Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer
This is a general purpose computer doing both scientific computing and commercial work. The system is scientifically oriented with fast internal speeds.

USA Ballistic Missile Agency Redstone Arsenal
Located at Computation Laboratory, Redstone Arsenal, Alabama, the system is used for scientific and commercial applications.

U. S. Army Electronic Proving Ground
Located in Greely Hall, Fort Huachuca, Arizona, system is used in support of the tactical field army and the technical program of the departments of the U. S. Army Electronic Proving Ground.

U.S.N. Pacific Missile Range Pt. Mugu
Operated by Land Air, Inc.
Located at the Pacific Missile Range, Point Mugu, the system is used for the processing of missile test data (radar, optical, and telemetry), for real time applications, and for the solution of general mathematical problems.
Land Air, Inc. operates two 709's for the Navy, one

at Point Mugu, California and one at Point Arguello, California. Land Air is the lessee, and our major committment is for missile test flight data reduction. In addition, we provide computing facilities for the entire installation at Mugu (general scientific and engineering research and data processing).

U.S.N. Pacific Missile Range Pt. Mugu
Operated by Land Air, Inc.
Located at the Naval Missile Faculty, Point Arguello, California, the system is used on the main problem of range safety impact predicition in real time using FPS-16 Radar and Cubic COTAR data. System is also used for post flight trajectory reduction of FPS-16 radar data and for trajectory integration and analysis, etc.

USN OTS China Lake, California
Located at the Data Computation Branch, Assessment Division, Test Department, the computer is used for data reduction and scientific computation as related to Naval Ordnance, Test, Development & Research (15% of computer time devoted to management data processing).
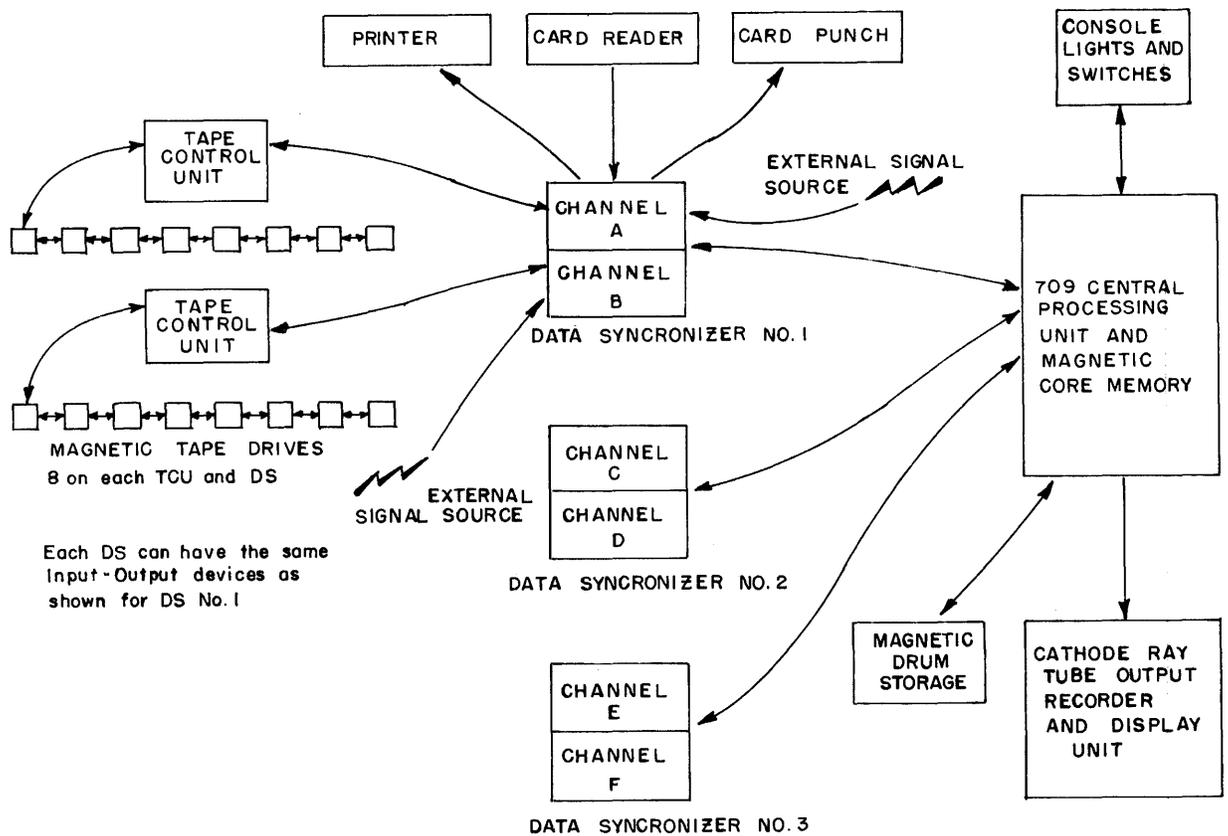
SCHEMATIC SHOWING DATA FLOW FOR INPUT-OUTPUT FOR IBM 709 DATA PROCESSING SYSTEM

National Aviation Facilities Experimental
        Station (FAA)
Located at Atlantic City, New Jersey, the system is used for fast time simulation of air traffic control systems, data reduction on data collected in various areas of air traffic control, data analysis, real time simulation, statistical analysis, and probability problems.

    C E I R, Inc.
Located at 1200 Jefferson Davis Highway, Arlington 2, Virginia, the system is used for linear programming, multiple regression, business data processing, and flight simulation, plus applications of our clients who rent time from us.

    Douglas Aircraft Company (2)
Located at A-250, and A-260, Santa Monica, both systems are used for strength analysis, trajectories, aerodynamic stability, aerodynamic performance, dynamic response, weight control, and propulsion analysis.

    Ford Motor Company
Located at the Central Services Building, Ford Road, Newport Beach, California, the system is used for computation of missile trajectories within the earth's atmosphere, computation of orbits (in light atmosphere or free space), computation of rocket motor performance, hydrodynamic computations, missile com-

ponent design computations, computer system simulation, miscellaneous scientific and engineering computations, data reduction of experimental and flight test data, and payroll, inventory control, and miscellaneous business applications.

    Hughes Aircraft Company
Located at Florence Avenue & Teale Streets, Building 6, Room F1022, Culver City, California, the system is used for all forms of numerical computation, including differential equations, numerical integration, parameter studies, solution of simultaneous equations, matrix manipulations, polynomial equations, integral equations, simulations of various systems (computers, mass raid attacks, fire control systems) partial differential equations, harmonic analysis, auto correlation and power spectrum analysis, statistical computations, Monte Carlo evaluations of various problems, network analysis, research in computer systems (assemblers, compilers), design studies, and development of problem oriented languages.

    IBM Space Computing Center
Located at 615 Pennsylvania Avenue, N.W., Washington, D. C., the system is used for orbital calculations for space vehicles, including formulation, testing and production, test center applications for Federal Systems Division of IBM, and customer test center for local 709 users who have ordered machines.

Lockheed Aircraft Corporation-Burbank
Located at Burbank, California, the system is used to solve all scientific and engineering problems submitted by the Engineering Division.

Lockheed Sunnyvale
The computing installation consists of two IBM 709's and peripheral equipment. It is used for scientific calculations involving matrix inversion, partial differential equations, trajectories, solutions for simultaneous equations, etc. The systems are also used for flight data reduction involving the preparation of labels and plotting tapes, data reduction and computation of calibration. Admisistrative applications include the solution of financial, material, and statistical problems.

The Martin Company-Baltimore
Located at the Missile Weapons Systems Division, Baltimore, Md., the system is used for missile design, vibrations analysis, nuclear shielding, reactor design, electronic design, information retrieval, trajectory analysis, compilers, aerodynamic research, circuit analysis, master lines automation, numerically controlled tools, data reduction, weight calculation automation, statistical analysis, structural analysis, and molecular research.

The Martin Company-Orlando
Located at the Engineering Division, the system is utilized for scientific calculations in engineering design, parts and assembly control, production and updating of engineering parts lists, and special reports emanating from complete files of system parts and components.

McDonnell Aircraft Corporation
Located on the 1st level of Bldg. 33, Engineering Campus, the system is used for flutter analysis, trajectory studies, probability studies, stress and loads analysis, aerodynamic performance, thermodynamic problems, numerical control of milling machines, flight test and wind tunnel data reduction, operations analysis, and engine performance.

Northern States Power Company
Located at 1925 Sather Street, St. Paul 13, Minnesota, the system is used for customers' billing and accounting, load flow studies, generator outage probabilities, plant life actuarial analyses, substation and feeder load record, and transformer loading and forecasting.

Phillips Petroleum Company
Located in the Adams Building at Bartlesville, Oklahoma, the system is used for the solution of engineering, technical and research problems and business accounting.

RCA Missile & Surface Radar Division
Located in Bldg. 116-1 Moorestown, N. J., the system is used for the real-time control of BMEWS (Ballistic

Missile Early Warning System), for engineering model tracking radar, for engineering calculations associated with design of BMEWS sites, and for data reduction for the Down Range Anti-Ballistic Missile Program (DAMP).

RCA Service Company, Patrick AFB
Located in the Technical Laboratory, Bldg. 989, Patrick Air Force Base, Florida, the system is used primarily to determine missile trajectory information (time, position, velocity, and acceleration) from observed observations, azimuth, elevation and slant range (where available). Data sources are Azusa, FPS-16, Mod II radar, ballistic camera, fixed camera, cine-theodolite, and DOVAP. Also digitizing and linearization of telemetry is performed.

RCA Service Company, Cape Canaveral
Located at Bldg. 2-1655, Cape Canaveral, Florida, the system is used for real time impact prediction computing during ballistic missile launches, ground instrumentation check outs, near real time computation for acquisition and vehicle recovery operations, post flight data reduction, and other engineering and scientific problems.

Space Technology Laboratories, Inc. (2)
Located at El Segundo, California, both systems are used in a full spectrum of scientific computations.

System Development Corporation
Located at 1923 Centinella Avenue, West Los Angeles, California, the system is used for data processing applications for the development of a system training program.

M. I. T. Lincoln Laboratory
Located at the M. I. T. Lincoln Laboratory, Lexington, Massachusetts, the computer is used for real time systems studies; evaluation, simulation, and analysis, physical data processing, and programming research.

University of California LRL
Located at Livermore, California, the system is used for the solution of differential equations.

University of California, Los Angeles
Located at the University of California, Los Angeles campus, the system is used for research and education in all university disciplines, with special emphasis on business management problems, operations research, gaming, and computer systems development.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Binary digits/instruction	36
Instructions/word	1
Instructions decoded	187
Arithmetic system	Fixed and floating point
Instruction type	One address

Number range

Floating $-10^{38} < N < 10^{38}$

Fixed $-(2^{35}-1) \leq N \leq (2^{35}-1)$

Instruction word format

Oper Code	Flag	Tag	Address
S,1 11	12-13	18-20	21 35

Format varies with instruction type.

SHARE Operating System (SOS) and FORTRAN are used.
There are 4 arithmetic registers (full word), viz.
accumulator, multiplier-quotient, storage, and sense.
There are 3 index registers.

ARITHMETIC UNIT

Incl Stor Access
Micorsec

	Fixed Pt.	Floating Pt.
Add	24	84
Mult	24-240	24-204
Div	36-240	36-216

Construction (Arithmetic unit only)

Vacuum tubes	2,000
Diodes	14,500
Arithmetic mode	Parallel
Timing	Synchronous for Central Processing Unit
	Asynchronous for Input-Output
Operation	Sequential for Central Processing Unit
	Concurrent Input-Output devices

Input-Output operations on up to 6 data channels
can operate concurrently with the main program in the
CPU (Central Processing Unit).

STORAGE

Manufacturer

Media	No. of Words	No. of Bin/Word	Access Microsec
Core	4,096; 8,192 or 32,768	36	12
Magnetic Drum	8,192 or 16,384	36	35,000 for initial word, 96 for subsequent wds.

Magnetic Tape Up to 48 reels at approx. 1/2 million words/reel 10.8 millisec access

No. of units that can be connected	48 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start-stop time	10.8 Millisec
Average time for experienced operator to change reel of tape	30-60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Acetate or Mylar

Mylar is DuPont's registered trademark for polyester film.

USA BMA Redstone
32,768 words Magnetic Core; Magnetic Tapes
USA EPG Fort Huachuca
32,768 words Magnetic Core; 24 Magnetic Tape Stations
USN PMR Pt Mugu
32,768 words Magnetic Core; 24 Magnetic Tape Stations
USN PMR Pt Mugu
8,192 words Magnetic Core; 6 Magnetic Tape Stations
USN OTS China Lake, Calif.
32,768 words Magnetic Core; Magnetic Tape
NAFE FAA
32,768 words MC; Mag Tape
CEIR
32,768 MC; Mag Tapes
Douglas
32,768 MC; 13 Mag Tape Sta.
Douglas
32,768 MC; 10 MT
Ford
32,768 MC; 9 MT
Hughes
32,768 MC; MT
IBM Space
32,768 MC; 14 MT Type 729-I
Lockheed Burbank
32,768 MC; MT

IBM 709

Lockheed Sunnyvale
32,768 MC, ea; 12 MT Type 729-I, ea.
    Martin Baltimore
32,768 MC; 10 MT Type 729-I
    Martin Orlando
32,768 MC; MT
    McDonnell
32,768 MC; MT
    Northern States
8,192 MC; MT
    Phillips
8,192 MC; MT
    RCA Moorestown
32,768 MC; MT. The 8,000 word magnetic drum was re-moved 6 months after initial installation of computer.
    RCA Patrick AFB
8,192 MC; MT
    RCA Canaveral
8,192 MC; MT
    Space Tech Labs
32,768 MC; MT
    Space Tech Labs
32,768 MC; MT
    System Development Corp
32,768 MC; MT
    MIT
32,768 MC; 10 MT Sta
    UCLRL
32,768 MC; 10 MT Sta
    UCLA
32,768 MC; 8,192 Drum; MT

INPUT OUTPUT

Manufacturer

Media	Speed	
Magnetic Tape	(Reads-records in BCD or Binary)	
Cards (Read)	250 cards/min	(on-line)
Card-to-Tape	250 or 800 cards/min	(off-line)
Card (Punch)	100 cards/min	(on-line)
Printed Page	150 lines/min	(on-line)
Cathode Ray Tube	135 microsec/point	(on-line)
Tape-to-Card	100 or 250 cards/min	(off-line)
Tape-to-Printer	150 or 600 lines/min	(off-line)

The 800 cards/min is obtained when the IBM 1401 System is used for generating input tapes.

The higher rates are obtained when using the IBM 1401 off-line for Tape-to-Card and Tape-to-Printer.
    USA BMA Redstone
Tapes, Cards, Printer
    USA EPG Fort Huachuca
Tapes, Cards, Printer
    USN PMR Pt Mugu
Tapes, Cards, Radar Data, Printer
    USN PMR Pt Mugu
Tapes, Cards, Printer, Radar Data, 30 x 30 Plotting Boards.
    USN OTS China Lake
Tape, Cards (on and off-line), Printer (on and off-line), Direct Data Device at 27,777 words/sec. Input from analog to digital conversion facility with real time capability.
    NAFE FAA
Cards, Tape, Direct Data Entry 27,777 words/sec.
    CEIR
Cards, Tapes (729I, II and IV), Printer
    Douglas (2)
Tapes, Cards, Printer

Douglas
Tapes, Printer
Ford
Tapes, Cards, Printer
Hughes
Tapes, Cards, Printer
IBM Space
Tapes, Cards, Printer (on and off-line)
Lockheed Burbank
Tapes, Cards, Printer
   All input of programs to the machine is on magnetic tapes. Card Reader is used only to initialize particular input tape.
   All output of printed or punched information is placed on magnetic tapes. The printer is used to monitir the system.
Lockheed Sunnyvale
Tapes, Cards, Printer, Paper Tape
   Paper Tape input/output is available on only one 709 system.
Martin Baltimore
Tapes, Cards (on and off-line), Printer (on and off-line), Cathode Ray Tube 7100 dots/sec
Martin Orlando
Tape, Cards, Printer
McDonnell
Tape, Cards, Printer (on and off-line)

Northern States
Tape, Cards, Printer
Phillips
Cards, Tape, Printer (on and off-line)
RCA Moorestown
Tape, Cards, Printer (on-line)
  Printer is used for operator remarks only.
RCA Patrick AFB
Tape, Cards, Printer (on and off-line). Paper Tape is transcribed to magnetic tape with off-line converter.
RCA Canaveral
Tape, Cards, Printer (on and off-line), Computer output direct to teletype at 60 or 100 words/min, real time direct data input at 30, 50, and 80 words/sec.
Space Tech Labs
Tape, Cards, Printer
Space Tech Labs
Tape, Cards, Printer
System Development Corp
Tape, Cards on line. All unit reocrd operations - card-to-tape, tape-to-card, and tape-to-print are performed off-line.

