), and the earliest date for a manned shot now is the last half of 1969 (M/R, May 9, p. 13). That target date could slip even further if the Air Force does not receive a desired $80 million in additional FY '67 funding for the program. While this has been recommended in Congress, there is no certainty DOD will let the Air Force use the money.

Momentum mounts—High-ranking Air Force officers feel the *MOL* project —which has suffered many delays since its inception—is now on very solid ground. They believe that DOD has made a strong commitment to the program and that it will proceed into the development and flight phase.

Top Air Force officials feel that *MOL* manned flights at first will be made at the rate of about one every four months or so. Later, as more flight experience is gained, this may increase in the 1970's to a rate of perhaps one every two or three months. It is not foreseen at this time that *MOL's,* even in an operational program, will be launched at a more frequent rate.

Limiting factors on the launch schedule are the high cost per launch, the turnaround time for launch and ground support facilities, and U.S. Navy support required for water recovery of the *Gemini-B.*

DOD and the Air Force report they have no present plans for land recovery of the *MOL* spacecraft despite the fact that the use of its forces for recovery is a serious problem for the Navy. The problem will be even more intense in 1969-1970 because long-duration Project *Apollo* missions will also be taking place.

There is at least a possibility, admittedly remote, that the Air Force may suggest attempting to snatch the *Gemini-B* out of the sky during re-entry using the same methods developed for its *Discoverer* unmanned satellite series. Informed sources report that the airplane/skyhook recovery system developed for that program was manrated and is available for use in the program.

Astronaut Maneuvering Unit undergoes zero-g simulation test in KC-135 aircraft.

The planned *MOL* polar orbit, ranging from an apogee of 150 n. mi. to a perigee of 100 n. mi., is especially good for *MOL's* primary surveillance role. In addition, because of its polar orbit it will pass over every area of the Earth once a day.

While the whole program is classified, ocean surveillance techniques appear to be especially sensitive. This indicates that this country perhaps has achieved a sharp breakthrough in antisubmarine warfare that will be tested aboard *MOL.*

Though *MOL* funding requirements started slowly in FY '66 and '67, both DOD and the Air Force expects it to reach its peak in FY 1968 and 1969 when a budget level of $400 million to $500 million a year is expected.

One method the Air Force has used to hold down *MOL* costs is the very extensive use of subsystems developed for NASA's *Apollo* and *Gemini* programs.

Experienced team—Douglas Aircraft Co., prime contractor for *MOL,* has already selected such firms as Honeywell, Inc., for the guidance system, Collins Radio for communications, and Pratt & Whitney for fuel cells (M/R, April 4, p. 15). Hamilton Standard Div. of United Aircraft Corp. was also named to develop the environmental control system. All these firms developed similar systems for *Apollo.*

DOD has not named a contractor for the *MOL* navigation system and presumably will build it in-house. Air Force officers stress that this approach does not indicate any problem with this subsystem. "If there were concern over this, we'd have a contractor," says the Air Force.

Also to be selected is either IBM or Sperry Rand for the data-management subsystem. Decision was expected in May but now reportedly has slipped a few weeks.

All other industry cost submissions were due at *MOL* headquarters at the Air Force Systems Command this month. The program is expected to move out of the definition phase and into early development within the next few months.

One of the prime purposes of the *MOL* mission is to discover the role of man in the vehicle, and one of the areas receiving particular attention at Aerospace Corp. and other organizations connected with the program is the nature of the man-machine interface, and the effect the presence of a man has on system design.

Computer details—On the launch pad, the *Titan III, MOL* and the *Gemini-B* spacecraft will contain an impressive complement of computers. The *Titan III* computer for this mission will have a random access memory instead of the drum memory hitherto used, and will consequently have much greater flexibility. The *Gemini* flight computer will function as backup to the *Titan III* computer, and will be modified for inertial guidance rather than radio guidance. The *MOL* itself will have a general-purpose computer aboard, which may be used to assist the astronaut decide which of the two navigation computers is giving the most reliable data.

Once in orbit, it will be important that the full powers of the general purpose computer are available to the astronauts and a capability for a "conversational" interaction with the computer is likely to be included.

There is some doubt whether cathode ray tube displays will be suitable for *MOL*. The tubes deteriorate in the helium atmosphere with inward diffusion of this gas. However, the CRT's ability to display rapidly changing data may not be required and an electric typewriter may prove quite adequate as an input-output device.

Lifting bodies—One phase of future manned spaceflight receiving close scrutiny by both DOD and Air Force officials is the use of lifting vehicles as logistics carriers and re-supply vehicles for large Earth-orbiting spacecraft.

Both agencies believe a decision on a lifting body design and some sort of go-ahead for development can be expected in about two years.

As part of that timetable, DOD and NASA signed an agreement calling for a joint lifting body research program six months ago. In it, three different vehicle designs will be glided back to Earth by pilots of both agencies after launch from a B-52 bomber.

The flight series, featuring NASA M2-F2 and HL-10 vehicles and the Air Force's SV-5, is scheduled to begin in the near future. In addition, both agencies are engaged in large efforts to find out what types of technologies will have to be developed to make lifting body vehicles feasible (see p. 76).

Space rescue—DOD's intention to get industrial participation in its space rescue program studies in about six months indicates the seriousness with which it is being considered. Several firms have already offered unsolicited proposals on systems they would like to develop.

DOD officials now believe that some sort of escape system that would use a small capsule with a heat shield to return an astronaut to Earth safely is perhaps the best answer.

Most feel that a real space rescue vehicle will probably have to wait until the development of a lifting body re-entry vehicle.

The problem is also evident at the Air Force's Space System's Div., where broad continuing studies have thus far failed to find a solution.

One study under way in-house, with technical support from Aerospace Corp., is aimed at "trying to get a better insight into the probabilities, what the problem might be, subsystem failures, etc., that might result in a spacecraft being disabled," one source said. "In general, this is not tied to the *Manned Orbiting Laboratory* program. We simply want to gain an idea of what might be the preferred way of attacking the problem. One is by preventive measures—high reliability, integrity, redundancy."

In general, opinion at SSD is split on whether a separate rescue spacecraft or an escape capsule built into a spacecraft would be the solution, with some spokesmen showing little enthusiasm for the subject at all. They point out that even if an acceptable escape capsule could be developed for a spacecraft, astronauts still could be lost, depending on where on the globe they landed and whether recovery forces could find and rescue them. Yet some spokesmen think the escape capsule method holds better possibilities than development of a separate rescue vehicle. This view is also said to be the most widely held at Aerospace Corp.

Proponents of some form of space lifeboat believe such a system could be built into a manned spacecraft with about 600 lbs. added to the complete hardware package.

SSD has reportedly asked that two contract studies be let to further pin down the problem. One would attempt to develop statistics on the likelihood and types of failures requiring escape; the second would call for preliminary engineering design of various escape capsule concepts. ◘

Congress Voices Strong MOL Support

The *Manned Orbiting Laboratory* appears to hold highest priority in terms of Congressional approval of military plans and programs. The strong support that the program has appears to traverse party lines and is unanimous in both House and Senate.

Though Vietnam funding is putting pressures on many research and development programs, the space programs hold a strong appeal to most Congressmen. Should any space program suffer, in fact, most of the legislators feel that the civilian space agency should receive the first trimming.

As an example of the feeling about *MOL*, all committees involved in defense—Armed Services and Appropriations committees of the House and Senate—last year wrote specific language into their bills stipulating that the $150 million earmarked for *MOL* in Fiscal Year 1966 could not be spent on another program.

The same clause has been written into the House Armed Services bill this year. As additional evidence of this committee's support, it has voted to ensure that the Air Force gets the additional $80 million which it requested from DOD for *MOL*.

While the Senate, which has already voted on the bill, did not add this money, it is understood that should DOD make a case for it, it would be forthcoming.

There has been criticism in the past that DOD has been too secretive about its activities, particularly with respect to the *MOL* program. Committee members now feel that the recent classified sessions elicited adequate information for the policy decisions they must make.

The *MOL* secrecy problem has never been as acute as that in such controversial areas as the manned bomber program, the nuclear Navy or military base closings, they add. Most dissatisfaction with DOD answers occurred during the long period in which the *MOL* program was delayed.

Full support also has been given by the Congress to the highly classified military reconnaissance space programs. While there have been some anguished cries behind closed doors about the cost of maintaining these programs, they have been accepted with the feeling that such an outlay is the inescapable price of highly technical and advanced protection.

The return from these programs justifies their cost, the committee members feel. And though there is a great deal of new emphasis on R&D for Vietnam, there is no loss of support for the existing programs—or loss of sight of the threat from a more sophisticated enemy.

missiles and rockets, May 30, 1966

Flight Support

Instrumentation Needs Low; Majority Are Tied to MOL

WASHINGTON—Few major additions to the national ranges are forecast by the Dept. of Defense to support the growing military space program. Exceptions include the new *Manned Orbiting Laboratory (MOL)/Titan III-C* launch facility at the Air Force Western Test Range and an instrumented range ship to cover *MOL* insertion and injection.

Written by Senior Editor Charles D. LaFond and Associate Editors Rex Pay, Ron Barnhart and Kurt Voss.

Range instrumentation at both Eastern Test Range (ETR) and Western Test Range (WTR) are considered reasonably adequate and need only modest equipment augmentation. Principal system improvements are expected to come in the addition of telemetry capability and new real-time data-handling systems. The Satellite Control Facility is being expanded to handle the *MOL* mission.

The general trend is toward improving efficiency at the ranges through greater use of multi-purpose, self-checking subsystems and of remote operation of electronic subsystems.

DOD officials estimate that annual expenditures for range improvements will be about $20 million over the next five years.

ELECTRONIC SYSTEMS DIV.

Responsibility for instrumentation systems development and management for all Air Force test ranges rests with the deputy for engineering and technology, Electronics Systems Div., Air Force Systems Command, Hanscom Field, Mass. This work is carried out by the Directorate of Aerospace Instrumentation (DAI). DAI is assisted in most of its projects by the range systems department of the Mitre Corp.

ESD's major unclassified programs dealing with range instrumentation for flight support are as follows:

Range telemetry conversion—DAI coordinates conversion of all national test ranges from VHF to UHF telemetry communications. The frequency bands to be utilized are L-band, for support of all manned missions, and S-band, to support all unmanned missions.

Test ranges to be fully converted to UHF by Jan. 1, 1970, are Edwards AFB, Calif.; Eglin Proving Grounds, Fla.; Holloman AFB, N.M.; Eastern Test Range, Fla.; and Western Test Range, Calif.

ESD's present activities in this area consist largely of requirements analyses, to determine what the space missions of the '70's will be, and, from this, equipment procurements, based on present state-of-the-art telemetry systems, with the drawing up of some component development specifications.

The conversion program began in February, 1965, and to date DOD has invested $4? million to buy, test and install equipment. It is estimated that another $70 million will be required to complete the program.

There are two major reasons for shifting to UHF: 1) there already exists a good deal of interference between the ranges and tactical military units in the VHF band, and 2) the ever-increasing use of wide-band TM systems has necessitated a shift to UHF, where these systems can be more readily accommodated.

Telemetry standardization program—In 1962 ESD, with technical support from Mitre Corp., was assigned the task of standardizing, insofar as possible, the telemetry systems used at all national test ranges. The objectives of this program are twofold: 1) to develop the highest degree of commonality and compatibility in TM systems at all national sites, and 2) to reduce development costs of new equipment.

The TM standardization program is a continuing one which will be in effect as far in the future as ESD can predict.

Telemetry systems development—ESD's budget includes money for advancing the state of the art in the telemetry field. Basic technology investigations in this area are carried out for ESD mainly by the Air Force Avionics Laboratory, Wright-Patterson AFB, Ohio. The Avionics Lab is concentrating on devising new TM-signal modulation and demodulation techniques, designing new TM antenna and test equipment, and evaluating new system components such as thin-film and integrated circuits.

In the area of TM systems development, ESD currently has two major projects under way. The first is the C-130 instrumentation program in support of the Air Force Space Systems Div. This program will enhance aerial-recovery capabilities of the aircraft through development of improved TM receivers, recorders, and data displays.

All C-130 TM equipment is palletized for quick and simple installation and removal. Five such pallets contain all the TM equipment required for one aircraft. Sufficient equipment to outfit 10 C-130's will be delivered to Edwards AFB for operational testing and use this September.

The other major TM program now going on is development of a new digital range safety/command system. This will be used to carry out the destruct functions required during R&D booster launches, and for other command functions.

Two system-definition contracts for the system have been let; both are complete and the final RFP is ready for release. Initially, ESD will buy one prototype system with an option, after prototype testing, for 10-12 more.

The RFP for this system specifies that the equipment contain a good deal of redundant circuitry and have a long mean time between failures, quick-turnaround capability for multiple launch operations, anti-spoof capability, and quick response time. Prototype system is to be delivered 18 months after contract award.

Re-entry systems evaluation radar—The RESER system will be used to evaluate ballistic re-entry systems and study the flight characteristics of multiple re-entry bodies.

The system has been through a contract definition, and a request for proposals to build one system will be issued shortly. ESD's goal is to have a firm under contract for RESER by year's end and have the system installed in the Pacific within 18 months thereafter.

Coherent signal processor—This system is being developed jointly by NASA and ESD. It is in reality a retofit, or modification, to existing range C-band radars—specifically the FPQ-6's and FPS-16's—which, using the Doppler effect, will enable them to make much more precise velocity measurements and double their acquisition range.

A contract for this equipment was awarded in March. The contractor has already delivered a preliminary design, which is now being reviewed by ESD and NASA. The equipment is slated to be operational on radars at Patrick AFB and Wallops Island by next summer.

Radar electronic scan techniques—This is a study project to evaluate the benefits of replacing the paraboloidal dish antennas of shipborne tracking radars with planar phased-array antennas. ESD believes that phased-array antennas will greatly increase the target-acquisition probability of those radars and give them faster track capability.

Two study contracts for devising separate approaches to the problem have been awarded and completed. Both contractors are now developing breadboard models of their proposed equipment, and these will be demonstrated to ESD in June.

Airborne instrumentation platform—Several years ago ESD recommended to Air Force headquarters that tracking systems be developed for very-high-flying aircraft to fill in the gaps between ground- and ship-based tracking stations. At that time, headquarters turned them down flatly because ESD had only limited data on techniques and costs.

Since then, ESD has strengthened its position and currently has a contractor making a cost-effectiveness study of the AIP concept versus an improved ship- or ground-based tracking equipment.

ESD's technical studies show that, since an AIP system would be above most of the Earth's sensible atmosphere, velocities of ballistic-orbit objects within 100 n. mi. of the system could be determined to within 7 fps, and positions could be determined to within 0.6 n. mi.

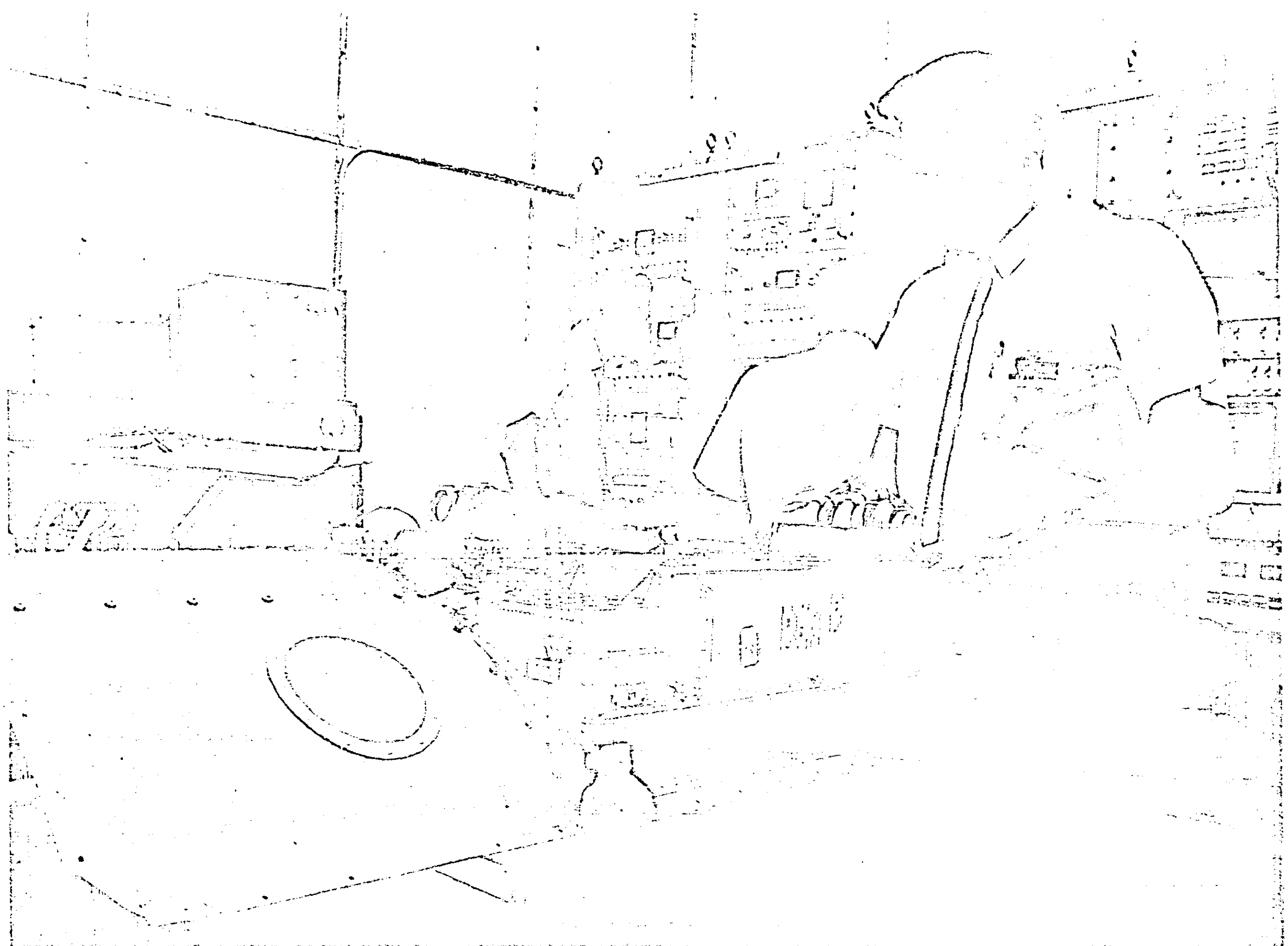
All the technical data, plus the cost-effectiveness information, will be presented to Air Force headquarters for evaluation this summer.

Apollo range instrumentation aircraft—In support of NASA's *Apollo* program, primarily the lunar injection-burn phase, ESD is directing the outfittting of eight C-135 aircraft with a variety of communications and telemetry equipment—15 tons per aircraft.

The 135's will carry voice-communications gear which will provide a direct voice link to the *Apollo* astronauts. Messages from the astronauts will be relayed from the A/RIA to NASA's Manned Spacecraft Center, Houston. Telemetry data from the *Apollo* module will be stored in memory equipment aboard the aircraft and then "dumped" via VHF transmission to ground stations. Other equipment to be carried includes two-way, high-frequency teletype systems, a nose-mounted, 7-ft.-dia. communications and TM high-gain antenna, and an airborne lightweight optical tracker (ALOT).

With the *Apollo* capsule parked in a 100-n.-mi. orbit over the Atlantic Ocean for lunar injection, three A/RIA aircraft, plus one backup, will be required. If lunar injection takes place over the Pacific, six A/RIA planes, plus two spares, will be required.

Four of the eight A/RIA aircraft will be capable of handling the ALOT system, but it appears that only one may be required. All the ALOT equipment will be housed in a 21-ft.-long pod mounted on forward left side of the aircraft fuselage. ALOT will be used to make detailed sequential photo



Prototype Space-Ground Link Subsystem (SGLS) is shown during tests at TRW Systems, developer of tracking, telemetry and command subsystems. The SGLS project includes both the spaceborne package and the ground station equipment.

graphs of the missile and spacecraft during early launch, passage through high-dynamic-pressure regions, staging, separation and—possibly—re-entry.

All equipment for the eight C-135's, which are Government-furnished equipment from the Military Air Transport Service, is being acquired and tested now. One outfitted plane will be ready for the first unmanned *Apollo* shot this fall. Three others will be ready in early 1967, and all will be completed by January, 1968. Total program cost is approximately $30 million.

MOL support ship—The *MOL* program foresees a need for an instrumented ship, to be placed about 700 miles downrange from the launch area to cover the insertion phase of the *MOL* trajectory. The Air Force, in collaboration with NASA, is studying the possibility that one of the *Apollo* I & I range ships being modified for support of that program also can be used for *MOL* support.

Calibration studies—ESD is doing a series of analytical studies to determine the feasibility of calibrating range instrumentation from satellites. Plans have advanced to the stage that some C-band radar calibration equipment is tentatively scheduled to go aboard the *OV1-7* satellite to be put in equatorial orbit from WTR this summer.

If ESD gets the results it anticipates from this experiment, it will develop more equipment to calibrate other radars. This equipment would be put on a polar-orbit satellite to be launched early next year.

Communications systems studies—ESD is in a continuing effort to improve its inter-range high-frequency and wire communications links. This work is primarily basic technology, devoted to devising new modulation techniques, improving error-control and detection equipment, and developing data-handling systems with higher data rates.

EASTERN TEST RANGE

The eight new highly instrumented A/RIA jet planes and five new ships are being procured out of Eastern Test Range for ESD to improve telemetry and communications by the Air Force.

Although prime requirement for the planes and ships will be in support of the *Apollo* program, Air Force spokesmen feel the units will also have a limited use in future—and strictly military—space flights.

The A/RIA C-135 jets provide a cruising speed of 440 knots, which is sufficient to follow changes in orbital passes. The ships include three T-2 tankers, stretched at General Dynamics, Quincy, Mass., shipyards, and two C-2 transports, being modified by LTV, Inc. at New Orleans (M/R, Jan. 24, p. 24).

Both planes and ships will be operational by early 1968.

Air Force planners are now studying whether the 11 C-130 planes now in use can be completely replaced by the C-135's. At least five of the older planes will go to Western Test Range to replace five Navy Constellations now handling telemetry there. Present plans call for the Air Force to take over the telemetry functions for both the WTR and the Pacific Test Range at Point Mugu, using the transplanted C-130's.

As a part of the move from VHF to UHF at ETR, command frequencies will be shifted to the C-band (the 5,000 mc region) from the 400-500 mc region.

Air Force technicians expect less in

terference in the higher bands, partly because of the elimination of military radio traffic, and partly because of the higher directionalism of the antennas used at the higher frequencies.

At the same time, engineers are looking into ways of "stretching" frequencies, to allow a greater use of the bands.

But no sizable changes are being planned in basic equipment, according to William S. Hines, technical adviser for range engineering.

Embarrassment of data—One of the most difficult problems, he said, is what to do with the huge quantities of TM data collected during missile/space R&D launches. He predicts the machine-editing of the data received, using judgment factors programmed into computers. These factors would be sensitive to readings outside of certain parameters by specific amounts. When the higher- or lower-than-usual readings were found, they would be transmitted.

Two firms, Lockheed and Radiation, Inc., are prime movers in experimenting with this form of adaptive telemetry.

Col. M. W. Elliot, deputy for range operations, agrees. He points to the complexities being introduced into telemetry studies by multi-unit guidance systems, such as those built into the *Saturn* rockets. In these systems, outputs from three inertial guidance systems are transmitted to ground stations, where they are compared. If two of the outputs agree, but differ from the third, the third is assumed to be wrong. This information is used in planning flight programming and in forming destruct judgments.

On the ETR, primary work is concerned with stepping up capacities, rather than replacing equipment.

A new data and communications cable has already been installed between Antigua and Grand Turk Islands, and the International Telephone and Telegraph Corporation is in the process of continuing the line from Grand Turk to Cape Kennedy.

New computer plan—The Cape's future, as Elliot sees it, will include a new central computer setup. He sees one computer to service the needs of the entire Cape Kennedy-Patrick AFB area, using remote input and readout units at many locations, to replace the more than 50 separate computers now in use in the area.

Under his direction, the Air Force is now in the process of putting the control of all range facilities through a single computer. The setup will be used to program both the resources of the range, and the needs of range users, in an attempt to simplify, with printed schedules, total programming.

Eastern and Western Test Ranges now have their radar sets hooked up, via computers, so that they can "talk" to each other. This inter-range acquisition allows one radar, following a space ship or satellite, to tell the other precisely where to look when the object passes from one field of view into the other. The system has been in partial operation for almost three months, and full operation is due next year.

One major new installation at the Cape is the new Range Control Center, which will take over when Central Control closes and is turned over to Range Safety. In the new building will be complete equipment to handle all tests, launch control, aircraft deployment and display capabilities such as range status and missile progress. It includes the new satellite center, which is already in operation to monitor smaller scientific satellites.

SATELLITE CONTROL FACILITY

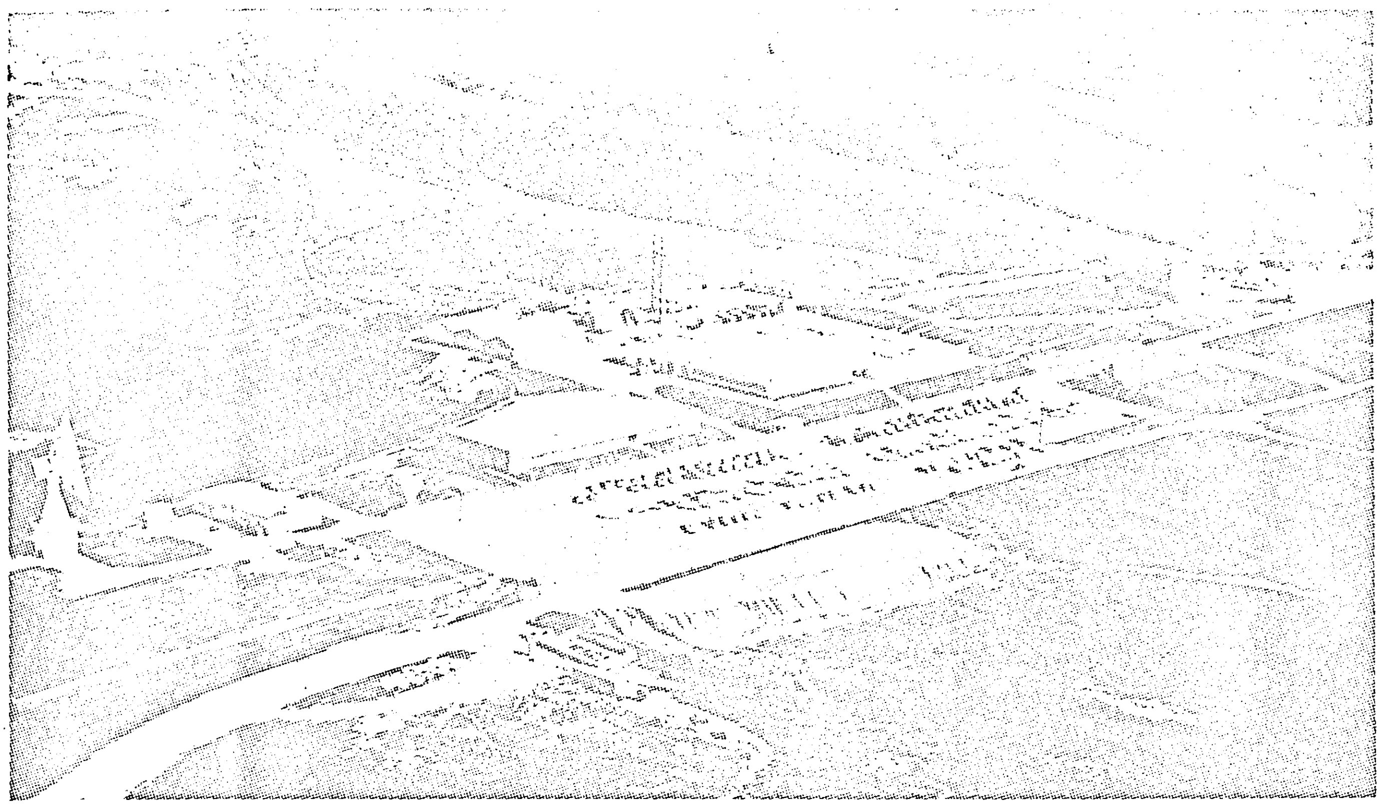
Support for Air Force space satellite operations is supplied by the world-wide Satellite Control Facility, which Space Systems Division spokesmen now describe as having the capability of supporting both equatorial and polar orbits. Six support stations are deployed around the world in the network: Guam; Vandenberg AFB, Calif.; Hawaii; New Boston, New Hampshire; Kodiak, Alaska; and on Mahe, Seychelles Islands, in the Indian Ocean off the east-central coast of Africa.

The Satellite Control Facility originally was intended for support of one Air Force satellite series and consisted of several ground stations and a control center. When other Air Force programs came along, the network was augmented with further stations and equipment—unfortunately, in many cases as a quick fix.

By 1961 a policy of more coherent development of the facility had been agreed upon and resulted in two overall trends—greater reliance on a high-capacity flexible computer system at the Satellite Test Center (the control point for the facility), Sunnyvale, Calif., and a movement toward increased standardization of ground equipment. The aim has been to obtain a standard set of ground equipment in which all changes in operation procedures can be achieved by computer re-programming.

Addition of new gear and rework of old gear has been restricted by scheduled support of space programs, which have been steadily increasing in number. However, the new computer system is now becoming operational and the development of standardized ground equipment is approaching reality with delivery of the first prototype Space-Ground Link Subsystem (SGLS) to the Vandenberg ground station.

General systems engineering and technical direction for the Satellite Control Facility is assigned to Aerospace Corp. Philco Western Development Laboratories has the hardware contract for the ground stations, other than the Satellite Test Center. Lockheed Missiles and Space Company has the hardware contract for the STC. System



Satellite tracking station operated by the 6596th Instrumentation Squadron at Vandenberg AFB, Calif. The station performs telemetry reception, radar tracking and command and control functions. WTR is now moving into a wider variety of space activities.

Development Corp. has the contract for computer program integration.

On-line operation—One of the chief features of the SCF is the on-line data transmission that takes place between computers at the remote ground stations around the world and the computer at the STC. Computers operate on-line at both ends of the data link. Parallel digital data words are transformed into serial words, encrypted, and tone-modulated for transmission.

On-line computer programs at the ground stations digitize, compress and format FM/FM telemetry data received from satellites, prior to transmitting it to the STC. The ground stations also check tracking data for quality, compress them, and transmit them to the STC for orbital calculations. In the opposite direction of transmission, commands for satellites that are transmitted from the STC are verified at the ground station and transmitted to the satellite, and receipt of the commands is sent back in real time to the STC for further verification.

At present, the various ground stations have different mixtures of telemetry and tracking equipment, which SSD spokesmen describe as very similar to standard range equipment. Operating frequencies include VHF, UHF, and S-band.

Two of the more standard antennas that are to be found in the network are the 14-ft.-dia. Prelort for accurate beacon tracking and the 60-ft.-dia. paraboloidal antenna for communication with high-altitude satellites. Usually one antenna is being used for command while another is being used for telemetry. To relieve the burden of telemetry from the paraboloidal tracking antennas, a dipole array is often used. All but one station is equipped with an instrumentation radar; four stations have the 60-ft.-dia. antennas.

SGLS—By going to a standardized Space-Ground Link Subsystem (SGLS), SSD hopes to reduce the amount of ground station equipment significantly. This subsystem will operate at S-band frequencies, to which the military will switch by 1970, and will enable the ground stations to standardize on two antennas.

The SGLS is made up of the airborne equipment and ground station equipment required to handle telemetry, tracking, and command. These three functions are carried over a frequency-multiplexed link. Use of digital techniques is extensive, and includes the telemetry, where PCM replaces FM/FM. As a result microcircuit construction techniques, using both integrated circuits and hybrid circuits, can be applied to the flight hardware, with significant reductions in size and weight, and increases in reliability.

By use of a modular form of construction, the specific telemetry, tracking and command requirements for each of SSD's systems program offices can be built up. Flight modules bolt together and are approximately 7 in. by 4 in. by 1 in., weighing about 1 lb. The SGLS also has the capability of transmitting a number of channels of voice, and is expected to be used in the *Manned Orbiting Laboratory*. By agreement with NASA, the SGLS is compatible with the agency's Unified S-Band System on the down link.

TRW Systems Group, contractor for the prototype ground and flight hardware for the SGLS, has delivered one set of ground equipment to the Vandenberg station of the SCF, including the PCM ground decommutator and interface unit for the ground station's computer. Another set of ground equipment, four flight units and four back-up flight units are due to be delivered imminently. The flight-test phase is likely to be entered into fairly rapidly, to provide information on which a production decision can be based. Piggy-back rides on other military space programs will be exploited.