MIT

Media	Speed
Magnetic Tape	15,000 char/sec
Cards (Reader)	250 cards/min
Paper Tape	240 lines/sec (Via Direct Data Entry)
Magnetic Tape	320 words/sec (Via Direct Data Entry)
Cards (Punch)	100 cards/min
Printer	150 lines/min
Cathode Ray Tube	7,100 points/sec

Various other inputs (e.g. phone line) are used with the Direct Data Entry feature from time to time.

UCLRL

Cards, Tape, Printer

UCLA

Cards, Tape, Printer (on-line), Cathode Ray Tube at 7,000 points/sec. utilize 714 card-to-tape for input preparation and 720 II Printer and 717 Printer off-line for output.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

There are 295,000, or 590,000, or 1,180,000 magnetic cores, depending on size of memory.

CHECKING FEATURES

Manufacturer

Accumulator overflow; divide check; floating point overflow and underflow; data channel I/O check; horizontal and vertical points check on magnetic tape; dual level sensing; two gap head for verification of tape writing; echo checking on line printer.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer		125.2 KVA	
Weight, computer		2,110 lbs	

Physical Planning Manual available on request IBM Form No. 12-7967-1.

USA BMA Redstone

Power, computer	94.8 Kw	131.8 KVA	0.72 pf
Volume, computer		26,800 cu ft	
Area, computer		1,376 sq ft	
Room size, computer		1,800 sq ft	
Floor loading		25.0 lbs/sq ft	
		1,000 lbs concen max	
Capacity		26.5 Tons	
		318,750 BTU/hr	
Weight, computer		34,370 lbs	

USA EPG Fort Huachuca
Power, computer   236.6 KVA
Capacity, air conditioner   150 Tons
                                 520,420 BTU
USN PMR Pt Mugu
Power, computer   138.5 Kw   205.6 KVA   0.67 pf
Power, air conditioner   300 KVA
Volume, computer   2,432.6 cu ft
Volume, air conditioner   15,000 cu ft
Area, computer   454.5 sq ft
Area, air conditioner   960 sq ft
Floor loading   11.8 lbs/sq ft
                                   2.50 lbs concen max
Capacity, air conditioner   70 Tons
USN PMR Pt Mugu
Power, computer   112.5 Kw   157.7 KVA   0.71 pf
Volume, computer   1,415 cu ft
Area, computer   264.6 sq ft
Floor loading   250 lbs concen max
Capacity, air conditioner   43 Tons
Weight, computer   42,060 lbs
    False ceiling, plenum floor, and concrete addition
to building.

USN OTS China Lake
Power, computer   70 Kw   100 KVA   0.70 pf
Power, air cond   87 Kw   100 KVA   0.87 pf
Volume, computer   2,244 cu ft
Volume, air conditioner   7,000 cu ft
Area, computer   420 sq ft
Area, air conditioner   800 sq ft
Room size, computer   1,776 sq ft
Room size, air conditioner   850 sq ft
Floor loading   175 lbs/sq ft
                               250 lbs concen max
Capacity, air conditioner   80 Tons
Weight, computer   52,110 lbs, incl periph-
                                     eral equipment
Weight, air conditioner   15,000 lbs
    Computer is located in a fire-proof area. The com-
puter area is not adjacent to any inflammable or ex-
plosive material or gases, stored, manufactured, or
processed.
    Structural conditions: All concrete-floor, walls
and roof.
    Partition separations from other areas (office) are
fabricated steel 3" thick with fire-proof insulation.
    Floor: All steel removable panel construction,
elevated one (1) foot above supporting concrete deck.
    Ceiling: Steel acoustical tile panels with 1" fiber-
glass insulation attached to underside of concrete
roof.

IBM 709

The entire computer area has its own refrigerated air-conditioning system plus humidity control. Air conditioning equipment located in separate, fireproof, building constructed for the expressed purpose of housing same. Building housing equipment located approximately 15 feet away from building housing the computer equipment.

NAFE FAA

Power, computer	89 Kw	160 KVA	0.765 pf
600 amps max. capacity			
Power, air cond		0.765 pf	15% Excess
Volume, computer		24,000 cu ft	

Area includes 16' x 30' customer eng'r area. Card room not included.

Volume, air conditioner	4,800 cu ft

Machinery, comp. heat exchangers, etc.

Area, computer	2,400 sq ft
Area, air conditioner	480 sq ft
Room size, computer	80 ft x 30 ft
Room size, air conditioner	30 ft x 16 ft
Floor loading	200 lbs/sq ft
Capacity, air conditioner	50 Tons

W. W. II Navy Galley completely refurbished to house computer. Removable floor and false ceiling installed. Room insulated. Preliminary air conditioning of power installed prior to computer selection. Additional power and air conditioning installed as required. Duct work above false ceiling. Electric power beneath removable floor. Air conditioning machinery remotely located with only air handling equipment in computer room. Fluorescent lighting throughout. Installation completed September 1959.

CEIR

Power, computer	75 Kw	108.6 KVA	0.70 pf
Power, air cond	10 Kw	12 KVA	0.85 pf
Volume, computer		11,500 cu ft	
Volume, air conditioner		10,000 cu ft	
Area, computer		1,150 sq ft	
Area, air conditioner		1,000 sq ft	
Room size, computer		25 ft x 40 ft	
Room size, air conditioner		25 ft x 40 ft	
Floor loading		30 lbs/sq ft	
		125 lbs concen max	
Capacity, air conditioner		120 Tons	
Weight, computer		34,370 lbs	
Weight, air conditioner		27,000 lbs	

This A/C equipment handles both 704 and 709. False ceiling. Plenums - modular floor in 2 ft x 4 ft sections, 6 inches clearance between floor and plenum.

Douglas

Power, computer	150 KVA
Area, computer	1,500 sq ft
Area, air conditioner	1,200 sq ft
Room size, computer	30 ft x 50 ft
Floor loading	16 lbs/sq ft
	200 lbs concen max
Capacity, air conditioner	40 Tons
Weight, computer	23,000 lbs

Sealed area, a/c ducts installed with 500 RCE/sink for each component, a/c unit and airfilter installed, motor generator set with transformer and controls.

Douglas

Power, computer	150 KVA
Area, computer	1,500 sq ft
Area, air conditioner	1,200 sq ft
Room size, computer	30 ft x 50 ft
Floor loading	16 lbs/sq ft
	200 lbs concen max
Capacity, air conditioner	40 Tons
Weight, computer	22,000 lbs

Sealed area, six inch raised floor installed over power cables, a/c unit and airfilter installed, motor generator set with transformer and controls.

Hughes

Power, computer	205 Kw	256 KVA	0.80 pf
M. G. set			
Power, air cond	99 Kw	120 KVA	$\pm$0.82 pf
Induction motor driven			
Volume, computer		23,496 cu ft	
Volume, air conditioner		14,160 cu ft	
Area, computer		1,958 sq ft	
Area, air conditioner		1,180 sq ft	
Room size, computer		42 ft x 46 ft 9 in	
Room size, air conditioner		33 ft 10 in x 34 ft	
Floor loading		100 lbs/sq ft	
		1,000 lbs concen max	
Capacity, air conditioner		70 Tons	
Weight, computer		33,460 lbs	

IBM Space

| Power, computer | 183.9 KVA |

4 wire 208V - 3 phase 800 amp supply

| Power, air conditioner | 92.6 KVA |

3 wire 208V - 3 phase Four 30 H. P. Compressors

Volume, computer	30,294.9 cu ft
Volume, air conditioner	13,221 cu ft
Area, computer	3,029.49 sq ft
Area, air cond (2 rooms)	1,469 sq ft
Room size, computer	48 ft 6 in x 62 ft
Room size, boiler room	30 ft x 20 ft
Room size, compressor room	21 ft x 37 ft 6 in

Floor loading 1,000 lbs/sq ft
Capacity, air conditioner 120 Tons (bldg.)
47 Tons (709 Machine)
Weight, computer 51,820 lbs (computer &
all component equipment)
Air conditioner is installed on basement slab.
Ceilings are 2 x 4 with rock lath and mineral block, hung type.
Building type - steel reinforced and masonry.
Building modifications - complete job on original accupancy.
Power Distribution: 1,200 amps, 3 phase, 4 wire, 120/208V - Bldg. load; 800 amps, 3 phase, 4 wire, 120/208V - machine load.

Lockheed Burbank
Volume, computer 12,500 cu ft
Area, computer 1,250 sq ft
Room size, computer 25 ft x 50 ft
Floor loading 34,650 lbs
Capacity, air conditioner 90 Tons
313,000 BTU
Weight, computer 34,650 lbs
The area has a raised floor which carries the cold air to the computer and a false ceiling which returns the hot air from the computer, back to the air conditioning units which then cools it and forces back to the computer. The raised floor also holds the inter-

Photo by Phillips Petroleum Company

connecting cables of the computer.

Lockheed Sunnyvale
Power, computer 337 KVA 0.90 pf
Available transformer power
Power, air conditioner 101 Kw
Power requirement for 100% operation
Volume, 2 709's & periph equip 96,000 cu ft
Volume, transformer, chiller, 27,000 cu ft
blower, precipptators, etc.
Area, computers 8,725 sq ft
Area, air conditioning 1,200 sq ft
Room size, computers 112 ft x 72 ft
Room size, air conditioning 33 ft x 33 ft
Floor loading 93 lbs/sq ft
80 lbs/sq ft con max
Capacity, air conditioning 125 Tons
Weight, computers 94,310 lbs
Weight, air conditioning 20,000 lbs
One foot raised floor (sheet metal sandwich with wood core flooring) steel frame. 11 ft. high (from raised floor) suspended ceiling, supply air ducted - return not ducted (ceiling plenum) tilt up reinforced concrete walls.

Martin Baltimore

Power, computer	225 KVA supplied, 144 req.	0.80 pf
Power, air cond	70 Kw	0.84 pf
Volume, computer	51,200 cu ft	
Volume, air conditioner	6,400 cu ft	
Area, computer	2,560 sq ft	
Area, air conditioner	640 sq ft	
Floor loading	200 lbs/sq ft	
Capacity, air conditioner	50 Tons operational	
	10 Tons standby	
Weight, computer	38,670 lbs	

System was installed in a balcony area of the building, thus eliminating the advantage of a plenum. The floor was reinforced to suit loadings and covered with vinyl. All walls are insulated and provided with a moisture. Power for the computer is supplied from a dual source 13,200 volt to the operating requirement (208V) thus insuring the stability required. Power for the air conditioning is supplied from the plant supply.

Martin Orlando

Power, computer	104 Kw	174.7 KVA	1.0 pf
Includes peripheral equipment			
Power, air conditioner	50.8 Kw		
Volume, computer	19,000 cu ft		
Volume, air conditioner	9,600 cu ft		
Area, computer	1,900 sq ft		
Area, air conditioner	800 sq ft		
Room size, computer	38 ft x 50 ft		
Room size, air conditioner	40 ft x 20 ft		

IBM 709

Floor loading   26 lbs/sq ft

Floor loading   26 lbs/sq ft
                                    875 lbs concen max
Capacity, air conditioner   67.2 Tons
Weight, computer   49,220 lbs
  Special raised pedestal type floor. Trade name -
Belair.
     McDonnell
Power, computer   171 KVA
Area, computer   5,617 sq ft
Floor loading   100 lbs/sq ft
                           100 lbs concen max
Capacity, air conditioner   37 Tons
Weight, computer   55,640 lbs
     Northern States
Power, computer   191 KVA
Volume, computer   38,400 cu ft
Area, computer   3,200 sq ft
Capacity, air conditioner   100 Tons
Weight, computer   31,810 lbs
  New building, built in 1957, cement block and brick
construction, computer and auxiliary room installed
with floating floor, manufactured by Floating Floors
Inc., New York. Honeywell climate control regulates
temperature and humidity.

    Phillips
Volume, computer   23,072 cu ft
Volume, air conditioner   1,512 cu ft
Area, computer   2,884 sq ft
Area, air conditioner   189 sq ft
Capacity, air conditioner   60 Tons
  Raised floor, free access - installed in office
building.
    RCA Moorestown
Power, computer 525.2 Kw   188.2 KVA 447,610 BTU's
Volume, computer   21,600 cu ft
Area, computer   2,160 sq ft
Room size, computer   72 ft x 30 ft
Capacity, air conditioner   75 Tons
  Used for complete area. Entire building air condi-
tioned.
  Special heavy steel building included area sealed
off from remainder for electrical shielding purposes.
Raised floor (12 inches) on extruded aluminum over
concrete base floor. Computer receives cooled room
air (not underfloor plenum). Separate power distri-
bution within building.

IBM 709

RCA Patrick AFB

Power, computer 103.8 Kw	154.1 KVA	0.67 pf
Power, air cond	56.2 Kw	
Volume, air conditioner	4,500 cu ft	
Area, computer	2,800 sq ft	
Area, air conditioner	450 sq ft	
Room size, computer	40 ft x 70 ft	
Room size, air conditioner	20 ft x 20 ft	
	5 ft x 10 ft	
Capacity, air conditioner	44 Tons	
Weight, computer	45,690 lbs	
Weight, air conditioner	10,000 lbs	

Computer room has false floor with removable sections 2.5 feet square. Air conditioning ducts are above false ceiling. Indirect chilled water system for air conditioning.

RCA Canaveral

Power, computer 113.6 Kw	158.9 KVA	0.72 pf
Power, air conditioner	78.3 Kw	
Volume, computer	11,000 cu ft	
Volume, air conditioner	4,500 cu ft	
Area, computer	2,472 sq ft	
Area, air conditioner	450 sq ft	
Room size, computer	39 ft x 56 ft	
	9 ft x 32 ft	
	Adjoining "L"	
Room size, air conditioner	15 ft x 15 ft	
	15 ft x 15 ft	
Capacity, air conditioner	84 Tons	
Weight, computer	43,130 lbs	
Weight, air conditioner	10,000 lbs	

Concrete block building, false floor in machine room for cables, terminal rack for real time inputs and communications, fast acting switch to transfer critical power input to the industrial bank during power fluctuations, and direct expansion system for air conditioning.

Space Tech Labs (2)

Power, computer	160 KVA
Volume, computer	20,000 cu ft
Area, computer	2,000 sq ft
Floor loading	80 lbs/sq ft
Weight, computer	50,000 lbs

24 inch false ceiling and 18 inch raised floor.

System Development Corp

Power, computer 212 Kw	235 KVA	0.90 pf
M/G fed		
Power, air cond 69 Kw	78.5 KVA	0.88 pf
372 KVA full load rating		
Volume, computer	29,400 cu ft	
Volume, air conditioner	63,000 cu ft	
Area, computer	4,200 sq ft	
Area, air conditioner	2,528 sq ft	
Floor loading	250 lbs/sq ft	
	1,000 lbs concen max	
Capacity, air conditioner	400 Tons	
Weight, computer	54,000 lbs	

False ceiling, seven foot plenum, and concrete block building.