WESTERN TEST RANGE

New ballistic missile programs, increased Air Force unmanned satellite operations, and the advent of manned launches are leading to increased sophistication in the support facilities of the Western Test Range. A decision on a new modular computer central is expected this summer; plans are being drawn up for a new telemetry central, a new tracking radar site is slated for the *MOL* launches, and greatly improved instrumentation facilities are planned for the Eniwetok lagoon.

WTR is in fact becoming less of an operational Strategic Air Command launch site and more of a common user facility for a wide variety of space activities.

Since much of the new equipment foreseen for the Vandenberg headquarters of the range will be highly automated, only a modest increase in personnel is expected over the next few years.

"There is also a real need to be able to tie in WTR in real time to the global network, which calls for precision timing," said range commander Brig. Gen. J. S. Bleymaier.

At sea—The range's requirements also are expanding in the open ocean. There are now 10 ships under operational control of WTR. Five are *Apollo* ships and two are satellite recovery ships based in Honolulu.

"The predominant operation has changed from SAC operational firings to space and R&D firings," noted Stanley R. Radom, technical director of Western Test Range. "As a result, we have had to become more sophisticated in our instrumentation. Whereas we previously had research and development shots confined to the Cape, there are now space systems and boosters fired here for the first time."

"We have to man rate our support instrumentation for *MOL*," he added; 'we need higher reliability and redundancy to avoid drop-out of critical data. We are looking at the geometry for manned polar launches and revising our instrumentation plan. We need very accurate impact prediction for the *Titan III-C* boosters and also for astronaut recovery in the early phases of *MOL* flight."

Radom added that WTR was not likely to duplicate anything at the Cape, although it is starting to receive certain types of instruments from the Cape for use at Vandenberg and in the impact area.

"We will not go to sophisticated instrumentation like Mistram or Azusa and that family," said Radom, "because we do not yet have the requirement for guidance evaluation."

Slow growth—By a scheme of trilateration, using existing radars, the tracking accuracy for both polar and westward launches will be raised. Then pulse Dopler techniques will be used to further increase capability. But the improvement will proceed slowly, keeping new instrumentation to a minimum.

Main tracking radars at Vandenberg are two FPS-16 units on Tranquillon Peak, and a TPQ-18 radar closer to the pads at South Vandenberg, having the same characteristics as the FPQ-6. This radar was procured for accurate tracking of *Minuteman* and for upgrading the range in general.

For *Atlas* and *Titan* launches, which can carry a suitable transponder, an X-band General Electric Range Tracking System (GERTS) provides both tracking and rate data for range safety.

Because of the high flame attenuation of radar signals expected from the big solids in the *Titan III-C*, the geometry of the radar tracking stations will have to be altered. For westward missile launches, FPS-16 radars at Point Pillar, near San Francisco, and on San Nicholas Island have circumvented the flame attenuation problem met by the Vandenberg radars. For the southerly *MOL* launches, however, a new radar site will be needed.

Computers—There are Univac 1218 computers at three of the instrumentation sites and a RCA 4101 at the TPQ-18 site. These are coupled to an IBM 7094 at South Vandenberg for present position digital data and for instantaneous impact prediction on Western launches and for some southerly launches.

By December the 7094 will be replaced by an IBM 7044, which has faster access and larger storage capacity. The other large computer will then be used exclusively for post operations analysis. The central computer now provides instantaneous acquisition data for the instrumentation sites. Data is transmited at 10 pps. The present computer does not make use of data from off-shore facilities.

A study of the optimum configuration for existing and future requirements for computers at the Vandenberg headquarters of WTR suggests that a computer center serving all range requirements by use of a modular central processor will be required. A final decision on this is expected this summer. System Development Corp. has a contract to analyze WTR computer requirements.

Range control factors—In the Range Control Center, the range control room is currently set up to enable two launch operations to proceed at the same time. Simultaneous launch, however, depends on compatible instrumentation on the two missiles. Within the range control room, the range control officer provides the single point of contact betwen the user and the range. He is responsible for the data collection by WTR. Responsibility for flight safety rests with the range safety officer.

A new range control room under construction will provide a capability of four simultaneous launch operations, having a total of 16 plot boards in the range safety area. There will be two range control officers, one for each pair of launch operations. This new room should be in use later this year.

Telemetry—Instead of expanding the telemetry station at South Vandenberg, WTR has expanded the telemetry central operated by the 6595th Test Wing. That is, one center has been expanded to become a Range Telemetry Central rather than fragment the facilities.

The telemetry central has decommutator units for all range user requirements. Also, it has a predetection recording capability using Defense Electronics Inc. pre-detection receivers and translation units. There is a very large and comprehensive system for closed loop and open loop testing, but the present RTC represents only a first step. Establishment of a central computer facility would make it logical to move the RTC to the same location and provide separate rooms for each user, with individual displays for both pre-launching check out and real-time flight data. By locating the computer central close to the telemetry central, full use of real-time digital readouts can be made.

A study is in progress to decide on the final configuration desirable for the telemetry central. The present system allows direct readout during pre-launch closed-loop testing, chiefly for ballistic programs; but it will be expanded for use with space boosters. It will not, however, get into space payload testing, as the payload developer has facilities for this.

To meet the needs of *Titan III-C* launches, a telemetry station is being moved to a ridge overlooking both the new and existing launch sites for the vehicle. ■

UNITED STATES: SATELLITES

ICBM Alarm (Air Force)

MILITARY DESIGNATION: Program 461 (formerly MIDAS)

TYPE: Early warning satellite

STATUS: Has remained in R&D and led to very successful results and sensor development

PRIME CONTRACTOR: Lockheed

ORBIT: Orbits of 300-3,000 mi.; polar; detects and warns of enemy ballistic missile launches

CONFIGURATION: No details available

INSTRUMENTATION: Infrared radiation sensors by Aerojet-General

REMARKS: Was open program until secrecy order of March, 1961; orbital system concept changed from one of precise orbits to one of random orbits; a number of in-space detections have been made of both liquid and solid-fueled ICBM launches; recent successes in sensor development has lead to start of a new multiple-purpose satellite, primarily for early-warning (Program 266), which will lift the satellite to synchronous orbit and move it to operational status.

Integrated Satellite System (Air Force)

TYPE: Advanced early warning satellite with some secondary sensing functions on non-interference basis; Program 266

STATUS: Pre-development; RFP's put out by SSD and at least four firms are believed to have responded—Aerojet/TRW as a team, Hughes, and a Lockheed team; development expected to start in FY '67

CONFIGURATION: Probably a 1,600-1,800 lb. satellite for synchronous orbit to be launched by Titan III. Aerospace Corp. reportedly did much concept formulation

REMARKS: Follow-on to Program 461, lifting to synchronous altitude for optimum ICBM launch detection, and incorporating major improvements in sensors, communications links, and data subsystem. System probably first of what will eventually be a true multiple-purpose satellite including early warning, meteorological, nuclear-detection and damage assessment sensors. Aiding development is APL project in which a satellite test bed is being developed to observe subsystem interactions

Initial Defense Communications Satellite Program (IDCSP) (Air Force)

TYPE: Initial military comsat network; primarily for R&D but will serve operationally after R&D phase

STATUS: Partially operational

PRIME CONTRACTOR: Philco WDL, satellites; Hughes will supply 40-ft. antenna systems for ground sites and 6-ft. antennas for Navy vessels; Radiation, Inc., 15-ft. highly mobile ground terminal antenna system

CONFIGURATION: Series of 24 100-lb. active repeater satellites placed in random 18,300-n. mi.-high circular equatorial orbit in three launches of 8 satellites each aboard three Titan III-C's. Satellite is spin-stabilized, operates at X-band, and will provide a few channels for global strategic communications

REMARKS: First launch June 16 highly successful; second launch this fall; 2-3 of total 24 will be gravity-gradient experimental satellites; provision also made for replenishment launch using refined version of Philco satellite; eventually to be replaced by ADCSP. IDCSP and ADCSP will be managed by DCA, with Air Force given satellite and booster responsibility, and Army and Navy responsible for respective ground and ship terminal development

Range Relay Satellite (NASA/DOD)

TYPE: Unmanned satellite

MISSION: Tracking satellite network which could replace existing ground and ship facilities in the 1970's

STATUS: Study

BOOSTER: Undetermined

PRIME CONTRACTOR: None

REMARKS: Both NASA and DOD are currently engaged in feasibility studies of the satellite system, which will probably be a joint effort if approved; Lockheed Aircraft Corp. and RCA selected in May, 1966, to perform studies of the NASA concept, the Orbiting Data Relay Network (ODRN)

SAMOS (Air Force)

MILITARY DESIGNATION: Program 720A

TYPE: Reconnaissance satellite

STATUS: Operational

PRIME CONTRACTOR: Lockheed; sensors, Eastman Kodak; re-entry capsules, GE; recovery system, Avco & Northrop

CONFIGURATION: Length, 22 ft.; diameter, 5 ft.; weight, 4,100 lbs. with E-5 capsule, 3,000 lbs. with E-6 capsule; weights do not include entire Agena stage

PERFORMANCE: Polar orbit of 100-300 n. mi.; solar cell paddles extend operating time

INSTRUMENTATION: Photo intelligence equipment by Eastman Kodak

BOOSTER: Atlas-Agena or Thrust-Augmented Thor

REMARKS: System has had highest national priority for recon efforts; apparently consists of one launch a month; photo equipment aboard has 20-day lifetime; processed film scanned by TV for immediately useful data, then recovered from orbit for detailed analysis after useful life ends; electronic eavesdropping version, known as Ferret, picks up communications and carries out electronic intelligence; a successor system, capable of changing orbital plane and altitude on command, may have been developed; this newer reconnaissance satellite would have up to six recoverable data capsules or cassettes with lifting-body characteristics, permitting data recovery without returning entire satellite to earth; major effort now is on developing SAMOS type able to function at synchronous altitude orbit.

Titan III (Air Force)

MILITARY DESIGNATION: Program 624A

TYPE: Standard space launch system

STATUS: Development and flight testing

CONTRACTORS: Martin Co., core vehicle, airframe and systems integration; UTC, large solid rockets; Aerojet-General liquid rocket propulsion; AC Electronics, guidance; Ralph M. Parsons Co., facilities design; Aerospace Corp., technical direction

PERFORMANCE: Capable of placing 5,000 to 25,000 lbs. in low Earth orbits or 2,100 lbs. in synchronous orbits, depending on configuration

PROPULSION: Core vehicle, two liquid rocket engines with 430,000 lbs. thrust total; one liquid rocket engine with 100,000 lbs. thrust, and two liquid rocket engines with 8,000 lbs. thrust each; strap-on motors of two solid rockets, each 120 in. in diameter, generating 2.4 million lbs. thrust total and weighing 500,000 lbs. each

CONFIGURATION: Titan III-A is core vehicle with new upper stage; Titan III-C, currently most powerful rocket ever launched by U.S., uses two five-segment outboard solid rockets; configuration used depends on mission parameters; Titan III-B, a non-man-rated version, being developed for satellite launches, other missions, uses first two Titan III-A stages minus man-rating electronics and an Agena upper stage; Centaur also being considered as an upper stage possibility; first launch planned in mid-1966; seven segment solid strap-on version to launch 30,000-lb. MOL into low-altitude, polar orbit from Western Test Range; Titan III-D with 2-3 segment solid strap-on also expected to enter development

REMARKS: First flight of Titan III-A, September, 1964; first Titan III-C flight, June 18, 1965; 17 development flights planned—4 Titan III-A and 13 Titan III-C; Titan III-C used to place first eight IDCSP satellites in orbit June 16, 1966; heavy use seen for III-C version; follow-on buy planned; will be used for future IDCSP, ADCSP, TACSAT, also for Vela and synchronous orbit military multiple-purpose satellites

Titan III Engines

MANUFACTURER: Aerojet-General

REMARKS: Titan II engines used in modified form; principal changes are in upper-altitude capabilities for the YLR-87-AJ-5 and the incorporation of a malfunction detection system; both liquid stages man-rated; first stage re-designed to start either on ground or in space and engine efficiency increased to accommodate various payloads; second-stage operating time increased beyond Gemini range; nozzle expansion ratio expected to be increased and injector design changed for core vehicle

Titan III Transtage

MANUFACTURER: Aerojet-General

PROPELLANTS: Storables—nitrogen tetroxide, Aerozene-50

START SYSTEM: Gas pressurized system

IGNITION: Hypergolic

WEIGHT: 228 lbs. each

RESTARTS: Unlimited

AREA RATIO: 40:1

THRUST: 16,000 lbs. total—8,000 lbs. from each of the twin barrels

REMARKS: Capable of start/stop operation in zero-g environment; engine has ablative chambers and titanium exhaust skirt; engine is slated to provide orbital changes for Titan III payloads

Titan III-C Staging Rockets

MANUFACTURER: United Technology Center

PROPELLANT: PBAN with aluminum additives and ammonium perchlorate oxidizer

NOZZLE MATERIAL: Composite structure with aluminum housing, asbestos phenolic exit cone and graphite throat

DIMENSIONS: 5 ft. long, 6 in. wide

THRUST: 4,500 lbs.

DEVELOPMENT STATUS: Flight tests under way

REMARKS: Each Titan III-C booster motor carries eight staging rockets for separation from the Titan III-C core after burnout

Titan III Transtage Attitude Control System

MANUFACTURER: Rocketdyne

MANUFACTURER'S NUMBER: SE-9 (covers system of eight small engines for attitude control and ullage)

PROPELLANTS: Nitrogen tetroxide, monomethyl hydrazine

COOLING: Ablative

THRUST: 25 lbs. and 45 lbs.

REMARKS: System composed of positive propellant tanks, pressurizing system and eight engines; four engines develop 25 lbs. thrust and four reach 45 lbs. thrust

Titan III-C Boosters

MANUFACTURER: United Technology Center

MANUFACTURER'S NUMBER: 1205

PROPELLANT: PBAN with aluminum additives and ammonium perchlorate oxidizer

NOZZLE MATERIAL: Steel with graphite cloth-phenolic and silica cloth-phenolic exit cone liner

DIMENSIONS: 92 ft. tall; 10 ft. dia.

WEIGHT: Approximately 500,000 lbs.

IGNITION: Small solid rockets

AVERAGE THRUST: More than 1,000,000 lbs.

BURN TIME: About 110 sec.

STATUS: In flight test

REMARKS: Each Titan III-C carries two 1205 motors; each motor consists of five center segments, two end closures, nozzle, nose cone, thrust termination and destruct system, and secondary liquid injection TVC; in addition to five-segment Titan III-C configuration, the 120-in.-dia. motors can be used in one- to seven-segment versions

technology week, July 25, 1966

Nuclear Detection Satellite (ARPA)

TYPE: Detection-satellite system for nuclear explosions in space; formerly Project Vela

STATUS: Operational and development

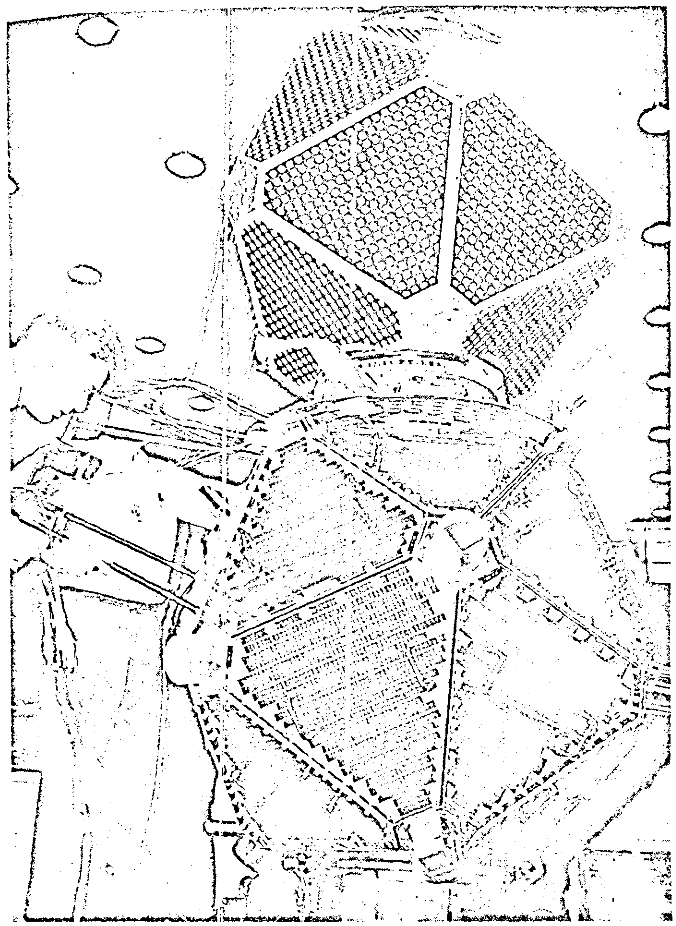
PRIME CONTRACTOR: TRW Systems; Los Alamos Scientific Laboratory, Sandia Lab.; Aerospace Corp., payload

PERFORMANCE: Operational system would consist of three satellites in one orbital plane with three more in a plane 90 degrees from the first; orbital altitude 60,000 n. mi.; can detect x-rays from a one-megaton nuclear explosion at a distance of 3×10^8 km; also has other detection equipment for gamma ray detection and complex memory logic

FRAME: Six satellites already launched were 20-sided for maximum coverage; weight, 500 lbs.; maximum in dimension, 40 in.; two new, 750-lb., 26-sided de-spun satellites, with attitude control will be launched in December

BOOSTER: Atlas-Agena B; Titan III-C for final pair

REMARKS: Initial pair of satellites were launched Oct. 17, 1963, in tandem and placed in virtually identical near-circular orbits; final positions were such that a constant separation of 100,000 mi. is maintained; 4 additional pairs of satellites were modified so as not to duplicate first launch data and second pair of nuclear test detection satellites was launched July 17, 1964; third pair launched July 20, 1965; last pair to be launched in December; highly successful program to date; data from first four satellites deteriorating now; third pair still performing well; eventually nudets sensors will be included in multiple-purpose satellites



NUCLEAR DETECTION SATELLITE

technology week, July 25, 1966

▶ McDonnell is working on a land landing design for the Gemini spacecraft, probably for the Air Force manned orbiting laboratory (MOL) Gemini B model. All fundamental design work has been completed for the final two National Aeronautics and Space Administration Gemini spacecraft.

AVIATION WEEK & SPACE TECHNOLOGY, July 25, 1966

Washington Roundup

MOL Progresses

Air Force's Manned Orbiting Laboratory (MOL) is moving quietly but quickly toward its first test launch, now scheduled for Oct. 28 from Cape Kennedy. MOL will start carrying men in space in 1969.

MOL backers must still forestall the White House budget cutters in sessions now under way on the Fiscal 1968 budget. But, after years of being stymied, MOL at last appears well on its way. Gen. Bernard A. Schriever is telling friends he would not have decided to retire as head of Air Force Systems Command if MOL's future was still in doubt. He leaves the service Aug. 31.

Martin/Denver is assembling at least 10 experiments to be flown on this first MOL test mission. The experiments—some directly related to the MOL program and others independent engineering measurements—will be placed in a Titan 2 oxidizer tank between MOL's modified Gemini capsule and its Titan 3C launcher.

The operational MOL will consist of Gemini connected to a can-shaped laboratory. Air Force astronauts, while orbiting in space, will go through a door in the Gemini heat shield to reach the laboratory. A door has been cut in the Air Force's test Gemini capsule to be flown in October, and the test will show if the door in the heat shield presents any dangers to the men in the capsule during re-entry (AW&ST Apr. 19, 1965, p. 26). The capsule will go into space and immediately re-enter; the tank will go into orbit and transmit data from the experiments.

USAF Secrecy

To the distress of Air Force space enthusiasts, these and other details about MOL are being suppressed. The Air Force's secrecy policy on MOL has even kept the service from revealing that one of its astronauts—Maj. Michael J. Adams—recently resigned to enter the X-15 program, and led to a tight-lipped policy on routine hardware details.

Actually, the Air Force plans to finish negotiations for its MOL hardware in September. This close deadline probably means the Air Force will award United Technology Center a sole-source contract for the seven-segment, strap-on solid motors which will be used on Titan 3 in its configuration for MOL operational launches. No competition for these motors has been announced. The solid motors will give Titan 3M the extra capability it needs to compensate for MOL's weight gain—from 20,000 lb. originally to 33,000 lb. now.

AVIATION WEEK & SPACE TECHNOLOGY, July 18, 1966

Johnson Signs DOD Bill

President Lyndon B. Johnson has signed the FY 1967 DOD authorization bill covering Defense Dept. research and development funds. Action came the day after Congress cleared the bill July 12.

The bill totals $17,480,759,000. This is $337.3 million less than the House authorization, $310.7 million more than the Senate version and $553.8 million more than the bill as it was presented to the Congress by the President.

The conference bill provides $7.04 billion for RDT&E, the remainder for procurement. Increases in RDT&E include $50 million for the *Manned Orbiting Laboratory*, $26.6 million for *Condor*, and $5 million for the Deep Submergence Systems Project.

Language in the bill regarding the *MOL* and funds for the Advanced Manned Strategic Aircraft directs that these funds are not to be used for any other purpose.

less than was called for in the total planned FY '67 Aerospace Corp. budget of $75.2 million. To meet this cutback in funds, a portion of the MTS had to go. Average MTS salary in 1965 was about $17,760; those now leaving probably average $15,000. Program offices at the corporation are said to be upset by the staff reduction, which they feel will make their job more difficult. Supporting staff will also be cut, by a number yet to be determined. Technical staffers who were laid off were given one month's notice and one month's severance pay.

IBM Confirmed as MOL Subsystem Winner

Douglas Aircraft Co., prime contractor for the Air Force's *Manned Orbiting Laboratory*, has confirmed the COUNTDOWN report (TW, June 27, p. 3) that International Business Machines Corp. has been selected for development of the data-management subsystem for *MOL*.

technology week, July 18, 1966

Section I

INTRODUCTION

1.1 MANNED ORBITING LABORATORY MISSION

MOL is the Department of Defense's (DOD) experimental orbiting laboratory for determining the military effectiveness of man in space. It is the outgrowth of several studies previously undertaken by the Air Force and NASA and will undoubtedly be the prime DOD effort in space for the next several years.

Although final funding has not been determined, it was initiated with approximately 1.5 billion dollars, of which approximately 150 million is allocated for Fiscal Year 1966. The experiments planned for MOL are oriented towards military objectives and what man's contribution can be in space towards the military mission; as such, the experiments will, for the most part, be under security classifications.

NASA's efforts in space have been oriented toward civilian scientific achievements and the ultimate landing of a man on the moon.

There will be a high degree of co-operation between the Air Force and NASA in order that costs be held to the minimum and that advantage be taken of technological advances. In order that the MOL Program may move ahead rapidly and economically, the Air Force plans to use as much of the "State-of-the-Art" equipment as possible. A modified Titan III-C will be used as the booster and a modified Gemini spacecraft will be used to house the astronauts during launch into orbit and re-entry back to the earth. The already established Satellite Test Annex at Sunnyvale and its associated Satellite Tracking Stations located around the world (together called Satellite Control Facility) will be modified as necessary for mission control and the control of experiments to be undertaken.

The Air Force also has "in-house" many of the capabilities needed for MOL which were developed for and with NASA in the past. Such facilities as Brooks AFB, Texas, have been instrumental in medical research related to the astronauts' well-being while entering into space, during mission and subsequent safe return to earth. Facilities of the Eastern and Western Test Ranges, where abundant capability already exists from previous space programs, will be used to launch, track and control MOL. The astronauts will be trained at the Air Force Aerospace Research Pilots' School at Edwards AFB.

Basically, MOL is a modified Gemini with a small housetrailer-sized laboratory module attached to it. When adapted to the Titan II-C booster and poised on the launch pad, the MOL vehicle will be about 153 feet high. The Gemini/canister payload will measure 54 feet, with the canister (laboratory) itself having dimensions of 41 feet long by 10 feet in diameter and a weight of 19,000 pounds. The laboratory will have two compartments approximately equal in size. One compartment, which is to be pressurized, will house life-support systems providing a shirt-sleeve environment for the MOL's two-man crews. The unpressurized compartment will contain instrumentation and power supply. (see figure this section)

Entry to the canister section from the attached Gemini capsule, in which the crew will ride into orbit, will be provided through an access hatch in the Gemini heat shield. Present concept calls for the two-man crew to remain in the approximately 1,000 cubic foot laboratory for the entire 30-day stay in space, keeping the Gemini section in a standby condition, poised for the return to earth at the end of a month, or earlier, if necessary. Re-entry from orbit will be accomplished by landings on water, using similar techniques presently employed with Gemini.

MOL orbits may have altitudes considerably higher than previous manned flights. Estimates to date indicate that they may reach 350 nautical miles. When launched at WTR, MOL can be inserted into orbit with inclinations ranging from 65 to 90 degrees. Any equatorial-type launches would be made from Cape Kennedy.

1.2 PRIME CONTRACTORS FOR MOL

The Douglas Aircraft Company was awarded the prime contract to develop and build MOL. While launches of a fully equipped MOL will not be until late 1968, several unmanned launchings will occur in late 1966 or early 1967. A total of five flights by two-man crews are currently scheduled.

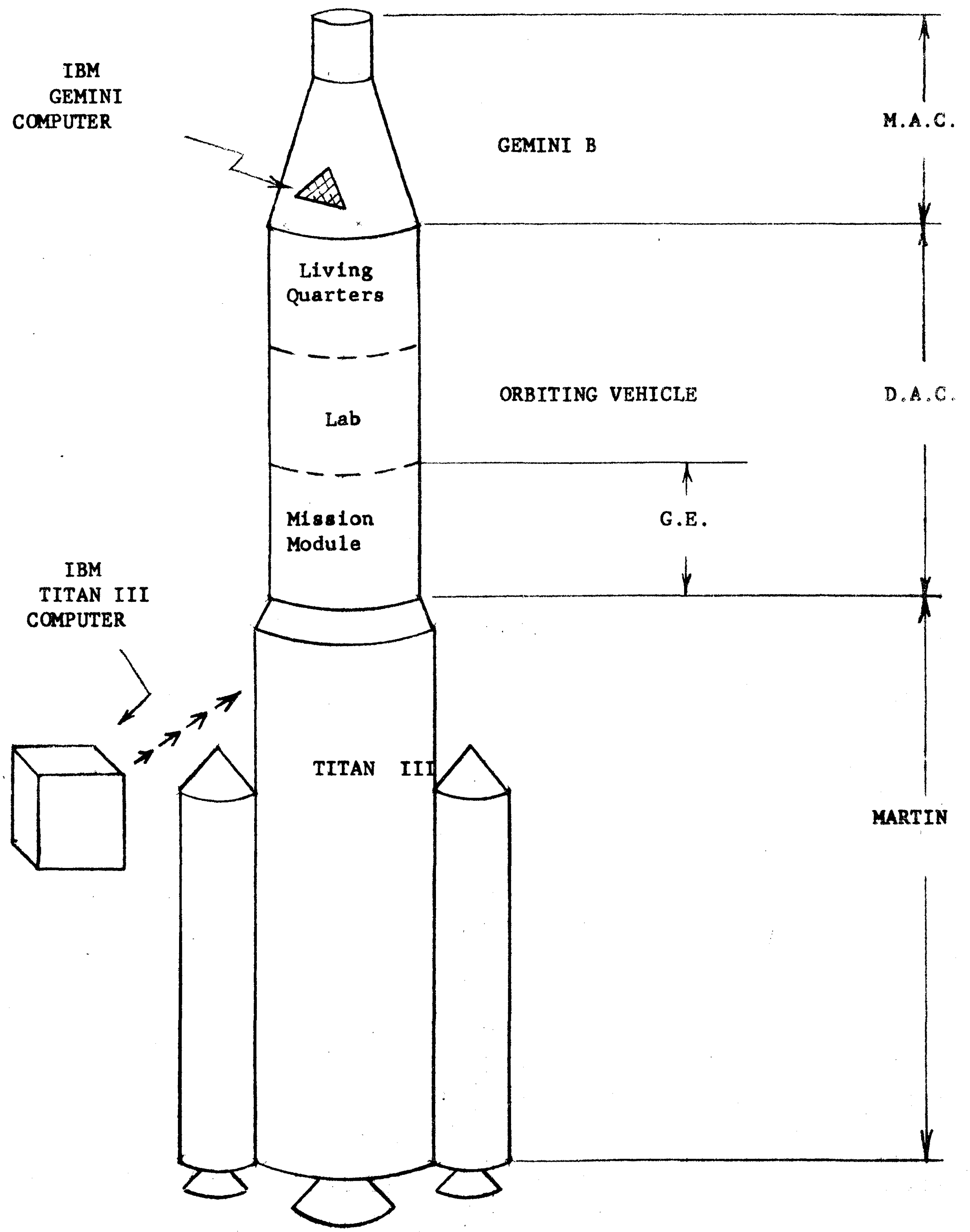
The General Electric Company has been chosen as prime contractor to plan and develop MOL space experiments. Although the experiments have not been revealed,both for reasons of security and final definition, they are thought to involve such things as visual definition of objects in space, visual definition of terrestrial features, radiation measurements, ocean surveillance, erection of large antennas in space and experiments in the use of large telescopes.

1.3 PROGRAM MANAGEMENT

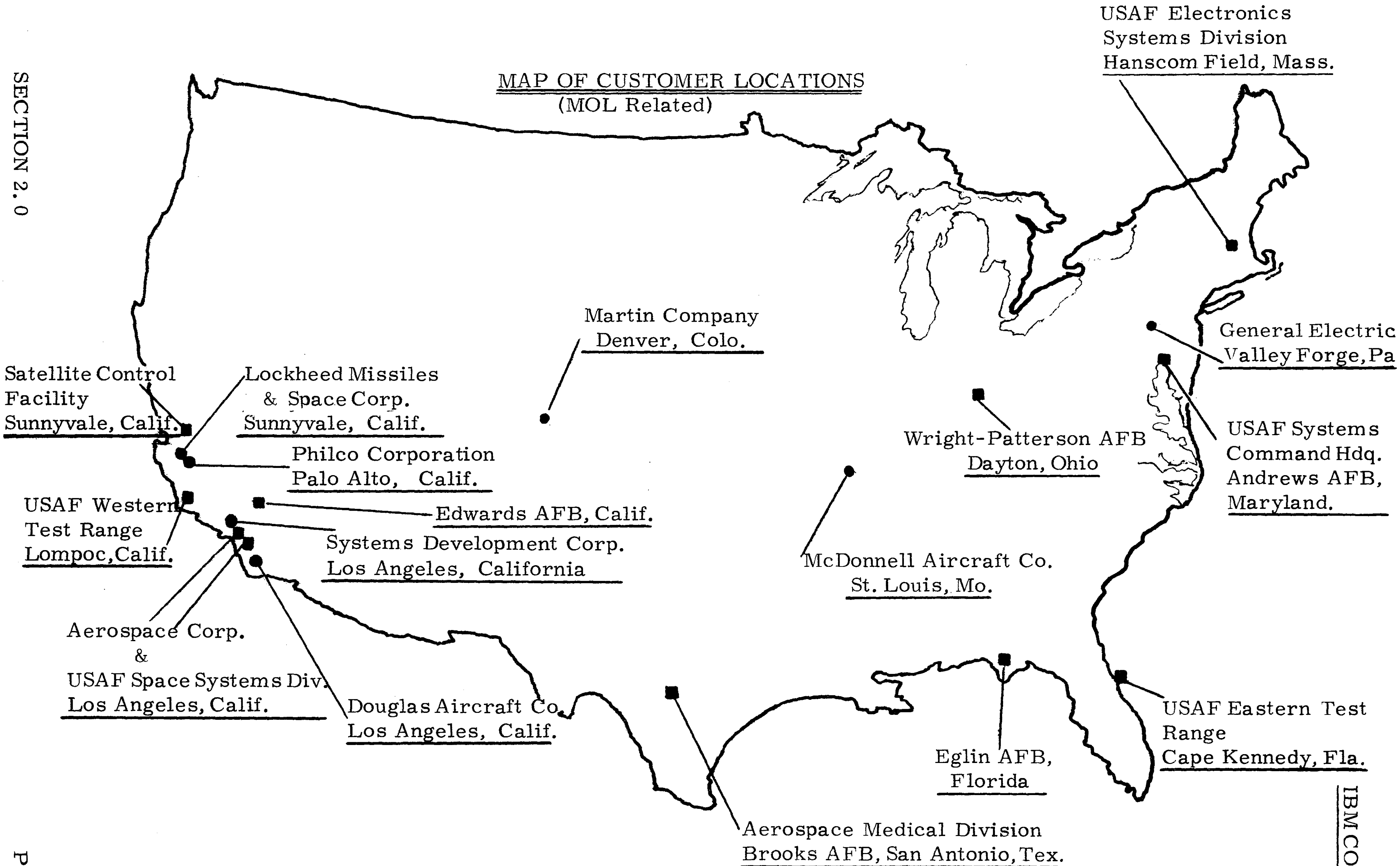
The implementation of the MOL Program will be directed by the Space Systems Division of the Air Force Systems Command with Aerospace Corporation playing a major role in general systems engineering, technical direction and overall technical management of systems and subsystems. MOL funding will be obligated from SSD in the specific areas of launch vehicles, ground equipment, launch pads and other facilities. Other tasks to be carried out by these two organizations are system procurement, integration, design, development, test, evaluation and mission operations.

MANNED ORBITING LABORATORY

FLIGHT SYSTEM



MAP OF CUSTOMER LOCATIONS
(MOL Related)



MOL PROJECT OFFICE PERSONNEL

Tie Line from the East: 8/153 +

Area Code 213/670-8350
776-3931

DPD

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C. B. (Charlie) Brown	649	213/363-4722
T. M. (Ted) Charbonneau	465	213/323-3456
K. I. (Ken) Friedman	259	213/894-8729
K. A. (Ken) Gajewski	466	213/671-2774
W. B. (Bill) Gibson	646	213/EL5-9131
R. C. (Bob) Heath	466	213/HI6-7605
R. G. (Bob) Krause	258	213/378-0957
M. B. (Mort) Needle	465	213/789-5359
J. H. (Jay) Priday	Lompoc 805/RE6-7594	805/937-3316
T. H. (Tom) Sawyer	245	213/372-6091

FSD

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D. A. (David) Fuchs	486	213/348-3949
J. E. (Jim) Hamlin	438	213/823-1588
F. M. (Fred) Kayser	412	213/456-6812
D. A. (Don) Lee	363	213/348-0438
J. J. (Jim) Selfridge	406	213/GL4-5622
G. D. (Jerry) West	363	213/395-4491
B. P. (Bert) Whipple	296	213/346-5691
F. H. (Fritz) Woelffer	412	No Home Phone

Map Index No.	Customer Location	Region	IBM Branch and Marketing Manager.
3.0	USAF Systems Command Andrews AFB, Md.	GEM	Air Force Programs J. W. Richardson
3.1	Aerospace Corporation Los Angeles, California	GEM	Westchester H. G. Hoyt
3.2	Space Systems Division Los Angeles, California	GEM	Westchester H. G. Hoyt
3.3	Satellite Control Facility Los Angeles, California	GEM	Westchester* H. G. Hoyt San Francisco** H. W. Funk
3.3.1	Satellite Control Facility Remote Tracking Stations Los Angeles, California	GEM	Westchester* H. G. Hoyt San Francisco** H. W. Funk
3.3.2	Satellite Control Facility Bird Buffers Los Angeles, California	GEM	Westchester* H. G. Hoyt San Francisco** H. W. Funk
3.3.3	Satellite Control Facility Computation Support Equipment Los Angeles, California	GEM	Westchester* H. G. Hoyt San Francisco** H. W. Funk
3.4	National Range Division Washington, D.C.	GEM	AFSC Programs B. Bruns
3.4.1	Western Test Range Vandenberg AFB, California	GEM	Westchester H. G. Hoyt
3.4.2	Eastern Test Range Cocoa Beach, Florida	GEM	Cape Kennedy W. O. Robeson
3.5	Edwards Air Force Base, Edwards, California	GEM	Riverside J. F. Bales

* Procurement through SSD,
** Account Support.

Map Index No.	Customer Location	Region	IBM Branch and Marketing Manager.
3.6	Aerospace Medical Division Brooks AFB, Texas	WRO	San Antonio J. R. McSween
3.7	Eglin Air Force Base, Eglin AFB, Florida	ERO	Mobile W. C. Stiefel
3.8	Wright-Patterson AFB Dayton, Ohio	GEM	Dayton B. O. Evans, Jr.
3.9	Electronic System Division Cambridge, Massachusetts	GEM	Boston GEM P. H. Bradley
4.1	Douglas Aircraft Company Los Angeles, California	WRO	L. A. Scientific C. D. Thimsen
4.2	General Electric Company Valley Forge, Pennsylvania	ERO	Philadelphia R. J. Dougherty
5.1	Martin Company Denver, Colorado	WRO	Denver N. H. Hawkins
5.2	McDonnell Aircraft St. Louis, Missouri	MRO	St. Louis D. C. Tobin
5.3	Philco Corporation Palo Alto, California	WRO	San Jose E. H. Dohrmann
5.4	Lockheed Corporation Sunnyvale, California	WRO	San Jose E. H. Dohrmann
5.5	Systems Development Corpn. Santa Monica, California	GEM	Westchester H. G. Hoyt

CUSTOMER NAME:	HQ Air Force System Command Andrews Air Force Base Maryland 20331 Phone: 301/981-9111
REGION:	GEM
DISTRICT:	Defense Programs
BRANCH MANAGER:	R. A. Simms - AF Program Director J. W. Richardson - Program Mgr.
DP SALESMAN:	J. W. DeBlasi
SYSTEMS ENGINEER:	Gene Lokey
FSD REPRESENTATIVES:	R. Strang W. McGentry
OTHER IBM PERSONNEL:	R. G. Taurence - Mktg. Rep. SPOs R. P. Bruns - Mktg. Rep. Ranges

AIR FORCE SYSTEMS COMMAND
Headquarters, Andrews AFB, Md.

Gen. B.A. Schriever, Commander

- AF Flight Test Center
  Edwards AFB, Cal.
  Brig.Gen. I.L. Branch
- MOL Directorate
  - Vice Director
    Pentagon, Washington, DC
    Brig.Gen. H.L. Evans
  - Deputy Dir.
    SSD, Los Angeles
    Brig.Gen. R.A. Berg
- Aerospace Medical Div.
  Brooks AFB, Texas
  Maj.Gen. T.C. Bedwell, Jr
- National Range Div.
  Andrews AFB, Md.
  Lt.Gen. L.I. Davis
- Air Proving Ground Center
  Eglin AFB, Fla.
  Maj.Gen. J.E. Roberts
- Space Systems Div.
  Los Angeles, Calif.
  Maj.Gen. B.I. Funk
- Electronic Systems Div.
  Hanscom Field, Mass.
  Maj.Gen. J.W. O'Neill
- Aeronautical Systems Div.
  Wright-Patterson AFB, Ohio
  Maj.Gen. C.H. Terhune, Jr.
- Ballistic Systems Div
  Norton AFB, Cal.
  Brig.Gen. H.J. Sands, Jr

RANKING AFSC PERSONNEL WITH MOL INFLUENCE

General B. A. Schriever - Commander AFSC, Director of MOL. Became Commander of ARDC, Later redesignated Air Force Systems Command, in 1959. As head of the AF Ballistic Missile Division, he directed the massive USAF ICBM R&D program. Relies heavily upon Aerospace Corporation engineering support.

Dr. Mike Yaramovych - Technical Director for MOL. Dr. Yaramovych is assigned to NASA but has been on loan to the Air Force for over a year. He was originally assigned to General Evans' staff when General Evans assumed the position as Director of the MOL project. He will probably remain with MOL during its lifetime, or at least until the program is well under way. He is pro-IBM and has worked with us on previous projects.

Brigadier General Evans - Deputy Director of MOL. Prior to assuming this position, General Evans was director of development under General Ferguson. During the source selection and evaluation procedures, General Evans was Commander of the MOL project - General Schriever was later moved in over him as MOL Director.

Brigadier Russ Berg - Director of MOL SSD. Prior to assuming this post, General Berg's only participation in MOL was in the source selection and evaluation procedures. During the past he has been primarily associated with AF "Dark" projects.

Lt. General J. Ferguson - Deputy Chief of Staff for R&D, AFS. Early in the MOL program, General Ferguson and his staff participated in the initial planning. Now that the project is established, it does not appear he will provide further assistance.

Colonel William Brady - Assistant Director of MOL, SSD. Colonel Brady was director of the MOL project in its conception. Prior to that, he was associated with Advanced Technical Groups at SSD. He has a long history of R&D Program activity.

Brigadier General Kronauer - DDR&E Ranges. General Kronauer has been associated with range business over the past 8 to 10 years. Before becoming Range Commander for DDR&E he was staff to General Paul Cooper. He interviewed with IBM in Washington when he was contemplating retirement.

Brigadier General Martin - General Martin has been associated with AF "Dark" projects for several years. He will probably have considerable input in the MOL payload area. Will also dictate security requirements.

Major Don Floyd - General Evans' staff. Major Floyd has visited the IBM Owego and Washington facilities. He was previously staff to General Ferguson and prior to that in a special group under MacMillan. He has had meaningful input to the MOL program in the course of his responsibilities in crew selection and experiments.

George Hess - Chief Scientist, technical director for MOL and NRD for General L. I. Daves Commander National Range Division.

Colonel W. R. Hedrick, Jr. - Director of AF Satellite Control facility. Directly responsible to the Undersecretary of the Air Force, Dr. Paul, for the operation of the SCF in Sunnyvale and its remote tracking stations. Reports administrative to Major General B. I. Funk, Commander SSD. Pro-IBM. Will actively manage configuration and operation of SCF in support of MOL.

General J. Bleymaier - Commander WTR. Formerly associated with MOL project in AFSC. Will dictate WTR systems support for MOL.

In order to strengthen its research and development effort, the Air Force activated the Air Research and Development Command (ARDC) on January 23, 1950. Most of the Air Force's technical resources, scattered throughout a half dozen commands, were transferred to ARDC, which assumed responsibility for the research and development phase of new weapon systems.

On April 1, 1961, ARDC became the Air Force Systems Command (AFSC) with the responsibility for research, development, production and procurement of all considerations involved in placing a complete aerospace system in operation. The Command assumed all former ARDC functions, facilities and personnel, except those involved in basic research. It also incorporated the necessary procurement personnel and their contract management regions in order to place complete weapon systems management control under AFSC . . . . . . from initial development to delivery to operational commands.

B. 1. Background

The Air Force Systems Command will manage MOL for the Air Force who has been designated by the Department of Defense to manage MOL. More specifically the Space Systems Division of AFSC will manage MOL, and coordinate MOL policy decisions through AFSC, USAF and DOD.

The Systems Command has gained considerable experience in Space projects through operation of the missile Ranges at Patrick AFB and Vandenberg AFB, and the Satellite Control Facility under Space Systems Division.

B. 2. Equipment installed at HQ AFSC includes IBM 1410 used in command data management. This system and a Honeywell 800 for major command date systems work is managed by the Comptroller organization. DCS/C manages a network of 1410s at AFSC Bases.

CUSTOMER NAME:	Aerospace Corporation, Inglewood, California
REGION:	GEM
DISTRICT:	Western
BRANCH:	Los Angeles, Westchester
BRANCH MANAGER:	Skip Hoyt
ACCOUNT MANAGER:	Ed Chappelear
DP SALESMAN:	Bob Fairbanks, Bob Krause, Bob Oller.
FSD REPRESENTATIVE:	Johnny Jones, Jim Selfridge, Glen McClure.

2260

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GROUP DIRECTOR

Yuri Tanaka X85162

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Marion Brownsberger X87544

J. L. Chambers X87779
B. M. Collins X87779
R. L. Hayes X87544

Lorraine Dinwiddie X87779

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Lenora Martinez X87438

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Director

Rhea Disrud X87436

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H. J. Tye X85780
F. J. Zampino X86710

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Liz Provence X87448

R. W. Day X86027
D. Saadeh X85274

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Ginni Thompson X87526

R. R. Arndt X87529
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J. L. Tillman X86634

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J. Machlis X85809

SGLS

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Betty Roach X85330

R. K. Moss X85330
H. R. Sigler X85330

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LaDeana Young X85334

M. C. Ackerman X87670
C. S. Hoff X87668
J. A. Jackson X87673
H. H. Ross X87671
F. T. Sinnott X87672
J. T. Thompson X87669

Joyce Brazee X87666

SCF Configurations

U. C. Nolte, Mgr. X85336

Florence Cloud X85336

J. R. Fleury X87855
L. S. Preston X86302
R. P. Reimert X87512

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Director

Dottie Allen X87542

C. E. Daniher X87457

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R. H. Scott, Mgr. X87440

Ann Veto X87440

M. L. Black X87524
V. L. Gentry X87520
H. H. Halpern X87521
P. G. Morton X87522

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E. L. Spalinger, Mgr. X87442

Carol Freeman X87442

G. P. Buck X87450
T. H. Hedene X87525
F. A. O'Leary X87859

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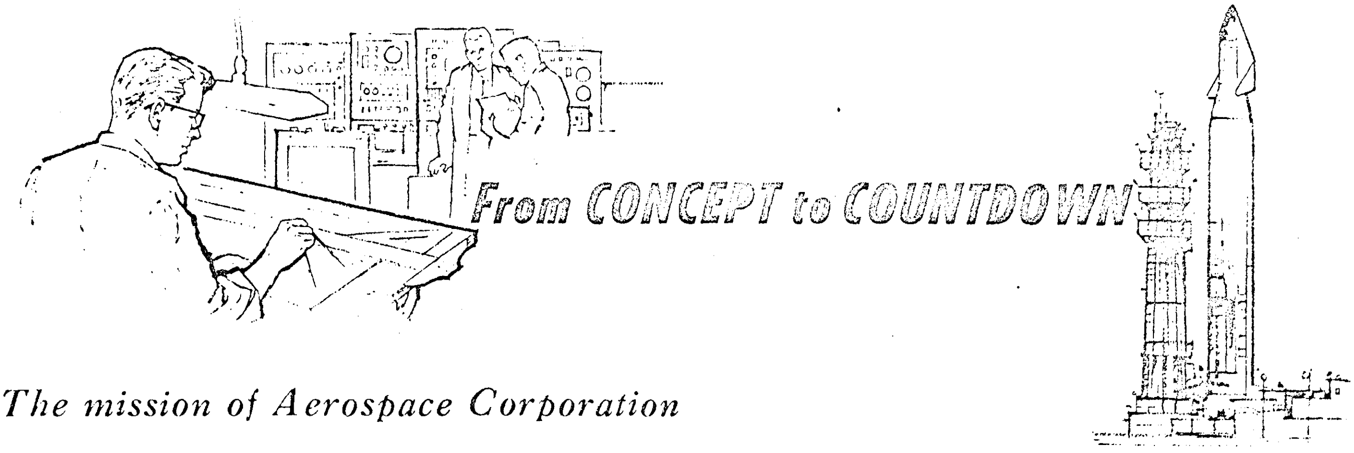
Doris Bowman X87454

L. S. Comyns X87452
T. R. James X87458
R. F. Mandich X87451
C. M. Nakamura X87460



From CONCEPT to COUNTDOWN

The mission of Aerospace Corporation

by D. D. WHITCRAFT, Jr.

Director of Government Relations,
Aerospace Corporation, El Segundo, Calif.

THE MISSION of Aerospace Corporation is a broad one. Working with the Air Force, the corporation takes part in planning advanced missile and military space systems, directs and supervises their development, and participates in test launchings. In effect, Aerospace Corporation's responsibilities range from the idea or concept in the mind of the scientist through the countdown at the missile range to successful demonstration of the system.

Aerospace Corporation was incorporated under the laws of the State of California on June 3, 1960.

The establishment of the corporation was predicated on the need of the U. S. Air Force for top scientific and engineering competence to provide advanced planning, general system engineering, and corresponding technical direction or supervision of advanced ballistic missile and space programs. To assure objectivity in all its relations with government and industry, the corporation was established as a not-for-profit, public-service institution.

The concept represented by Aerospace Corporation was recommended in the "Eleventh Report by the (House) Committee on Government Operations," based on a study by the Committee's Military Operations Subcommittee and dated September 2, 1959.

Shortly after, the Secretary of the Air Force requested a management study committee headed by Dr. Clark B. Millikan of the California Institute of Technology to review the management of Air Force ballistic, missile and space systems programs. The committee recommended establishment of a new non-competitive organization to replace Space Technology Laboratories, Inc., in providing assistance to the Air Force in the management and direction of missile and space programs.

This is how Aerospace Corporation was born. Headquarters for the new organization were set up in a modern research and development center located in El Segundo, Calif., adjacent to Los Angeles International Airport.

Technology advanced by leaps and bounds after World War II. Designers and builders of aircraft and missiles were coping with systems far more complex than ever before. The Air Force recognized that new and improved management methods should be formulated if its ballistic missile program were to proceed at the urgent pace required for national defense. To assist in the management of ballistic missile projects, the Air Force in 1954 utilized a new approach—a private contractor as a system engineer and technical director over numerous associate contractors.

Development of the required missile systems sooner than anyone had dared hope, and performance that exceeded the original design specifications, proved the basic soundness of this new technical management approach.

However, by 1959 it appeared that perhaps refinements could be made in the Air Force's technical management approach. The organization providing the technical assistance was owned by a profit-making firm. Industry—those companies which sought the job of building missile and space systems and subsystems—questioned the objectivity of the Air Force's systems engineer.

Objectivity in this case means absolute fairness and impartiality in dealings with both the government and industry. Recommendations concerning contract awards, for instance, must be based solely on contract bidders' competence to handle the job. No personal financial interest in the job should sway the systems engineer's decision. It was because the system engineering organization was owned by a profit-making corporation—which conceivably could wield influence for its own benefit—that industry at large was moved to object to the privilege of a potential competitor.

To safeguard objectivity, it was decided to form a not-for-profit organization, with no stockholders to appease or dividends to earn—an organization whose only reason for being was to serve the government, an organization in which every U. S. taxpayer was a "stockholder." As a further step in assuring objectivity, the organization would engage in no manufacture or production. This organization is Aerospace Corporation.

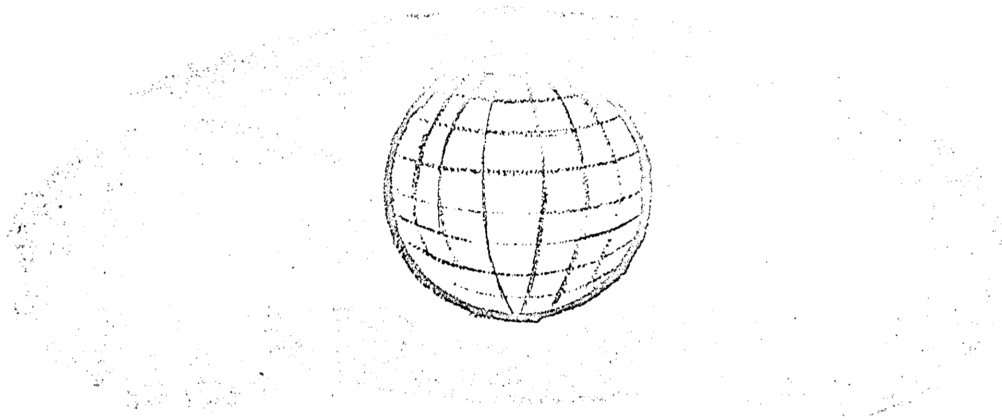
Aerospace Corporation performs its work under contract with the government—principally the Air Force. Its technical work is divided into three main categories of effort: systems research and planning, technical program operations, and laboratory operations.

The scientists and engineers engaged in *systems research and planning* channel their talents to planning for ballistic missiles and space systems, working as a team with the Air Force. This effort is devoted to assisting the Air Force in conceiving advanced weapons and military space systems and preparing initial general specifications. Included in this effort is the technical evaluation of proposals submitted by industry for such new systems. The objective for this operation in essence is the translation of military requirements into concepts of military systems to fulfill those requirements. This is called advanced systems analysis, planning and initial systems engineering.

In the area of systems research the corporation is currently conducting study projects related to advanced ballistic missiles, orbital interceptors, manned satellite maintenance vehicles, low-cost space launching systems and recoverable satellites, and is conducting other studies involving advanced technology.

Technical program operations take over where system research and planning leaves off. Supposing for example, that initial systems-engineering efforts have resulted in a concept of an advanced satellite system for which the Air Force has a requirement. So the concept can be converted into hardware, contracts have been awarded to industry to build the system. Technical program efforts are directed toward assisting the Air Force in the technical management involved in the actual development of the space system. In most cases, Aerospace Corporation performs what is called general systems engineering.

This might be the time to discuss briefly what is meant by systems engineering. Basically it concerns the operations involved in developing a complex system usually requiring the integration of a number of relatively complex subsystems, each of which may concern a different branch of technology. General systems engineering, that portion of systems engineering which Aerospace Corporation performs, deals with the overall putting together of a system. It involves design compromises between subsystems, such as deciding that the engines must be bigger because the payload cannot be smaller, or that the payload must be smaller because the engines can't be larger. Analysis of subsystems seeks to find if anything can give to make the system better, cheaper, or more reliable. Recognition and definition of how the subsystems fit together to form a whole system constitutes a part of the process as well as supervision of system testing. All these are conducted to the extent required to assure that system concept and objectives are being met in an economical and timely manner. In order to fulfill its general systems engineering responsibilities, the corporation technically directs the associate contractors working on the programs.



Detailed systems engineering, the actual detail work of engineering the system, is normally the responsibility of the industrial contractors. Aerospace Corporation does not intend to get into the detailed systems engineering, although it is ready to lend assistance to the contractor when required. It may be given responsibility for detailed systems engineering in special cases where approved by the Secretary of the Air Force.

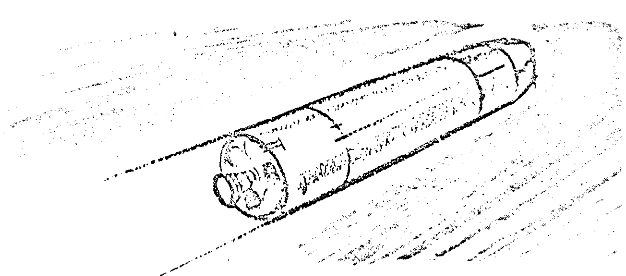
Aerospace Corporation is concerned with nearly the entire spectrum of Air Force space systems. Work in the missile area includes a mobile, mid-range ballistic missile (MMRBM) system. In addition to Air Force-funded programs, the division supports several missile-space programs of other government agencies in which the Air Force has responsibility. On the Mercury program, for example, the Corporation works with the Air Force in supplying to NASA the Atlas launch vehicle. It also performs general systems engineering on the Titan II booster for Project Gemini, follow-on to Mercury, and on the Titan III space booster program.

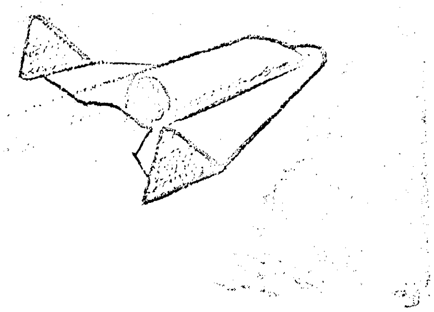
At Aerospace Corporation, *laboratory research operations* are conducted in two general areas:

1. Research and experimentation aimed at assisting the corporation in its systems research and technical program operations; and advancing the state of the art in areas critical to achieving continuing scientific progress.
2. Applied research program management to assist the Air Force in the management of its applied research programs being performed by industry under Air Force contracts.

The corporation is involved currently in a number of laboratory research projects. Chemical, nuclear, and electric *propulsion* are being studied. In the field of *aeromechanics*, study work is under way concerning winged and ballistic reentry configurations; simulation of hypersonic flight conditions using a hypersonic shock tunnel; arc tunnel experiments to measure heat transfer rates of various materials which might be used for reentry applications; and ionized gas studies. In *materials research*, investigations are being made into solid state physics, materials, structures, and environmental effects on materials. In *electronics*, research is being conducted in advanced solid state circuits for space communications and detection systems, research in electromagnetic and communications techniques, and in attitude and position sensors and controls. In *space physics*, the corporation is performing studies of the atmosphere, the radiation belts, and solar and stellar radiation.

As the foregoing indicates, during its brief existence, Aerospace Corporation has become deeply involved in the nation's missile and space programs. In September 1962, total employment reached approximately 4,000 persons, nearly 1,400 of whom were scientists and engineers working in three technical divisions. In addition, construction was underway on facilities to house the Aerospace Corporation San Bernardino Operations which was established in June 1962 to provide technical support of advanced programs of the Air Force Ballistic Systems Division which had moved to Norton Air Force Base near San Bernardino, California.





General Bernard A. Schriever, USAF Systems Command (AFSC) commander, before the reorganization of the Air Research and Development Command, commented on the urgent need for such a reservoir of trained personnel:

"I am frequently asked, 'Wouldn't the Air Force prefer to handle the integration of systems itself as an in-house job?' I do not want to minimize the outstanding contributions made by our Air Force engineers and scientists in our own laboratories . . . but the expanding budget for research and development and the sharply accelerated growth in our requirements . . . has forced us to enlist the aid of companies such as Rand, Aerospace, Mitre Corporation, and others. . . .

"When we add to it the further need for integration of the best industrial contractors we can find, the magnitude of the problem facing the Air Force today becomes clear. We simply do not have, internally, all the manpower resources necessary to carry out the technical management of all our programs.

"We do not, however, lack competence within the Air Force to manage complicated technical programs. We do have this managerial competence. We will continue to have the capability for technical management, and will continue to expand it. . . .

"However, the total requirement for personnel of this kind throughout the Air Force far exceeds the number of people we now have or can hope to get. There will be continuing need to employ objective organizations which can provide the Air Force with additional technical competence. Aerospace Corporation has an essential part in our long-range planning."

Mr. Whitcraft joined the Aerospace Corporation as Director of Government Relations in August 1960. He previously headed the Western District Office of the Defense Systems Department of General Electric Co.

From August 1956 to January 1957, on a leave of absence from G.E., Mr. Whitcraft served as a consultant to the House Appropriations Committee (Nugent Group) on a three-man inquiry into the overall guided missile program of the Department of Defense. A major in the Air Force Reserve, he served on active duty from 1945 to 1955.

January 25, 1966

MEMORANDUM TO FILE:

Subject: Meeting with Aerospace on Communications Control on January 19, 1966

Mike Burke, T. Charbonneau and I met with Earl Ragland, Carl Beyer and E. Retzlaff to discuss communications control, monitoring and switching. In this meeting Mike Burke went over again our rationale for recommending that switching of encrypted circuits be performed external to the CPU. Aerospace agreed with the rationale. We then discussed our approach to line monitoring and switching. This was fairly complete but did not consider automatic switching at Remote Sites.

Earl Ragland summed up their requirements, as follows:

1. At least three lines/station, (1) one or more voice; (1) data; (1) spare fully used for sync. purposes.

2. All lines are long lines, no radio, routing is not controlled.

3. Backup is always required, voice and teletype.

4. Indicators and alarms are required at the STC and remote sites.

5. Control should be exercised by the STC.

6. Reinitiation should require essentially no time.

7. High priority and remote manual override should be provided.

8. The remote sites should be able to reinitialize at that end.

9. The computer program for Comm. Control should be protected from interference by other programs.

Aerospace would like us to present a design which includes tradeoffs in error detection, such as channel costs, programming, storage and interference if the spare and data lines are used to carry the same information with checking internal to the computer, versus external checking. They also implied that we would help them and ourselves if we discussed the design with AT & T.

Mike Burke has agreed to develop and coordinate our technical work in this area. We should be able to discuss our new design with Aerospace about February 3, 1966.

J. J. Selfridge

JJS:jh
cc: M.Burke,Bethesda,
J.E.Hamlin
R.Krause
G.McClure
A.Valakos,Bethesda.

March 24, 1966

MEMORANDUM TO THE FILE

SUBJECT: Discussion with Aerospace Corporation Personnel
22 March 1966

Attendees at this discussion were as follows:

Aerospace	IBM
F. Arndt	B. Krause
G. Hansen	M. Needle
H. Reynolds	G. West

We discussed the security problem associated with a multi-processor configuration for the STC buffer computer. We presented, informally, our solution to the problem using System/360 storage protect feature and some hardware partitioning capabilities. The Aerospace people were receptive to our suggestion for a formal briefing on the subject, and recommended certain points to be emphasized.

G West

G. West

GW:jh

cc: Messrs. C. B. Brown
W. B. Gibson
J. E. Hamlin
R. G. Krause
M. Needle
J. J. Selfridge

Manned Orbiting Laboratory Project
LOS ANGELES AEROSPACE BUILDING

March 24, 1966 **IBM CONFIDENTIAL**

TO: Mr. J. J. Selfridge

BRIEFING TO AEROSPACE CORPORATION ON IBM DIAGNOSTICS

Aerospace Attendees:

Dr. Marsh
Earl Ragland
Don Stevenson
Vic White
Lee Murphy

On Tuesday, March 22, Messrs. Jim Selfridge, Bob Krause, and Rip Coalson briefed the above Aerospace personnel on subsystem Diagnostics which have been designed and operated by IBM. The diagnostics performed at WSMR (AF Athena Program) on the radar, telemetry and command subsystems were discussed in order to exemplify IBM credentials in diagnostic techniques.

During the course of, and following the briefing, the following observations were made:

1. In general, the briefing was very well received, and there was active participation (constructive) from the customer.

2. Lee Murphy stated that the diagnostics presently performed at the Remote Tracking Sites are not as comprehensive or automated as those described during the briefing.

3. Dr. Marsh stated that the Air Force wanted to replace the men who check out the tracking equipment with completely computerized, detailed, diagnostics. He also implied that he desired the diagnostics techniques we presented to be extended to a more detailed level of fault isolation.

4. After the briefing, Lee Murphy requested that we give the same presentation to other members of the Aerospace organization. We replied affirmatively.

R. V. Coalson

R. V. Coalson

RVC/lr
cc: Mr. C. B. Brown
Mr. R. G. Krause

CUSTOMER NAME:	Space Systems Division, Inglewood, California
REGION:	GEM
DISTRICT:	Western
BRANCH:	Los Angeles, Westchester
BRANCH MANAGER:	Skip Hoyt
ACCOUNT MANAGER:	Ed Chappelear
DP SALESMAN:	Bob Fairbanks, Bob Krause, Bob Oller.
FSD REPRESENTATIVE:	Johnny Jones, Jim Selfridge, Glen McClure.

12/2/65

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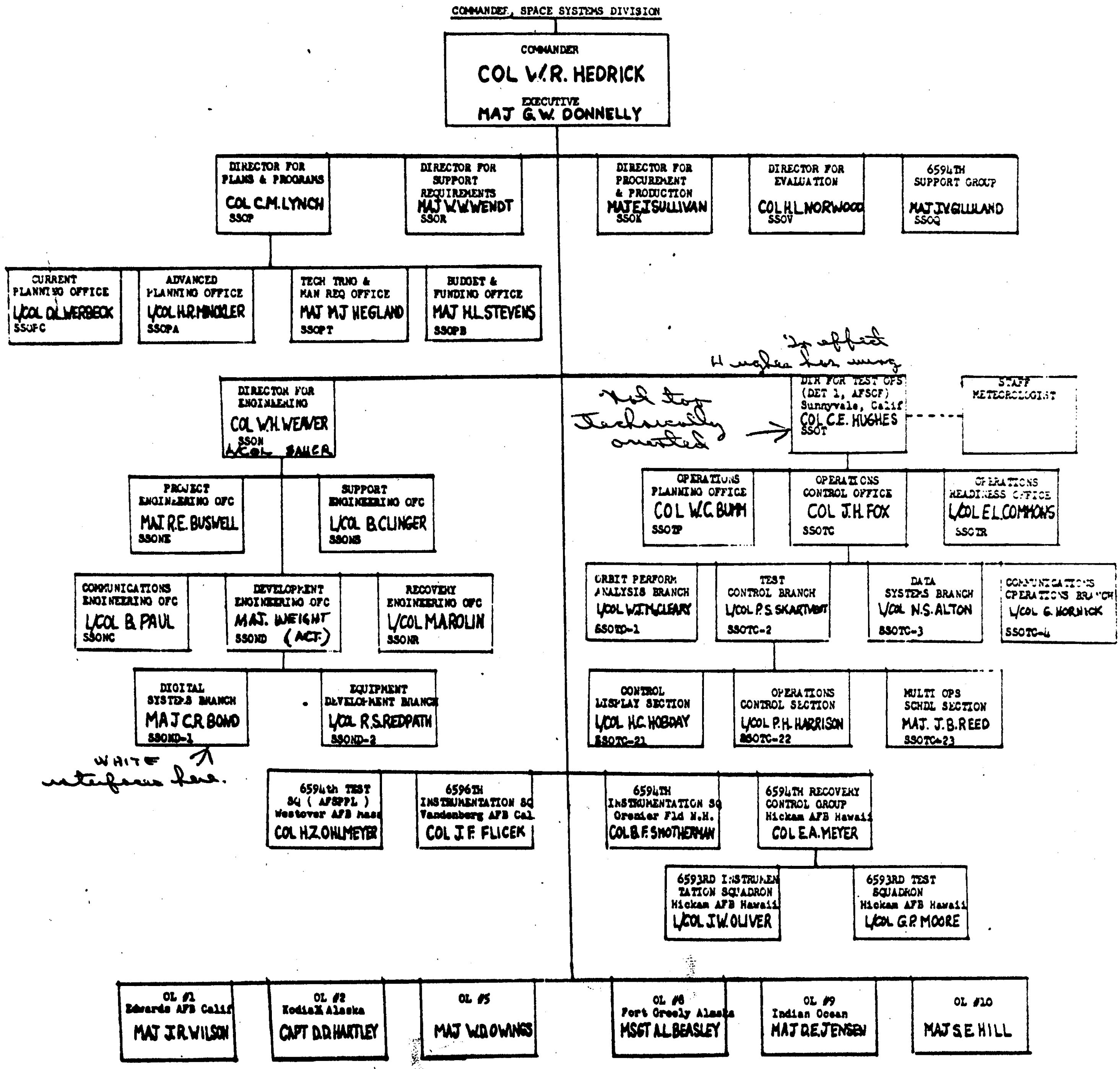


Fox has a doctorate in some astrodynamic field.