MIT

New building, false floor, 1 foot deep wiring plenum. False ceiling for air ducts and lighting conduits. Building concrete block, aluminum-foil-backed gypsum board interior to reduce water vapor intrusion. Power from new sub-station from 4160 volt building distribution system. Floor loading 125 lbs/sq ft special point loads handled by extra steel. False floor 1 1/4 inch plywood on light steel frame.

UCLRL

Power, computer	192 Kw	134 KVA	0.70 pf
Power, air cond	32 Kw	22 KVA	0.90 pf
Volume, computer		1,060 cu ft	
Volume, air conditioner		2,000 cu ft	
Area, computer		250 sq ft	
Area, air conditioner		360 sq ft	
Room size, computer		25 ft x 40 ft	
Room size, air conditioner		12 x 30 x 10 ft	
Floor loading		900 lbs concen max	
Capacity, air conditioner		30 Tons (nominal)	
Weight, computer		16,000 lbs	
Weight, air conditioner		16,000 lbs	

UCLA

Power, computer	250 KVA
Area, computer	4,700 sq ft

Class A building containing 25,000 square feet built especially to house computer and staff. Computer area incorporates false floor and ceiling plenum chambers, custom designed power connections, etc.

PRODUCTION RECORD
Manufacturer
Delivery on availability basis only.

COST, PRICE AND RENTAL RATES
Manufacturer

Type	Description	Model	Monthly Charge	Purchase Price
709	Central Process Unit	1	$10,000	$500,000
711	Card Reader	2	800	32,000
716	Printer	1	1,200	54,200
721	Card Punch	1	600	25,000
729	Magnetic Tape Unit	1	700	27,500
733	Magnetic Drum Storage	1	2,900	110,000
733	Magnetic Drum Storage	2	2,900	110,000
736	Power Supply	2	1,100	57,200
737	Magnetic Core Storage	3	3,700	192,400
737	Magnetic Core Storage	4	3,700	192,400
738	Magnetic Core Storage	1	19,700	940,000
740	CRT Recorder	1	2,450	96,000
741	Power Supply	2	1,400	72,800
741	Power Supply	3	1,400	72,800
746	Power Distribution Unit	2	1,400	72,800
746	Power Distribution Unit	3	1,300	67,600
755	Tape Control	1	1,500	90,000
766	Data Synchronizer	1	3,600	190,000
780	CRT Display	1	400	16,000

Monthly Rental, average system: $55,200 and up
Selling Price, average system: $2,630,000 and up
Maintenance contract available.

USA EPG Fort Huachuca

Rental rate for basic system is $68,900 per month.
Rental rate for additional equipment is $11,300 per month.
Maintenance is included in rental costs.

USN PMR Pt Mugu
On-line rentals are:

1	709	$48,130.00
13	Tape drives at $700	9,100.00
1	Card Reader	800.00
1	Card Punch	600.00
1	Printer	1,225.00
	Total monthly rental	$59,855.00

Off-line rentals are:

2	010 at $10	$ 20.00
3	024 at $40	120.00
9	026 at $60	540.00
4	Verifiers at 50	200.00
1	Sorter	55.00
1	Tabulator	1,002.50
1	Collator	247.00
1	Reproducer	204.00
1	Interpreter	216.00
1	Tape-to-Card	2,375.00
1	Card-to-Tape	3,365.00
1	Tape Printer (hi speed)	5,330.00
	Total monthly rental	$13,674.50

USN PMR Pt Mugu
Basic system
8K, 3 Data Synchronizers, 6 tapes rent for $42,905.
Peripheral Equipment rents for $3,450.

USN OTS China Lake
Basic system rents for $64,490 per month.
Electric Accounting Machines rent for $3,260/month.

NAFE FAA
Types 709, 711, 716, 721, 7291, 736, 738, 741, 746, 755, 766, and 776 rent for $50,450.
Types 714, 717, 757, 759, and 7291 rent for $5,750 per month.

CEIR
Basic system
709, 711, 716, 721, 729 (10), 755 (2), 766, 738, 736, 741, and 746 cost $2,014,900.
Additional equipment
774, 720, 714 also included with 704 cost $441,000.
709, 711, 716, 721, 729 (10), 755 (2), 766, 738, 741, and 746 rent for $50,075.
777, 720, and 714 rent at $12,707.
Standard IBM rental maintenance.

Douglas
Main frame, 13 magnetic tape units, 1 printer, 1 card reader, 1 card punch, and 28,672 words additional core memory rent at $52,000/month.

Douglas
Main frame, 10 magnetic tape units, 1 printer, and 28,672 words additional core memory rent at $51,000 per month.

Ford
Basic system rents for approximately $50,000/month including about $2,000/month for off line printer.

Hughes

Machine Type	No. of Units	Monthly Rental
709	1	$10,000
711	1	800
714 714	1	1,675
716	1	1,200
717	2	2,800
721	1	600
729	13	9,100
736	1	1,100
738	1	19,700
741	1	1,400
746	1	1,300
755	1	1,500
757	1	650
757	1	740
759	1	990
766	1	3,600
	Total	$57,155

Lockheed Burbank
With 32K core memory and 11 tapes, system rents at $450 per hour.
Additional Equipment
714 $22 per hour
722 16 per hour
720 34 per hour
The 709 (32K core, 11 tapes) rents at $49,825 per month, base shift.
Additional Equipment
714 $3,200 per month base shift
720 4,950 per month base shift
722 2,300 per month base shift

Lockheed Sunnyvale

Type	Description	Monthly Rental	Hourly Rate	Extra Shift per Hour
709	C.P.U. w/clock	$10,165	$57.76	$23.11
736	Power Supply	1,100	6.25	2.50
738	Core Memory	19,705	111.96	44.78
741	Power Supply	1,400	7.95	3.18
746	Power Dist.	1,300	7.39	2.96
766	Data Synch.	3,830	21.76	8.70
766	Data Synch. Mod.	125	.71	.28
A	Total Main Frame	37,625	213.78	85.51
755	Tape Control	1,500	8.52	3.41
755	Tape Control	1,500	8.52	3.41
729	Tape Units (12)	8,400(12)	47.72 (12)	19.09(12)
711	Card Reader	800	4.54	1.82
716	Printer	1,200	6.82	2.73
721	Card Punch	600	3.41	1.36
9307	Paper Tape I/O	1,300	7.39	2.96
B	Total On Line	15,300	86.92	34.78
	Total 709 (A + B)	$52,925	300.70	120.29
720A	Printer	1,950	11.08	4.43
727	Tape Unit	550	3.12	1.25
760	Control	2,500	14.20	5.68
	Total Printer 1	5,000	28.40	11.36
722	Card Punch	875	4.97	1.98
727	Tape Unit	550	3.12	1.25
758	Control	850	4.83	1.93
	Total Tape to Card	2,275	12.92	5.16
714	Card Reader	1,650	9.38	3.75
727	Tape Unit	550	3.12	1.25
759	Control	975	5.54	2.22
	Total Card to Tape	3,175	18.04	7.22
729	Tape Unit	700	3.98	
C	Total Off Line	$11,150	$63.34	$23.74
	Total System 1 (A+B)	$64,075	$364.04	$144.03

The 766 Data Synchronizer Mod. is used to handle paper tape I/O.
The 9307 consists of 9307 Paper Tape Read Punch and 9807 Reader Punch Control.
Monthly rental includes 10% F. E. T. where applicable)
Hourly rate is 1/176th of monthly rental.
Extra shift per hour is 40% of 1/176th of monthly rate.

709	C.P.U. w/clock	$10.050	$57.10	$22.84
736	Power Supply	1,100	6.25	2.50
738	Core Memory	19,700	111.93	44.77
741	Power Supply	1,400	7.95	3.18
746	Power Dist.	1,300	7.38	2.95
766	Data Synch.	3,600	20.45	8.18
A	Total Main Frame	$37,150	$211.06	$84.42
755	Tape Control	1,500	8.52	3.41
755	Tape Control	1,500	8.52	3.41
729	Tape Units (12)	8,400(12)	47.72(12)	19.09(12)
711	Card Reader	800	4.54	1.82
716	Printer	1,200	6.82	2.73
721	Card Punch	600	3.41	1.36
B	Total On Line	$14,000	$79.53	$31.82

		Monthly Rental	Hourly Rate	Extra Shift per Hour
	Total 709 (A+B)	$51,150	$290.59	$116.24
720A	Printer	1,950	11.08	4.43
729	Tape Unit	700	3.98	1.59
760	Control	2,500	14.20	5.68
	Total Printer 2	5,150	29.26	11.70
C	Total Off Line	$5,150	$29.26	$11.70
	Total System 2 (A+B+C)	$56,300	$319.85	$127.94
	Total Installation (709 Systems 1 + 2)	$120,375		
010	Key punch	$11.00	$ .06	$ .03
026	Key punch	66.00	.37	.19
026	Key punch	71.00	.40	.20
026	Key punch	77.00	.44	.22
026	Key punch	71.50	.41	.20
026	Key punch	71.50	.41	.21
026	Key punch	71.50	.41	.20
056	Verifier	60.50	.34	.17
056	Verifier	60.50	.34	.17
056	Verifier	55.00	.31	.15
	Total Key punch	$615.50	3.49	1.74
082	Sorter	68.20	.39	.20
085	Collator	154.00	.87	.44
407	Acctng. Machine	915.75	5.20	2.60
519	Reproducer	161.70	.92	.46
519	Reproducer	178.20	1.01	.50
557	Interpreter	192.50	1.09	.55
	Total Auxiliary	$1,670.35	$9.48	$4.75
	Total Unit Record	$2,285.85	$12.97	$6.49
	Total Sunnyvale Installations	$122,660.85		

Palo Alto

Type	Description	SN	Monthly Rental	Hourly Rate	Extra Shift per Hour
	Univac	22	$20,980.00	$119.20	$59.60
	Core Storage		4,500.00	25.57	12.79
	Float Point		1,545.00	8.78	4.39
	Variable Block		290.00	1.65	.83
A	Total Main Frame		27,315.00	155.20	77.61
	Uniservo (10)		3,200.00(10)	18.18(10)	9.09(10)
	Read Punch		890.00	5.06	2.53
B	Total On Line		4,090.00	23.24	11.62
	Total EDP 22 (A+B)		$31,405.00	$178.44	$89.23
	Univac	27	20,980.00	119.20	59.60
	Core Storage		4,500.00	25.57	12.79
	Floating Point		1,545.00	8.78	4.39
	Variable Block		290.00	1.65	.83
C	Total Main Frame		$27,315.00	$155.20	$77.61
	Uniservo (10)		3,200.00(10)	18.18(10)	9.09(10)
	Read Punch		890.00	5.06	2.53
D	Total On Line		$4,090.00	$23.24	$11.62
	Total EDP 27 (C+D)		$31,405.00	$178.44	$89.23
	High Speed Printer		3,300.00	18.75	9.38
	High Speed Printer		3,300.00	18.75	9.38
	Card to Tape		2,605.00	14.80	7.40
D	Total Off Line		9,205.00	52.30	26.16
	Total EDP Systems (A+B+C+D+E)		$72,015.00	$409.18	$204.62
026	Key punch		77.00	.43	.22
026	Key punch		71.50	.41	.20
026	Key punch		71.50	.41	.21
056	Verifier		60.50	.37	.19
A	Total Key punch		$280.50	$1.62	$.82
077	Collator		126.50	.72	.36
082	Sorter		68.20	.39	.20
407	Acctg. Machine		915.75	5.20	2.60
519	Reproducer		178.20	1.01	.51
552	Interpreter		99.00	.56	.23
B	Total Auxiliary		$1,387.65	$7.88	$3.90
	Total EAM (A+B)		$1,668.15	$9.50	$4.72
	Total Palo Alto		$73,683.15		

Martin Baltimore

709 System - 10 tapes (on line), CRT, Punch, Card Reader, Printer, 2 tapes (off line), Card Punch & Reader, Printer $63,350/month.

3 Hand Punches, 3 Key Punches, 2 Verifiers, Sorter, Collator, Tabulator, 2 Reproducing Punches, Interpreter, Cardatype Tape Punch $2,368/month.

Total system rents for $385/hour.

Off line Card Punch 20/hour
Off line Printer 35/hour
Off Line Reader 30/hour

Martin Orlando

			Monthly Rental
		Qty	Total
709	Central Processing Unit	1	$10,090
729	Mod. I Tape Units	13	5,100
711	Card Reader	1	800
738	Magnetic Core Storage	1	19,705
755	Tape Control Unit	2	3,000
766	Data Synchronizer	1	3,830
716	Printer	1	1,200
721	Punched Card Recorder	1	600
776	Tape Switching Device	1	75
736	Power Supply	1	1,100
741	Power Supply	1	1,400
746	Power Distribution Unit	1	1,300
714	Card Reader	1	1,500
759	Card Reader Control Unit	1	915
720A	Printer	1	1,900
760	Printer Control & Storage	1	2,500
774	Tape Data Selector	1	2,300
747	TDS Power Supply	1	500
		Total	$57,815

McDonnell

The 709 with 11 tapes, card reader, card punch, on-line printer, and one data synchronizer cost $2,421,300 and rents at $50,560/month.

The 717, 757, 727's, 722, 758, 720, 760, 714, 759, 9701, 9702, 024, 026, 056, 046, 082, 077, 519, 552, and 407 cost $741,800 and rents at $19,650/month.

Northern States

		Qty	Monthly Rental	Price
709	Central Processing Unit	1	$10,000	$500,000
711	Card Reader	1	800	32,000
716	Printer	1	1,200	54,200
721	Card Punch	1	600	25,000
729	Tape Units	13	9,100	357,500
736	Power Unit	1	1,100	57,200
737	Core Storage	2	7,400	384,800
741	Power Unit	1	1,400	72,800
746	Power Unit	1	1,300	67,600
755	Tape Control	2	3,000	180,000
766	Data Synchronizer	1	3,600	190,000
	Total Computer		39,500	1,921,100
714	Card Reader	1	2,960	127,650
722	Card Punch	3	5,850	292,500
720A	Printer	3	14,850	666,600
408	Printer	1	1,273	70,500
407	Printer	1	899	43,750
024	Keypunch	14	924	27,300
026	Printing Keypunch	4	380	12,000
056	Verifier	6	330	14,400
083	Sorter	2	250	12,400
085	Collator	1	138	7,700
101	Statistical Sorter	2	924	48,000

519	Reproducer	5	1,155	32,750
557	Interpreter	6	1,735	92,040
			31,668	1,447,590

Phillips

The 709, 711, 714, 716, 717, 720 II, 721, 722, 13-729's Mod 1, 736, 2-737's, 741, 2-755's, 757, 758, 759, 760, 766, 746 monthly rental, excluding taxes, prime shift is $50,460.

RCA Moorestown

Type	Description	Qty	Monthly Rental
709	Central Processing Unit	1	$10,000
711	Punch Card Reader	1	600
716	Alphabetical Printer	1	1,200
721	Punch Card Recorder	1	600
729	Magnetic Tape Unit (700)	12	8,400
755	Tape Control Unit (1,500)	2	3,000
738	Magnetic Cone Storage	1	19,700
740	Control Output Recorder	1	2,450
780	Display Unit	1	400
736	Power Frame No. 1	1	1,100
741	Power Frame No. 2	1	1,400
746	Power Distributor Unit	1	1,300
766	Data Synchronizer (3,600)	2	7,200
714	Card Reader	1	1,075
759	CD Reader Control	1	975
720	Printer	1	1,000
760	Control & Storage Unit	1	7,500
722	Card Punch	1	800
758	CD Reader Control	1	975

RCA Patrick AFB

The 026 Key punch, 709 CPU, 716 Printer, 727 Mag Tape, 736 Power, 711 Card Rdr, 721 Punch, 729 Mag Tape (12), 737 Core Storage (2), 741 Power, 755 Tape Ctrl, 776 Tape SW, 746 Power, and 766 Data Syn rents at $40,285/month.

The 714 Card Rdr, 757 Control, 9200 Converter, 717 Printer, and 759 Control rents at an additional $8,325/month.