Ground Systems
Lt.Col. O'Toole*
Tel. 31263

Air Force

Maj. George Hrebec*	Tel. 31263
Capt. Robt. B. Stuart	Tel. 30070
Lt. Donald G. Hard	Tel. 30070
Lt.Dennis J. Scovern	Tel. 31263

Aerospace

Richard E. Day*
Britan
Chuck Hazel
Andy Pope*
Joe Helland
Art Halenbeck*

* = Prime mover

TITAN III
Col. David Miller
Tel. 30734

Air Force

Col. Russell Herrington, Jr.	Tel. 30410
Capt. Norman North	Tel. 31402
Maj. Chas. McGinn	

Gemini
Lt. Col. Gandy
Tel. 31304

Air Force

Maj. Howard Clark   Tel. 31304

Aerospace

Ernie LaPorte
Jim Henry
Pete Soule*

* = Prime mover

Crew & Biomedical
Col. A. I. Karstens*
Tel. 31820

Air Force

Col. Robt. Levin	Tel. 31820
Capt. Frank Brunstetter	"
Capt. Robt. Zeiger*	"
Capt. Buena Parks	"
Capt. Chas. Wilson	"

Aerospace

Jim Roberts*
Dr. Pete Husman
Dr. Leon Thomas

* = Prime mover

Procurement
Lt.Col. Robert Borman*
Tel. 31265

Air Force

Capt. Oma Hester, Jr.	Tel. 33538
Lt. Lawrence Savage	"
Leonard Atkins*	Tel. 31265
Merlin Dunn	"

UNSOLICITED PROPOSAL TO SSD

I. PROPOSAL GOAL: Acquire Software Support and Integration contract for the 2250 in the STC.

A. Design, produce, test and document 160A driven diagnostics for the 2250.

B. Design, produce, test, document and install a display software subsystem operating on the BB in a Postpass mode, utilizing the recording tape. (Much like a current program which drives analog plotters).

C. Simultaneously or subsequently build a real time display module which "plugs into" a Model 8.0 or 9.0 Bird Buffer.

D. Design, produce and demonstrate advanced display application of 2250's as follows:

1) Mission Control Complex command and control data display and computer input methods, with special emphasis on high priority unmanned vehicles and MOL.

2) Diagnostic display information both for the STC and RTS.

3) Replacement of SOC display and command functions.

II. PROPOSAL METHOD:

A. Acquire MLSD/Division Litton Industries as a subcontractor.

1) Definition of responsibilities:

a) Design the programs up to and including detailed Interface Specification **	IBM/MLSD
b) Produce control and/or sub-control routine	IBM
c) Produce display driver subroutines	IBM
d) Produce data production and/or retrieval, interpretation, tagging and formatting sub-routines	MLSD
e) Provide interface code for Operational BB	MLSD
f) Provide operational procedure documentation	MLSD

B. Do detailed design in Los Angeles in close concert with SSD/ASCO/SDC and SPOE offices.

C. Do program development/testing/demonstration at AF/CPDC (Santa Monica) and STC (Sunnyvale).

** Proposal should indicate that any existing software in the AF/CDDC would be used for this task.

III. ADVANTAGES FOR IBM OF MAKING THIS PROPOSAL:

A. Gives us a better feel for current aspects of SCF mission control (The project that needs this is the big one)

B. May give us access to advanced information on the BB replacement and associated display philosophy.

C. Provides an opportunity to get feedback intelligence on how displays will be set up for MOL at the STC.

D. Provides IBM protection in terms of P.R. on the 2250. (i.e., no chance of another situation like the 3600/1300)

E. Provides a feel for working with MLSD in the event we would consider them as a potential subcontractor for future larger proposals.

IV. TIMING: FINAL PROPOSAL TO SSD IN 13 WORKING DAYS:

Technical Schedule:	Costs:
A. by 1/1	6 mm
B. by 2/15	10 mm
C. by 3/15	16 mm
D. by 6/30	16 mm
	48 mm (4 man years).

CUSTOMER NAME:	Satellite Control Facility Space Systems Division, AFSC Inglewood, California
REGION:	GEM
DISTRICT:	Western
BRANCH:	Los Angeles Westchester
BRANCH MANAGER:	Skip Hoyt
ACCOUNT MANAGER:	Ed Chappelear
DP SALESMAN:	Bob Fairbanks Bob Krause Bob Oller
FSD REPRESENTATIVE:	Johnny Jones Jim Selfridge Glen McClure

SECTION B

SATELLITE CONTROL FACILITY

I. Introduction

The Mission of the Space Systems Division of the Air Force Systems Command is the development of Space Systems. A major portion of the effort of the Space Systems Division is the development of satellite systems. One of these systems is the Discoverer Program which is a research and development space program designed to demonstrate Air Force capabilities for the launch, stabilization, control and recovery of instrumented capsules from orbit.

Inherent in the development of each satellite system is the development of the capability to control its functions while in orbit. Once the satellite has been successfully injected into orbit, the fulfillment of the test objectives depends on maintaining contact with the vehicle and controlling its operations. This is the task of the Satellite Control System.

The Satellite Control System consists of the ground and space equipments that are required to permit intelligent on-orbit operation of a satellite system. This operation relies on the real time analysis of telemetered status data, the determination of the characteristics of the satellite's orbit, the issuing of commands to precisely control the functioning of the payload and experiments, and the various communication links and computation centers. The ground portion of the Satellite Control System is termed the Satellite Control Facility.

II. Objective and Approach of the Satellite Control Facility

The primary objective of the Satellite Control Facility is to satisfy the on-orbit control requirements of approved satellite system development programs. The Facility is required to support many different satellite programs in the next few years. While there are some common satellite control functions among each program, in general, each program and even each flight series withina satellite program, has peculiar control requirements which must be met.

To meet these various requirements, the approach has been to provide a Research and Development Satellite Control Facility tailored to accomplish the real time, on-line, orbital control of satellites during their development. The Facility is an R&D tool that must reliably provide on orbit satellite control support during the flight testing period. In addition, the Satellite Control Facility is used to simulate and test operational prototype Satellite Control Systems. Thus, the approach has been to maintain basic support while testing and developing new and advanced satellite control systems for approved Air Force space programs.

III. Satellite Control Facility, SCF

The SCF consists of the Satellite Test Center (STC)(sometimes called Satellite Test Annex because of its Lockheed, Sunnyvale location) and the Remote Tracking Stations of which there are ten. Dual tracking stations exist at Vandenberg; Hawaii; New Boston; New Hampshire; single stations are located at Kodiak; Guam; Alaska; Indian Ocean; and a northern site. The entire facility was developed to support Air Force space programs which are for the most part highly classified. Additional tracking sites have been deactivated and are referred to as mobile sites available for MOL at SUVA or Okinawa. Communication between the sites and the STC consists of voice and data. Data lines are 1200 bps phone lines where these are available. From the IOS,data is transmitted over 100 wpm teletype (Note: The modems have a 50 kbps capability). The present ground system configuration is shown in Figures 1 and 2.

The STC is equipped to support six satellites simultaneously. Its data processing subsystems are divided into two groupings. There are nine (160A's). Six 160A's are used as Bird Buffers for the six programs supported, two 160A's are spare Bird Buffers and one 160A is a switching computer.

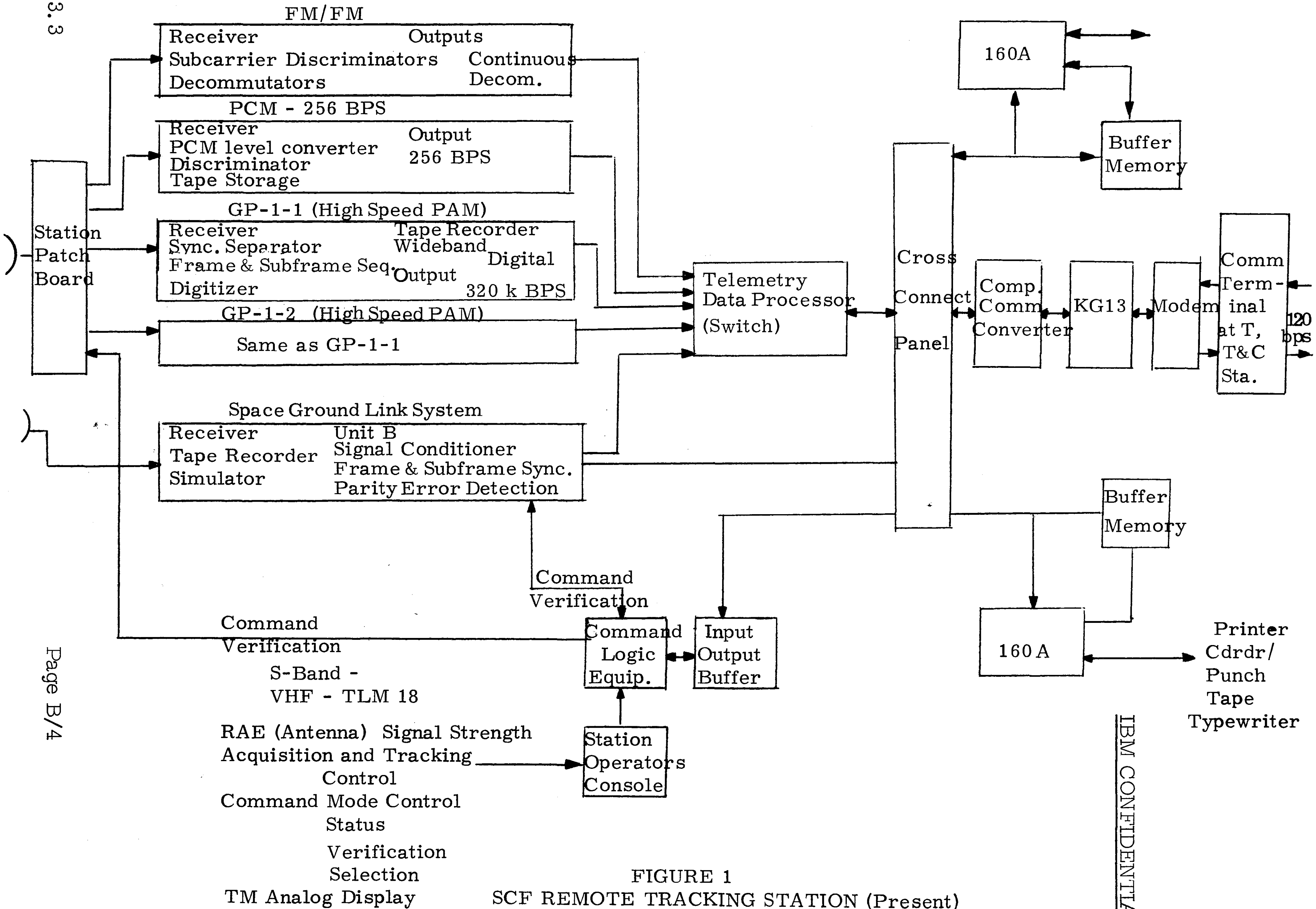
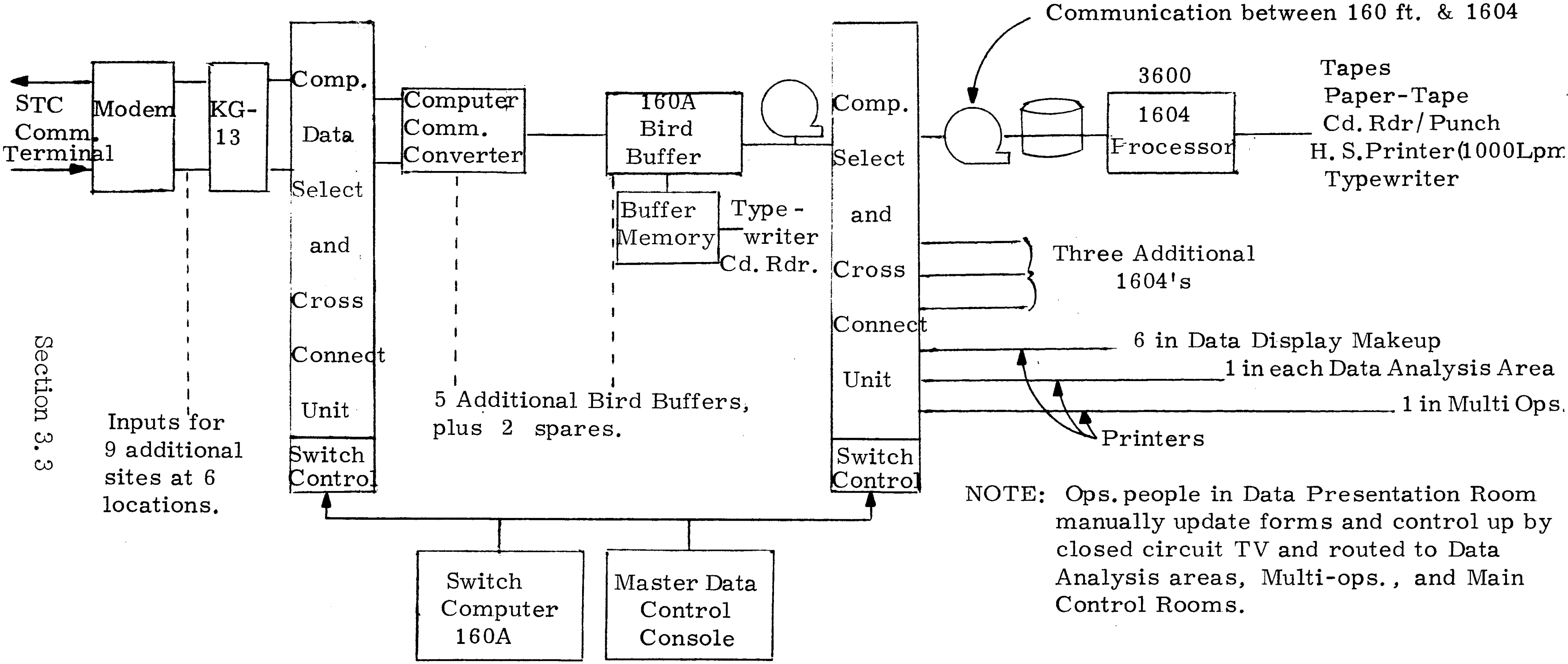


FIGURE 1
SCF REMOTE TRACKING STATION (Present)



NOTE: Ops. people in Data Presentation Room manually update forms and control up by closed circuit TV and routed to Data Analysis areas, Multi-ops., and Main Control Rooms.

FIGURE 2
STC DATA SYSTEM (Present)

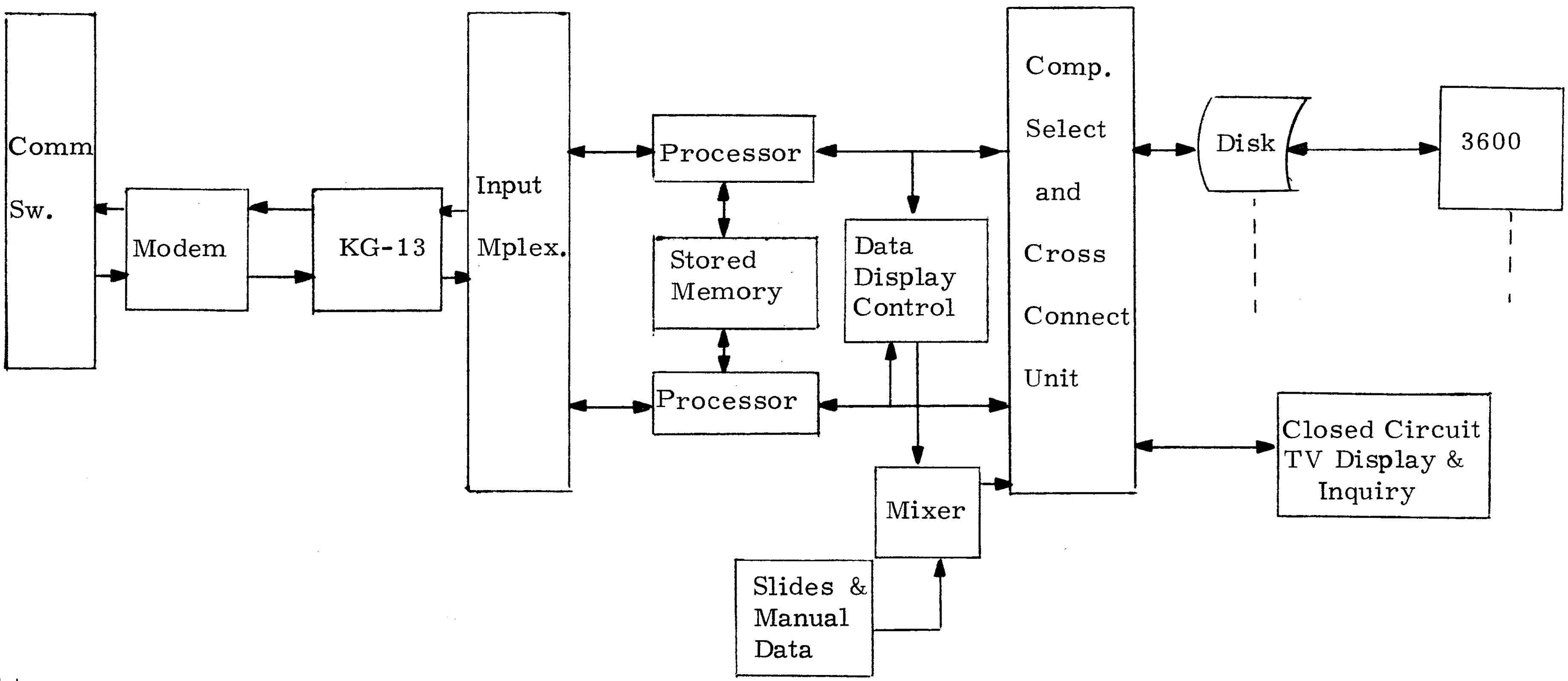


FIGURE 3
IMPROVED STC

The four 1604 computers (now being changed to five 3600's) perform the extensive computations for the SCF. The STC has six areas or complexes set aside for the User Programs where orbit planning, data analysis, and command generation is performed. A Data Presentation Room has facilities for monitoring each satellite and the portion of the network involved at any time and making up status displays for the User Program Complexes, a Multi-Ops Room and a Main Control Room. The User Program areas provide a means to analyze and control on-board systems. The Multi-Ops Room oversees scheduled operations, detects conflicts and resolves operations and maintenance difficulties throughout the SCF. The Main Control Room has facilities for supervising all satellite operations and has six satellite controller positions. Data Display and Voice communication are available to each control position in Main Control, Multi-Ops and the User Program Complexes.

The three dual tracking stations are capable of supporting certain combinations of two satellites simultaneously. Each tracking station has four main groupings of equipment. These are:

1. The antenna systems for tracking, acquiring telemetry signals, and transmitting commands;

2. The subsystems used to convert raw TM to digital form, to acquire the satellites, lock on and route range, azimuth, and

elevation signals to the tracking computer, and to initiate and verify command transmission

3. The Data Processing System which uses one 160A for tracking and the other for telemetry data compression, this system interfaces with the STC

4. The Station Operator's Console which is used to monitor the site operation and make adjustments to obtain the desired performance.

The SCF in MOL

The SCF may be adapted for MOL as easily as any other network and mission control facility. This becomes particularly obvious when planned improvements to the SCF are implemented. At the STC, improvements include the addition of computer generated display and operator inquiry capability; replacement of the 1604 computers with 3600 computers; and the replacement of the tape intercome system between the 160A and the 3600's with disk files. The Bird Buffer complex is undergoing study with a goal of replacing the (8) 160's with (2) larger computers as a possibility. The computers would back each other up and share memories. This change could result in replacement of the switch computer (160A) and the Computer Data Select and Cross Connect Unit. User Program security would be maintained through a memory protect device. A configuration like this is shown in Figure 3. The Computer Select and Cross Connect Unit, the disks, and the 3600's would remain. The planned displays will make use of the existing STC closed circuit TV system and may mix computer generated data with slides and data prepared manually on forms. Routing of this data to User Program Complexes may be under control of the Computer Select and Cross Connect Unit or by computer switching of channels. Tracking station inputs would be handled by the Input Multiplexor with the computer performing a Bird Buffer as well as a Tracking Station Buffer function.

Such a configuration lends itself well to the present STC operations and to MOL operations. The entire facility is assumed dedicated to MOL in the following discussion although a subset could be used. All of the computer equipment could be dedicated to a MOL mission which would be difficult with the present Bird Buffers; i.e., sharing of the mission data processing and display generation can be assigned easier to two machines which look like one than assigning portions of the job to six different computers although the multicomputer approach is feasible. Any display could access any of the system information. The use of more than one of the 3600's for MOL however would not be justified and even that could be eliminated if the new computers are large.

Station or Bird Buffers

The Station Buffers or Bird Buffers have and would continue to have the following capability:

Executive Control	This program controls the operating sequence and input/output
Command	This program verifies transmission of commands to sites; processes and

	maintains command status; and prints out commands in post-pass.
Prepass	This program maintains an updated file on TM processing tables, command messages, antenna pointing data, scheduling messages, and operator instructions. Upon request, it transmits this data to the site, verifies and records the transmission. It also changes the TM mode on request.
Telemetry Processing	This program accepts TM from the station, performs the data conversion to engineering units, and prepares display or printer messages.
Tracking	This program accepts tracking data from the site, formats the data for display or printout, and sets up the display or print flags; transfers data to the (1604/3600) for updating of ephemerides; detects alarms or status messages and alerts Program Users.
Communications	This program provides the capability of communicating with the 1604/3600 to obtain data from the 1604/3600 for prepass, commands,

and scheduling and sends data to the 1604/3600 for vehicle tracking data.

Input Processing — This program provides the operator interface with the Bird Buffers and uses control cards now and will use at a later time inquiry keyboards to initiate activities, request prepass data, obtain information for display, send data to sites, obtain scheduling data, request and verify commands, send operator instructions to sites, select or modify the TM mode, and other miscellaneous operator functions.

Computing Facility (1604-3600)

The 1604's/3600's are time shared by all satellite program users, with the actual schedule of usage being prepared by the scheduling program and multi-ops personnel. Four main functions are performed:

1. Orbit determination and prediction
2. Ascent and reentry calculations
3. Preparation of vehicle command messages
4. Production of operations schedules for the SCF

Orbit determination and prediction involves the collecting of tracking data from the launch site and tracking stations, and the use of these data to generate ephemerides for the active satellites in the system. The specific operations performed by the Orbit Determination and Prediction programs are:

- Receive raw tracking data from the launch site and tracking stations via the Bird Buffer Subsystem
- Screen and process the raw tracking data to obtain updated orbital elements.
- Print out the raw tracking data for visual analysis
- Use nominal or actual orbital elements to calculate vehicle acquisition rise and set times for SCF tracking stations
- Use nominal or actual orbital elements to generate vehicle ephemerides over designated time periods.
- Provide for data fitting and tracking data prediction over an orbit adjust.
- Maintain the capability to select and combine orbital vectors to obtain updated orbital elements.
- Generate pointing data for driving antennas at tracking stations.

The Ascent and Reentry programs support the critical phases of a satellite's operational life by performing the following operations:

- Process nominal vehicle ascent parameters to provide tracking station antenna pointing data for vehicle ascent.
- Produce a nominal ascent ephemeris.
- Process data from weather balloons to determine wind shear and its effect upon booster performance.
- Reduce ascent tracking data received from tracking stations and determine orbital-injection parameters.
- Provide the capability to establish a nominal orbit with nominal injection conditions.
- Predict the time to start the reentry thrust stage, based upon desired impact location.
- Determine nominal reentry impact location, based upon the time of thrust start.
- Receive, screen, and process raw reentry tracking data to determine the impact point location.
- Provide a reentry ephemeris and antenna pointing data for driving antennas and for use by operations personnel.

The vehicle command messages that are transmitted to the veh cle by the tracking station are assembled and formatted by the Vehicle Command programs. Operations performed by the Vehicle Command programs are:

- Generate Real Time Commands (RTC) and Stored Program Commands (SPC).
- Update command tables based upon transmission and verification of reception by the vehicle.

In general, analog or digital commands are transmitted to satellite systems to perform the following types of functions:

- Set or reset a Fairchild timer and shorten or lengthen timer periods. (The Fairchild timer turns equipment in the satellite on or off at predetermined times.)
- Send Stored Program Commands (SPC's) to turn equipment on or off at the proper time.
- Turn beacons, payload, or telemetry systems on or off with Real Time Commands (RTC's).
- Adjust or calibrate internal systems; initiate special events such as engine ignition, separation, or recovery.

Operating Areas

The STC operating areas presently contain the Main Control, User Program, Multi-Ops, and Data Presentation areas.

The Main Control Area presently has facilities to permit a satellite controller and his assistant to monitor and control a particular satellite in real time. These people are the interface between the users and the SCF operations. Their station equipment includes TV displays which permit them to obtain status data on the vehicle systems, commands, and results of TM processing. Voice communication is provided with the site, the Users and the Data Presentation personnel. In addition, the satellite controller can request that pre-prepared slides be shown on the large screens in the Main Control Room. There are eight screens on which 35 mm slides can be projected so that they are visible to all Main Control Room people.

There are six controller positions in Main control. In addition, a supervisory controller's position is located on a dais behind the controllers and a Program and Test Director is located on a balcony overlooking the Main Control area. The balcony area also accommodates a few VIP's.

Main Control contains approximately 2000 square feet and is laid out similar to the MOCR at the MSC. With computer driven display (as planned) and allocation of functions to controllers by MOL MCC requirements such as Spacecraft systems, Flight Surgeon, Network Control, etc., the room would be similar in capability to an MOCR.

The User Program Areas (six) each contain approximately 1,000 square feet. They are divided into sub areas for data analysis, orbit planning and command generation. Presently these areas have closed circuit TV and printers driven by the 160A through the Computer Select and Cross Connect Unit. Each area is closed off from all of the other Program areas. Voice communications with the controllers and other STC personnel is provided. These rooms could be used as staff support rooms for MOL and would have the equipment required.

The Multi-Ops area which contains approximately 400 square feet has a 160A driven printer, closed circuit TV, and voice communication for scheduling and controlling the SCF in conjunction with the scheduling program. A similar function is required for MOL.

The Data Presentation room contains approximately 1300 square feet. Personnel in this room monitor and direct operations at the site through voice contact; focus TV cameras on 160A printouts, update status forms manually which are picked up by TV cameras; advise the satellite controllers verbally of station performance; initiate and monitor changes in the computer program operation; and perform record keeping functions. These personnel have closed circuit TV displays, a printer, and teletype. They will have the new display when it becomes available. In general they support the satellite controller by preparing material he will need, implementing his requests for action, and assisting in monitoring the over-all operation for each program.

In addition, there are six rooms which contain closed circuit TV and voice communication. These are used by the Test Directors as offices and to monitor their system during non-real-time operation. These rooms vary in size from 200 to 400 square feet. These will also get the new display system when it becomes available.

The SSD baseline document states that the MCR and support areas would require approximately 6,200 square feet of floor space. The STC operating areas contain approximately 11,000 square feet exclusive of communications, computers, maintenance, and other support.

CURRENT SCF EQUIPMENTS

AND COST

PART I. 160A COSTS (MONTHLY LEASE RATES)

TRACKING STATION CONFIGURATION - SINGLE SITE COST

ITEM	NO.	EACH	SITE TOTAL	160A SYSTEM	SUB TOTAL
160A Main Frame	2	2250	4500		
166-2 Printers	2	690	1380		
169-2 Memories (16K)	2	200	4000		
167 Card Readers	2	460	920		
603 Tape Drives	8	550	4400		
161 On-Line Typewriter	2	262	524		
162-3 Data Synchronizer	2	600	1200		
			16924		
4 Single Sites (Each 16,924) 3 Dual Sites (Each 33848)					*169,240

BIRD BUFFER CONFIGURATION - SINGLE

ITEM	NO.	EACH	BB TOTAL	SYSTEM	SUB TOTAL
160A Main Frame	1	2250	2250		
166-2 Printers	4	690	2760		
169-2 Memory (16K)	1	2000	2000		
167 Card Reader	1	460	460		
603 Tape Drives	4	550	2200		
161 On-Line Typewriter	1	262	262		
162-3 Data Synchronizer	1	600	600		
Cost per Single BB			10532		
8 BB and 1 Switch Control Computer (Each 10532)					* 94,788
					**264,028

STC BLACK ROOM CONFIGURATION - 160A USED FOR CLASSIFIED PROJECT	160A SYSTEM	SUB TOTAL
Approx. 8,000		8,000
		**272,028

AF/CPDC TEST BED AT SDC FOR BB/TS PROGRAM CHECKOUT

ITEM	NO	EACH	CPDC TOTAL	
160A Main Frame	3	2250	6750	
166-2 Printers	5	690	3450	
169-2 Memories(16K)	3	2000	6000	
167 Card Readers	1	460	460	
603 Tape Drives	12	550	6600	
161 On-Line Typewriter	3	262	786	
162-3 Data Synchronizer	3	600	1800	
Total SDC/CPDC RTS Installation			25846	*25,846
				**297,874

STC - PERIPHERAL SUPPORT COMPUTERS (2-160A's)
Approximate Figure *13,064
**310,938

AF/CPDC Peripheral support computers (2 - 160A's)
Approximate Figure *14,000
**324,938

PART II. 3600 COSTS (Although Several 1604's are yet in system, they are in process of being phased out and replaced;monthly rentals were approximately same).

ITEM	NO.	TOTAL
3604 Processor & Console	1	13,000
3603 Core Storage	1	10,000
3606 Data Channel (900 ea.)	5	4,500
3623 Mag. Tape Controller	1	2,900
606 Mag. Tape Transport (825 ea.)	8	6,600
3602 Com. Module	1	2,000
3644 Card Punch Controller	1	675
3649 Card Reader Controller	1	325
405 Card Reader	1	400
415 Card Punch	1	295
3659 Line Printer Controller	1	700
501 Line Printer	1	865
3691 P-T Reader Punch	1	310
3681 Data Channel Converter	1	275
3682 Satellite Coupler	1	175
3000/7000 Data Channel adapter (Approx).	1	1,000
7631-2 File Control	1	835
1301-1 Disk File	1	2,100
731 Typewriter(Approx).	1	45
TOTAL SINGLE CONFIGURATION:		47,000
CONFIGURATIONS IN SCF: 5-STC;2-AF/CPDC;1-ASCO		* 376,000
TOTAL SCF MONTHLY CDC LEASE		** *700,938

The following equipment is on lease to SSD for the Satellite Control Facility:

Qty.	Machine	Description	Total Monthly Rental
7	523	Card Punch	$ 745.00
20	026-1	Alpha Printing Punch	$1,350.20
1	010	Card Punch	$ 10.00
2	056-1	Alphabetical Verifier	$ 111.00
8	082-1	Sorter	$ 496.00
4	519-1	Document Orig. Machine	$ 656.00
5	557-1	Alpha Interpreter	$ 898.00
8	407A-1	Accounting Machine	$6,900.00
1	826-2	Card Punch	$ 120.00
1	083	Sorter	$ 119.00
2	066	Data Trans. Print Card	$ 248.00
2	068	Data Trans. Telephone Signal	$ 170.00
5	7631-2	File Control Unit	$4,300.00
5	1301-1	Disk Storage Unit	$10,500.00
1	7360	Special Char. Printing Device Code	$ 10.00

SUBJECT: CDC Computers Purchased by SCF

TO: MOL Project Notebook

In a call January 25, 1966, on Max Kostiner, head of CPDC at SDC, I learned that the CDC computers recently purchased were:

1 - 1604 stored now at SDC

1 - 1604 now installed at the STC

1 - 1604 stored at the STC

Mr. Kostiner felt that these 1604's would go on an Air Force availability list and not be used in the SCF.

R. G. Krause

IBM CONFIDENTIAL

January 31, 1966

TO: Mr. J. J. Selfridge

FROM: W. Derango, G. West

SUBJECT: Trip to Los Gatos and Palo Alto to discuss the SCF Proposal (28 January, 1966).

Our design concepts for the SCF Real-Time Data System were discussed with Dick Crus (ASDD) in Los Gatos. Before joining IBM, Dick worked for LMSC at the Satellite Test Center in Colonel Alton's organization for about four years. He was surprised that the Bird Buffers might be replaced by another system of data buffers and believes, as we do, that the ultimate solution to the STC's computer problems is the integration of Bird Buffer and 3600 functions into a single computer complex. He agreed that we should not attempt to levy extensive requirements on the 3600 computers to support our proposed real-time system, but should instead strive to maintain a "hard" interface with the on-demand processors.

He considered our design concepts reasonable, in light of his experience, but felt there would be a security problem with a multi-processor configuration at the STC. The persons levying requirements for one of the highly-sensitive projects have a reputation for "unreasonableness". Dick did not contribute any new concepts for our proposal, but promised to let us know if he had any subsequent thoughts about the matter.

We next called on Arnold Peckar and John Bridges (FSD) in Palo Alto. We hoped to get an idea of the future processing requirements for the satellite program in which IBM has been engaged. For security reasons they could not discuss the detailed support requirements that are being proposed but they were able to indicate that very little in the way of orbital support (other than payload data collection) would be required for their satellite program. The bulk of the processing workload would be payload data reduction which is not the responsibility of the SCF.

G. West

G. West

GW:jh

Distribution: C.B.Brown,
W.B.Gibson,
J.E.Hamlin,
MOL Group.

MOL STANDARDIZED CALL/TRIP REPORT

Customer/Prospect Name (1) Satellite Test Center (15)

Individual(s) contacted (16) See List Below (59)

Your Name (60) J. J. Selfridge (70) Date (71) February 18, 1966 (76)
SCF Project Manager

Summary of Facts Covered:*

Attendees:

M. Burke, IBM
W. Derango
R. K. Johnson
R. G. Krause
J. J. Selfridge

Lt.Col. Alton, Test Wing
Major Kuhn
Major Mullarz
Major Clearwater
Capt. Wallace
Capt. Leonard
Lt. Grove

Our briefing to the Systems Operations people under Lt.Col. Alton started about 9:30 a.m., continued to 12:30, discussions continued through lunch. The Air Force people had another meeting at 1:00 p.m. We resumed the briefing at 2:00 and continued to 3:30 and then briefly toured the STC.

We had excellent technical constructive criticism from Col. Alton. We had anticipated most all of Col. Alton's questions in our briefing. On a number of points he asked if we had considered something and we were able to say "We will expand on that on a later chart." During the briefing, if we said something which was incorrect, incomplete or difficult to understand, he advised us on the best way to make the point in future briefings. We could not have asked for a better audience. Our approach is correct although it needs improvement in the communication and system diagnostic areas. No exceptions were taken to any of our computer, software, or display subsystem design. Col. Alton did not discuss anything proprietary to the Air Force in the way of plans.

Major points of discussion were as follows:

1. System Control will be at the STC with diagnostic control at the tracking stations. System diagnostic capability must be greatly improved.

2. Communications is a system-wide problem with many facets: rates from TTY to 50 Kb; secure and non-secure semi-fixed, dial and conferencing capability; some communication satellite commitments are already firm.

***If two unrelated subjects were covered, please fill out two forms (i.e., Bio-Med and Checkout).**

3. The implementation schedule will be tight.

4. Data security is a severe problem.

The following points were raised during the briefing and are itemized below:

Remote Sites:

1. SGLS will not go through the TDP-2 but is selected independently.

2. The 670 has been troublesome and some of its functions should be part of the station computer (as per our expanded system approach for two SGLS bit streams with STL). The 670 will be replaced.

3. Col. Hedrick does not want mission control capability at the sites. Diagnostic control at the sites is necessary.

4. We should expand the number of sensor and control status indications brought into the computer through the Data Control Unit, 1827.

5. If SGLS became the only TM link, the sites would need only one computer.

Communications:

1. Sensing of Red switches with same device used to sense Black switches may be considered improper.

2. SCF will have complete encoded voice system with the new data system.

3. Operations people not convinced they can ever do voice switching on a scheduled basis. Nor are they convinced of reasons for doing so.

4. Teletype circuits to the sites as well as other geographic points is a necessity.

5. There will be a wide band (50KC perhaps) link to the launch complex for prelaunch and powered flight.

6. There is also a wide band link to STC for non-real time (i.e., 461 data analysis) which must be considered.

7. Communications system must include a local dial and conferencing system and voice circuits to the sites all of which are not encrypted.

8. Teletype store and forward circuits for internal and external use may be a necessity. They hope they can omit paper tape.

9. Although they believe comm. switching under computer control with scheduled interval switiching is pretty fancy, they see a need for Goddard-type (490) syste. (IBM has been asked informally to improve this).

10. Communication switching should possibly be under control of a separate computer.

11. Conferencing of digitized voice circuits is a severe problem in red switch area. (Philco, in Philadelphia, has demonstrated a system called a HUB controller for conferencing digitized voice.)

12. The MOL program will use a 50 KC COMSAT channel in 1971.

13. They wanted to know our credentials in digitized voice, commercial error detection and correction equipment, EDAC, and line monitoring for quality. They suggested that line problems are transient in nature rather than slowly deteriorating.

14. They suggested we work with Lt.Col. Paul at SSD in the communications area.

Satellite Test Center:

1. They suggested we refer to System Control rather than Operations Control.

2. They suggested we develop a demonstration for the data security problem if we want to convince project people.

3. Computer scheduling of support; i.e., Scrabble, may be scrapped after a year's evaluation. They don't believe they have answer yet. We did not get into our approach to computer-aided scheduling.

4. There is a class of data which requires a separate computer system and a secure link to the 3600's.

5. There is a need for large board display for status information; e.g., the display FSD built for DCA to show communication lines. CRT's will not meet all needs of Multi-Ops.

Programming:

1. Suggested we pitch simulation hard to SSD and Aerospace since it is overlooked by them and may take place of rehearsals and aid in training.

Implementation:

1. Remote Sites will not be easy because of space problem and need to tie into more sensing and status points.

2. Our schedule is optimistic; implementation will start later and end earlier.

3. The present system will not be operating after 1968.

4. There will not be any computers in the present building when the new system is in.

5. The 3600's will remain in the system. The investment in programs is too great to replace them; although by 1968, 60% of the programs will be in JOVIAL.

6. The STC addition will require DOD approval which will impede the schedule, making installation in November 1967 at the STC very optimistic.

Miscellaneous:

1. Col. Hedrick had to report personally to Dr. Flax on the 4M overrun on SGLS.

2. They may allow as much as 90 days for proposal preparation followed by 60 days for evaluation. RFP perhaps two to three months away.

3. The MOL Project will define its own mission control requirements. This may be a way of getting MOL funding for the SCF.

4. They would like some data on programmers' effectiveness using JOVIAL or other higher order languages. They had heard there was a 2 1/2-times improvement in programming efficiency.

5. They wanted to know if the 1827 was actually available.

- more -

6. We have an opportunity to go back and give more detailed briefings on such subjects as communications, security and system control; i.e., scheduling.

7. Col. Alton is willing to spend a day at Houston with us. He suggested that Bob Krause arrange this with Tom Carr of Aerospace.

Followup:

1. Russ Johnson should be provided with data on higher order language for Col. Alton as an opportunity to assess briefing.

2. Teaming or communications should be investigated with W. E., ITT or Philco.

3. Ask Col. Alton for data to improve site diagnostics. (Major Bond refused us this data).

4. Provide Col. Alton's group with information or demonstrations on large boards such as the San Jose development on the Nortronics system we installed at Goddard.

5. Provide Col. Alton with exact data on progress of FAA implementation.

J. J. Selfridge
SCF Project Manager

JJS:jb

cc: Messrs. C. B. Brown
M. Burke
F. E. Chappelear
W. B. Gibson
J. E. Hamlin
R. K. Johnson
J. Klotz
R. G. Krause
G. McClure
MOL Group (one copy)

March 18, 1966

SAN FRANCISCO GEM

MEMORANDUM

TO: Mr. W. B. Gibson
MOL Project
LOS ANGELES AEROSPACE BUILDING

SUBJECT: Your Letter of January 17, 1966

The penetration of the Satellite Test Annex has been successfully initiated. Mr. R. E. (Bob) Curtis, Systems Engineer, has been introduced into the account. The STC accepts his presence, and he has been given a desk. Some initial activities are in process relating to 1301 file application. In addition, I have been making regular calls and have been able to meet a growing number of people in the activity. Col. Alton accepted my suggestion that a briefing of STC operation would be helpful to us. He will give us this briefing as soon as security clearances have been established for us at STC. The lack of security clearances, yet, do inhibit our penetration, but we hope to have them soon.

I have managed to learn the following information on the new building:

1. Start date is targeted for January 1, 1967.

2. Completion date is targeted for February 1, 1968.

3. It will be a four-story building of 40,000 square feet per floor--total 160,000 square feet. Ceiling height is currently planned as 13' including a 3' space under the floor for housing of cabling, etc.

4. Some apprehension exists that the height of the building makes it an overly conspicuous one for Air Force tastes.

5. The building will be devoted almost entirely to technical and computer equipment with little space devoted to other facilities. No space is allocated under present planning for technical representatives, for example.

6. Approximately 300 MOL personnel will be assigned to the new facility.

I have been unable to learn who the contractors are, or will be, for the building. I have not yet been able to learn either the status of LMSL or Philco in the eyes of the AF STC personnel.

Lt. Col. Alton certainly appears to be a key decision maker at the STC because of his very close liaisons and associations with the future plans.

Further information on this subject will be passed on to you as it is learned.

RKJ

R. K. Johnson

RKJ/jag
cc: Mr. Herb Funk

April 5, 1966

MEMORANDUM TO: The File

SUBJECT: Satellite Control Facility

Phone call from Russ Johnson confirmed that Col. Alton is being transferred from the STC in Sunnyvale to be General Hedrick's right-hand man in charge of the ADP Committee. General Hedrick wants Col. Alton to continue to be in charge of all electronic equipment procurement and action. Col. Bond from the SCF, Los Angeles, is being transferred to Sunnyvale to take Col. Alton's place.

Col. Alton commented upon our recent PL 1 presentation to the effect that the JOVIAL language has had some recent revisions which caused substantial improvements. We are attempting to verify this.

WBG

W. B. Gibson

WBG:jb

April 5, 1966

MEMORANDUM TO: The File

SUBJECT: Mellonics

DP Salesman Vince Ziogas, in San Jose, called on Bernie Dove who is an old friend. Bernie volunteered the following information:

1. They have just received an additional $500,000 programming contract for the Satellite Control Facility.

2. He is convinced that Mellonics will get the programming contract for the monitor portion of the upcoming data systems procurement.

3. Mellonics has some programming contracts from Philco but is having difficulty working with Philco well.

4. Dove does not believe that Philco has a chance of winning a major programming systems contract in this area.

By copy of this memo to Bob Krause and Glen McClure, I am asking them to verify what area the recent contract is in.

WBG

W. B. Gibson

WBG:jb

cc: Messrs. R. G. Krause - LA Westchester
G. T. McClure - FSD, LA Aerospace Bldg.

FEDERAL SYSTEMS DIVISION
Los Angeles, California
May 9, 1966

MEMORANDUM FOR RECORD

SUBJECT: AFSCF Proposal Planning Meeting, May 6, 1966

Our marketing data indicates that the RFP will be released during May. Because of this, a meeting to determine an IBM course of action in responding to the AFSCF RFP was held in the Westchester GEM conference room on May 6, 1966.

Attendees:

C. B. Brown, MOL Project

H. G. Hoyt, Westchester GEM
R. G. Krause, Westchester GEM

R. G. Finnegan, FSD Marketing
J. P. Jones, FSD Marketing

R. Harris, Jr., FSC WC Manager

J. E. Hamlin, Advanced Programs
J. V. Klotz, Advanced Programs
J. J. Selfridge, Advanced Programs

R. B. Talmadge, FSD Space Systems

A proposal organization and teaming considerations were presented and discussed. Everyone present generally agreed that the RFP will require a systems response with standard computing equipment, special equipment, engineering services and programming. Thus, FSD should plan to respond for IBM.

The attached organization chart illustrates the responsibilities delineated below.

Mr. J. E. Hamlin, as Proposal Manager, will be responsible for IBM's systems bid, making sure that our response is complete, competitive and timely by using all necessary IBM resources.

Mr. R. G. Krause, SSD and Aerospace DP Account Representative, has customer account responsibility. He will be Proposal Manager for the

DP portion. Since the account is a DP account and since Mr. Krause has IBM responsibility for it, he must concur with all phases of the proposal's development, develop the marketing plans associated with it, and approve the final proposal itself before submission.

Mr. J. V. Klotz, Advanced Programs, will be responsible for the Management Proposal, including the Program Office Organization, Functions, Plan, Personnel and Facilities.

Mr. J. J. Selfridge, Advanced Programs, will be responsible for the Technical Proposal including the system design, equipment configuration, programming, systems engineering, and the detailed project implementation plan. Mr. Selfridge will integrate the efforts of the FSD Engineering Lab and SDD Special Engineering.

As explained by Jon Klotz, FSD intends to bid prime at this time. Outside of present SCF contractors, there does not appear to be any advantage to teaming. An arrangement with one and not the other of the present SCF integrating contractors may not look proper to the USAF. Since only one of the present contractors is interested in teaming with IBM, we plan to go prime deferring final decision until receipt and analysis of the RFP.

Other points covered in the meeting were:

a. The need for a backup equipment configuration for the STC.

b. The need for further technical meetings and agreements between the people concerned with the technical proposal.

Note: In regard to (a) and (b) above, meetings will be held in Poughkeepsie starting on May 10, to develop a backup equipment configuration and to determine the SDD support available for the proposal and contract implementation.

c. MOL Project support to the proposal will be provided through Mr. R. G. Krause.

d. DP will, as a separate course of action, continue to market IBM standard products to other bidders.

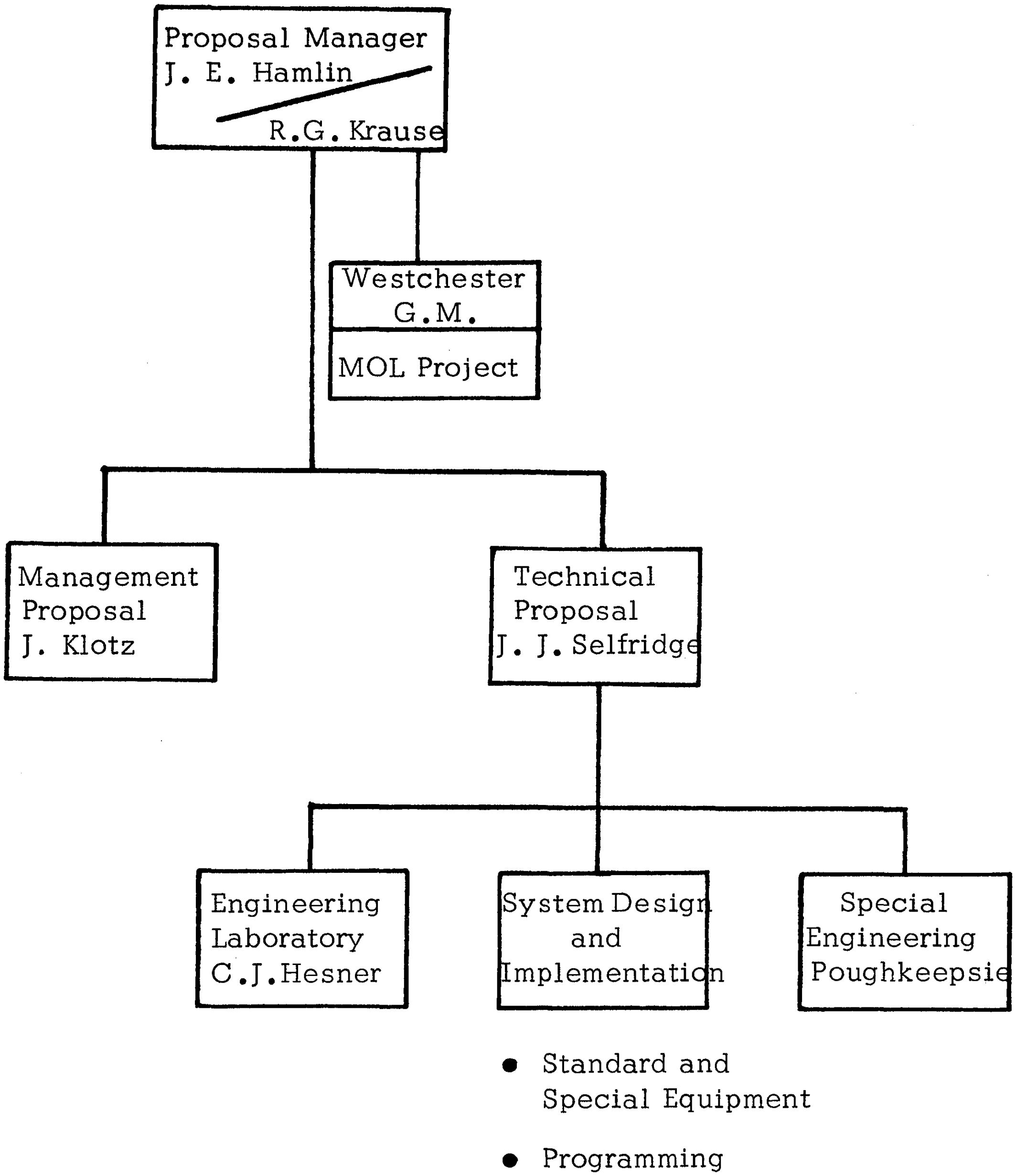
J. J. Selfridge

J. F. Selfridge

JJS/pc

cc: Attendees

F. E. Chappelear	T. Gill
G. B. Gerrish	J. W. Haanstra
W. B. Gibson	C. E. McKittrick, Jr.



ADVANCED DATA SYSTEM

MANAGEMENT ORGANIZATION FOR THE PROPOSAL

MOL STANDARDIZED CALL/TRIP REPORT

Customer/Prospect Name (1) Air Force Satellite Control Facility (15)

Individual(s) contacted (16) Col. H.R. Minckler, SCF Advanced Planning Office (59)

Your Name (60) R.G. Krause, J. Klotz (70) Date (71) 5/16/66 (76)

Summary of Facts Covered:

The purpose of the call was to discuss the SCF posture on lease versus purchase. The subject was very timely inasmuch as Colonel Alton and Colonel Minckler had just returned from Washington where Colonel Alton had been giving his briefings on the upcoming RFP to replace equipments in the SCF. Colonel Minckler met with Colonel Alton frequently while in Washington and made the following comments about the Washington briefing:

> "The problem of lease versus purchase came up again. GAO, which thinks in terms of commercial machines, was trying to fit the SCF into its commercial views. These people do not understand the SCF's R&D role, nor its systems approach. Colonel Alton presented Colonel Hedrick's view that he firmly believed in lease since it allowed him to retain flexibility. Colonel Hedrick would like to move equipment in and out as needed instead of being stuck with purchased equipment."

This is one more substantiation of earlier expressions by Colonel Hedrick on this subject, both in his trip to Poughkeepsie, and in the call Bob Evans made in February. In practically every conversation with Air Force and Aerospace personnel concerning data processing equipment, I have been asked if that item could be leased; therefore, it is absolutely essential that any computer equipment bid to the SCF be made available for lease.

R.G. Krause

R. G. Krause

RGK/lr

cc: Mr. C. B. Brown
Mr. F. E. Chappelear
Mr. W. B. Gibson
Mr. J. E. Hamlin
Mr. H. G. Hoyt
Mr. J. Klotz
Mr. C. E. McKittrick, Jr.
Mr. J. J. Selfridge

MOL STANDARDIZED XXXX/TRIP REPORT

Customer/Prospect Name (1) IBM - Poughkeepsie, N.Y. (15)

Individual(s) contacted (16) SDD Personnel (see below) (59)

Your Name (60) G. West (70) Date (71) May 18, 1966 (76)

Summary of Facts Covered: J. Selfridge, C. B. Brown, R. Talmadge and G. West met with SDD personnel in Poughkeepsie on May 10-11, 1966, to discuss the computer hardware requirements of the SCF project. Joe Terlato, Dave Dossin, Jim DeRose, Chuck Harden, Ron Hurley, and Lloyd Cudney of SDD were present at the meeting.

We reviewed the features of the Model 9020 which led to its tentative selection as the STC buffer computer. We then inquired concerning feasibility and cost of having similar features developed for the Model 44 as a backup STC configuration in the event the rental price for the 9020 cannot be obtained or determine that the STC application requires more compute power. The features needed, listed in order of priority, are as follows:

a. A multi-processor configuration; i.e., shared memories and cross communications between processors;
b. Malfunction detection and configuration control;
c. Stand-alone storage and compute elements.

Joe Terlato indicated that the 2 and 3-processor shared memory configuration of Model 44's is known to be feasible but doubted that a 4-processor configuration would be practical. The primary problem is a lack of space for additional circuit boards in the Model 44. He estimated that the engineering cost to develop 9020-type error detection and reconfiguration capability and stand-alone memories would be on the order of three quarters to one million dollars. This expense does not seem justifiable for the STC application alone. We were not certain that the 3-machine configuration of Model 44's can accommodate the I/O components required for the STC. A second HSMPX channel is needed, and the space usually occupied by that circuitry may be taken up by the shared-memory boards.

We requested clarification of the error detection and fault isolation capabilities of the RTS shared-memory 44's. A list of questions on the Model 44 was compiled to be answered by the engineering people at Hursley. The questions were:

1. Explain the error-checking techniques in the Model 44 processor. What triggers the machine check indicator?
2. Is it possible to have two HSMPX channels and the shared-memory feature by rearranging the circuit boards?
3. Does a four-plex configuration of Model 44's appear feasible?
4. Can anything be done to improve the error detection capability of the machine?

The call to Hursley was not completed while we were there, but Dave Dossin is to provide us the answers.

Joe Terlato promised the full support of SDD in our SCF proposal effort and assigned Dave Dossin to work with us on any problems that might arise.

G. West

GW:jh

cc: C. B. Brown
D. Dossin
R. Hurley
J. J. Selfridge
R. Talmadge
J. Terlato

IBM CONFIDENTIAL

MOL STANDARDIZED ~~CALL~~/TRIP REPORT

Customer/Prospect Name (1) IBM - Atlantic City - FSD (15)

Individual(s) contacted (16) FAA Project Staff (59)

Your Name (60) G. West (70) Date (71) May 18, 1966 (76)

Summary of Facts Covered:

G. West (FSD, Los Angeles) and T. Sawyer (DPD - Westchester Branch) met with FAA project people in Atlantic City concerning the characteristics and status of their real time control program for the Model 9020. The management personnel for the Project were busy dealing with FAA people and we were able to see them for only a few minutes.

Jack Duey gave us a rundown on the plans and status of the control programs, and answered our technical questions. It appears that a good portion of their program design is directly applicable to the SCF control program. However, the FAA computer program itself will by no means satisfy the SCF requirements. The principle differences are the following:

a. The FAA software does not have to run in a secure environment, hence, it has, at best, a rudimentary memory protect scheme.

b. Since data from one flight can be mixed with other data from other flights, all processing routines cycle through their message queues prior to exiting.

c. Data is passed via common "message queues" which are not secure.

d. The sequence control portion of the SCF control program should be compatible with the Model 44, while the FAA monitor need operate only on the Model 9020.

e. Some of the I/O components in the SCF differ from the FAA configuration. The FAA program has no capability for handling disks or 2250 displays. However, this display code could be used with minor modification.

The FAA control program (excluding OEAP) will have about 12k words of code, and it appears that the direct labor cost will be 9-12 man years. Hank Warren discussed the I/O portion of the control program with us.

Some design documentation has been produced, and we desire to have copies of the existing documentation and to be placed on the distribution list for future documents concerning the control program. Art Geiger recommended that we make a written request for this material.

G. West

T. Sawyer

GWTS:jh
cc: C. B. Brown, E. Chappelear,
W. B. Gibson, J. J. Selfridge

GEM Region
Air Force Programs
Washington, D. C.

June 1, 1966

MEMORANDUM

TO: Mr. W. B. Gibson
LA Aerospace

SUBJECT: SCF Advanced Data System

We learned this week in calls at USAF R&D that financial considerations continue to be a major concern in this procurement. The RFP will not be released until funding is resolved, probably after the first of July. According to R&D, the announcement of the procurement in Commerce Business Daily was premature and SSD has been so advised.

As mentioned in my memo dated May 26, initial operating capability of ADS is planned for January 1969. The competitive RFP will address only the Bird Buffers and Remote Tracking Computers, however, and the 3600's may be replaced sole-source with 3800's. An operational date of January 1969 makes it feasible to consider purchase of the installed 160A's. As a result, the 160A's are on the Air Force "Buy List" and will be bought as soon as purchase funds are available.

R. P. Bruns

RPB:mr

cc: Mr. J. W. Richardson, Local
Mr. H. G. Hoyt, LA GEM
Mr. R. C. Strang, FSD

TO: R. G. Krause

SUBJECT: Status Report of SCF Simulation as of July 20, 1966

The simulation of the proposed 9020 System for the Satellite Tracking Center using 7094 GPSS III has reached a point where some progress can be reported. The model for simulating the 9020 System assumes the following:

1. a configuration of 4 CE's, 4 IOCE's each with multiplexor and 3 selector channels and 8 memory boxes of 262K bytes each.

2. that there will be 10 tracking sites communicating with the STC via dual 2400 baud lines.

3. 14 missions will be supported simultaneously.

4. 3 2314 disk file units which will communicate between the 3600's and the 9020 System.

The model presently simulates the following:

1. message traffic from the tracking sites via 2400 baud lines.

2. 100 wpm teletype message traffic into the system.

3. attention interrupts from the 14 mission control rooms from the 2250's.

4. updating of displays and 2311 disk files in the system control area and mission control rooms as a result of 1, 2, and 3.

5. updating of 2314 disk files as a result of 1, 2, and 3.

6. updating of 2311's in mission control rooms as a result of 1, 2, and 3.

The results of this data can be summarized as follows:

1. utilization of core and CE's is low (1-14%).

2. utilization of 2314 is about 30%.

3. queues as defined in the model practically do not exist with the exception of those waiting for updating of 2260's in system control area--these still are not large, max. length of 4

4. additional modification and additions to the model will include simulating the following:

   a. inputs from the 3600's via the 2314
   b. generation of attention interrupts via the 2250's in the system control area
   c. message transmission to the 10 tracking sites via the 2400 baud lines
   d. 100 wpm teletype message output
   e. make further verification to see model simulates real world.

The conclusion that can be drawn from what has been learned up to the present date is that the simulated 9020 System, as indicated above, has not come close to becoming saturated.

K. I. Friedman

KIF:jle
cc: F. E. Chappelear
J. J. Selfridge
W. B. Gibson
C. B. Brown
T. H. Sawyer

CUSTOMER NAME:	Satellite Control Facility Remote Sites Space Systems Division, AFSC Inglewood, California
REGION:	GEM
DISTRICT:	Western
BRANCH:	Los Angeles Westchester
BRANCH MANAGER:	Skip Hoyt
ACCOUNT MANAGER:	Ed Chappelear
DP SALESMAN:	Bob Fairbanks Bob Krause Bob Oller
FSD REPRESENTATIVE:	Johnny Jones Jim Selfridge Glen McClure

Engineering
Col. Weaver*

Air Force

Maj. Buswell - Proj. Engr.
Lt.Col. Birks - Comm.
Lt.Col. Lutz - Comm.
Lt.Col. Sauer - Development
Lt.Col. Rolin - Recovery
Lt. Col. Frobom - Support Engr.
Lt.Col. Redpath - Digital Systems
*Maj. Bond - Digital Systems

Aerospace

*Vick White - Digital
E. Ragland - "
J. Hansen - "
R. Brandsberg - "
D. Stevenson - RF & Analog
W. Tackett - "
U. Nolte - "

Retzlaff
R. Berri
H. Tye
H. Farmer
F. Sinnott

Test Operation
Col. Hughes

Air Force

Col. Baum - Planning
Col. Fox - Control
Lt.Col. Alton - Control
Lt.Col. Cummins - Readiness

Aerospace

R. Colander - Requirements
E. Spalginter - "
T. Hedene - "
R. Scott - "
W. Arndt - "

6595th Aerospace Test Wing
Col. Newton

Air Force

Maj. Hartrin
Lt. Smith

Aerospace

Jack Morris
Bob Falconer

B. 2 EQUIPMENT INSTALLED AND SYSTEM DESIGN

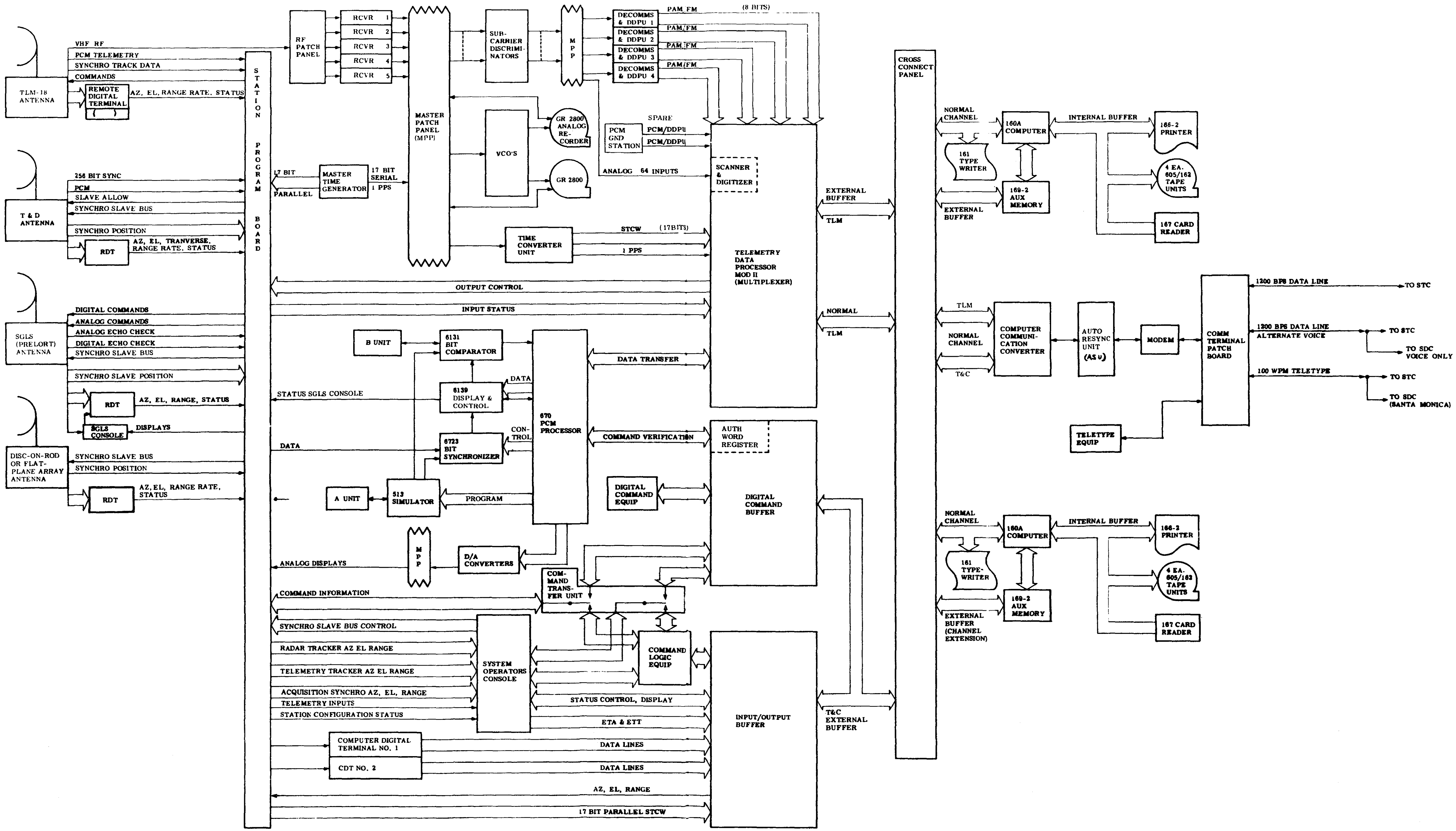
CURRENT SCF EQUIPMENT AND COST

160 A COSTS (MONTHLY LEASE RATES)

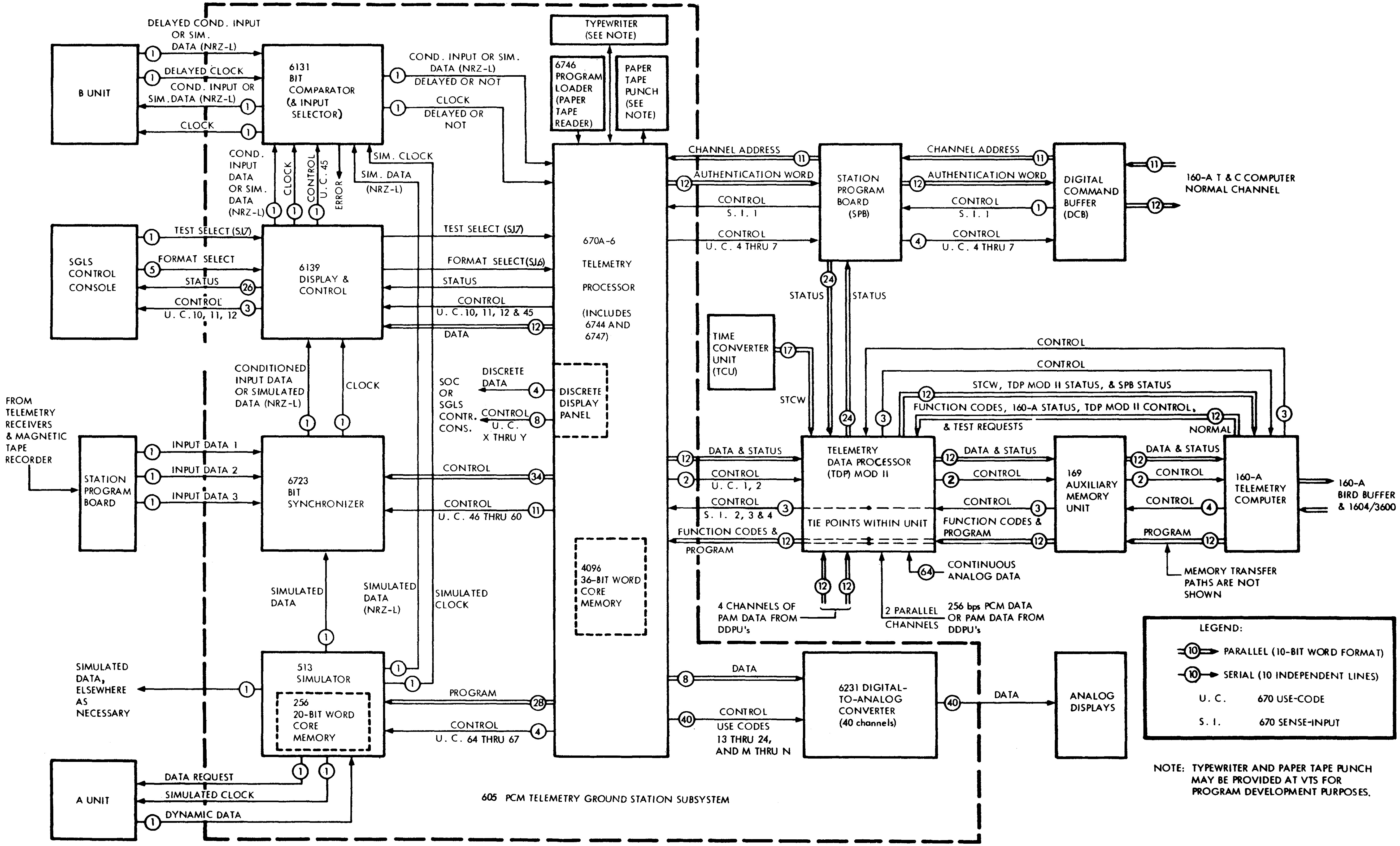
TRACKING STATION CONFIGURATION - SINGLE SITE COST

ITEM	NO.	EACH	SITE TOTAL	160 A SYSTEM	SUB TOTAL
160 Main Frame	2	2250	4500		
166-2 Printers	2	690	1380		
169-2 Memories (16K)	2	200	4000		
167 Card Readers	2	460	920		
603 Tape Drives	8	550	4400		
161 On-Line Typewr.	2	262	524		
162-3 Data Synchron.	2	600	1200		
			16924		

4 Single Sites (Each 16,924) 3 Dual Sites (Each 33,848) *169,240



Attachment 1. **Remote Station Equipment Configuration**



Attachment 2. **PCM Telemetry Ground Station Subsystem and Interface Units**

PRELIMINARY

BRIEF OF EXPECTED RFP FROM AF SSD FOR REMOTE TRACKING STATIONS

PART I. HARDWARE CHARACTERISTICS AND REQUIREMENTS

The Remote Tracking Stations (RTS) of the Air Force Satellite Control Facility (SCF) are believed to require upgrading to meet new and expanded requirements for tracking, commanding and telemetry. An RFP is expected from AFSSD which will delineate improvements which are required in the digital handling subsystem. The digital data handling system includes computer equipment, associated peripheral equipment, real time input-output channels and software. Specifically, the existing subsystem expected to be replaced includes the presently installed CDC 160A computer real time I/O peripheral devices and software. In addition, bidders will be expected to submit alternate proposals which include incorporation of functions now performed by the existing Input/Output Buffer (IOB) and the Computer Communications Converter. This would enable the computer channels to interface with the Command Logic Equipment(CLE), the DigitalCommand Buffer (DCB), the Station Operators Console(SOC), Timing Data Generator(TDG), Computer Data Terminals (CDT), Antenna Servo Control Registers, the KG-13 and teletype(TTY).