RCA Canaveral

The 709 CPU, 716 Printer, 729 Mag tape (8), 737 Core Storage (2), 711 Card Rdr, 721 Punch, 736 Power, 741 Power, 746 Power, 766 Data Synch (3), 755 Tape Ctrl (2) and 776 Tape SW rent at $43,650/month.

The 717 Printer, 024 Key punch, 407 Acctg Mach, 548 Interpreter, 757 Control, 047 Tape to Card, and 519 Reproducer rent at an additional $3,343/month.

Space Tech Labs (2)

Cost of installation would be $2,558,800 each. Monthly rental is $53,900 per month. System is rented.

System Development Corp

32K memory, 2 DSU's, 4 TCU's, 20 mag. tapes, reader, punch, printer rent at $70,000/month for 176 hours.

717 Print System, 714 Card Read System, (2) 722 Punch Systems rent at $11,500/month for 176 hours.

MIT

Type	Description
709	Central Processing
711	Punch Card Reader
716	Alphabetic Printer
721	Punch Card Recorder
729 x 10	Magnetic Tape Unit
736	Power Frame 1
738	Magnetic Core Storage
740	Cathode Ray Tube Recorder
741	Power Frame 2
746	Power Distribution
755 x 2	Tape Control Unit
766	Data Synchronizer
780	Cathode Ray Tube Display

Total cost $2,526,670.
Total rental $52,765/month.

714	Card Reader
717	Printer
720	Printer
722	Card Punch
729 x 2	Magnetic Tape Unit
757	Printer Control
758	Card Punch Control
759	Card Reader Control
760	Control Storage
776	Special EDPM Unit

Total cost $593,975.
Total rental is $12,445/month.
The system is rented.

UCLA

Basic system and peripheral equipment is on loan rent-free. The maintenance is donated.

PERSONNEL REQUIREMENTS

Manufacturer

Education, training, program testing, technical assistance on all phases is available.

USA BMA Redstone

	One 8-Hour Shift
Supervisors	1
Programmers	49
Clerks	10
Librarians	1
Operators	2
Engineers (IBM)	5
In-Output Oper	1

Two operators required for each additional extra shift.

Day shift is monitor run on 709.

Operators are used on 704's, 705, and 709 - rotating shifts. Other personnel on 8 hours shift.

Engineers rotate shifts on 704's and 709.

Operation tends toward open shop.

USA EPG Fort Huachuca

	One 8-Hour Shift Used	Two 8-Hour Shifts Recomm	Three 8-Hour Shifts Recomm
Supervisors	1	2	3
Librarians	1	1	1
Operators	1	2	3
In-Output Oper	2	3	4
Tape Handlers	1	2	3

Operation tends toward closed shop.

Methods of training used includes formal classroom training with about 50% on-the-job training interspersed over a 5 week period. Continuous on-the-job training and routine of operators.

Personnel figures shown above do not include personnel in the process of on-the-job training.

All operating personnel are military, therefore, turnover is very heavy.

USN PMR Pt Mugu

	Two Shifts
Supervisors	4
Analysts	5
Programmers	15
Coders	5
Clerks	2
Librarians	2
Operators	11

IBM supplies engineers (generally 3). In addition to the above, there are about 12 people in the machine room doing key-punching, routine sorting, etc. We also have a Systems Group of about 8 programmers who are building their own, special purpose operating system.

Our operation is closed shop as regards the actual machine operation, but open shop as regards programming.

We use all the standard training procedures, but depend most heavily on "on-the-job" training for machine operators; and both in-shop courses and supervisory instruction for programmers.

USN PMR Pt Mugu

	One 8-Hour Shift
Supervisors	2
Programmers	4
Clerks	1
Operators	1
Engineers	1

Operation tends toward closed shop.
Operators are trained on-the-job and programmers by informal training from supervisor.

USN OTS China Lake

	1st Shift
Supervisors	1
Analysts-Programmers-Coders	14
Clerks	1
Operators	4
In-Output Oper	6

Two additional operators are used on second 8-hour shift.
Operation tends toward open shop.
Training is in-house. All mathematicians possess BS degree or higher.

NAFE FAA

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	30	30
Clerks	1	1
Librarians	1	1
Operators	2	2
Engineers	1	1
Technicians	2	2
In-Output Oper	1	1

Operation tends toward closed shop.
Methods of training used includes IBM schools for programming, and in-house training for operators.

CEIR

	Total for One 8-Hour Shift		Total for Two 8-Hour Shifts		Total for Three 8-Hour Shifts	
	U	R	U	R	U	R
Supvr	1	1	2	2	3	3
Program	17	17	17	17	17	17
Clerks	1	1	1	1	1	1
Librar	1	1	1	1	1	1
Operator	1	1	2	2	3	3
In-Outp	1	1	2	2	3	3

For the purpose of this personnel requirement, our staff was cut in half, since our staff operates both a 704 and a 709. We have one dispatcher, program librarian, magnetic tape librarian, etc., to handle both computers.
Operation tends toward open shop.
Operators are given on-the-job training.
Programmers are given a 6-month course evenly divided between formal classes and on-the-job training.

Douglas

	One 8-Hour Shift
Supervisors	1
Analysts-Programmers-Coders	30
Clerks	1
Operators	5

Operation tends toward closed shop.
Own course followed by on-the-job training.

Douglas

	One 8-Hour Shift
Supervisors	3
Analysts-Programmers-Coders	70
Clerks	2
Operators	5

Operation tends toward closed shop.
Own course followed by On-the-job training.

Ford

	One 8-Hour Shift		Two 8-Hour Shifts	
	Used	Recommended	Used	Recommended
Supervisors	4	6		
Analysts-Prog	18	30		
Clerks	0	2		
Librarians	0	1		
Operators	12	15	0	3
Technicians	2	3	0	1
In-Output Op	1	1	0	1
Tape Handlers	0	1	0	1

Operation tends toward open shop.
Methods of training used include hiring trained people, on-job training or classes taught by Aeronutronic personnel, and IBM-supplied classes.

Hughes

	First 8-Hour Shift	Second 8-Hour Shift	Third 8-Hour Shift
Supervisors	4	1	
Analysts	7		
Programmers	8	3	1
Clerks	3		
Librarians	1		
Operators	2	1	1

Three shift total is 32.
Operation tends toward open shop.
On-the-job training is given in conjunction with company sponsored classes.

IBM Space

	Three 8-Hour Shifts
Supervisors	5
Analysts	10
Programmers	25
Coders	10
Clerks	5
Librarians	1
Operators	8
Engineers	3
In-Output Oper	3
Tape Handlers	2

Operation tends toward closed shop.
Methods of training used include formal class instruction in basic programming and machine operation – 3 to 4 weeks, informal class instruction held at Center covering specific system used here, and supervised programming assignments.

Lockheed Burbank

	Three 8-Hour Shifts
Supervisors	4
Analysts	15
Programmers	43
Clerks	2
Operators	7
Engineers	10 (Recommended)

Operation tends toward closed shop.
All new personnel attend a class which covers the use of Fortran and also machine coding. This class lasts about 4 weeks.

Lockheed Sunnyvale

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	5	6
Programmers	130	
Clerks	2	3
Librarians	2	2
Operators	12	14
In-Output Oper	7	8

Operation tends toward closed shop.
Training is rendered by shift leaders, IBM Customer Engineers, and IBM Applied Science Representatives.
Supervisors includes Supervisor and shift leaders.

Operating analysts function is accomplished by supervisor and shift leaders. Programming is accomplished by separate department from Operations. The number of programmers recommended depends upon the number of functions being performed at LMSD. Scientific, Flight Data Reduction, and Administrative Data are processed on the two IBM 709 computer systems. Coders and programmers are synonymous at LMSD. Tape handlers are included under "Operators".

Martin Baltimore

| | One 8-Hour Shift | |
	Used	Recommended
Supervisors	4	6
Analysts	2	4
Programmers	13	17
Coders	2	4
Clerks	2	2
Librarians	0	1
Operators	7	8

Two additional operators are required for second 8-hour shift.

Operation tends toward closed shop.

Classes for newcomers given by our own personnel.

Martin Orlando

| | Three 8-Hour Shifts | |
	Used	Recommended
Supervisors	1	1
Analysts	2	3
Programmers	15	
Librarians	1	
Operators	7	7
Engineers	5	5

Operation is closed shop.

For non-experienced personnel, an on-the-job full time training program of approximately three weeks, plus close supervision for at least six months, is given.

McDonnell

| | First 8-Hour Shift | | Second 8-Hour Shift | |
	U	Recom	U	Recom
Supervisors	5	5	1	1
Programmers	31	31		
Librarians	1	1		
Operators	2	2	2	2

Operation tends toward closed shop.

Methods of training used includes initial two-week training course, followed by on-the-job training with an experienced programmer.

Northern States

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	9
Librarians	1
Operators	1
In-Output Oper	7

Four additional operators are required for second 8-hour shift and two additional operators for the third 8-hour shift.

Operation tends toward closed shop.

IBM Programming School and on-the-job training is used.

Phillips

	Total for One 8-Hour Shift	Total for Two 8-Hour Shifts	Total for Three 8-Hour Shifts
Librarians	1	1	1
Operators	1	2	3
In-Output	0 2	3	3
Tape Hand	1	2	2

Above figures includes only operating personnel. Analysts, programmers, coders, etc. operate as a team to serve all computing and EAM systems.

Operation tends toward closed shop.

Training is by lessor of equipment and on-the-job.

RCA Moorestown

| | Three 8-Hour Shifts | |
	Used	Recommended
Supervisors	4	7
Analysts	3	5
Programmers	17	22
Coders	8	11
Clerks	2	2
Librarians	0.3	0.5
Operators	7	10
Engineers	5	5
Technicians	2	5
In-Output Oper	5	7

Operation tends toward closed shop.

Methods of training used includes in-house, both formal classes and on the job, for both programmers and all operating personnel. We rarely send personnel to the manufacturer's classes. We extensively use individual mentors; each new person comes in at random times of the year, and is separately guided.

This is basically a scientific computing facility, solving engineering problems on missiles and surface radar equipment. However, we do spare parts lists and drawing indexes as 8% of our total load, using "commercial" programming systems. We use FORTRAN 709 and SOS for engineering computations.

RCA Patrick AFB

| | Three 8-Hour Shifts | |
	Used	Recommended
Supervisors	7	7
Analysts	12	12
Programmers	24	24
Coders	3	3
Operators	10	10
Engineers	1	1
In-Output Oper	6	6

Operation tends toward closed shop.

Methods of training used includes IBM courses, on-the-job training, and a training manual developed in-house.

RCA Canaveral

| | One 8-Hour Shift | |
	Used	Recommended
Supervisors	1	2
Analysts	5	5
Programmers	5	5
Secretary	1	1
Operators	3	3
Engineers	2	2

Operation tends toward closed shop.

Methods of training used includes training courses conducted locally by IBM Applied Science representatives, on-the-job training provided by programmers and the more experienced operators, and manuals.

The operation performed at this facility is unique in that personnel must be familiar with the computer system as well as range operations. As a consequence it takes special requirements for personnel to qualify as computer operators, programmers, analysts, and engineers at this facility.

Space Tech Labs (2)

	Three 8-Hour Shifts
Supervisors	10
Analysts	3
Programmers	30
Clerks	1
Librarians	0.5
Operators	5
Engineers	1
Technicians	2
In-Output Oper	1
Tape Handlers	0.5

Above figures are for each system.

Operation tends toward closed shop.

Methods of training used includes IBM local short courses, an internal two-week course, and on-the-job training.

System Development Corp

	Three 8-Hour Shifts
Supervisors	2
Analysts	2
Clerks	2
Operators	15

Operation tends toward closed shop.

Internal formal classroom and on-the-job training are used.

MIT

	Total for One 8-Hour Shift	Total for Two 8-Hour Shifts	Total for Three 8-Hour Shifts
	R	U	R	R
Supervisors	2	2	3	4
Librarian	1	1	1	1
Operators	3	4	4	5
Engineers	2	2	2	2
Technicians	1	0	2	2
In-Output	0 2	3	3	4
Tape Handl	2	3	3	4

This computing facility is run as a Laboratory service for any and all members of the research staff. There is no formal distinction of activity such as analyst, programmer, etc. About 70 persons are regular users. There are two small groups, totalling some 15 persons, whose primary role is to write programs and utility systems in support of research projects.

The facility is on a two-shift operation but is staffed for a possible third shift in the future.

The machine is maintained by IBM engineers. Technician help is variously obtained as needed from an activity primarily working on research items.

Operation tends toward open shop.

Methods of training used includes on-the-job instruction by supervisors. Scheduled classes by qualified members of the Laboratory staff are given.

UCLRL

	Seven days/week
Supervisors	1
Programmers	21
Coders	5
Operators	9

Operation tends toward open shop.

Personnel are trained by working with an experienced person.

UCLA

	Total for One 8-Hour Shift	Total for Two 8-Hour Shifts
Supervisors	1	2
Analysts	2	2
Programmers	3	3
Coders	0	0
Clerks	4	4
Librarians	0.5	0.5
Operators	2	4
Engineers	4	4
Technicians	0	0
In-Output Oper	1	1

For two 8-hour shift operation, a full time librarian is recommended. For three 8-hour shifts, three supervisors are recommended.

Operation is open shop programming, closed shop machine operation.

Short Fortran programming classes and apprenticeship system is used.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA BMA Redstone
Good time	113.1 Hours/Week (Average)
Attempted to run time	116.6 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.969

Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 1 Jan thru 31 Mar 60
Time is not available for rent to outside organizations.

USA EPG Fort Huachuca
Figures based on period 1 Sep 59 to 1 Sep 60
Passed Customer Acceptance Test 1 Feb 59
Time is available for rent to qualified outside organizations.

USN PMR Pt Mugu
Average error-free running period	3.5 Hours
Good time	55.6 Hours/Week (Average)
Attempted to run time	60.4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.921

Above figures based on period 1 Feb 60 to 29 Feb 60
Passed Customer Acceptance Test 8 Jan 60
Time is available for rent to qualified outside organizations.

USN PMR Pt Mugu
Average error-free running period	7 Hours
Good time	35.2 Hours/Week (Average)
Attempted to run time	37.1 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.948

Above figures based on period 1 Feb 60 to 28 Feb 60
Passed Customer Acceptance Test 15 Aug 59
Time is available for rent to qualified outside organizations.

USN OTS China Lake
Good time	100 Hours/Week (Average)
Attempted to run time	105 Hours/Week (Average)
Operating ratio	0.95

Above figures based on period 1 Apr 60 to 30 Apr 60
Passed Customer Acceptance Test 13 Jan 60
Time is available for rent to qualified outside organizations. Availability is dependent on workload.

NAFE FAA
Average error-free running period	40 Hours
Good time	40 Hours/Week (Average)
Attempted to run time	41 Hours/Week (Average)
Operating ratio	0.98

Above figures based on period from Jan 60 to Apr 60
Passed Customer Acceptance Test Oct 59
Time is not available for rent to outside organizations.

CEIR
Good time	47.5 Hours/Week (Average)
Attempted to run time	50.5 Hours/Week (Average)
Operating ratio	0.94

Above figures based on period 10 Feb 59 to 1 Jan 60
Passed Customer Acceptance Test 10 Feb 59
Time is available for rent to outside organizations.

Douglas
Average error-free running period	6 Hours
Good time	110 Hours/Week (Average)
Attempted to run time	115 Hours/Week (Average)
Operating ratio	0.95

Above figures based on period from Jul 59 to Jul 60
Passed Customer Acceptance Test Feb 59
Time is available for rent to outside organizations.

Douglas
Average error-free running period	6 Hours
Good time	110 Hours/Week (Average)
Attempted to run time	115 Hours/Week (Average)
Operating ratio	0.95

Above figures based on period from Sep 59 to Jul 60
Passed Customer Acceptance Test Sep 59
Time is available for rent to outside organizations.

Ford
Average error-free running period   10 Hours
Good time   95 Hours/Week (Average)
Attempted to run time   101 Hours/Week (Average)
Operating ratio   0.94
Above figures based on period 23 Mar 60 to 23 May 60
Passed Customer Acceptance Test   23 Mar 60
Time is available for rent to outside organizations.