Alternate proposals are believed acceptable especially in computer real time channels and control equipments. Alternate(s) proposals should, if possible incorporate: Display consoles of the computer driven CRT type which permit the station operator to monitor and modify station operation through access to programs, data base or live data from storage and to enter data into the computer through a keyboard; the functions of the Telemetry Data Processor Mod. II(TDP-2)if the functions it performs can be performed economically in computer and/or channel equipment; Digitizing of analog telemetry data, and decommotation of PAM, FM/FM and PCM now performed by TM ground stations in the RTS may also be considered for inclusion in the proposal if overall station performance can be improved, leads to greater standardization and is economically feasible (in any case the computer equipment proposed should have the basic capability to integrate these functions at a later time.

I/O equipment now interfacing with the present computer is formatted into 12 bit words. Some of these equipments have been designed to be expandable to larger word sizes. The current equipment configuration is shown in attachment 1 and 2 . The proposed system should optimize the interface word length to increase speed and minimize interruptions.

The use of CRT displays will, in effect, cause certain of the functions now performed by the SOC or CLE to be redundant. Alternate proposals should clearly delineate portions of the SOC, DCB or CLE which may be eliminated.

The proposed systems should provide a multiprocessing capability, i. e. all processing units should have access to all preliminary storage so that programs, tables, and data are available to all processors. The multiprocessing approach selected should provide a fail-soft capability without the need for complete redudancy of computer elements.

REMOTE TRACKING STATIONS I/O SOURCES

Input/Output at the Remote Tracking Stations consist of telemetry inputs from the Telemetry Data Processor Mod. II; inputs from and outputs to the Station Operators Console; inputs from and outputs to the STC at Sunnyvale (CCC); inputs from and outputs to the Digital Command Buffer; and a variety of control signals and data to and from other station equipment. The data channels required and data rates - assuming 16 bit in/out channels - are as follows:

Equipment		Channels	Rate
Telemetry		1 (Note: the TDP-2 may be modified to output words greater in length than 12 bits).	80 KC, 12 bit words per sec.
SOC	In	(4) individual control bits	less than 1/sec.
		(2) 4 decimal digit numbers	less than 1/sec.
		(1) 2 decimal digit numbers	less than 1/sec.
	Out	(26) individual condition bits	less than 1/sec.
		(4) 5 decimal numbers	less than 1/sec.
Command Equipment	In	(22) individual condition bits	less than 1/sec.
		(5) 2 decimal digit numbers	less than 1/sec.
		(4) 6 bit quantities	less than 1/sec.
		(1) 5 bit quantity	less than 1/sec.
	Out	(3) 12 bits	2500 wps max.
		(4) 2 decimal digit numbers	less than 1/sec.
		(1) 4 bits	1/sec.
Site/STC Communications	In	1	100 12 bit words/sec with parity check
	Out	1	100 12 bit words/sec with parity generatio
TTY	In	1	60 wpm
	Out	1	60 wpm

Timing	In	(17 bits)	1/sec.
		(20 bits)	1/sec.
		(10 bits)	less than 1/sec.
		(Note: 10 bit input is presently from I/O typewriter)	
Antenna	In	2	12 bits, 10/.sec.
(RAE)	Out	3	12 bits, 20/sec.
Status	In	24 (Individual bits)	less than 1/sec.
Switching	In	18 (Individual bits)	less than 1/sec.
		1 (2 bit indication)	less than 1/sec.

TELEMETRY DATA PROCESSOR MOD. II.

The TDP - Mod. II is a buffering and multiplexing device capable of handling: (4) digitized PAM FM/FM inputs at 900, 12 bit, words per second; (1) continuous analog data PAM or FM/FM at 40,000 samples per second for which the TDP-II also performs scanning and digit izing; (2) low speed, 256 bits per second, VE LA-PCM data stream; (3) medium to high speed PCM parallel inputs, typical speeds are 10,000 and 83,000, 12 bit words/second. The TDP-II outputs 12 bit words, status or data to the telemetry computer. Each word contains source identification (1 to 8 sources) in addition to Sync. identification. status or data bits.

The TDP-II also provides the System Time Code Word to the telemetry processor on a separate output channel.

The maximum data rate from the TDP-II is encountered from high speed PCM at one megabit. One input word would be required at each frame and subframe indication. Outputs to the TDP-II is one 12 bit word to select one of eight TDP-II channels or input words (data or status).

STATION OPERATORS CONSOLE

Inputs from the SOC are used to inhibit STC Communications, select the Command Mode, computer or manual, to start and stop manual commanding, to set the command reject level, and to enter and verify the number of the current and next vehicle to be commanded. Each vehicle number requires 4 decimal digits. Command reject level requires 2 decimal digits.

One bit outputs to the SOC are as follows:

Computer verified
Acquisition program in process
Acquisition program ready
TM antenna manual
TM antenna search
TM antenna slaved
Automatic Tracking
Radar manual
Radar search
Radar slaved
Locked-on
Command equipment not ready
Command equipment ready
Timing ready
Timing not ready
TM ready
TM not ready
Radar tracker ready
Radar tracker not ready.

Command computer ready
Command computer not ready
Radar tracker digital
Radar tracker analog
Computer Auto Commanding ready
Computer Auto Commanding in progress
Computer Automatic Commanding Completed

Outputs to the SOC also include 5 decimal digits for each of the following indicators:

Estimated Time of Arrival (ETA) Current Vehicle
Estimated Time to Track (ETT) Current Vehicle
Estimated Time of Ar rival (E A) Next Vehicle
Estimated Time to Track (ETT) Next Vehicle

Each input or output to the SOC normally occurs at speeds greater than once per second and are negligible in any I/O timing or interference calculations.

COMMAND EQUIPMENT

The command equipment is presently known as the Command Logic Equipment and will be replaced by the Digital Command Buffer. Inputs from the Command Logic Equipment are as follows:

One bit inputs
Command Transmit Request
Analog Manual
Remote Enable
Computer Automatic
Master Control & Display Unit
Computer Command Advance
Reject Count Clear
Accept Verifications
Reject Verifications
Digital Manual
Single Command

Analog Long
Repetitive
Repetitive Stop
Computer Automatic Stop
Error Override
Manual Verify
Spoof Reset
Command Verify
Analog Command Error
Verification Accept
Verification Reject

Eight bits or two decimal digit inputs
Command Number Select
Repetitive Number Select
Reject Level Select
Vehicle Verification
Transmission Count

Six bits inputs are
Master Control & Display Unit Command Number
Master Control & Display Unit Command Data
Analog Command Verification
Analog Echo Check

Five bit inputs are
Echo Check

Outputs to the Command Equipment are as follows:

One bit outputs in three words
"V" command bit
"O" command bit
"I" command bit
End of Word
Storage reset - 2 commands, 1 ms and 50 ms.
Command error
Spook
Complete block
Analog verification error
Improper command
Verification not received
Command reject
Command accept

Reject level reached
Analog select
Digital select

Eight bits or 2 decimal digit outputs are:

Analog command number
Improper command number
Reject count
Repetitive count number

Four bit outputs are:
Pulse width

Inputs from the command equipment are mostly manual with the except of command verification.

Outputs to the command equipment in the present system could occur at a maximum reate of 2,500 words per second, i.e., a 99 word table output at a 25 per second rate.

DIGITAL COMMAND BUFFER (DCB)

The DCB will replace the CLE and the command functions of the IOB in the ICS (Integrated Command System) and it will provide the ICS with considerably more command and verification capability than that provided by the CLE. It will comprise Command Buffer logic, Authentication Buffer logic, and Command Selection Logic.

(a) Command Buffer Logic

This section of the DCB will comprise the logic required to interface the computer (through the CCP) with the SOC and the SPB. Computer outputs and inputs will be formatted and routed to and from proper destinations by means of function code logic similar to that employed in the IOB. Command bits will be formatted and transferred by means of logic similar to that employed in the CLE.

(b) Authentication Buffer Logic

This section of the DCB will comprise the logic required to interface the computer with the Model 670 Telemetry Processor. By means of this logic, the computer will provide the 670 with addresses to enable the 670 to decommutate the proper verification and authentication channels. The logic will also provide means for transferring verification and authentication data from the 670 to the computer.

(c) Command Selector Logic

This section of the DCB will provide the logic required to select command sources, command transmission configurations, command transmission bit rates, verification sources, and the DCE. It will also provide echo check logic, loop-test logic, and simulated verification signals for checkout of the ICS.

DIGITAL ENCODER EQUIPMENT (DCE)

The DCE is a new equipment which will operate only when the DCB is the selected command source. The DCE will accept the formatted digital command bit stream from the DCB, modify it, and forward it to the command transmitter. When the DCE is in use, echo check signals will be obtained from the input to the DCE rather than from the output of the command transmitter.

NOTE: The 670 stored-program telemetry data processor decommutates command verification and authentication data and provides it to the computer through the DCB.

STATION OPERATORS CONSOLE (SOC)

A new SOC command panel complex will be used with SGLS and the DCB. The new panel complex will not affect commanding operations when the CTU is in the CLE mode, except possibly to add additional capability. The new command panel complex will comprise a Primary Panel, an Analog Command Panel, a Stepper Switch Command Panel, a Command Status Panel, and SOC Status Displays.

(a) The Primary Command Panel will provide the following capabilities:

(1) Selection and display of a four-digit command number.

(2) Selection and display of a two-digit repetitive number.

(3) Selection of a one-digit reject level.

(4) Display of a one-digit reject count.

(5) Display of a three-digit transmission count.

(6) Selection and display of one of four command sources.

(7) Selection and display of one of up to twelve command modes.

(8) Selection and display of one of eleven command transmission configurations.

(9) Selectionand display of computer control of command transmission configuration.

(10) Selection and display of one of eleven command transmission bit rates.

(11) Selection and display of computer control of command transmitter.

(12) Selection and display of one of four verification and control modes.

(13) Selection and display of the DCE, and display of computer selection of the DCE.

(14) Selection of a Transmit Signal and display of Transmission in Progress.

(15) Display of Improper Command.

(16) Selection of Restricted Command Enable and display of Restricted Command.

(17) Display of Transmission Alarm and selection of Transmission Alarm Reset.

(18) Display of Verification Alarm and selection of Verification Alarm Reset.

(19) Display of Spoof Alarm and selection of Spoof Alarm Reset.

(20) Display of Reject Level Alarm and Selection of Reject Level Alarm Reset.

(21) Display of Verification Accept, Verification Reject, Verification Not Received, and Verification Error.

(22) Selection of Computer Command Advance.

(23) Display of Authentication Error.

(24) Selection of Repetitive Stop and display of Repetitive Stopped.

(25) Selection of Computer Auto Stop and display of Computer Auto Stopped.

(26) Display of DCE Alarm and selection of DCE Alarm and selection of DCE Alarm Reset.

(d) The Command Status Panel will provide the following displays:

(1) Computer Cmd Ready, In Progress, and Complete.

(2) DDE Ready, In Progress, and Complete.

(3) VHF Command Subsystem MSAP or ZZZ Control.

(4) Prelort Encoder Analog or Digital Mode.

(5) Display of Decommutator numbers 1, 2, 3 and 4 Sync & Out of Sync.

(6) PCM Decommutator numbers 1 and 2 Sync and Out of Sync.

(7) UHF Command Subsystem Status.

(e) The SOC Status displays will provide Ready, Not Ready, and Configuration indications for the following equipments:

(1) VHF Command Transmission Subsystem.

(2) UHF Command Transmission Subsystem.

(3) Command Antenna Complex.

(4) DEC.

(5) DCB.

(6) SGLS.

COMMUNICATIONS TO AND FROM THE STC

Site/STC communications are handled by 1,200 bps phone lines and teletype. The phone lines are connected to the data processing system via modems and encryption equipment. Inputs to and outputs from the encryption equipment in the present system is performed by a Computer Communications Converter (CCC). The CCC performs serial to parallel and parity checking on input data. Parallel to serial and parity generation are performed on output words. Additionally the CCC, in the present system, selects the proper computer for data input and alternates between computers after each transmit and receive operation. The CCC provides status of itself and the auto-sync (ASU) equipment (associated with the encryption) and accepts control commands for itself and the auto sync. equipment.

Data is transferred at a 1200 bps rate over two half-duplex lines; i.e., the CCC can receive on one line and transmit over the other simultaneously.

Teletype at 60 wpm can be received and transmitted at each site. TTY for the computer is not presently entered automatically. It must be manually entered/ output via a paper tape reader/punch.

OTHER CONTROL SIGNALS AND DATA

Timing:

The System Time Code Word (STCW) is input to each computer once each second from the Timing Data Generator. The SYCW is 17 bits in length.

The Vehicle Time Code Word (VTCW) is input to the computer once each second from the VTCW Interpolator. The VTCW is 20 bits in length. An additional 10 bits are used and provided through the computer typewriter to indicate VTCW offset from the STCW. The offset is used to indicate differences in actual and predicted time associated with tracking data.

RADAR AND TELEMETRY ANTENNA DATA

R, A, E Range Rate and Status from the Radar and TM antennas are input to the computer as 12 bit words. These data could occur as 24 bit words. Each antenna is read once per second for a total of 120 bps for each antenna.

Outputs to the R, A, E acquisition servos are three separate output words. One word from each of three output channels to each acquisition servo. These occur at the rate of 20 wps.

EQUIPMENT STATUS AND SWITCHING

Status of the station; equipment; i.e., ready, search, in progress, etc., as indicated at the Station Patch Board, SPB, is input to the computer. One bit inputs are as follows:

TM Auto tracking
TM slaved
TM search
TM manual
TM tracker ready
MCDU ready
MCDU complete
Remote Command equipment ready
Remote Commanding in progress
Remote Commanding completed
Radar tracker 1 on
Radar tracker 2 on
TM tracker 3 on
FM/FM 1 on
FM/FM 2 on
PAM Ground Station 1 on
PAM Ground Station 2 on
Decom 1 Sync Out
Decom 2 Sync Out
FM/FM ready
TDP ready
PAM Ground Station ready

The switching status of station equipment as indicated at the Cross Connect Panel is also input to the computer.

One bit indications are as follows:

TLM Inhibit
T & C Inhibit
CCC 1A TM
CCC 1B TM
CCC 2A TM
CCC 2B TM
CCC 1A T & C
CCC 1B TM
CCC 2A TM
CCC 2B TM
CCC 1A T & C
CCC 1B T & C

CCC 2A T & C
CCC 2B T & C
T & C Computer 1, 2, 3 and 4
TM Computer 1, 2, 3 and 4
Command Equipment
CCC ready
TLM Fade
T & C Fade

Two bit indications are as follows:

TDP-1

The above status and switching data would not be likely to occur at a rate exceeding once per second. More likely it would be ready by the computer once per pass.

PERIPHERAL EQUIPMENT

Auxiliary storage is required at the RTS for program storage, data logging, and other functions. This storage may be tape or disk. Disk is preferred to avoid errors which may arise in station setup and operation due to mishandling of tapes by operators.

Card reading and punching equipment is required to enter program changes and would not normally be performed as part of the real time operation.

Hard copy output printout is required at the station in advance of a PASS operation to provide operating instructions as received from the Satellite Test

Center, to provide a printed record of events, and to assist in program or equipment maintenance. This information could possibly be desired via CRT displays at the SOC console. Real time display of data may also be desired at the SOC Console.

PRELIMINARY
BRIEF OF EXPECTED RFP FROM AFSSD FOR
REMOTE TRACKING STATIONS

PART II SOFTWARE CHARACTERISTICS AND REQUIREMENTS

OPERATING SYSTEM DESIREMENTS

The programming and operating system will be integrated for the new RTS Data System. It will include an Executive Monitor, assembled library routines, input/output control program for all peripherals, a JOVIAL Compiler, an assembler and a loader. All RTS programs must operate under control of the Executive Monitor.

- Executive Monitor Characteristics

  The EM will control operations on both CPU's and will permit easy transition between RTS modes of operation by previously scheduled information or by manual operator intervention. An example of this transition would be entering an STC-scheduled Satellite PASS operation during the printing of non real-time data in a POSTPASS mode. Information on interrupted in-process jobs should be saved so that processing may be completed at a later time. Additional characteristics of the EM should guarantee the following:

a) Standard communications between the CPU's and any operator-user.

b) Real-time access to the RTS library programs to take full advantage of written, tested code.

c) I/O assignment tables with automatic handling of hardware locations and flags associated with traps, interrupts and special registers.

d) Standard linkage from object programs and system programs to commonly used subroutines within the EM.

e) Task assignment to available processors in prioritized order using a multi-processing philosophy.

f) provision of a job execution status report upon request.

g) Standard job accounting and record keeping routines for RTS operations.

o Multiprocessor Philosophy Characteristics

A multiplicity of program execution is scheduled by the EM which also controls the time sharing of I/O, memory, and processors. This should be accomplished by use of a job table specifying a list of current programs and their status, and a memory map specifying available, in use, or unavailable (locked) areas. The EM will also maintain tables containing file information and concomitantly control usage of each I/O device. Accordingly, a single program should be able to be executed truly simultaneously by the two processors referencing different sets of data. Generally, the EM must insure the programmer the ability to believe that he is using a single conventional computer, yet never let a piece of the total system remain idle.

- System Program Sample Design

The design of the total set of RTS system programs will not be designed in detail, but a sample design outline of important components will be contained in the RFP to illustrate and restate design objectives.

1) assembler -EM interplay

Assume a program has been read into memory for execution. Specified program points should enable program segments to operate in parallel. When these points are reached, the EM is entered. The action of the EM at these entrance points depends on the type of executive call made. Many entrances will be required; declaring parallel program segments will be different from declaring the end of a segment. Entrances will also be required for timing, loop control, job delineating statements, etc.

Job definition and segment flagging should be possible by means other than a transfer instruction to a symbolic entrance name. This means should be as close to a natural language expression as possible with no need for artificial symbology. The assembler or compiler must be able to accept the imperative statements of the programmer which direct the EM to a course of action and translate these statements into entrance instructions for the EM. In addition, the assember must construct all other entrance parameters and a job table.

2) Job Table - a complete set of job tables should be loaded by the EM to guarantee that the monitor has knowledge of all possible parallel processing at that moment.

3) More considerations of system design

- Debugging on simulation tools must be available, as well as the ability to run the program totally on one CPU.

- the compiler should not demand that the task to be performed is done on multiple processors.

- prioritization scheduled tasks should be able to be changed in real-time. New tasks should be able to be defined at any time.

- It should be possible to resolve memory conflicts when CPU's are attempting to get to the same memory module.

CENTRAL I/O CONTROL PROGRAM

Input and output to the CPU's will be controlled by a Central I/O control program (IOC) which is, of course, controlled by the EM. The IOC will:

a) Control the reading/writing of records

b) Provide for overlapped I/O reading, writing and computing

c) Perform automatic blocking and deblocking of disc file records

d) Check reading and writing errors and correct program corrigible errors. Error analysis should be attempted in all cases.

e) Provide sequential and random processing of data on the disc file.

f) Schedule the use of disc file arms including automatic handling of arm failure.

g) Alter I/O unit assignments if necessary at execution time by means of manual intervention.

h) Insure that RTS disk packs are properly formatted and contain standard labels. Labels should be written upon output and read on input.

i) Check/Process end-of-data file conditions

j) Write recovery-flags to facilitate restart recovery.

The IOC will provide for standard operator program communications. It must be accessed operationally by on system program by means of appropriate assembler/compiler MACROs. No program should be able to initiate I/O directly without the use of these MACRO's. Execution of MACRO-constructed instructions will necessitate entry to the Executive, and the Executive will control and monitor the IOC.

The computer console will be considered an I/O piece of gear, and accordingly will function under control of the IOC.

STORAGE PROTECTION

A storage protection feature shall be provided to preserve a program if another erroneously attempts to store over it, whether the storage medium is core or disc. Storage operations either from a CPU or Channel will be subject to this feature.

Programs should be self-checking, with program or machine error producing a unique interrupt condition so that the cause of the error may be easily ascertained.

Software must automatically initiate corective action to the fullest possible extent.

Examples of necessary and desirable interrupt conditions are as follows:

A. Internal (Processor Generated) Interrupts

1) Illegal instruction executed
2) Halt instruction executed
3) Arithmetic overflow
4) Real-time clock overflow
5) Attempt to write out of bounds
6) Parity error from memory
7) Interrupt a computer
8) Initiate I/O
9) Store interrupt mask register

10) Store memory bounds registers

11) Executive call

B. External Interrupts:

1) Interrupt from the other processor

2) Failure of an I/O device to respond when interrogated

3) Primary power (which had failed) is now restored

4) An I/O operation is completed

Checkout of New Programs

The operating system should provide for facilitating the checkout of new programs. Simple procedure for loading new programs with test environment and operating it must be provided. Test tools (such as console snaps, memory dumps, tape dumps, trace, etc.) should be available.

The EM will control and monitor the operation of all programs - including programs being debugged and associated test tools.

Automatic Graceful Degradation

The principal aim of the RTS multiprocessor is to guarantee support activities with just one processor functioning. This requirement must specifically guarantee that:

a) I/O activities can be initiated on any channel from any CPU.

b) The EM is not to be permanently associated with either of the CPU's, nor does it require the complete attention of a whole CPU.

c) CPU's must respond to all types of interrupts, including I/O interrupts. To avoid duplicate handling of I/O interrupts, one CPU could be designated to receive such interrupts at any one time.

d) Programs must be capable to operate correctly on either CPU, or if both are available. If a system component fails during task execution, the EM must be able to sense the condition, reassign I/O units, and continue operations. If necessary, it should be able to take steps to service tasks in a degraded mode.

In particular, if one CPU fails, the EM must reassign its current task to the other CPU. Possible methods for notifying one CPU that the other has malfunctioned might be:

1. A unique interrupt signal is generated, by a malfunction which interrupts the other CPU.

2. The malfunction makes a status register - addressable by the other CPU and tested each time the EM is operated therein - to change state.

NOTE: In either case, the EM when operated by the still-functioning CPU should take note, institute recovery action, and output appropriate alarm messages.

As mentioned earlier, both CPU's must be able to receive and act on I/O interruptions, but only one CPU is so designated at any one time. When the EM schedules tasks to a CPU, or attempts to find tasks and fails, it determines which CPU has the lowest priority activity and selects that one to receive I/O interruptions, until the next task assignment is considered. If a malfunction occurs in the designated CPU, the EM should automatically switch I/O interrupts to the operable CPU.

If component failure is so serious that full operation cannot continue, the Executive must decide which functions to perform and delete. It is conceivable that the type of failure would determine which tasks would be performed; however, in general, selecting the tasks to be retained would be done: 1) on the basis of the predetermined priority associated with each task, or, 2) by shifting some of the tasks normally performed at the RTS to the STC, or, 3) by a combination of 1) and 2).

Job Accounting

Standard job-accounting and record-keeping programs will be provided. The Executive will account for elapsed time on each CPU and on each I/O device according to program (Satellite Project) office. The job accounting code will be provided at the same time as the job request is made. During vehicle-related activity, the vehicle number may serve to correlate to the appropriate accounting code. Start, stop, and elapsed time figures for each job, and related statistics, will be displayed or sent over the 2400 bps lines upon request.

PROCESSING PROGRAM REQUIREMENTS

- TLM Program Characteristics

  Telemetry programs should be able to accomplish the following:

  1) Input data from up to eight sources
  2) Demultiplex data
  3) Establish synchronization
  4) Compress and proces s data
     a) Normalization
     b) Compression algorithms (flexibility, several algorithms operated on same point)

c) Ability to group individual TLM points

d) correlation of telemetered events with transmitted command

e) Time-tagging of data

5) Data display at SOC

6) Data transmission to STC

7) Digital recording of TLM data (excluding one megabit PCM)

8) STC Control of TM processing

• Tracking and Commanding Program Characteristics

1) Calculation of pointing data from minimum parameters

2) Input and processing of tracking data

3) Output of pointing data

4) Data transmission to STC

5) Data display at SOC (TRK and CMD)

6) Digital recording of TRK data

7) STC control of report rates and antennas

8) STC control of commanding

9) CMD data transmission to STC

10) Command rates of up to 10 KC

11) Extensive echo checking and CMD verification

12) Ability to make command mode changes

13) SOC control of site computers

14) Digital recording of CMD data

NOTE: Software RFP may request that Diagnostic and Utility programs be integrated with the operational system.

REMOTE TRACKING STATIONS - SATELLITE CONTROL FACILITY

The proposal IBM submitted in Jult of 1964 to the Air Force Space Systems Division and Aerospace Corporation recommended a two machine configuration of System 360 Model 40 operating in the multiprocessing mode to provide load sharing and a fail-soft capability. This proposal was unsolici ted and it was intended that System 360 would replace two CDC 160A's each operating independently. The 160A systems at each remote station, of which there are 10 stations, are leased at an approximate rental of $16,900 a month. With shared memory and two Data Communication Channels (29XX) our Model 40 system rented for approximately $24,490 a month.

Since July, 1964, IBM has announced the Model 44 and the 1800. The customer has been continuously supplied with information on these equipments. This has led to them being conditioned toward a Model 44 multiprocessing system with an 1800 front end and an OEM Channel. This could permit them to add more of the telemetry pr e processing to the computer system.

RPQ's SCF REMOTE SITES & BIFD BUFFERS

Below is a listing of the subject RPQ's with quantities and acceptable prices. Note the price of a particular RPQ is not significant in itself, except as it affects the total site configuration costs. The site rental (bottom line of attached equipment lists) is the important figure.