Hughes
Good time   127 Hours/Week (Average)
Attempted to run time   14 Hours/Week (Average)
Operating ratio   0.95
Above figures based on period 16 May 60 to 22 May 60
Passed Customer Acceptance Test Apr 59
Time is available for rent to outside organizations.
   Analysis of the 14 hour figure includes: machine
failure, rerun time, operator error, time lost due
to program failure.
   An additional 13 hours down time should be added
for preventive maintenance care.
   There were 14 hours during this period considered
idle time.

IBM Space
Good time   130 Hours/Week (Average)
Attempted to run time   134 Hours/Week (Average)
Operating ratio   0.97
Above figures based on period 1 Mar 60 to 1 Jun 60
Passed Customer Acceptance Test Sep 59
Time is not available for rent to outside organizations.

Lockheed Burbank
Average error-free running period   6 Hours
Good time   126 Hours/Week (Average)
Attempted to run time   148 Hours/Week (Average)
Operating ratio   0.85
Above figures based on period from Jan 60 to Apr 60
Passed Customer Acceptance Test May 59
Time is not available for rent to outside organizations.

Lockheed Sunnyvale
Average error-free running period 31 hours/system
Good time   258.53 Hours/Week (Average)
Attempted to run time   269.71 Hours/Week (Average)
Operating ratio   0.9585
Above figures based on period 1 Jan 60 to 1 Apr 60
Passed Customer Acceptance Test 1-29 Dec 58; 2-4 Aug 59
Time is available for rent to qualified outside organizations.
   Statistics are based on elapsed time totals of two
(2) 709 systems.

Martin Baltimore
Good time   70 Hours/Week (Average)
Attempted to run time   74 Hours/Week (Average)
Operating ratio   0.94
Above figures based on period from Mar 60 to May 60
Passed Customer Acceptance Test Oct 59
Time is available for rent to outside organizations.

Martin Orlando
Good time ⸌   110 Hours/Week (Average)
Attempted to run time   115 Hours/Week (Average)
Operating ratio   0.96
Above figures based on period 1 Jan 60 to 31 May 60
Time is available for rent to qualified outside organizations.

McDonnell
Good time   100 Hours/Week (Average)
Attempted to run time   106 Hours/Week (Average)
Operating ratio   0.941
Above figures based on period 4 Apr 60 to 29 Apr 60
Passed Customer Acceptance Test 3 May 60
Time is available for rent to outside organizations.

Northern States
Good time   99 Hours/Week (Average)
Attempted to run time   106 Hours/Week (Average)
Operating ratio   0.934
Above figures based on period 1 Jun 60 to 30 Jun 60
Passed Customer Acceptance Test May 59
Time is not available for rent to outside organizations.

Phillips
Good time   77 Hours/Week (Average)
Figure based on period 1 Feb 60 to 31 Mar 60
Time is not available for rent to outside organizations.

RCA Moorestown
Good time   115 Hours/Week (Average)
Attempted to run time   138 Hours/Week (Average)
Operating ratio   0.90
Above figures based on period from Jan 60 to Jun 60
Passed Customer Acceptance Test 18 Jun 59
Time is not available for rent to outside organizations.
   Excellent operational experience during initial
3 months, poor experience for several months follow-
ing due to stress placed on computer by excessive
humidity, temperature, and power failure conditions.

RCA Patrick AFB
Good time   67 Hours/Week (Average)
Attempted to run time   72 Hours/Week (Average)
Operating ratio   0.93
Above figures based on period 1 Nov 59 to 31 Mar 60
Passed Customer Acceptance Test 8 Jul 59
Time is not available for rent to outside organizations.
   Figures are based on production usage only.

RCA Canaveral
Average error-free running period   1 Week
Good time   80 Hours/Week (Average)
Passed Customer Acceptance Test 8 Jan 59
Time is not available for rent to outside organizations.

From 8 Jan 59 to Nov 59   99% reliability
From Nov 59 to May 60   96% reliability

Space Tech Labs (2)
Good time   108 Hours/Week (Average)
Attempted to run time   123 Hours/Week (Average)
Operating ratio   0.88
Above figures based on period from Apr 60 to Jun 60
Passed Customer Acceptance Test Apr 59 and Jan 60
Time is available for rent to qualified outside organizations.

System Development Corp
Good time   120 Hours/Week (Average)
Figure based on period from Dec 59 to Jun 60
Passed Customer Acceptance Test   Dec 58
Time is not available for rent to outside organizations.
   120 hours/week is defined as available time used,
exclusive of all forms of maintenance and down time.

MIT
Good time   84 Hours/Week (Average)
Attempted to run time   86 Hours/Week (Average)
Operating ratio   0.98
Above figures based on period 1 Apr 60 to 1 Aug 60
Passed Customer Acceptance Test   15 Feb 59
Time is not available for rent to outside organizations.

UCLRL
Good time   145 Hours/Week (Average)
Attempted to run time   161 Hours/Week (Average)
Operating ratio   0.90
Above figures based on period from Sep 58 to Jul 60
Time is not available for rent to outside organizations.

UCLA

Average error-free running period   75 Hours
Good time   110.4 Hours/Week (Average)
Attempted to run time   112.5 Hours/Week (Average)
Operating ratio   0.981
Above figures based on period 1 Jan 60 to 31 May 60
Passed Customer Acceptance Test   18 Oct 58
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include high speed, large memory, compatibility with 704 and 7090, and a rich operation code set.

Unique system advantages include overlap input and output operations with computing with very low memory interference rate and convert commands for facilitating Binary-Decimal conversions.

Many special features and attachments are available on "Request for Price Quotation" basis; i.e. clocks, data channel trap, extended precision, direct data device, tape switches, etc.

Recommended procedures for magnetic tape storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage:

Acetate Base Tape:

Storage for frequent usage.
Relative humidity 40 to 60%
Temperature 65 to 80°F.

Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, the following specifications would apply:

Storage for infrequent usage.
Temperature 40 to 120°F.

The tape must be placed in a dust proof container and hermetically sealed in a plastic bag. Before re-using, the tape must be reconditioned by allowing it to remain in the conditioned atmosphere for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

Mylar Base Tape:

Storage for frequent or infrequent usage.
Relative humidity 0 to 80%
Temperature 40 to 120°F.

The tape should be stored in a dust proof container. Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, it must be reconditioned by allowing it to remain at the given condition for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours. The upper limits on humidity is given to prevent the formation of fungus and mold growth. This limit may be exceeded by hermetically sealing the tape in a plastic bag.

General Precautions:

The tape should not come in contact with magnetic material at any time and should never be subjected to strong magnetic fields. Either of these can cause the loss of information or the introduction of noise.

When shipping magnetic tape, the reel should be placed in a dust proof container and hermetically sealed in a plastic bag. Additional support should be obtained by enclosing in an individual cardboard box.

USA BMA Redstone

Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage

are external labels - pressure adhesive, tape cabinet storage, and for humidity, tapes are stored in computer room.

USN PMR Pt Mugu

Outstanding features are entry of digital telemetry data (PDM, FM, and PCM) from analog tapes. Direct entry of remote site radar and COTAR data. Output may also be to x-y plotters or 30 channel oscillograph.

Magnetic tape is stored in computer room for humidity and temperature protection.

USN PMR Pt Mugu

Outstanding features are directly connected plotting boards for display of impact prediction information, direct entry of FPS-16 Radar and AME COTAR Data from remote sites, digital to analog conversion of output/replacing, CRT system, and direct data RPQ on channels B & D.

Unique system advantages include cubic DH14 DMS input 6 channel, radar and/or COTAR information, and direct through channel D with computer interrupt.

Magnetic tapes labelled and stored in computer room for humidity and temperature protection.

USN OTS China Lake

Outstanding features include dual read/write heads on 729 Tape Units and the data synchronizer.

Tapes are stored in standard tape storage cabinets under controlled humidity and temperature conditions.

NAFE FAA

Tapes are stored in containers in the 709 room and thus under temperature and humidity control.

CEIR

Tapes are labelled with Labelon Plastic Tape, they are shipped in special metal cases, they are stored in humidity and temperature controlled rooms, and fire extinguishers are placed throughout machine room and tape room.

Hughes

Outstanding features are high speed and reliability and the data synchronizer for simultaneous input, output, compute.

Tapes are stored in a humidity and temperature controlled storage room.

IBM Space

Outstanding features are data communications channel and direct data modification package to allow for high speed teletype input and specialized output for real-time operations, three channel operation for maximum overlapping operation, internal accounting clock and interval timer, and a tape switching device.

Tapes are stored in air conditioned, non-smoking areas in racks and cabinets. All tapes are numbered and catalogued as used; a punched card tape log is maintained. Little tape shipping is done.

Lockheed Burbank

An outstanding feature is that all work is run under a Monitor System which gives us the maximum usage of the machine.

Lockheed Sunnyvale

Outstanding features include a powerful set of input/output commands, indirect addressing, automatic priority processing, real time input, full word sense indicators, read-compute-write facilities, and a buffered input/output.

Magnetic tape labels are color coded for TTC, CTT, reserved and TTP with written identification and instructions. Some labels are machine printed for repeat jobs. Storage in original plastic containers and in conventional reel cabinets. Tapes are shipped (very little required) in original containers, plastic bag and cardboard cartons. Tapes are retained in the computer room where the temperature and humidity

is maintained at the recommended level. Studies are being made for acquisition of suitable fireproof containers for those tapes requiring special consideration.

System summary:
Binary (36 bits/word)
Single address - parallel operation
3 Index Registers
32,000 words of 12 microsecond access
Fixed and floating point commands
1 to 3 card readers (250 cards/min)
1 to 3 card punches (100 cards/min)
1 to 3 printers (150 lines/min)
Cathode ray display
15,000 char/sec magnetic tape

Martin Baltimore
Tapes are stripped once each month.

Martin Orlando
Tapes are stored in humidity controlled machine room. Protection against damage is maintained by retention file of early cycle master tapes in a remote area.

RCA Moorestown
Outstanding features are that the computer is used in a real-time control loop at the BMEWS Engineering Model Tracking Radar.

All tapes are stored in a computer area, TABCO Storage Bins. Magnetic tapes assigned by usage class, labels removed after printing unless permanent labels are used.

Present peripheral equipment consists of two 720 printers, one 714 card/tape device, and one 722 tape/card punch.

RCA Canaveral
An outstanding feature is the service provided by IBM.

Majority of tapes are classified. They are labelled and stored in a secure walk-in cage which is perforated for air conditioning and humidity control purposes. Label is a 1"x1" sticker.

This installation's primary function is the real time support of ballistic missile launches. Secondly, it is used for data reduction.

FUTURE PLANS

USA EPG Fort Huachuca
IBM 1401 Tape System to replace the present peripheral equipment.

USN PMR Pt Mugu
Future plans provide for the continuing operation of the present computer system and concentration of development effort on the direct linkage of the computer to external instrumentation. The ultimate goal is to minimize the calendar time required to deliver missile test results to the project engineers for evaluation.

USN OTS China Lake
Consideration is presently being given to replacing the IBM 709 with the IBM 7090.

NAFE FAA
In March 1961 the 709 and peripheral equipment will be replaced by an IBM 7090 and 1401 System.

CEIR
An IBM 7090 to replace 709.
An IBM 7090 to be installed in New York, New York.

Ford
IBM 709 to be replaced by IBM 7090. IBM 1401's to be used as peripheral equipment.
IBM 7223 high speed (500 cards/minute) card reader being attached on-line to the 709.

Hughes
Possible acquisition of IBM 7090 EDPM to replace IBM 709. Use of IBM 1401 series for peripheral handling

of input-output.

Lockheed Burbank
Delivery of a 7090 Computer is expected. Its configuration will be 16 high speed Mode IV tapes, 32 K Core, On-Line Printer, and On-Line Card Reader.

Lockheed Sunnyvale
Installation of our first IBM 7090 System is scheduled. This consists of a four (4) channel, twenty (20) high density tape transports (62,500 characters per second), card reader, on line printer and on line card punch.

When this system becomes operational, one 709 will be removed.

Installation of the second IBM 7090 System is scheduled for several months later. This second 7090 System consists of the same configuration as the first 7090 System. When this system becomes operational, the second 709 will be removed.

Three IBM 1400 series systems are scheduled for delivery in early 1961. The first 1401 will be a model 1401-C with six tape transports. These systems will be used as input-output devices for the two 7090 Systems and will replace a majority of the off-line peripheral equipment now in use.

We are tentatively planning to make use of magnetic disc memory devices for data and program storage in the IBM 7090 Systems. These auxiliary memories would operate on line to the 7090 for processing runs and would be loaded and unloaded off-line using magnetic tape storage devices.

Martin Baltimore
A 1401 System is to replace our off line equipment. We intend to install a 7090 in the near future.

Martin Orlando
In 1961 an IBM 7070 with 10 tape units plus an IBM 1401 with 4 tape units will be installed to handle our inplant commercial programs. The programs planned for this equipment are as follows:
  Master Requirements Program
  Shop Order Control Program
  Scheduling and Machine Loading Programs (Short Term and Long Range)
  Material Control Program
  Payroll Program (Hourly and Salary)
  Cost Distribution Program (Material and Labor)
  Purchase Order Program

McDonnell
An IBM 7090 and two IBM 1401 Systems are scheduled.

Northern States
New components for 1961 include 2 IBM 1401 Model C-3 and 2 IBM 1401 Model D-3. To be retired in 1961 are 1 IBM 714 Card Reader, 3 IBM 720A Printer, and 3 IBM 722 Card Punches.

Phillips
Replacement and intended acquisition of new systems include replacing the IBM 709 with an IBM 7090 and 2 1401's, installation of a Burroughs Model 205 Computer with card I/O (new system). Installation of an additional IBM 650, Model 2, card I/O.

RCA Moorestown
Heavy usage (3.5 shifts) indicates early acquisition of a transistorized machine to reduce work load to one-shift operation. Machine not indicated by name at this time. Probably within one year. Two 1401 Model C Computers are on-order to replace present peripheral equipment.

RCA Patrick AFB
It is currently planned to replace 717 off-line printer with an IBM 1401 System, to replace the present 8,000 word core storage with a 32,000 word unit, and to replace off-line input-output equipment with an IBM 1401 System.

RCA Canaveral
It is currently planned to replace the present 8,000 word core storage with a 32,000 word unit.
   Space Tech Labs (2)
Plan to replace both our IBM 709's with our IBM 7090's.
   MIT
The 709 will be replaced by a 7090. It will have a third channel and four additional tape drives. Otherwise, it is compatible with the 709. The present off-line equipment will be replaced by two IBM 1401 Systems.
   UCLA
1401 System on order for peripheral operations.

INSTALLATIONS

U. S. Army Ballistic Missile Agency
Computation Laboratory, Bldg. 4663
Redstone Arsenal, Alabama

U. S. Army Electronic Proving Ground
Fort Huachuca, Arizona

U. S. Navy Pacific Missile Range
Range Operations Department, Code 3280
Point Mugu, California

U. S. Naval Missile Facility
(Land-Air, Inc.)
Point Arguello, California

U. S. Naval Ordnance Test Station
China Lake, California

National Aviation Facilities Experimental Station
Simulation and Computation Branch
Atlantic City, New Jersey

C-E-I-R, Inc.
1200 Jefferson Davis Highway
Arlington 2, Virginia

Douglas Aircraft Company, Inc., Dept G-318 (2)
3000 Ocean Park Blvd.
Santa Monica, California

Ford Motor Company
Aeronutronic Division
Ford Road
Newport Beach, California

Hughes Aircraft Company
Building 6, Room F1022
Florence Avenue & Teale Street
Culver City, California

IBM Space Computing Center
615 Pennsylvania Avenue, N. W.
Washington, D. C.