Remote Tracking Sites

F16233	Shared Processor Storage - M44	12	300
F16584	Switch, Program Controlled, 3 x 3	3	500
F16585	Attach 2814 to M 44	9	n/c
F16587	Switch, Program Controlled, 2 x 2	6	300
F16676	Quick Disconnect Cables - 2250-1	15	20
F16677	P4 Phosphor - - 2250-1	15	20
F16xxx	Shared Processor Storage, 3-way - M44	9	300
F16xxx	Telemetry Instruction - Special - M44	21	200
F16xxx	Direct Data Connection - 32 bit	21	200
F16xxx	Simulation Instructions - M44	21	300

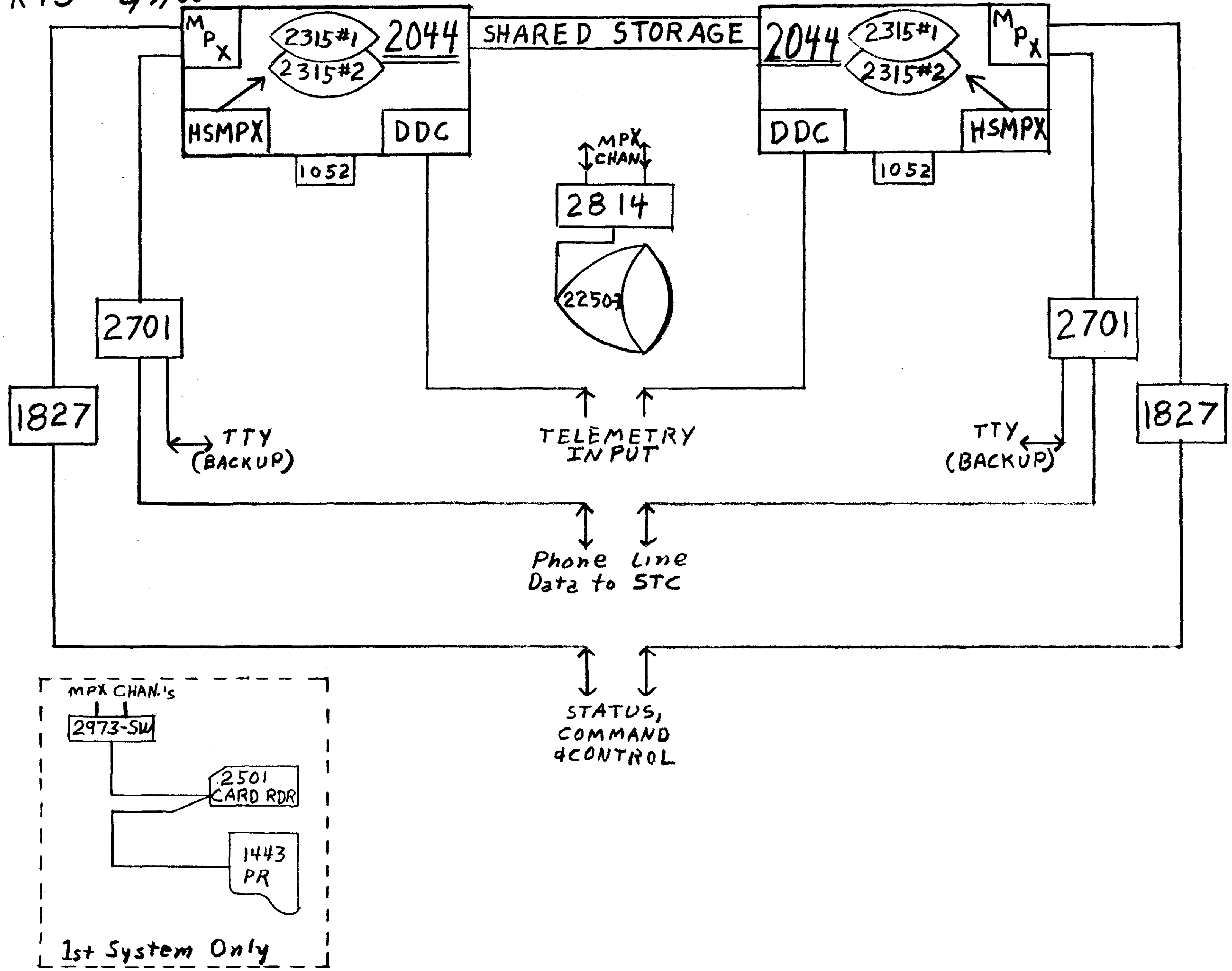
Bird Buffer

F16xxx	Telemetry Instruction - Special, 9020	2	200
F16xxx	Attach 2814 to 9020	6	n/c
F16xxx	Switch Unit - Voice Line	1	1,100
F16xxx	2902 with 10 SDA Adapters	2	4,000

RTS SINGLE SITE - DUAL CPU - 360/44

Unit	Description	Qty.	Rental
CPU's			
2044-F	Processing Unit, 65K bytes	2	$ 9,330
3895	External Interrupt	2	60
5248	Mpx Channel	2	700
4598	Hi Speed Mpx Channel - first	2	1,300
4560	Hi Speed Mpx Subch. add 1st	2	250
6415	Second Single Disk	2	460
RPQ	Telemetry Inst.	2	400
RPQ	Simulation Insts.	2	600
RPQ	DDC Channel	2	1,600
RPQ	Shared Processor Storage	2	600
RPQ	Storage Protection	2	300
			15,600
Displays			
2814-1	Switching Unit	1	125
2250-1	Display Unit	1	700
1002	Absolute Vectors	1	300
1245	Alphameric Keyboard	1	50
1880	Character Generator	1	300
5855	Program Function Keyboard	1	100
			1,575
Communication			
2701-1	Data Adapter Unit	2	400
7862	Teletype Adapter Type 1	2	150
7696	Sync. Data Adapter Type 1	2	400
3815	Extended Capability	2	50
3855	Expansion Feature	2	160
			1,160
Digital I/O			
1827-1	Data Control Unit	2	380
3284	Digital Input Basic	2	140
3289	Digital & Analog Output Base	2	140
3262	Digital Input Adapter	4	80
3286	Digital Input-Voltage	20	280
3285	Digital Input-Contact	4	32
3296	Digital Output Control	2	30
3295	Digital Output Adapter	2	30
3612	Elec "Contact" Operate	6	120
6125	Register Output	2	46
			1,278
			$19,613
Additional Options:			
2501	Card Reader & 1443 Printer-Switched		1,435
2311	Disk (1 control, 2 drives)		2,450

SINGLE RTS - 3/7/66 TMC



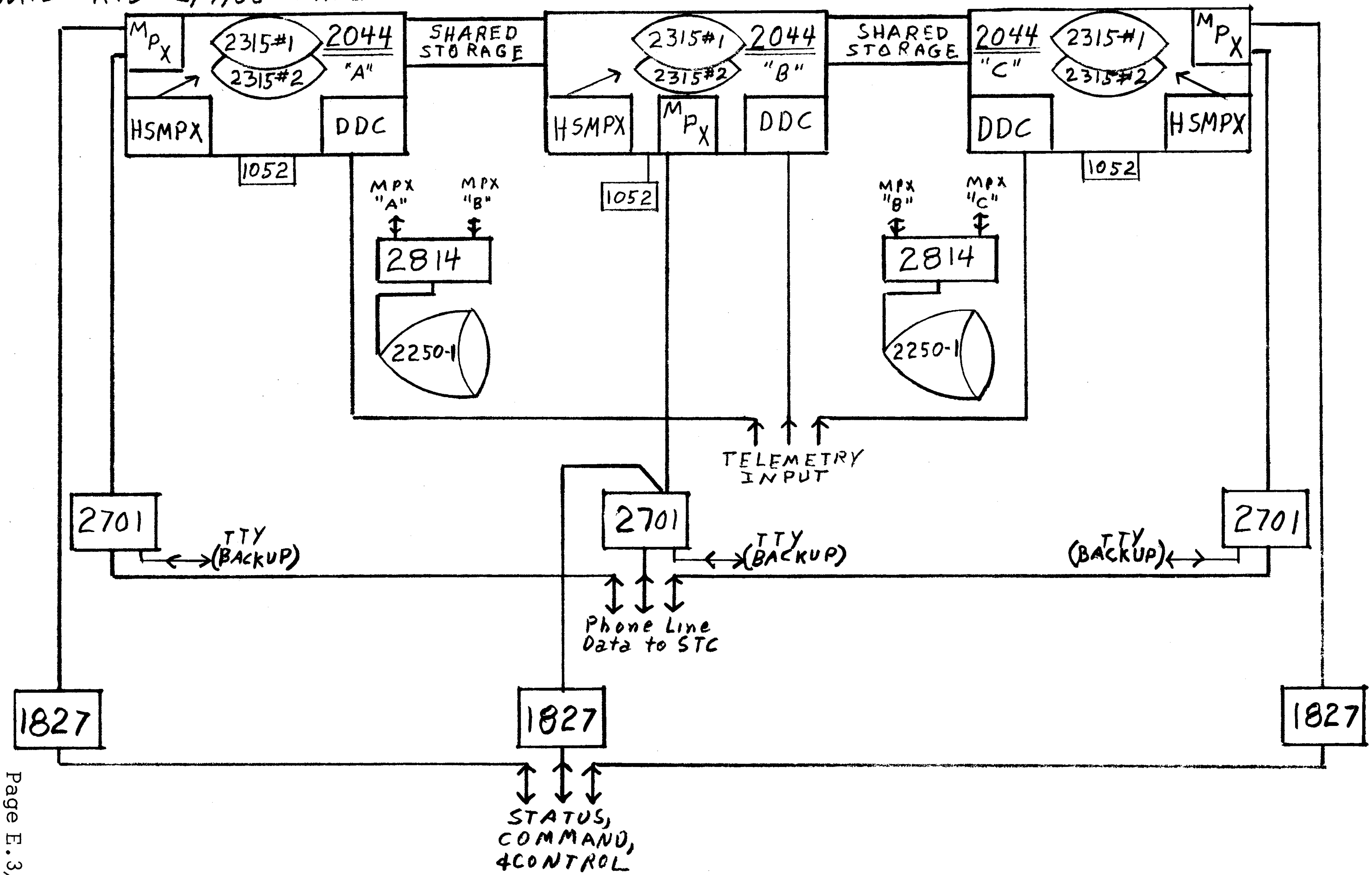
RTS DUAL SITE - 3 CPU - 360/44

Unit	Description	Qty.	Rental
CPU's			
2044-F	Processing Unit, 65K	3	$13,995
3895	External Interrupt	3	90
5248	Mpx Channel	3	1,050
4598	High Speed Mpx Chan.	3	1,950
4560	High Speed Mpx Subch. add 1st	3	375
6415	Second Single Disk	3	690
RPQ	Telemetry Inst.	3	600
RPQ	Simulation Insts.	3	900
RPQ	Direct Data Channel	3	2,400
RPQ	Shared Processor Storage	3	900
RPQ	Storage Protection	3	450
			23,400
Displays			
2814-1	Switching Unit	2	250
2250-1	Display Unit	2	1,400
1002	Absolute Vector	2	600
1245	Alphameric Keyboard	2	100
1880	Character Generator	2	600
5855	Program Function Keyboard	2	200
			3,150
Communication			
2701-1	Data Adapter Unit	3	600
7862	Teletype Adapter - I	3	225
7696	Sync. Data Adapter	3	600
3815	Extended Capability	3	75
3855	Expansion Feature	3	240
			1,740
Digital I/O			
1827-1	Data Control Unit	3	570
3284	Digital Input Basic	3	210
3289	Digital & Analog Out Basic	3	210
3262	Digital Input Adapter	6	120
3286	Digital Input-Voltage	30	420
3285	Digital Input-Contact	6	48
3296	Digital Output Control	3	45
3295	Digital Output Adapter	3	45
3612	Elect. Contact Oper.	9	180
6125	Register Output	3	69
			1,917
			$30,207

Additional Options:

2501 Card Reader & 2 1443 Printers-Switched	2,510
2311 Disk (2 controls, 6 drives)	4,700

DUAL RTS - 3/7/66 TMC



RTS SYSTEM SELECTION CRITERION

Central Processor Units

CPU requirements for the RTS and typical of tracking stations. They are:

High reliability

Fail Soft Capability

Automatic System (Minimum operator intervention)

Load Sharing

High Speed data acquisition

High Speed Scientific Computing

Minimum possible physical space

Price

The following CPU's were evaluated against the above requirements:

System 360/40-44-50

9020

1800

Of these 5 CPU's the System 360/44 comes closest to satisfying all requirements, with Price/Performance, planned data acquisition capabilities, and space required as the major advantages.

Memory Size - 16K 32 bit words per processor.

The present system is built around CDC 160 A's with 24K,12 bit words per processor. This is considered to be roughly equivalent to 8K 32 bit words on the 7044.

The requirements of range are increasing three ways:

1. More Satellites
2. More data per satellite
3. Higher Transmission speeds.

The 16K 7044's will handle more than twice the present RTS load. The shared memory will allow one model 44 to handle the total job in a degraded mode in case of failure.

The JOVIAL compiler available for the 9020 will require modification to operate in this size core.

Disk

Each CPU has access to 2 sets of 2311's and 1 internal single disk. The disks are attached through two High Speed Multiplexor subchannels. A single failure can cause the loss of less than one half of the total disk capacity.

During normal operation, the disk major assignment is:

Internal disk - Programming Systems Residence and Telemetery mode tables.

2311's. - Log input telemetry data during satellite pass.

These disk functions are presently performed by 16 magnetic tape drives.

The telemetry data recorded during a 10 to 15 minute satellite pass, will fill up to six disk packs, requiring physical pack replacement during the pass. A minimum of two operational 2311's per satellite tracked are required. Degraded operation due to a system failure will met this minimum.

2250 Display Consoles

The 2250's are used for input & display as the major portion of the SOC (Station Operators Console). There are two 2250's per SOC. The first is used primarily for Tracking and Commanding information. The second is used primarily for Telemetry data.

In case of 2250 failure, the displays serve as backup for each other. In case of 2840 control unit failure, the 1443 line printer serves as backup.

OEM Channel (DDC)

The high speed input to the system is through the TDP#2. The present data rate is 80K 12 bit words/sec. This data rate will be increased in the future (approximately doubled). The increased speed will be both in the form of longer word length and faster word transfer.

The OEM Channel is required to minimize the inteference inherent to the byte mode of transfer, and to provide ease in hardware interfacing.

1827 Data Control Unit

The 1827's are included to handle the miscellaneous digital inputs and outputs from the Station Operators Console and the radar positioning indicators. Backup is recommended here by the manual changing of a patch panel to tie in a particular 1827s Digital inputs and outputs.

2701 Data Adapter Unit

The 2701's are included to provide the communication capability to the STC, via both the telephone and the teletype lines. For backup, it is recommended that manual switching be done on the telephone and teletype lines themselves. Switching at this point is considerably simpler than switching at the input to the 2701 or the input of the Dataset. In addition, this approach provides backup to the Datasets as well as the 2701's.

2701 & 1827 vs. 2909 or PAM (7289-02)

Features similar to the communication and Digital I/O specified in the 2701 and 1827 could be accomplished in a 2909 or a PAM (7289-02) .

All features supplied in the 2701 and the 1827 are standard or close to standard and therefore supply attractive pricing.

The 7289 could be more seriously considered if rental prices were available.

The 2909 could be more seriously considered if it were approved for the 360/44. The present base price on the 2909 is too high.

SDD POUGHKEEPSIE
Department B70
Building 951
Extension 5-7202

April 21, 1966

Memorandum to: Mr. W. B. Gibson

Subject: Our Meeting of April 13, 1966 - MOL

Referring to the notes that I took, here is my summary of the key points discussed in our day-long meeting:

(1) Present information on the current status of the RFP is that it has been written, has begun final review and sign-off procedures, and is due out between May 1 and May 15.

(2) The RFP will call for a technical response in the following areas:

- (a) remote site hardware
- (b) bird buffer hardware
- (c) control programs for both systems
- (d) diagnostic programs for radar and communications equipment
- (e) communications switching

(3) For remote site hardware a single engineering design based on triplex 360/44's will be pursued. This design will permit a duplex system to exist by disabling the circuitry for the 3rd CPU.

(4) Because of the requirement to maintain a 1.25 us storage cycle, the physical configuration of the triplex system will be as shown in figure #2 of D. D. Dymond's letter of February 23, 1966. Mr. Ted Charbonneau accepts the responsibility to obtain Field Engineering concurrence that this configuration is maintainable.

(5) It was pointed out that RPQ #F16955 (special switch for voice grade lines) has been submitted to SDD but was in suspense because Mike Burke of FSD was working on a solution. FSD's progress on this special switch was unknown. More information on the switch will be obtained by SDD to see if it is a product of interest to Raleigh.

(6) FSD plans to write a single control program multiprocessing operating system with the following characteristics:

(a) capable of operation in both the 360/44 and the 9020 (written with reduced instruction set).
(b) will be completely re-entrant.
(c) will feature multi-tasking and use a common task table.
(d) will have a single IOS.
(e) will have a multi-level priority scheduling system.
(f) will have a security system very much like that currently planned for OS/360 (software security).
(g) supports both store and fetch protection.
(h) will have an interface to the standard unit diagnostics so that they may be run under control of the operation system.

(7) FSD states that no checkpoint/restart function is required and will not be written.

(8) FSD estimates that the magnitude of the programming system will require approximately a 100 man effort.

(9) All application programs for MOL are to be written in JOVIAL (SDC version). Since no JOVIAL compiler exists for the 360/44, FSD had hoped that SDD would modify JOVIAL to produce only re-entrant code, and use only the 44 instruction set. J. M. Terlato stated that SDD would not undertake this modification and requested Mr. J. Selfridge to include this effort in the FSD cost estimate.

(10) DPD expects SDD to provide a System Diagnostic Monitor and unit diagnostics for all IBM hardware. This was agreed to by Mr. Terlato.

(11) The hardware definition of triplex 360/44's was felt to be weak in a number of areas. SDD accepted the responsibility to rewrite the specification to more clearly meet the job needs and to provide engineering with more precise guidance.

(12) An alternate plan for the central facility is to be developed in Poughkeepsie (this work is now scheduled to begin with FSD participation on April 26). Among the guidelines offered by Mr. Gibson were:

(a) central facility must have at least 3 CPU's
(b) a compute-power growth play is desired
(c) security partitioning is a requirement
(d) price limitations are unusually severe

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Alternate configurations suggested (not necessarily in order of DP preference) included:

(a) 9020 without IOCE - possibly with 2909 channels
(b) triplex/44's
(c) dual/65's with one/44
(d) twin configurations of dual/44's
(e) triplex/67's
(f) speed improvements on 9020 storage (since judged impractical because of high development cost).

(13) The possibility of including limit and event checking instructions in the 360/44 were discussed with Mr. K. Gajewski. A proposal for 2 special instructions to meet this need were sent to Messrs. Gibson, Charbonneau, and Gajewski on April 19, 1966.

James F. DeRose

JDR/cmg

cc:	Mr. P. A. Beeby	
	Mr. C. Brown	(Los Angeles)
	Mr. T. M. Charbonneau	"
	Mr. W. Derango	"
	Mr. D. A. Dossin	
	Mr. K. A. Gajewski	"
	Mr. C. R. Harden	
	Mr. E. V. Hofler	
	Mr. J. F. Manning	
	Mr. M. Needle	"
	Mr. J. M. Terlato	
	Mr. J. Selfridge	"
	Mr. G. West	"

CDC 3300

MOL POSITION

CDC 3300

Impact on 3100/3200

The prices for the 3300 indicate that the 3100 as well as the 3200 has been impacted. Only the very small 3100 systems remain cheaper than the 3300. See examples below.

Minimum Systems

		Rental	Purchase
3100	CPU, 4K, one channel and integrated console	2,700	95,000
3100	CPU, 8K, two channels, I/OT. W. & console	3,820	142,500
3200	CPU, 8K, two channels, I/O T. W. & display console	4,300	205,000
3300	CPU, 8K, two channels, I/O T. W. & display console	3,450	155,000

16K Scientific Systems

		Rental	Purchase
3100	CPU, 16K, 2 channels, Flt. Pt., I/O T. W. & console	5,530	232,500
3300	CPU, 16K, 2 channels, Flt. Pt., I/O T. W. & console	5,210	235,000

This would virtually eliminate the possibility of CDC bidding the 3100 for any of the sites involved in this application.

The 3300 is a 3200 with an improvement in the time-sharing area, offering a multiprogramming option for dynamic allocation and relocation of program instructions, data and I/O in memory. Memory expansion up to 262K words is also provided by the MPO option. Provision is also made for dual CPU's. The basic CPU and memory units are the same as the 3200, but the following price changes have been made:

	3300		3200	
	Rental	Purchase	Rental	Purchase
CPU, 8K, 2 Channels	3,450	155,000	4,300	205,000
8K wds	1,100	50,000	1,250	60,000
16K wds	1,900	86,000	2,250	105,000
Flt. pt. option	660	30,000	700	35,000
Dec. hdw. pkg.	750	35,000	750	38,000
Total	7,860	356,000	9,250	443,000

- more -

For a 32K general processor system, the total change in rental price would be $1,390. Note that the above reduced units comprise a 32K general processor system. This represents a 15% reduction on the CPU and necessary units for a large system. If we assume that the CPU and memory represents 50% of a large system, and since the I/O prices have not changed, then this would equal a 7.5% reduction on a complete system.

Program Support and Delivery

The new 3300 system has been promised for delivery for the first quarter of 1966.

The following programming support has been promised for the 3300:

Real-time tape-oriented SCOPE	1Q 1966
Real-time dissk-oriented SCOPE	2Q 1966
Time-sharing monitor for scientific installations	2Q 1966
Time-sharing monitor for business installations	4Q 1966
"MASTER" operating system	1Q 1967
MATS (Multi-access time-sharing)	1Q 1967?

Performance of 3300

The following analysis indicates the internal speed of the 3300 in comparison to the IBM 7094 and the IBM 360/44. Note that this analysis was done for the 3200 but the 3300 has the same speed. The estimated 7.5% price reduction has not been included, but the 360/44 would still show a definite advantage in the short performance area, which would apply in this case.

- more -

360/44 – Performance

Kernel	7094		360/44 STANDARD				360/44 HI-PERF.			
	(E)	(D)	(E)		(D)		(E)		(D)	
(1) Polynomial Eval.	89.0	150.0	105.85	.84	362.75	.42	99.80	.89	356.75	.42
(2) Address Arithmetic	34.0				39.50	.86			29.25	1.16
(3) Float. Point Arith.	163	114	74.12	.85	284.40	.40	68.87	.91	279.15	.41
(4) Fortran IF Statements	29.1				46.49	.63			30.74	.95
(5) Matrix Multiply (5x5)	3552	5677	4786	.74	11413	.50	3904	.91	10530	.54

(All times above in micro seconds)

Assumptions:

Kernels #2 and #4 weighted 10% each
Kernels 1,3,5 weighted 80%

Price-Performance 3200 Versus 360/44

System	Rental	P/P	Purchase	P/P
CDC 3200	22,500	0.40	1,091,000	0.47
360/44 (STD Short)	18,015	0.32	821,180	0.35
360/44 (STD Long)	18,015	0.51	821,180	0.56
360/44 (Hi Perf. Short)	18,715	0.28	850,580	0.31
360/44 (Hi Perf. Long)	18,715	0.45	850,580	0.49

History of Discounts

The following pages list several discount situations involving the CDC 3100/3200 and other CDC computers. Several other discount situations existed with the 6000 series, especially in the educational allowance. At Oakridge, CDC offered 100% trade-in allowance on a 1604 toward purchase of 6400.

ADDITIONAL SCIENTIFIC MIXES are included which show the capability of the 3300.

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CDC 3200

MIX 1

-	Inst. Time	%	Total
DIV	12.0	2.0	.24
MPY	10.4	5.6	.58
FAD/FSB	12.0	9.5	1.14
LD/ST	3.75	28.5	1.07
LD/ST Indexed	3.75	3.6	.14
Other Indexed	3.75	18.9	.71
Test	3.2	13.2	.42
Others with Op.	3.75	11.3	.42
Others without Op.	2.5	7.4	.19
			4.91

MIX 3

LD/ST	3.75	31.2	1.17
Add/Sub	2.50	6.1	.15
CAS	3.2	3.8	.12
TRA(C)	3.2	16.6	.53
FAD/FSB	12.0	6.9	.83
FMP	29.0	3.8	1.10
FDP	29.0	1.5	.44
MPY	10.4	.6	.06
DIV	12.0	.2	.02
Shift	2.65	4.4	.12
Logical	2.5	1.6	.04
No. Ref. Stg.	2.5	5.3	.13
Indexing	0.0	18.0	
			4.71

CDC 3200

MIX 4

	Inst. Time	%	Total
LD/ST	3.75	38.0	1.43
Add/Sub	2.50	7.5	.19
CAS	3.20	4.6	.15
TRA(C)	3.20	20.2	.65
FAD/FSB	12.00	8.4	1.01
FMP	29.00	4.7	1.36
FDP	29.00	1.8	.52
MPY	10.4	.82	.08
DIV	12.0	.2	.02
Shift	2.65	5.3	.14
Logical	2.5	2.0	.05
No. Ref. Stg.	2.5	6.5	.16
			5.76

SCIENTIFIC MIX

LD & St.	3.75	28.5	1.07
Index	0.0	22.5	0.0
Testing	3.2	13.2	.42
FAD/FSB	12.0	9.5	1.14
FMP	29.0	5.6	1.62
FDP	29.0	2.0	.58
Misc.	3.75	18.7	.70
			5.53

Average of 4 Mixes: 5.22

DISCOUNT HISTORY
Control Data Corp.

Date	Situation	Competitive System	Discount	Disposition
Jan. 63	USAF Climatic Center	CDC 1604/160 Offered 100 hr. use plan at 60% of base rental	40%	7040 ordered
June. 63	AMR	(2) CDC 3600 Estimated discount by the AF Program was 7-1/2%. This is the same discount allowed on 2-1604's in the GS Contract. There are no discounts for multiple 3600's.	7 1/2	Ordered 2-3600's
Sept. 64	Argonne National Laboratory	CDC 8090 CDC offered an "educational allowance" in a situation which would not qualify for the IBM educational allowance.	30%	CDC 8090 ordered
Dec. 64	NASA, Goddard	CDC 3200 Not entered in GS Contract	12% 6 systems (Purchase) 10% 4 systems (Purchase) 8% 3 systems (Purchase)	Ordered 4 - CDC 3200
Dec. 64	National Science Foundation	CDC 3200 Probably an "Educational Allowance".	20% No extra use charges	Ordered CDC 3200
Jan. 65	U.S. Forest Service	CDC 3100 Based on customer information CDC would have had to have offered a 20% discount to arrive at the prices indicated by the customer. Not entered in GS contract. (The above discount may include a reduction in maintenance charges which have been entered in the GS Contract).	20% (estimated)	4 - CDC 3100's ordered

DISCOUNT HISTORY
Control Data Corp.

Date	Situation	Competitive System	Discount	Disposition
April '65	Aerospace Corp.	CDC 6600 CDC offered Aerospace the following: 1. Unlimited test time 2. Two hours per day free test time immediately on a test center machine 3. Guaranteed 7094 simulator 4. 65K processor at 32K prices 5. No extra shift charges	Unknown	No Decision
April '65	Army Map Service	CDC 3600 CDC offered two 3600's at $1. 9 million each. The configurations offered would normally sell for $2. 7 million each	30% (est.)	7094 ordered
May '65	D. Brown Associates	CDC 3100 In addition to the above discount, CDC agreed to buy back 20% of prime shift time. Would be too early to appear in the GS Contract	10%	CDC 3100 ordered
May '65	NRL	CDC 3870	35%	CDC 3870 ordered
May '65	VA Hospital Washington, D. C.	CDC 3200 We were unable to give an educational discount	20%	CDC 3200 ordered
May '65	NIH	CDC 6400/6600	20-25%	360/65 ordered
June '65	NASA Goddard	CDC 6400/6600/6800	20-25%	360 Systems ord.
June '65	D. C. Dept. of Highways	CDC 3200 Offered to buy back $2000 of prime shift for one year	20%	360/30 ordered
June '65	SPADATS Mobile	CDC 3600 klug	30% (est.)	360 ordered

June '65	ARO	CDC 3100 Trade in 3 old ERA 1102 $105 toward purchase on CDC 3100		RA 520 ordered
July '65	Center for Naval Analysis	CDC 3400	15%	3400 ordered
Aug. '65	Navy Fleet Weather San Francisco	3 CDC 3100's 1 CDC 3200 Special package discount		3 CDC 3100's ord 1 CDC 3200 ord.

Comments on Discounts

Since CDC has impacted both the CDC 3100 and the CDC 3200 with the release of prices for the CDC 3300, it is reasonable to assume that the CDC 3100 will be bid at reduced prices in special situations. Since the CDC 3200 and the CDC 3300 are basically the same, the new prices for the CDC 3300 may be applied to the CDC 3200. This move with the CDC 3300 price certainly places CDC in a unique position for discounting the CDC 3100.

Additional discounts on the CDC 3200 and the CDC 3300 are not expected to be as large as in the past for the CDC 3200. However, it is believed that where several systems are involved, as in this case, that CDC would discount from 10% to 15% on the CDC 3300.

1966 GSA Contract Terms

Basic Monthly Rental	176 hrs.
Unlimited Use	120%
Extra Use Charge	7 - 14%
Educational Discount	20% R/P
Multiple Discounts	Old Systems 160, 924, 1604 Current tape drives 7.5% - 30%
Purchase Option	% of total rent paid 60% - 2 yr. 40% - 2 yr. + 70% - max. Edu. Discount 52% - 2 yr. 32% - 2 yr. + 70% - max.
Maintenance	"on-site" $30,000 and up "on-call" No chg. for RM during PPM $15/hr. 2 hr. - min.
Program testing & compiling	180 days

Systems Configurations

CDC 3300 DUAL CPU CONFIGURATION

SINGLE SITE

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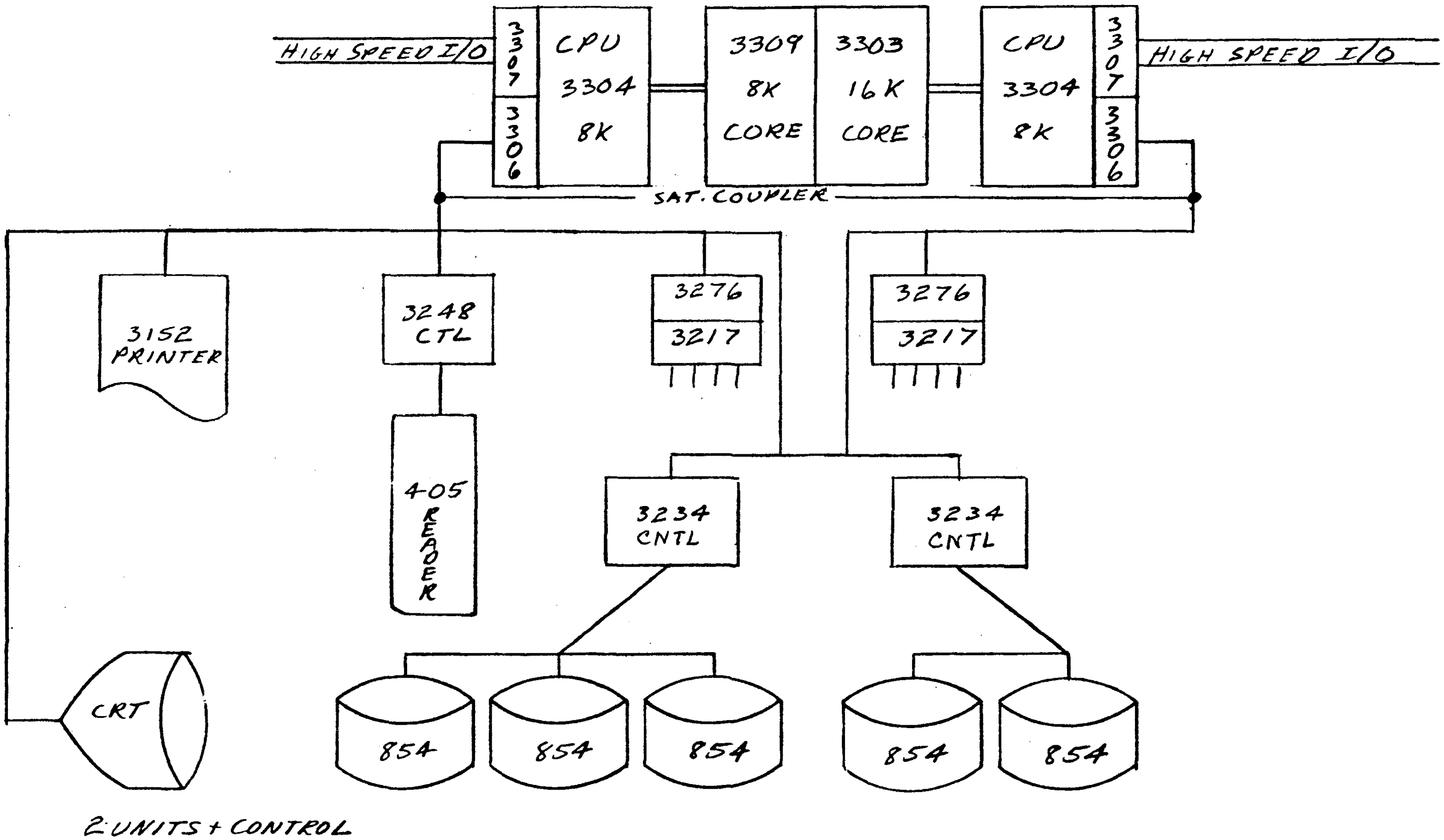
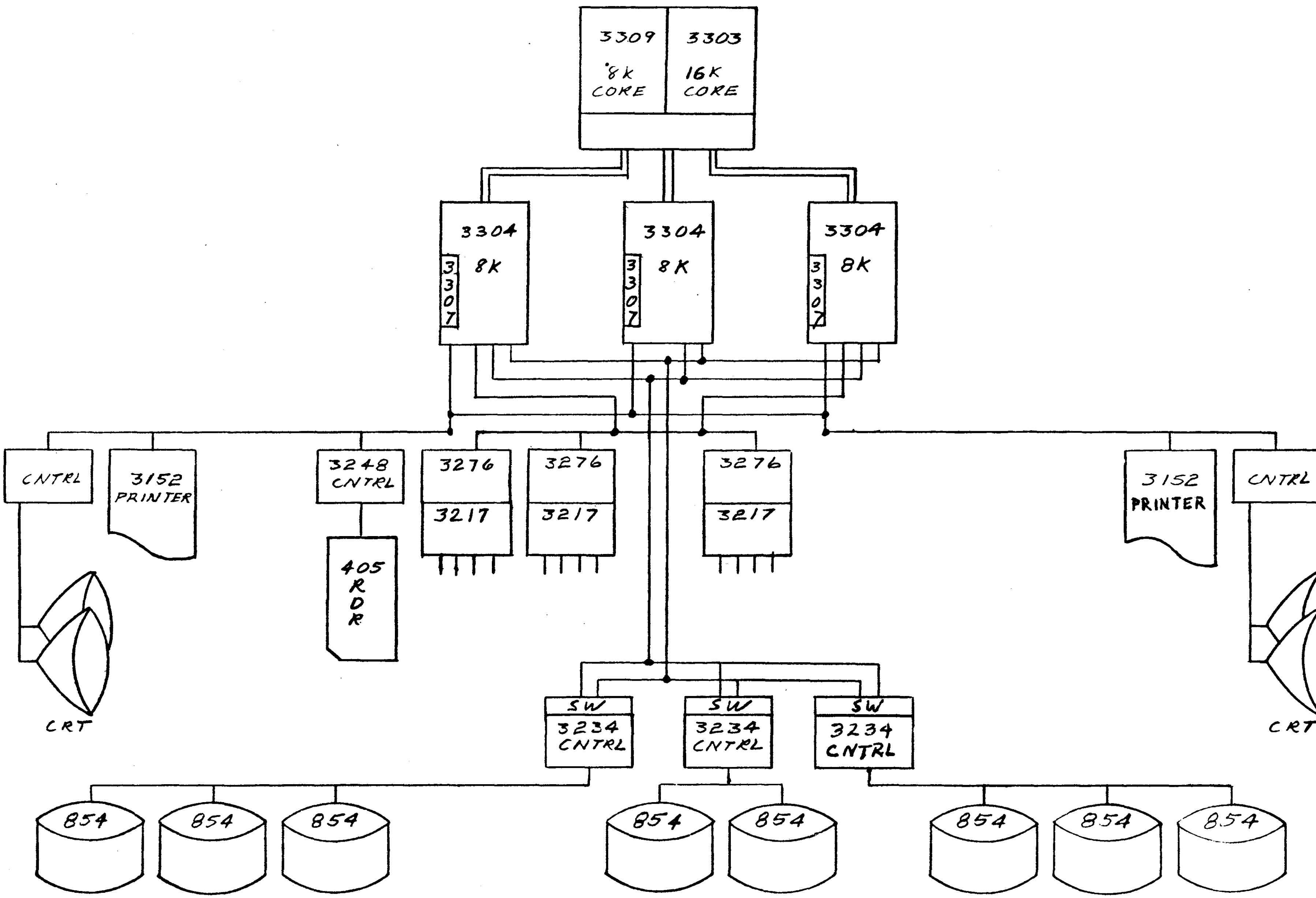


IBM CONFIDENTIAL

CDC 3300 — TRI-CPU CONFIGURATION FOR DUAL SITE



CDC 3300 -- System/360 Model 44

PRICE COMPARISONS ON REMOTE SITES

1.	Current remote site price using CDC 160A's (allows one extra site).	$186,164/mo.
2.	IBM System/360 Model 44's	$188,686/mo.
3.	CDC 3300's including recent price increase on CPU and core memory.	$204,065/mo.
4.	CDC 3300's same as above but at 20 percent discount.	$163,252/mo.