Lockheed Aircraft Corporation
Math Analysis Dept.
Burbank, California

Lockheed Aircraft Corporation
Missiles and Space Division, P. O. Box 504
Sunnyvale, California

The Martin Company
Missile Weapons Systems Division
Baltimore 3, Maryland

The Martin Company
Engineering Division
Orlando, Florida

McDonnell Aircraft Corporation
Box 516
St. Louis 66, Missouri

Northern States Power Company
1925 Sather Street
St. Paul 13, Minnesota

Phillips Petroleum Company
Adams Building, Computing Dept.
Bartlesville, Oklahoma

RCA Missile & Surface Radar Division
Building 116-1
Moorestown, New Jersey

RCA Service Company
Technical Laboratory, Bldg. 989
Patrick Air Force Base, Florida

RCA Service Company
Data Processing Division, Bldg. 2-1655
Cape Canaveral, Florida

Space Technology Laboratories, Inc. (2)
Computation & Data Reduction Center
2400 East El Segundo Boulevard
El Segundo, California

System Development Corporation
1923 Centinella Avenue
West Los Angeles, California

M. I. T. Lincoln Laboratory
P. O. Box 73
Lexington 73, Massachusetts

University of California L. R. L.
Box 808
Livermore, California

University of California
Western Data Processing Center
Los Angeles 24, California

Texas Engineering Experiment Station
Data Processing Center
College Station, Texas

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

System is designed and used for commercial applications, including payroll, railroad freight car accounting, public utility customer accounting, merchandising, and accounts receivable for retailers.

Hickok Manufacturing Co., Inc.

To be located at 850 St Paul Street, Rochester , New York, the system will be used for order processing (packing lists and shipping labels), invoicing, accounts receivable preparation, item sales statistics and forecasting, inventory planning and control, prime cost reports, customer statistics, salesmens territory reports, and hourly payroll.

Western Electric Company, Inc. - Laureldale Plant

Located at Laureldale, Penna., the system will be used for a variety of data processing problems on a one shift basis. Initial plans are to convert major tabulating applications such as payrolls, labor distribution, order accounting and accounting analysis which will require twenty-five percent utilization and effect cost reduction in released punch card equipment and personnel. New applications planned

are inventory control, parts explosion, product in-process inventories and results, statistical analyses of product test results, X bar-R chart plotting, and cost bulletin.

Westinghouse Electric Corporation, Steam Division

Located at Lester Branch P.O., Philadelphia 13, Pa., the system is used as off-line equipment auxiliary to 7090, for tape-to-card operations, card-to-tape operations, tape-to-printer operations, card-to-printer operations, etc. In addition, as a computer for small jobs currently done on punched card tabulating equipment.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	Variable length
Decimal digits/instruction	one to eight
Instructions per word	Variable length
Arithmetic system	Fixed point
Instruction type	One or two address

Instruction word format

OP	A/I Address	B Address	d Modifier
X	XXX	XXX	X

OP	(A/I)	B
X	XXX	XXX

OP	(A/I)	d
X	XXX	

OP	(A/I)
X	XXX

OP	d
X	X

OP
X

OP 1 character operation code
A/I 3 character storage address where A is loca-
    tion of a data word or I is address of next
    instruction
B 3 character storage address of a data word
d 1 character modifier

Automatic coding includes a symbolic programming
system.
  Registers
I   Address Register
A   Address Register
B   Address Register
A   Register
B   Register
A   Index Register
B   Index Register
AB Index Register
  A and B Address Registers allow chaining of instruc-
tions, i.e., performing a series of operations on
several fields that are in sequence in storage. Less
time is required to perform the operations and space
is saved in storing instructions.
  Indexing is part of optional advanced programming
feature which also includes abilities to move full
records and to store A and B Address Registers for
easy program modification.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	300 (8+8 digits)
Mult	1,960 (6x4 digits)
Div	2,170 (10/4 digits)

  Multiply-Divide times are for the Multiply-Divide
feature installed.
  1401 is an "Add-to-Storage" system. No additional
instructions or time is required to store results.
Arithmetic mode   Serial (by character)
Timing   Synchronous Asynchronous
                     (depending on function)
Operation   Sequential   Concurrent
                     (depending on function)
Timing - Operations
  Card input/output can often be overlapped with
processing.
  Print output can be partially overlapped with pro-
cessing; or can be completely overlapped with print
storage installed.

Magnetic tape input/output is not overlapped.
Internal processing is serial.

STORAGE

Manufacturer

Media	No. of Alphanum/Char	Access Microsec
Core	1,400; 2,000; 4,000; 8,000; 12,000; 16,000	11.5
Magnetic Disk (Type 1405) Model I	10,000,000	500,000 (Avg)
Magnetic Disk (Type 1405) Model II	20,000,000	500,000 (Avg)

  50,000 two hundred character records on 25 discs
(Model I).
  100,000 two hundred character records on 50 discs
(Model II).
  Both models have two read-write arms.
Magnetic Tape
  No. of units that can be connected   6 Units
  No. of chars/linear inch of tape   556 Char/inch
  Channels or tracks on the tape   7 Tracks/tape
  Blank tape separating each record 0.75 Inches
  Tape speed   75 Inches/sec
  Transfer rate   15,000 to 62,500 Char/sec
  Start time   7.3 or 10.8 Millisec
  Stop time   7.3 or 10.8 Millisec
  Average time for experienced
operator to change reel of tape 60 - 120 Seconds
  Physical properties of tape
    Width   0.5 Inches
    Length of reel   2,400 Feet
    Composition   Mylar
  Two tape units can be specified: 729 II or 729 IV.
  Mylar is DuPont's registered trademark for its
polyester film.
  Westinghouse

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4000 char	6 bits/char, 1 parity bit, 1 word mark bit.	11.5

INPUT

Manufacturer

Media	Speed
Cards (80 column Type 1402)	250 or 800 cards/min
Magnetic Tape (729 II or 729 IV)	15,000 or 62,500 char/sec

Dual density standard
Paper Tape   500 char/sec
  Reading is controlled by a panel which decodes the
paper tape in binary coded decimal for 5, 6, 7 or 8
channel tape.
Optical Character Reader   290 to 400 documents/min
  Cards or documents may be read. Reader is under
program control. Characters which may be read are
the Type 407 print, .093 inches high. Characters
which may be read are the integers 0 - 9, -, 1-, and
a ◫ . Paper or cards must have a horizontal width
dimension of 5-7/8 inches minimum to a 8-3/4 inches
maximum. The vertical dimensions are 2-3/4 inches
minimum to 3-2/3 inches maximum. Option of one or
two lines/document. Reading is serial, left to right.
Console Inquiry Station   Manual
  (Type 1407)
  Modified IBM Electric Typewriter with a 12 inch
carriage, using a continuous form.

Westinghouse

Media	Speed
Magnetic Tape IBM 729 II	75 in/sec
	15,000 or 42,000 char/sec

Character rate varies due to high or low density tape option.

Card Reader	800 cards/min
IBM 1402 Card Read-Punch	

OUTPUT

Manufacturer

Media	
Cards (80 column)	250 cards/min
Magnetic Tape	15,000 or 62,500 char/sec
(Type 729 II and 729 IV)	
Dual density standard	
Printer	60 lines/min

Westinghouse

Card Punch	250 cards/min
IBM 1402 Card Read-Punch	
Printer	600 lines/min
IBM 1403 Printer	
Magnetic Tape	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	
Diodes	6,213 - 14,171	(Min. and max. systems)
Transistors	4,315 - 9,805	(Min. and max. systems)
Magnetic Cores		
Type 17:	17,540	Minimum system
Type 24:	200	
Type 17:	129,540	Maximum system
Type 24:	600	
Type 18:	1,120	

CHECKING FEATURES

Manufacturer

Parity and validity checks are made. Programming checks, balances and controls may be made.

1402 Checking

Automatic hole count check between read stations.

Automatic Hollerith Validity check before storage entry.

Automatic hole count check between punch station and read station.

1402 Translation

Automatic card to internal BCD input translation.

Automatic internal BCD to card output translation.

1403 Checking

Automatic parity check of character to be printed.

Automatic validity check of character to be printed.

Hammer action to be performed.

Hammer action performed.

729 II - 729 IV Checking

Vertical parity check by character

Horizontal check by record

Two-gap head verifies validity at the time data is written

Dual-level sensing provides additional checking of tape read and write operations and error-free operation on valid data.

1402 Card Read Punch - Punch feed read and 51/80 column interchangeable read feed.

1403 Printer - print storage.

Input-output - column binary device.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer 2.88 Kw 3.2 KVA min. = Model A
(Max.) 12.15 Kw 13.5 KVA 0.80 to 0.90 pf
max. = Model C+6-729s

Power, air condition approx 3 Kw (Min.)
approx 11 Kw (Max.)

The KVA and power factor varies with manufacturer. Minimum system requires 1 Ton, amximum system requires 3 1/2 Tons.

Volume, computer	117.2 cu ft min.
	403.8 cu ft max.
Area, computer	33.8 sq ft min.
	80.8 sq ft max.
Room size	239 sq ft min.
	463 sq ft max.
Floor loading	25 lbs/sq ft
	325 lbs concen max
Volume, air conditioner	6 cu ft - 1 ton unit
	84 cu ft - 5 ton
Area, computer	3 sq ft - 1 ton
	12 sq ft - 5 ton
Capacity, air conditioner	Depends on manufacturer

3 1/2 tons are required for maximum size system, a 5 ton unit would be nearest size available.

Weight, computer	3,063 lbs (Min.)
	11,530 lbs (Max.)

Normal air conditioning will usually be adequate, providing the capacity is available to handle the added B.T.U. of heat generated by the system.

Relatively few restrictions are placed on the arrangement of the 1401 System units.

Electrical requirements - 208 or 230 volts (±10%), 3-phase (4-wire), 60 cycle (± 1/2 cycle).

Environmental requirements

Power On (system operating) temperature 60° - 90°F, relative humidity 20 - 80%, air filtration - 20% minimum by National Bureau of Standards discoloration test for mechanical-type filter.

Power Off (extended non-operational period) temperature 50° - 110°F, relative humidity 0 - 80%.

These environmental requirements are less stringent than those that apply to storage areas for IBM cards and magnetic tape.

It is recommended that instruments capable of recording temperature and humidity be provided.

The 1401 System does not require a raised floor. However, if the rated floor loading of the area in which the system is to be installed is inadequate, certain types of raised floor can serve the purpose of spreading the load evenly over a larger area. Also, the use of a raised floor reduces the possibility of damage to cables and improves the appearance of the installation.

Westinghouse

Power, computer 208 or 230 volts, 60 cycle, 3 phase, 4 wire system.

Power, air conditioner	limited amount needed
Volume, computer	326 cu ft (approx)
Volume, air conditioner	60 cu ft (approx)
Area, computer	70 sq ft (approx)
Area, air conditioner	12 sq ft (approx)
Room size	350 sq ft (approx)
Floor loading	50 lbs/sq ft
	70 lbs concen max
Weight, computer	14,655 lbs
Weight, air conditioner	400 lbs

IBM 1401

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PRODUCTION RECORD

Number produced to date   Over 2,800
Time required for delivery   24 months
   Over 2,800 systems have been sold to date.

COST, PRICE AND RENTAL RATES

Manufacturer

Basic System		Cost	Monthly Rental
IBM 1401 Processing Unit, Model A-1	$	70,500	$1,200
IBM 1402 Card Read Punch, Model 1		24,800	550
IBM 1403 Printer, Model 1		30,300	725
Total		$125,600	$2,475

Additional Equipment

	Cost	Monthly Rental
IBM 729 II Magnetic Tape Unit	$ 27,500	$ 700
IBM 729 IV Magnetic Tape Unit (Maximum of 6 tape units)	59,000	1,100
Tape Input-Output Adapter Feature	22,700	980
IBM 1406 (Additional Core) Storage (3 models)	20,100 to 55,100	575 to 1,575

Maintenance contracts available for purchased or rented equipment.

Hickok Mfg Co.

Rental configuration scheduled for installation:

	Model or Type Device	Description	Monthly Rental
1	1401 C03	Processing Unit	$2,680
1	560	Multiply-Divide Md 1 B C	325
1	617	Print Storage Md 1 B C D	375
1	497	High Low-Eq Comp B C D	75
1	1403 002	Printer ARR A	775
1	1402 002	Card Read Punch	550
5	729 002	Magnetic Tape Unit	770 ea

WE - Laureldale Plant

The Laureldale Plant presently employs conventional punch card equipment for mechanized data processing. A feasibility study has recently been completed and an IBM 1401 data processing system has been recommended. Management is currently considering this recommendation.

The recommended components of the 1401 are as follows:

Machine	Model	Description	Monthly Rental
1401	B4	Processing Unit (4,000 positions)	$ 1,630
	27	Advanced Programming-Index Registers	105
	321	Expanded Print Edit	20
	560	Multiply-Divide Device	325
	605	Additional Print Control	60
	611	Punch Feed Read	55
	497	High-Low-Equal Compare	75
	617	Print Storage	375
	627	Read Punch Release	25
	682	Sense Switches	15
1402	1	Card Read Punch	550
	619	Punch Feed Read	25
1403	2	Printer	775
1406	1	Storage (4,000 positions of Magnetic Core Storage)	575
		Total Monthly Rental	$4,610

Westinghouse

System components are IBM 1401-c3, IBM 1402, IBM 1403, IBM 1406, and IBM 729 II. The approximate monthly rental is $8,300.

Maintenance and service is provided by the manufacturer and is included in monthly rental.

PERSONNEL REQUIREMENTS

Manufacturer

Varies considerably according to installation and application.

Training made available by the manufacturer to the users includes programming and practical experience on systems.

Programming systems available are: symbolic programming system; generalized tape sorts; tape system utilities, including card-to-tape, tape-to-card, tape-to-printer; card report program generator; sub-routines; and debugging aids - service routines.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability is achieved by utilizing solid state devices, i.e. core storage, printed circuits, and transistorized circuits. Checking, as previously detailed, also provides reliability.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features are: high speed card input-output, high speed magnetic tape input-output, high speed on-line printing, completely variable length core storage assignments, "Add-to-Storage" simplifies programming, and single-instruction print editing.

Unique system advantages are: solid-state engineering, economical, independent data processing system, auxiliary system to 700/7000 series, and simplified programming.

Growth of the system is permissible in the basic card system, the advanced card system, and the card and magnetic system.

Optional features as required, are available.

INSTALLATIONS

Boston Naval Shipyard
Boston, Massachusetts

General Electric Company, Inc.
Missile and Space Vehicle Department
3198 Chestnut Street
Philadelphia 4, Pennsylvania

General Insurance Company of America
4347 Brooklyn Avenue
Seattle 5, Washington

Hickok Manufacturing Company, Inc.
850 St. Paul Street
Rochester 1, N. Y.