RTS SINGLE SITE - DUAL CPU - CDC 3300

Unit	Description	Qty.	Rental	Purchase
CPU's				
3304	Processing Unit	2	8,600	310,000
3309	8K Words Memory	2	2,750	100,000
3302	16K Words Memory	1	2,380	86,000
3306	Std. Channel (12 bit)	6	900	33,000
3307	Std. Channel (24 bit)	2	500	17,000
3xxx	Special Instructions	2	400	16,000
			15,550	630,640
Disk				
3438	Disk Control (Dual)	1	1,050	47,000
854	Disk Storage Drive	3	1,410	35,400
			2,460	82,400
Displays			1,575	63,000
Communication				
3276	Comm. Term. Control	2	500	25,000
316	Data Set Adapter	2	50	2,500
3xx	TTY Adapter	2	50	2,500
			600	30,000
Digital I/O				
3xxx	Digital I/O Controller	2	400	18,000
3xx	I/O Points	2	800	35,000
			1,200	53,000
			21,385	859,040
	Less 20%		4,277	171,808
			$17,108	$687,232

Additional Options:

		Rental	Purchase
405	Card Reader & 3152 Printer Switched	1,425	67,800
854	Disk (2 additional drives)	940	37,600

RTS DUAL SITE - 3 CPU - CDC 3300

Unit	Description	Qty.	Rental	Purchase
CPU's				
3304	Processing Unit	3	12,900	465,000
3309	8K Word Memory	4	5,500	200,000
3302	16K Words Memory	1	2,380	86,000
3306	Std. Channel (12 bit)	9	1,350	49,500
3307	Std. Channel (24 bit)	3	750	25,500
3xxx	Special Instructions	3	600	24,000
			23,480	850,000
Disk				
3438	Disk Control	2	1,020	45,000
3xx	Two Channel Switch	2	200	8,000
854	Disk Storage Drive	4	1,880	75,000
			3,100	128,000
Displays			3,150	126,000
Communication				
3276	Comm. Term. Control	3	750	37,500
316	Data Set Adapter	3	75	5,000
3xx	TTY Adapter	3	75	5,000
			900	47,500
Digital I/O				
3xxx	Digital I/O Controller	3	600	27,000
3xx	I/O Points	3	1,200	52,500
			1,800	79,500
			32,380	1,231,000
	Less 20%		6,476	266,936
			$25,904	$964,064

Additional Options:

		Rental	Purchase
405	Card Reader & 2 - 3152 Printers	2,250	107,300
854	Disk (1 control & 4 drives additional)	2,490	99,600

REMOTE SITE REPROGRAMMING COST

An analysis of the programs now being used on 160A's in Remote Sites indicates that the following CDC 160 programs must be converted before the last 160A can be taken out of the first Remote Site being upgraded.

		CDC 160 Instructions
A.	Prepass	17,000
B.	Pre-Aquisition	16,000
C.	Pass	46,000
D.	Post Pass	6,000
E.	Diagnostics*	47,500
F.	1/2 of Plotter/Printout Routines	11,000
		143,500

*highly time dependent

Since these 143,500 CDC instructions are approximately equivalent to 48,000 instructions in the 360 Model 44, we estimate that this will require approximately 22 man years costing $500,000 to reprogram.

In perspective, this is a one-seventh increase in the yearly cost of programming Remote Sites for one year.

UNIVAC 1230 at REMOTE SITES

The system priced below is the rough equivalent of the duplex 360/Model 44 configuration shown on page E.3/4. The CPU is hardened, has 2 us core, and uses a 400 nanosecond read-only storage.

Sperry won 40 APOLLO Remote Sites with this system. General Dynamics, San Diego, is doing some of the programming.

Typical instruction times are:

Add, subtract, logic	2 to 4 us
Compare, mask, branch	4 us
Multiply	10-15 us

The instruction set is similar to a 7040. A real-time control program exists, but we do not have a description. The system has both a FORTRAN IV and NELIAC Compiler as well as normal utilities.

The system has 81 discreet external interrupts and 32 channels of 30-bit parallel information.

PRICE: (Skimpy information, estimates only)

Qty.		Purchase	Estimated Rental
2	CPU and 12K words core reader, punch, printer	$800,000	$ 19,000
4	Tapes and 2 controls		6,100
2	Data Communications Terminal (2701 equivalent)		1,400
4	I/O channel switches		925
2	Parallel input/parallel output		140
2	1827 equivalents		1,278
1	2250 systems		1,575
2	Shared storage (estimate)		600
	TOTALS	$800,000	$ 31,018/month

CDC 160A SIMULATOR

Introduction

A preliminary study was made to determine the cost and performance feasibility of a 160A Simulator for System/360. The following paragraphs will deal with the special considerations, assumptions, design goals, preliminary results and conclusions concerning this study. This preliminary study is intended to be used as a tool in determining which approaches appear to be feasible and to select the approach in line with the marketing philosophy for the SCF.

The System/360 Model 44 with high speed registers was chosen as the machine used for timing the 160A Simulator. However, at this time the machine which will be proposed has not been selected, but the Model 44 appears to be the best price/performer. The 9020 System is also under consideration and has some unique hardware features which make it more adaptable to implement a simulator (emulator). The ROS of the Compute Element (CE) of the 9020 System allows for easier implementation of special instructions which can increase the performance of the simulator. The CE also has the standard instruction set of System/360; whereas the Model 44 has a "scientific" subset of the System/360 instruction repertoire. The above features are important in attaining the design goals of the simulator.

The simulator, in the ideal case, should run at 160G speeds with the lower limit being 160A performance. Another important goal is to keep hardware modification and programming costs to a minimum. These design goals are of prime importance in the design of the simulator and in the evaluation of other approaches to the solution of simulating the 160A. Since the 160A is a relatively small machine with minimal capability, a translator may be the quickest, cheapest solution and should be investigated. Another solution would be to reprogram all or part of the real time applications programs. There are approximately 85,000 words of programs required for the present satellite load. Detailed flow charts are available for these programs which reduces reprogramming time. The frequency of use and response time of any one program must be determined to analyze which programs may be run under simulation in a degraded mode. If some of the programs can run in degraded mode, a program simulator with no hardware assistance (cost saving) can execute these programs until phase-out occurs. An analysis of satellite operation concerning response time, planned obsolescence and the processing modes of pre-pass, pass and post-pass can supply valuable information to determine which programs must be reprogrammed or which can run under simulation. Configuration control and the monitor program changes are important factors in simulation mode operation and must be closely studied for efficiency and cost. The remainder of this document will analyze the programmed simulator approach to the program execution of existing applications.

Before describing the simulator, the assumptions and special considerations must be stated. These are:

(1) No input/output or interrupt operations will be simulated.

(2) One's complement arithmetic is not taken into account.

(3) The simulation is done strictly with the standard Model 44 instruction set.

(4) Although the minimum design goal was to execute standard 160A instructions at 160A execution speeds, no special consideration was given to Model 44 core requirements and configurations or special instructions implemented on the 160A for satellite support.

(5) All the timings and mixes used in this analysis are for completely programmed simulation with no hardware assistance.

Simulator

The programs will be executed after the original 160A machine language (binary) decks have been pre-processed. The pre-processing will reformat the 160A words and also compensate for 1's complement arithmetic. After initializing the program (setting constants, instruction counter) it is estimated that the housekeeping for each instruction execution is 16ms. The total time for execution, which includes housekeeping, operation decoding and execution, and effective address generation, is approximately 34ms. The following table shows a mix of instructions timed under the simulator and 160A operation. For lack of a better word, let's call this group of instructions the MOL Mix. The makeup of this mix was chosen because of the following criteria. SCF "real time" data must be scaled, linearized, normalized and compressed for transmission to the STC. These operations require arithmetic and shifting operations and loop control. Since the 160A does not have multiply or divide instructions, an alogorithm is used. Hence, the large number of add and subtract instructions. Another important data reduction function is the analyzing of events. Since the 160A does not have mask instructions to analyze bit patterns, the logical product (and) instruction is used extensively in conjunction with various shift instructions. The MOL Mix shows that the simulator is running about 2.35:1.

MOL MIX

Instructions	%	160A	Simulator
Logical Product	15	19.2	30.75
Shift Replace	5	19.2	40.25
Replace Add One	5	19.2	39.75
Load	10	19.2	30.75
Add	35	12.8	35.00
Store	10	25.6	39.25
Shift	10	6.4	26.50
Miscellaneous	10	15.0	37.50
	100%	14.6 Avg.	34.3

$$\frac{\text{Simulator}}{\text{160A}} = \frac{34.3}{14.6} = 2.35$$

Although the ratio of the simulator to 160A operation is only 2:35 to 1, it must be remembered that no I/O operations or interrupts have been serviced under the simulator.

Conclusions

Hardware assistance will be required to increase the performance of the simulator. Special instruction(s) should be implemented which will execute automatic branches to subroutines depending on the op code. Special hardware to handle interrupts more efficiently than the present System/360 capability is required. Interrupt processing is extremely important in real time data acquisition and expanded capability in this area can realize an advantage over the 160A. The input/output functions can be performed with less interference and faster on the System/360 machines. However, a special routine will have to be written to implement 160A I/O on a System/360 machine. As an alternative, all 160A input/output instructions could be implemented in the hardware of a particular machine. Hardware simulation of instructions or increased hardware capability for the interrupt functions will probably be expensive. However, the 9020 System CE has ROS which hopefully will make hardware simulation cheaper. There should be detailed follow-up meetings with the appropriate special engineering groups to determine the feasibility and cost of hardware assistance in instruction execution and interrupt servicing for both the Model 44 and 9020 System CE.

Using a simulator along with standard S/360 programs in the same operating system will present an additional programming problem to the implementation of the monitor program. This additional cost coupled with the additional hardware costs may cause the total system cost to be beyond the customer's acceptable price range. Therefore, the cost of a translator or the total reprogramming effort should be investigated and compared to the simulation cost. The latter two approaches could be part of the programming contract and not affect the hardware price, making the hardware contract more price competitive.

Implementing special instructions in the S/360 Model 44 will definitely increase the performance of the simulator. It is hoped to increase the performance of a particular routine by three times. The following routines should be implemented with one hardware instruction:

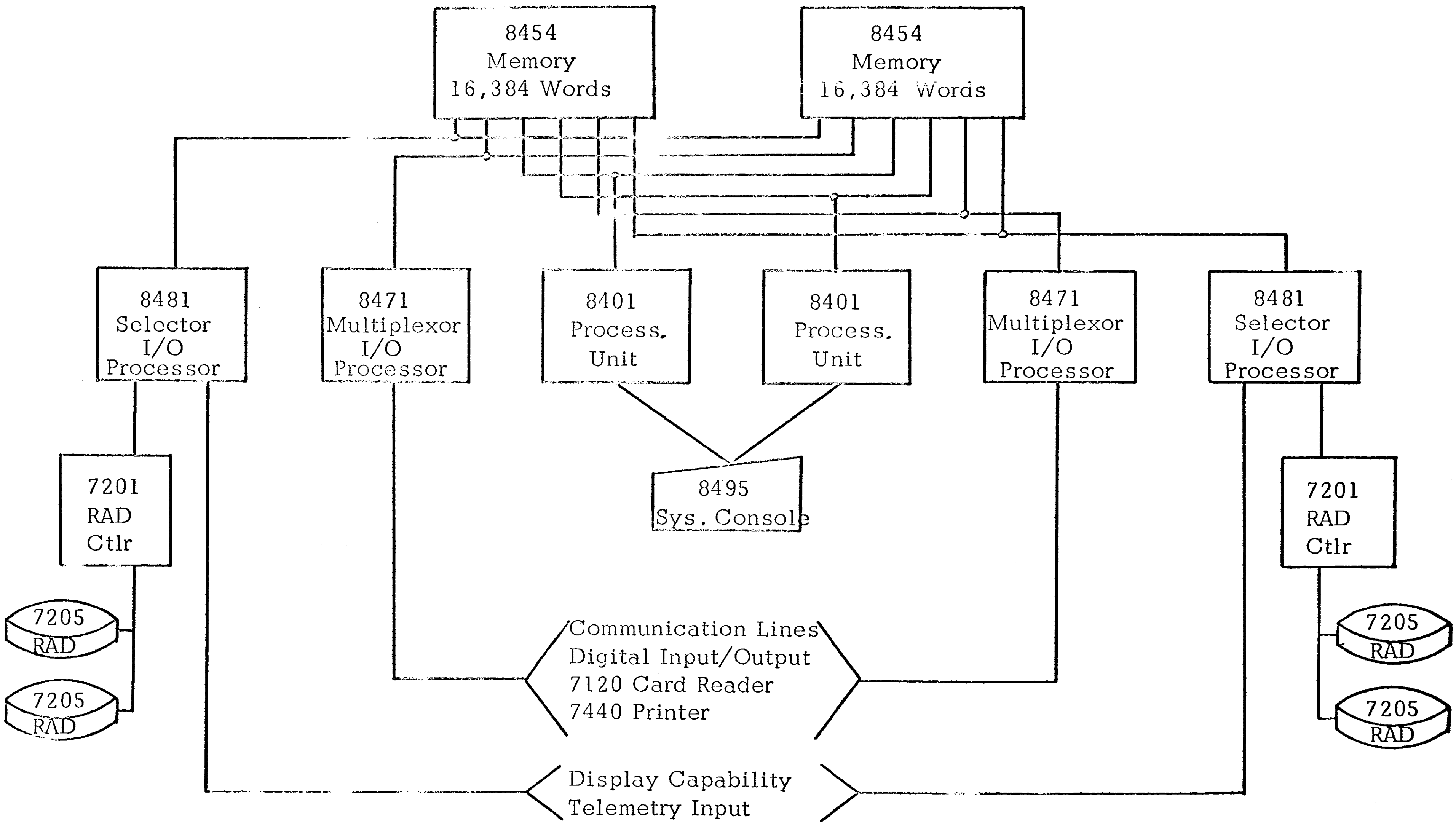
1. One's complement arithmetic
2. Op code decoding
3. Effective address generation
4. Data packing

One's complement arithmetic will need special handling because of the plus and minus zero possibilities and the different tests performed on zero. System/360 uses two's complement arithmetic.

Input/output can best be handled by special instructions also. There are two types of I/O for the 160A; namely, buffered or normal. Buffered I/O is like a high speed multiplex channel operation; normal I/O operation is a character-by-character operation. There are also I/O operations which transfer characters to the accumulator directly. For buffered I/O, the instruction can proceed to a particular area of storage which has the initialization data. Then the input/output can proceed in a normal manner on the Model 44 High Speed or Standard Multiplex Channels. With the present configurations, the high speed channel will transfer data in packed form to the storage. The standard channel will transfer data to storage in the byte mode. This data will be unpacked and will take a special program to pack it before it can be used. Although the configurations use both Model 44 channels to simulate buffered I/O, there appears to be no problem, except packing, in handling data from external sources; e.g., telemetry, etc. The normal input and I/O transfers to the accumulator; e.g., communications, printer, card reader, console inquiries, etc., will be handled by the standard multiplex channel. Since these data transfers will be of relatively low speed and low frequency, a programmed subroutine should handle these data transfers more efficiently than the 160A. The subroutine will handle data transfers in the normal System/360 Model 44 Multiplex Channel mode and put the data in the proper storage locations as prescribed by the 160A program.

SDS SIGMA 7

RTS SINGLE SITE CONFIGURATION



5/9/66 MBN

SDS SIGMA 7

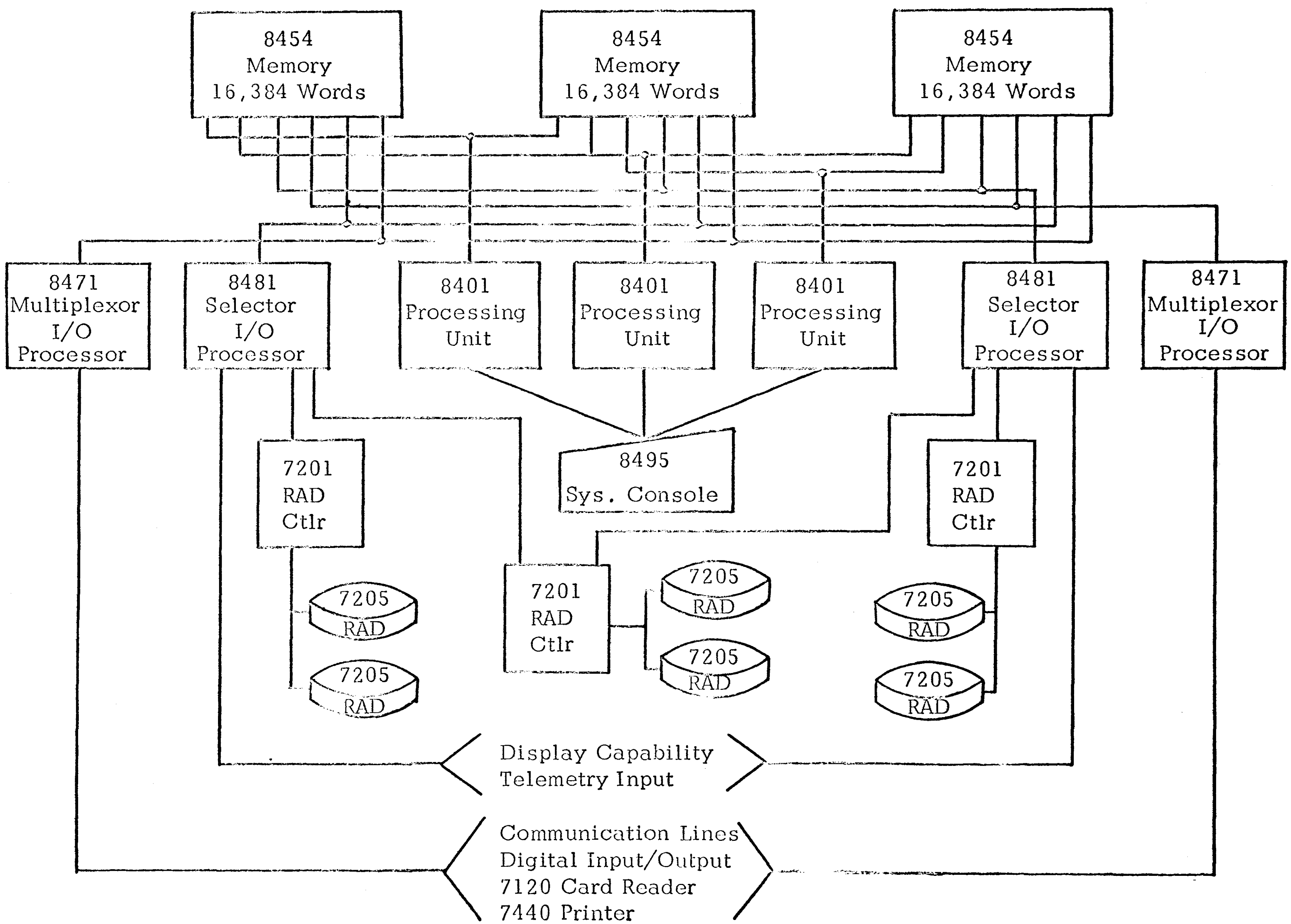
RTS SINGLE SITE CONFIGURATION

Qty.	Model	Description	Lease (4 Yr.)	Purchase
2	8401	Processing Unit	$ 5,500	$220,000
2	8454	Memory Module - 16,384 Words	4,600	184,000
2	8456	Three-Way Access	250	10,000
2	8413	Power Fail Safe	50	2,000
2	8414	Memory Protect	250	10,000
2	8416	Additional Register Block	150	5,000
2	8471	Multiplexor I/O Processor	1,000	40,000
2	8481	Selector I/O Processor	750	30,000
* 2	8482	Additional Selector Channel	500	20,000
* 1	8495	System Supervisory Console	690	25,000
2	8457	Six-Way Access	600	20,000
2	7010	Keyboard/Printer	300	12,000
2	7201	RAD Controller	400	16,000
4	7205	RAD Storage - 1.5 MB	2,700	108,000
			19,015	
1	(2250)	Display Capability	1,575	---
2	(2701)	Comm. Capability	1,160	---
2	(1827)	Digital I/O Capability	1,278	---
1	7120	Card Reader, 400 CPM	400	16,000
1	7440	Line Printer, 600 LPM	875	35,000
			1,275	
			$24,303	

*Unknown Requirements

SDS SIGMA 7

RTS DUAL SITE CONFIGURATION



5/9/66 MBN

SDS SIGMA 7

RTS DUAL SITE CONFIGURATION

Qty.	Model	Description	Lease (4 Yr.)	Purchase
3	8401	Processing Unit	$ 8,250	$330,000
3	8413	Power Fail Safe	75	3,000
3	8414	Memory Protect	375	15,000
3	8416	Additional Register Block	225	7,500
3	8454	Memory Module (16K)	6,900	276,000
3	8456	Three-Way Access	275	15,000
3	8457	Six-Way Access	900	30,000
2	8471	Multiplexor I/O Processor	1,000	40,000
2	8481	Selector I/O Processor	750	30,000
* 2	8482	Additional Selector Channel	500	20,000
* 1	8495	System Supervisory Console	625	25,000
3	7010	Keyboard/Printer	300	12,000
3	7201	RAD Controller	600	24,000
6	7205	RAD Storage - 1.5 MB	4,050	162,000
			24,825	
2	(2250)	Display Capability	3,150	---
3	(2701)	Comm. Capability	1,740	---
3	(1827)	Digital I/O Capability	1,917	---
1	7120	Card Reader, 400 CPM	400	16,000
2	7440	Line Printer, 600 LPM	1,750	70,000
			2,150	
			$33,782	

*Unknown Requirements

LOS ANGELES AEROSPACE BUILDING
Manned Orbiting Laboratory Project

January 18, 1966

TO: Mr. C. E. McKittrick, Jr. - GEM

RENTAL PRICES ON 9020

You were previously informed about the combination of the Remote Site and Bird Buffer RFP's into one package. As you know, we plan to bid shared memory 44's for Remote Sites. Purpose of this letter is to ask your assistance by having the GEM Region formally request rental prices on the 9020 system for the Bird Buffer. A typical configuration is attached. The customer will require two such systems. One to be located in Sunnyvale in the Satellite Test Annex and the second to be located at Systems Development Corporation for programming checkout and backup.

You should be aware that the I/O configurations are not firm; but, since these are essentially standard equipment, these I/O configurations do not affect the problem of getting a rental price on the 9020.

Your prompt action would be appreciated.

W. B. Gibson /jb

W. B. Gibson

WBG:jb
attachments

IBM CONFIDENTIAL

January 12, 1965

MEMORANDUM TO FILE:

Subject: Meeting with Colonel Hedrick.

Bob Krause and I met with Colonel Hedrick on January 3, 1966. In our P'keepsie meeting Colonel Hedrick said that he had expected to discuss our approach to AFSCF problems. He said that our July, 1964 proposal had been well received and he thought we would have shown how we could extend or improve that proposal.

He said he has funds programmed to completely install SGLS throughout the network and to upgrade his data system (i.e. Remote Tracking Stations and Bird Buffers). He feels that his funds may be cut by the Vietnam situation and he will know for sure after the President's budget goes to Congress.

He indicated some concern for his overall data system design and, in fact, said he was considering having a PDP wherein he would have companies like IBM, CDC, etc., supplied with data on their system design, anticipated growth and problems which they would use to develop under contract a new system design which he would then procure. He also discussed the possible application of Comsat or military satellites as the communication link between remote sites and the STC. This may provide higher bandwidth transmission and allow smaller or perhaps no computers at the remote sites. He recognizes that waiting for a PDP or communication satellite would delay satisfying immediate requirements and that not waiting may cause him to have an outdated system in a few years.

As a result of this meeting, Bob and I realized that we must present our overall design to Colonel Hedrick as soon as possible. Our system would permit the growth he needs, without tying him to obsolete equipments. Accordingly, we are preparing a presentation and working session with him for January 18, 1966. In the meantime, Bill Grisham, Bethesda, is investigating tradeoffs in the phasing and costs of commercial and military communication satellites operating at wide bandwidths in the next several years. The material developed by Grisham should be part of our presentation.

J. J. Selfridge

J. J. Selfridge

JJS:jh

cc: W.B.Gibson, J.E.Hamlin, J.P.Jones, R.Krause.

Federal Systems Division
Field Marketing-Los Angeles
February 2, 1966

To: Mr. W. Peavy

Subject: SGLS/PCM Data Handling Equipment

In a discussion with Jerry Trobaugh, TRW Subcontracts, the following information came to light:

1. TRW expects an RFP calling for system production in the next 30 days.

2. Unless there is a drastic change in AF requirements, the PCM Data Handling Equipment will be procured using the present proposals.

3. TRW will be glad to review our technical approach with us; however, it would be best to do this after they receive the AF RFP.

4. The IBM bid is high when compared to others they have received, possibly caused by the use of a computer in the system. (This indicates that the use of a computer is the exception rather than the rule.)

5. Jerry did not want to say more until he has seen the engineering recommendations.

Assuming that item 4 is correct, we will have to re-examine our approach and list the advantages vs. the disadvantages as the customer would see them. If the comparison is favorable, the results should be presented to TRW at the earliest possible time.

B. L. Reynolds

B. L. Reynolds

BLR/jeb

CC: Mr. J. P. Jones
Mr. G. T. McClure
Mr. J. J. Selfridge ←

Date: February 9, 1966
From (Dept, Loc): MOL Project - LA Aerospace
Telephone Ext.:

IBM

Subject: Model 44 Programming Translation

IBM CONFIDENTIAL

Reference:

To: Mr. W. B. Gibson, MOL Project

Per your suggestion, I contacted Otto Alexander in Poughkeepsie. Our discussion brought forth the following:

- o BPS FORTRAN, Assembler and utilities were analyzed on a Model 40 using a hardware monitor to determine the frequency and use of non-Model 44 instructions. Analysis of the results indicated that brute replacement of these instructions would suffice in the generation of M44 software.

- o These programs were converted using 46 man/months at a cost of about $60,000 including machine time. 36 of the 46 man/months were student (new) programmers.

- o The resulting FORTRAN compiler was 99,200 bytes in length while the original is 74,400 bytes in length.

- o Degradation of compiler execution time is about 10%.

- o The instruction production rate came out to about 1800 instructions per man/month.

- o He will be sending the code substitutions, usage analysis and a technical paper on the topic.

Mort

Mort Needle

MBN/lr
cc: Mr. C. Brown
Mr. B. Cabaniss
Mr. W. Derango
Mr. G. West

NOTE:

The above indicates the feasibility of supplying JOVIAL compiler and/or PL 1 compiler for Model 44 if required.

WBG

February 11, 1966

MEMORANDUM TO FILE:

TRIP REPORT TO SATELLITE TRACKING STATION
at New Boston, New Hampshire.

IBM ATTENDEES:
W. Derango
R.G.Krause
W.Patterson-Cambridge
J.J.Selfridge

AIR FORCE:
Colonel Smotherman (Commander)
Lt.Col.Hammond (Tech.Ops.Director)
Lt.Welch (Data Systems Coordinator
Sgt.Delaney (Computer Operation)
Others, approx. 8 officers,
10 senior non-comms.

Colonel Smotherman and staff spent most of the day with us. A System/360 briefing was followed by a description of our Tracking Station and STC real-time data system design. From the questions we believe the audience followed the briefings completely and were interested in giving us ideas to improve the design or use. Examples of significance were:

1. Possible use of one computer at a single site and two computers at a dual site,

2. Maintaining security at a dual site if only two computers were used,

3. Providing a program for orbit updating at site, possibly in real-time with inputs from the first several numbers of pass,

4. Provide a capability for supporting multiple command operations in one computer at a dual site,

5. Provide a means for assembling telemetry modes from a number of standard tables.

A good deal of interest was expressed in System/360 FLT techniques and machine diagnostic programs.

Trip Report - STS
New Boston, New Hamps.

February 11, 1965

During the last half of the day we toured the site (main buildings and antenna subsystems) and showed the System/360 Graphics Film.

It was learned that at New Boston the basic CDC system now is leased for $30,000 per side, $4,000 is required for additional core now being installed and $6,000 is required for extra shift maintenance. Total cost is $40,000 per month.

It was an extremely worthwhile trip, in that it confirmed our design and previous marketing data.

Philco wanted to attend the meeting and seemed to believe they should have been included. One Philco man attempted to discuss potential teaming with W. Derango. Will pleaded ignorance.

Win Patterson, Cambridge, will follow up by delivering a set of our briefing charts to Colonel Smotherman and showing the Gemini film (2250) at the Tracking Station.

J. J. Selfridge
J. J. Selfridge
Manager, SCF Project

JJS:jh
C B Brown

Date:	May 23, 1966
From (location or mail address):	P. O. Box 1117
	Lompoc, California
Dept. & Bldg.:	93436
Telephone Ext.:	(805) RE6-7594

IBM

Subject: DCA's Communication Satellite Series

Reference:

To: Charles Brown, FSD, Los Angeles

Dear Charlie:

You will recall that you asked me for information on DCA's forthcoming communication satellite series. The first is the IDSCP (Interim Defense Communications Satellite Project), the second is the ADCSP (Advanced DCSP). Unfortunately, only the IDCSP is defined (by hardware) so that capabilities can be defined. The ADCSP will be let as an RFP sometime this Fall.

The parameters that describe the system are attached, but in a nutshell, links can be established between the Mark 1B ground terminals capable of 38,400 bits/sec or 16 channels at 2400 bits/sec.

If you wish further information, the most recent can be found in Electronic News, May 9, 1966; and Electronics Magazine, May 2, 1966.

Sincerely,

W. H. Grisham

whg:dp

Attachment

IDCSP SYSTEM CHARACTERISTICS

Satellites:

Booster:	Titan III-C, 8 sats per booster
Orbit:	Near synchronous, random
Prime Vendor:	Philco
Weight:	100 lbs.
"X" band frequency:	8 g.c. "up", 7 g.c. "down" (approximate)
RF power:	About 2.5 watts
Gain:	About 8
Effective power:	About 20 watts (+13 dbw)

Ground Station:

2	60 ft dishes (stations) at Fort Dix, and Camp Roberts
8	40 ft dishes (stations) designated AN/MSC-46 or Mark 1B
12	15 ft antenna stations, designated AN/TSC-54 or Mark V

Capacity for Mark 1B Links:

2 high quality duplex voice (SNR = 53 db)
or 16 vocoded voice channels (duplex)
or 5 low quality voice channels