Western Electric Company, Inc. - Laureldale Plant
Marion and Vine Streets
Laureldale, Pennsylvania

Westinghouse Electric Corporation, Steam Division
Lester Branch P. O.
Philadelphia 13, Pennsylvania

U. S. Army, Headquarters, TAGO
Washington 25, D. C.

U. S. Army Corps of Engineers
Engineer Maintenance Center
52 Starling Street
Columbus 16, Ohio (Proposed)

U. S. Army Quartermaster Depot
Richmond, Virginia (Proposed)

U. S. Army Signal Supply Agency
225 S. 18th Street
Philadelphia, Pennsylvania

U. S. Navy Administrative Office
EXOS, AO, EAD, EDPB
Washington 25, D. C. (Proposed)

U. S. Navy Bureau of Yards and Docks
Washington 25, D. C. (Proposed)

U. S. Navy Mare Island Shipyard
Vallejo, California

U. S. Naval Ordnance Laboratory
White Oak
Silver Spring, Maryland

U. S. Navy Ships Parts Control Center
Mechanicsburg, Pennsylvania

U. S. Air Force Air Defense Command
Ent Air Force Base
Colorado Springs, Colorado (Proposed)

U. S. Air Force Aviation Supply Office
700 Robbins Avenue
Philadelphia 11, Pennsylvania

U. S. Air Force Mathematical Services Laboratory
Eglin Air Force Base, Florida

U. S. Air Force Mobile Air Materiel Area
Brookley Air Force Base, Alabama

U. S. Air Force San Bernardino Air Materiel Area
Norton Air Force Base, California

Wright Air Development Center, ARDC
Directorate of Systems Engineering
Wright Patterson Air Force Base, Ohio (Proposed)

Air Weather Service
Climatic Center
225 D Street, S.E.
Washington 25, D. C. (Proposed)

U. S. Department of Agriculture (5)
Commodity Stabilization Service
New Orleans, Louisiana

Bureau of Flight Standards
Federal Aviation Agency
Oklahoma City, Oklahoma

Department of Health, Education & Welfare
Social Security Administration
Candler Building
Baltimore 2, Maryland (Proposed)

National Aeronautics and Space Administration
Lewis Research Center
Cleveland 35, Ohio

Tennessee Valley Authority
116 Old Post Office
Chattanooga, Tennessee

U. S. Treasury Department
Internal Revenue Service
10th - Constitution Avenues
Washington, D. C.

Veterans Administration
Data Processing Center
Hines, Illinois (Proposed)

American Telephone & Telegraph Company
Mount Kisco, New York (Proposed)

American Telephone & Telegraph Company (4)
50 Varick Street
New York, N. Y. (Proposed)

AVCO Corporation
Crosley Division
1329 Arlington Street
Cincinnati 29, Ohio (Proposed)

Bank of America (4)
500 Howard Street
San Francisco, California

Bankers Life Insurance Company of Nebraska
Cotner at O Street
Lincoln, Nebraska

Bell Telephone Laboratories (3)
Murray Hill, New Jersey (Proposed)

Bell Telephone Laboratories (3)
Whippany Road
Whippany, New Jersey (Proposed)

California Institute of Technology
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena 3, California

Chase Manhattan Bank
57 William Street, Room 200
New York, N. Y.

Combustion Engineering, Inc.
200 Madison Avenue
New York 16, N. Y.
(Installation Newark, New Jersey)

Consolidated Edison Company of New York
4 Irving Place
New York 3, N. Y.

Convair (2)
Fort Worth, Texas (Proposed)

Eastman Kodak Company (2)
Rochester, New York

El Paso Natural Gas Company (2)
P. O. Box 1492
El Paso, Texas

Esso Standard (2)
Humble Oil & Refining Company
P. O. Box 551
Baton Rouge, Louisiana

Firestone Tire & Rubber Company (2)
Akron 17, Ohio

Ford Motor Company
Dearborn Stamping Plant, Box 494
Controller's Office
Dearborn, Michigan (Proposed)

Ford Motor Company (2)
Ford Division
Rotunda and Southfield
Dearborn, Michigan (Proposed)

Ford Motor Company (2)
Manufacturing Services
Rouge Office Building
Dearborn, Michigan (Proposed)

General Motors Corporation (2)
A. C. Spark Plug Division
1300 N. Dort Highway
Flint, Michigan (Proposed)

General Motors Corporation
Allison Division
Indianapolis 6, Indiana

General Motors Corporation
Research Laboratories
12 Mile and Mound Roads
Warren, Michigan

Gulf Research & Development Company
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania (Proposed)

Hughes Aircraft Company
5405 West 102nd Street
Los Angeles, California (Proposed)

International Business Machines Corporation
Scientific Computations Laboratory
Endicott, New York

International Business Machines Corporation
Data Systems Division
Poughkeepsie, New York

International Business Machines Corporation
Methods DS Manufacturing
South Road
Poughkeepsie, New York

International Harvester Company
1301 West 22nd Street
Broadview, Illinois (Proposed)

International Harvester Company
Motor Truck Division, Box 1109
Meyer Road
Fort Wayne, Indiana

The Marquardt Corporation
16555 Saticoy Street
Van Nuys, California

The Martin Company
Baltimore, Maryland (Proposed)

The Martin Company
Denver, Colorado

Minnesota Mining & Manufacturing Company (3)
900 Bush Avenue
St Paul 6, Minnesota

Newport News Ship and Drydock Company
Washington Avenue
Newport News, Virginia (Proposed)

The Ohio Oil Company (2)
539 South Main Street
Findlay, Ohio

Pratt and Whitney (2)
Florida Research & Development Center
United, Florida

Republic Aviation Corporation
Farmingdale, L. I., New York

Sandia Corporation (2)
Albuquerque, New Mexico (Proposed)

Service Bureau Corporation
IBM Plant
San Jose, California

Socony Mobil Oil Company, Inc.
150 E. 42nd Street
New York 17, N. Y.

Standard Oil Company of California
Electronic Computing Center
225 Bush Street
San Francisco 20, California (Proposed)

Standard Oil Company of Indiana
EDP Department
2400 New York Avenue
Whiting, Indiana

Standard Oil Company of Ohio (3)
717 Republic Building
Cleveland 15, Ohio

Texaco, Incorporated (11)
P. O. Box 2332
Houston 1, Texas

Western Electric Company (3)
77 South Wacker Drive
Chicago 23, Illinois (Proposed)

Western Electric Company (3)
100 Central Avenue
Kearny, New Jersey

Westinghouse Electric Corporation
Sharpsville Avenue
Sharon, Pennsylvania (Proposed)

Johns Hopkins University
Johns Hopkins Road
Scaggsville, Maryland

Midwestern Universities Research Association
2203 University Avenue
Madison 5, Wisconsin

Yale University
Computing Center
135 Prospect Street
New Haven, Connecticut

REMARKS

General Motors Allison Division

The 1401-1 is scheduled for shipment. The present specifications and prices are as follows:

Qty	Unit		Monthly Rental
1	1401 C-3		$3,385.03
	This price includes:		
	Advanced programming	$105	
	Column Binary	100	
	High-Low-Equal Compare	75	
	Print Storage	375	
1	1402		558.25
1	1403-2		786.63
	Printing Arrangement F		
2	729 II		at 710.50

The 1401-2 is also scheduled for shipment. The present specifications and prices are the same as the 1401-1 above with the exception of 1 729 II.

The 1401-3 is scheduled for shipment in May 1961. The present specifications and prices are as follows:

1	1401 C-4		$3,801.18
	This price includes:		
	Advanced programming	$105	
	Column Binary	100	
	High-Low-Equal Compare	75	
	Print Storage	375	
	Multiply Divide	325	
	Back Space File RPQ	40	
1	1402		558.25
1	1403		786.63
	Printing Arrangement F		
1	1406		583.63
1	729 II		710.50

IBM 1410

IBM 1410 Data Processing System

The new IBM 1410 greatly extends the range of intermediate computers for commercial data processing. Together, the 1410 and the 1401 system form a compatible machine family. Transition from a 1401 to a 1410 is possible with a minimum of system development costs.

Shown here is an expanded RAMAC 1410 system. The 1410 comes in card, magnetic tape, RAMAC and RAMAC tape models. With five RAMAC disk storage units, the 1410 can store 100-million characters of information for in-line processing.

Operator is seated at the 1415 console. From left to right in background are the 1403 printer, the 1402 card read punch, the 1411 processing unit and the 1011 paper tape reader. The girl is standing in front of the 1412 magnetic character reader used with the 1410 in banking applications. To her right are a 1405 disk storage unit, a 7330 low-cost magnetic tape unit and two 729 magnetic tape units. The 1410 can handle a total of twenty tape units.

APPLICATIONS

Portions of this description have been reprinted by permission from IBM General Information Manual 1410 Data Processing System, Copyright 1960 by International Business Machines Corporation.

Large volume commercial data processing and rapid scientific computations. System is available in a variety of configurations. The three basic configurations are the IBM 1410 Card System, the IBM 1410 Tape System and the IBM RAMAC 1410 System.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	Variable
Decimal digits/instruction	1 to 12
Instruction word format	

Op Code	A-or I-address	B-address	d-character
X	XXXXX	XXXXX	X
	(X-control field) XXX		

Operations which may be performed are addressing operations, program control operations, arithmetic operations, logic operations, indexing, general data operations, input-output operations and checking operations.

To read out an address from storage, a device is needed to accept the address characters and keep them until the complete address has been read out. The devices used to do this are the address registers.

Instruction Address Register. The Instruction Address Register is a 5-character register. The address read into it specifies the initial address of an instruction in core storage.

A-Address Register. This register accepts a 5-character address that specifies the storage location of the first A-field character involved in the operation.

B-Address Register. This register accepts a 5-character address that specifies the storage location of the first B-field character involved in the operation.

Op Register. The Op-register (operation) is a 1-character register that stores the operation code of the instruction in process.

I/O Channel Select Register, Unit Select Register, and Unit Number Register. These registers accept the hundreds, tens, and unit positions of the X-control field that designates an I/O device. The hundreds position specifies the data transmission channel.

The tens position specifies the I/O device. The units position specifies the number of that device such as tape drive 2.

There are 15 Indexing Registers of 5 characters each.

The 1410 uses stored-program instructions to cause input and output devices to operate. These instructions perform all the tape, RAMAC, arithmetic, logical, general data, and miscellaneous operations. The actual operation to be performed is indicated by the format and contents of the instruction itself.

The basic instruction format for the 1410 is divided into 4 parts - the operation code, the A-or I-address (5-characters), the B-address (5-characters), and a d-character modifier to the operation code. Because of the variable length instruction format, the length of a valid instruction can vary from 1 to 12 characters. An instruction word may also have an X-control field (3-characters) which designates an input-output device.

Programming aids include basic autocoder, advanced autocoder, with Macro instructions and an input/output package, FORTRAN, report generator, tape sorts, RAMAC sorts, utility programs, and COBOL.

ARITHMETIC UNIT

Add to storage system of logic is used to perform these operations.

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Characters	Access Microsec
Magnetic Core	40,000	4.5/char
Magnetic Disc (1405)	10,000,000(Model 1)	100,000 min
	20,000,000(Model 2)	800,000 max

Up to 5 disc units may be connected to the system. Thus, 5 Model 2 RAMAC units will have a capacity of 100,000,000 digits.

Magnetic Tape 729 (II and IV)

No. of units that can be connected	10 Units
No. of char/linear inch	200 or 556 Char/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 or 112.5 Inches/sec
Transfer rate	15,000; 22,500; 41,667; 62,500 Chars/sec
Start time	10.8 or 7.3 Millisec
Stop time	10.8 or 7.3 Millisec
Average time for experienced operator to change reel of tape	30 - 60 Seconds

Physical properties of tape

Width	0.5 Inches
Length of reel	2,400 Feet
Composition	Mylar

Mylar is DuPont's registered trade mark for Polyester Film.

IBM Magnetic Tape Unit 7330 operates at less speed and cost than the 729 Units. Both units utilize the two gap head and dual level sensing. Thus, a parity error is detected when the character is written.

Characteristics of the disc files are 10 or 20 million alpha-numeric characters per file, up to five files - 100,000,000 characters, up to 3 arms per file-maximum of 12 arms to a system, 200 characters per record, average access time - 500 ms. - 600 ms., one instruction to read a full track - 1,000 characters, and read and write overlapped with processing if overlap device is on Channel 1.

INPUT

Media	Speed
Cards (1402-2 Read/punch)	800 cards/min
Magnetic Tape	
729 II	15,000 or 41,000 char/sec
729 IV	22,500 or 62,500 char/sec
7330	7,200 or 20,000 char/sec
Paper Tape	500 char/sec

OUTPUT

Media	Speed
Cards (1402-2 Read/punch)	250 cards/min
Printer (1403)	600 lines/min
Magnetic Tape	As above

System utilizes an IBM 1414 Input-Output synchronizer, allowing CPU to compute while an input-output device is operating. Card units are completely buffered and checked. Printer operates at 75 inches/second, 100 or 132 char/line, with high speed carriage skipping.. Magnetic tape units have optional overlap and dual gap heads for write checking.

The characteristics of the input-output synchronizers are:

The 1414-I has controls for 729 Tape Units and can attach 10 tapes to 1414-I.

The 1414-II has controls for 7330 Tape Units and can attach 10 tapes to 1414-II.

The 1414-III has controls for 1402 Card Read/punch and 1403 Printer, can attach 1-1402 and 1-1403, and has controls and buffers for other devices, e.g. paper tape input at 500 char/sec, which uses 5, 6, 7, or 8 channel tape.

System can have a maximum of three 1414's, one 1414-III, and two 1414-II's or I's, thus a maximum of 20 tapes is possible.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

System is composed of solid state, printed circuit, modular-cube components.

CHECKING FEATURES

Special checking features in the IBM 1410 Data Processing System assure reliability and accuracy of results. Checks must be made on the validity of data handled by the input-output units and one the handling of data within the system itself. Some of the checks include: legitimate instruction codes, arithmetic overflows, valid signs of numerical quantities, and many others.

In many cases, it is not necessary to interrupt machine operation when an error condition is detected. The programmer can insert branch instructions to recognize certain types of errors as exceptions. An error in reading a record from tape, for example, can be programmed to backspace the tape and re-read the record. If a correct reading is obtained the second time, normal operation continues. If the error persists, operation can be interrupted, or the incorrect record can be noted and operation continued.

Some machine check indicators, however, stop all processing immediately. They indicate such conditions as: a blown fuse, a broken tape, and card jams.

Three internal self-checking features incorporated into that 1410 system are parity, validity, and hole count.

Parity Checking

The 1410 uses an odd-bit parity system of recording binary-coded-decimal information. Each character is checked at various locations in the system to be sure that it has an odd number of bits.

If a parity error occurs, a console light is turned on to indicate the error location.

Validity Checking

If an invalid combination of punches enters the system through the card reader, the validity-check circuits detect it and turn on the read-check light on the card reader.

Hole-Count Checking

To provide additional reliability of data that are read or punched, the system employs a hole-count check feature. To perform hole-count checking, the system keeps an internal count of the total number of holes read from each column at the read-check station. The system compares this number against another count of the total number of holes read from the same column of the same card, when it passes the read station. Hole-count checking is also performed during punching operations. The count of the total number of holes to be punched in each column is retained internally for one punch-feed cycle. Another column-

by-column hole count is taken when this same card passes the punch-check station, and the two counts are compared.

If a hole-count error (unequal comparison of hole-count totals) occurs in the reader or punch, the system indicates the unit in error.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Unit	Dimensions (Inches)			Weight (Lbs)	Service Clearance (Inches)		KVA
	Width	Depth	Height	(Maximum)	Sides	Front and Rear	
1402 Model 2	58	30 5/8	45	1,400	36	36	
1403	47 3/4	29	53 1/4	750	30	36	
1405	61	30	70	2,090	48	30	5.3
1411	146	31	70	2,800	2	43	14.0
1414 Models 1, 2, 3	38	31	70	600	2	43	
1414 Model 4	74	31	70	1,200	2	43	
1415	70	29	44	300	-	-	
729 II, IV	29 1/8	33 7/8	69 1/4	1,200	2	30	1.5
7330	29	31	58	500	2	30	1.0
Compressor	40	33	29	700	30	30	4.0

System requires 208V or 230V ($\pm$10%), 3 phase, 60 cycle.

Arrangement of units of the 1410 depends largely on the size and shape of the machine area, the system configuration, and the cable lengths available. Other factors to consider are customer-engineering service space, operator convenience, and visibility of units from a central operating position. Where space is limited, service clearance of adjacent units may overlap.

Storage and file area for cards, forms, and magnetic tape should be located conveniently in or near the machine room. Space near the 1410 is also required for customer-engineering test and maintenance equipment.

The 1410 system does not require raised flooring. However, a raised floor reduces the possibility of damage to cables, and presents a more attractive appearance of the installation.

Air conditioning equipment must maintain the machine-room area within certain limits of temperature and humidity:

Temperature 60 - 90°F.
Relative humidity 20 - 80%
Air Filtration 20% minimum (by National Bureau of Standards discoloration test)

These limits can be extended to 50-110°F. and 0-80% R. H. during non-operational periods. Low temperature and high humidity may cause moisture condensation. High temperatures deteriorate solid-state components.

If IBM cards and magnetic tape are not stored in the machine room, the storage area should be maintained at 50-90°F. and 30-65% R. H. for IBM cards, and 40-120°F. and 0-80% R. H. for magnetic tape. Recording instruments are recommended to provide a continuous record of temperature and humidity conditions in both the machine room and storage area.

Normal room air conditioning is usually adequate to accommodate the added heat generated. The table shows the approximate heat dissipation and air-flow for units of the 1410 system.

Unit	BTU/hr	CFM
1402 Model 2	5,600	390
1403	2,600	310
1405 (first unit)	7,240	800
each additional 1405	4,400	600
1411	18,000	2,000
1414 Model 1	2,130	500
Model 2	1,825	500
Model 3	2,560	500
Model 4	5,560	1,000
1415	940	--
729 II	4,310	350
IV	3,520	350
7330	2,400	400
Compressor	10,800	300

COST, PRICE AND RENTAL RATES

Basic System
Central Processing Unit 1411
Card Read-Punch 1402-2
High Speed Printer
Console 1415
    Additional Equipment
Magnetic Tape 729 II
Magnetic Tape 729 IV
Magnetic Tape 7330
Disc Storage 1405
Input-Output Synchronizer 1414-1-2-3-4

ADDITIONAL FEATURES AND REMARKS

Add to memory type instructions
    Add two fields and store result in one instruction
    No limit on size of result
Table look-up on high-low-equal or any combination
Edit, and expanded edit, are standard
Multiply and divide are standard
Any instruction can be indexed
    Fifteen 5-position index registers
    Increment or decrement
Move entire record or any part with one instruction
Additional logical instructions
    High-low-equal compare
    Zero balance test
    Overflow test
    Test digit or character
Store address register instructions

INSTALLATIONS

International Business Machines Corporation
590 Madison Avenue
New York, N. Y.

IBM 1620

IBM 1620 Data Processing System

Photo by International Business Machines Corporation

Engineer adjusts paper tape which feeds data to IBM 1620 Data Processing System at the rate of 150 characters a second. The IBM 1620 is a compact, all-transistorized computer which handles the complicated formulas encountered in solving engineering and scientific problems in industry. Additions and subtractions are performed by the 1620 at the rate of more than 1700 a second for five-digit numbers. The use of conventional decimal arithmetic and simplified programming techniques, large-capacity core memory, and high-speed operation are among features of the new computer. A general purpose computer in the scientific area that features magnetic core storage.

APPLICATIONS

Manufacturer

System is used for the solution of problems in petroleum, public utilities, optics, general manufacturing, general engineering, civil engineering, and electronics. American Machine & Foundry Co., Mechanics Research Div. Located at 7501 North Natchez Avenue, Niles, Illinois, the system is used primarily for parachute design, thermodynamics (e.g. heat engines), structural design, soil loading, operations research, and servo system analysis.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	Variable field
Decimal digits/instruction	12
Instructions/word	Variable field 1 per 12 digits
Instructions decoded	32
Arithmetic system	Fixed point

Variable field fixed point; programmed floating point (8.5 millisec/floating add).

Instruction type	Two address
Number range	Variable field

Instruction word format

1	2	3	7	8	12
Operation		P Address		Q Address	

Automatic coding includes Symbolic Programming System, ForTran, and Go Tran.

Indirect addressing plus immediate instructions are available instead of indexing. Immediate instructions are standard. Indirect addressing is optional at $25 monthly rental. Branch transmit instruction provides single instruction linkage to subroutines.

ARITHMETIC UNIT
Manufacturer

	Incl Stor Access Microsec	
Add	(10 digit)	960
Mult	(10 digit)	17,700
Div		16,800

The 1620 is a 2-address system and times given above include access time to the two operands and the storing of the result.

Divide time includes loading dividends.

Table look up arithmetic is used. Table is stored in main memory of magnetic cores.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE
Manufacturer

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	Variable Field	20,000-60,000	20

INPUT
Manufacturer

Media	Speed
Paper Tape	150 char/sec (8-channel)
Typewriter	Manual (Alphanumeric)
Cards	250 cards/min (Buffered)

OUTPUT
Manufacturer

Media	Speed
Paper Tape	15 char/sec (8-channel)
Typewriter	10 char/sec (Alphanumeric)
Cards	125 cards/min (Buffered)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Diodes/Quan		Diodes/Quan		Diodes/Quan	
GS	174	AES	48	AS	1
FS	342	JS	24	AU	26
AAS	498				

Transistors/Quan		Transistors/Quan		Transistors/Quan	
-	4	039	969	078	36
015	48	065	48	083	172
025	436	071	78	086	40
033	1,357				

Magnetic Cores/Quan		Magnetic Cores/Quan	
17	120,000	24	200
18	384		

CHECKING FEATURES
Parity check on input, output, and internal manipulations of data.

POWER, SPACE, WEIGHT, AND SITE PREPARATION
Manufacturer

Power, computer	2 Kw
Area, computer	22 sq ft
Weight, computer	1,210 lbs

Special air conditioning or site preparation are not required.

AMF

Installed in air conditioned building. No special modifications were made.

PRODUCTION RECORD
Time required for delivery   10 months

PERSONNEL REQUIREMENTS
AMF

One supervisor and one programmer for one 8-hour shift. Operation tends toward open shop.

Methods of training includes group instruction in Fortran.

FUTURE PLANS
The following organizations are replacing their IBM 610 Systems with the IBM 1620 Systems:

U. S. Naval Propellant Plant, Crane, Indiana
U. S. Army Transportation Research Command, Mathematical Sciences Division, Fort Eustis, Virginia
Lockheed Electronics Company, Plainfield, New Jersey
University of Louisville, Computing Laboratory, Louisville 8, Kentucky

INSTALLATIONS
American Machine & Foundry Co., Mechanics Research Division, 7501 N. Natchez Avenue, Niles, Illinois
Institute of Technology, Air University, Wright-Patterson Air Force Base, Ohio

COST, PRICE AND RENTAL RATES
Manufacturer

Components	Model or Feature No.	Monthly Charge	Purchase Price	Monthly Maintenance Charge Based on Age of Machine in Months		
				0-36	37-72	73-108
1620 Central Processing Unit	1	$1,375	$64,000	$76.75	$78.50	$81.00
Automatic Divide	47	55	2,400	2.75	2.75	2.75
Indirect Addressing	493	25	1,150	1.50	1.50	1.50
1621 Paper Tape Reader	1	200	9,100	14.50	14.50	17.50
1622 Card Read Punch	1	625	30,000	51.00	68.25	94.00
1623 Core Storage						
(20,000 positions)	1	800	39,500	29.00	32.50	36.00
(40,000 positions)	2	1,275	62,400	35.75	39.50	45.25
961 Tape Punch (8-track)	1	25	1,400	4.75	5.25	6.75

Monthly charges and rental rate, plus taxes when applicable. (Note: In our opinion, the 1620 system, with the exception of the 961 Tape Punch, at the present time is considered not to be subject to Manufacturers' Federal Exise Tax.)

Monthly maintenance charge applies to first 176 hours of use. Each hour of use beyond the 176 is billable at the rate of 1/176th of the charge listed.

Purchase price plus charge to field install of $40.00 for Automatic Divide, $35.00 for Indirect Addressing.

IBM 7070

IBM 7070 Data Processing System

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer
System is used in the many areas of management deci-
sion criteria such as engineering design and develop-
ment, research, accounting controls and reports, pro-
duction, inventory controls and reports, and mathe-
matical models.

U. S. Army Oversea Supply Agency
Located at the Brooklyn Army Terminal, Brooklyn 50,
New York, the computer will be used to validate, edit,
maintain supply status and render reports for requi-
sitions received from Oversea Commands serviced by
this Agency.

U.S.A.F. 1608th Air Transport Wing (MATS)
Located at the Statistical Services Division,
Charleston Air Force Base, South Carolina, the sys-
tem is used for the solution of problems in materiel,
maintenance, personnel, accounting and finance, air
operations, vehicle management, and civil engineering.

Union Carbide Chemicals Company
Located at the Union Carbide Chemical Company, Tech.
Center, South Charleston, West Virginia, the system
is used for engineering design calculations connected
with building new plants and chemical processes, re-
duction and analysis of experimental data pertaining
to research and development of new processes, and
(future) business and data processing applications
including cost accounting, inventory control and
payroll.

Brown University
Located at the Division of Applied Mathematics, 180
George Street, Providence 6, R. I., the system is
used for education in numerical analysis, data pro-
cessing, and computer applications and for the con-
duct of research in computer applications in the
physical, biological and social sciences, mathematics
and linguistics.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Decimal
	2 out of 5 fixed count code
Decimal digits/word	10 plus sign
Decimal digits/instruction	10 plus sign
Instructions per word	1
Instructions decoded	241
Arithmetic system	Fixed point
	Floating point (optional)
Instruction type	One address

Ability of addressing any part of a word

Number range

$$\text{Fixed} \quad -10^{10} < x < +10^{10}$$

$$\text{Floating} \quad \pm 10^{-50} < x < \pm 10^{49}$$

Instruction word format

Sign	Two Digit Operation Code	Two Digit Indexing Address	Field Control	Address of Data to be Processed
	X | X	X | X	X | X	X | X | X | X

Automatic built-in subroutines include interrupt system, edit commands, tape compression, table look-up, and record scatter-gather.

Automatic coding

Autocoder is a technique of programming which allows the 7070 to generate many machine instructions for one written operation; easily adaptable to commercial problems.

Fortran is a technique of programming in which the 7070 accepts problems written in formulae form; easily adaptable to scientific work.

Report generator is a generalized program permitting report preparation from any tape file containing the basic data required.

Input-output control system is a package which when included in a program automatically schedules simultaneous reading, writing and processing functions.

In addition to the above, utility routines, sort and merge programs and simulation routines are available for the 7070.

Registers

There are 99 words which may be designated as index words simplifying program preparation through automatic address modification and multiple use of single instructions. There are three addressable accumulators, an arithmetic register (intermediate storage) and an auxiliary register.

ARITHMETIC UNIT

Manufacturer

Fixed Point
Incl Stor Access

	Microsec	Digits
Add	72	(10+10)
Mult	672-1,488	(10x10)
Div	792-984	(1 to 5 in quotient)

Construction (Arithmetic unit only)

The arithmetic unit is constructed of transistors, diodes, and magnetic cores.

Arithmetic mode	Serial (adder)
Timing	Synchronous (Central Proc Unit)
	Asynchronous (Input-output Devices)
Operation	Sequential (Central Proc Unit)
	Concurrent (Input-output Devices)

The arithmetic unit is not an isolated unit.

Through a standard automatic priority processing feature, an input or output device can signal a 7070 stored program immediately on completion of an operation. On the basis of priority signals, a stored program can determine which steps to perform next to optimize utilization of all components.

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Microsec
Magnetic Core	5,000-9,990	50,000 to 99,900	6
Disc Storage	600,000 to 4,800,000	6 to 48 million	100-850 mil/sec

Disc storage access time is 100 to 850 milliseconds

Magnetic Tape

No. of units that can be connected	40	Units
No. of char/linear inch of tape	556	Char/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating record	0.75	Inches
Tape speed	112.5	Inches/sec
Transfer rate	62.5K	Char/sec
Start time	7.3	Millisec
Stop time	7.3	Millisec
Average time for experienced operator to change reel of tape	60	Seconds

Physical properties of tape

Width	0.5 Inches
Length of reel	200-2,400 Feet
Composition	Mylar base

The above specifications reflect but one tape unit (729-4). There are other tape speeds attainable through another tape unit (729-2) with the tapes completely compatible. Mylar is DuPont's registered trademark for its polyester film.

USA OSA			
Core	10,000	100,000	6
USAF MATS			
Magnetic Core	5,000	50,000	6
Magnetic Disk	2,400,000	24,000,000	100-850 Millisec
UCC			
Magnetic Cores	5,000	50,000	6
Brown Univ			
Magnetic Core	5,000		
Magnetic Tape	4 units		

INPUT

Manufacturer

Media	Speed
Card Reader	500 cards/min
Magnetic Tape	15,000; 22,500; 41,600; 62,500 char/sec
Typewriter Remote Inq.	Manual
Console	Manual

USA OSA
Cards and 62,500 char/sec magnetic tape.

USAF MATS
Cards and 41,667 char/sec magnetic tape.

UCC
Cards

Brown Univ.
Cards, magnetic tape, and typewriter

OUTPUT

Manufacturer

Media	Speed
Card Punch	250 cards/min
Magnetic Tape	15,000; 22,500; 41,600; 62,500 char/sec
Printer	150 lines/min 120 alphanum char/line
Typewriter	600 char/min

Peripheral operations i.e. card to tape, tape to printer, and tape to card will in many cases replace card input, printer and card output and be done by the IBM 1401 Data Processing System. Speeds are as follows:

Card Read	800 cards/min
Printer	600 lines/min
Card Punch	250 cards/min

USA OSA

Tape	62,500 char/sec
Card	250 cards/min
Typewriter	10 char/sec

USAF MATS

Magnetic Tape	41,667 char/sec (729 II Tape Drive)
Punched Cards	250 cards/min

UCC

Cards	250 cards/min

Brown Univ.
Cards, printer, magnetic tape, and typewriter.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	
Magnetic Cores	300,000	5,000 words memory
	600,000	10,000 words memory

CHECKING FEATURES

Manufacturer

The transfer of information between memory and the arithmetic and programming unit or input/output devices is completely checked for validity.

All input/output devices including card readers, card punches, tape units and printers are validity checked on transfer of information. For example, tape units have dual read/write heads which check writing validity at the time the record is created.

All arithmetic operations are checked.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer   19.3 KVA
Weight, computer   23,150 lbs

It is suggested that the space requirements for the 7070 be extracted from actual installations, as this figure can vary widely. Physical planning manual available from manufacturer.

USA OSA

Power, computer	30 Kw	54 KVA	0.75 pf
Power, air cond	54 Kw	72 KVA	0.75 pf
Volume, computer		1,130 cu ft	
Volume, air conditioner		800 cu ft	
Area, computer		1,600 sq ft	
Area, air conditioner		800 sq ft	
Room size, computer		40 ft x 40 ft	
Room size, air condi		20 ft x 40 ft	
Floor loading		400 lbs/sq ft	
		2,800 lbs concen max	
Capacity, air condition		50 Tons (incl transceiver room)	

Weight, computer   41,000 lbs
Weight, air conditioner   15,000 lbs

Site preparation consisted of building modification, power installation, floating floors and air conditioning.

USAF MATS

Power, computer   39.8 KVA
Power, air conditioner   24 Kw

UCC

Power, computer   18.6 KVA
Area, computer   864 sq ft

Floating floor.

Brown Univ.

Computer is housed in a separate building, designed by Philip Johnson, Associates, for the purpose.

PRODUCTION RECORD

Manufacturer

Time required for delivery   approx 12 months

COST, PRICE AND RENTAL RATES

Manufacturer

		Model	Monthly Rental	Purchase Price
729	Magnetic Tape Unit	2	$ 700	$ 27,500
		4	900	48,500
7150	Console Cntrl Unit	1	300	13,050
7300	Disk Storage	1	975	62,200
		2	1,500	74,800
7301	Core Storage	1	3,500	160,000
		2	6,800	285,400
7400	Printer	1	950	41,500
7500	Card Reader	1	400	18,000
7501	Console Card Reader	1	75	3,700
7550	Card Punch	1	550	24,600
7600	Input-Output Control	1	1,400	63,000
		2	800	33,000
7601	Arith & Prog Cntrl	1	3,000	138,100
7602	Core Storage Control	1	1,400	65,200
		2	1,600	73,950
		3	1,500	69,800
		4	1,800	83,800
		5	1,900	88,500
7603	Input-Output Synch	1	1,000	46,050
		2	1,300	59,250
		3	1,350	62,050
		4	1,650	75,250
		5	2,000	91,250
		6	1,700	78,050
		7	1,600	72,450
		8	1,950	88,450
		9	2,300	104,450
7604	Tape Control	1	2,700	122,550
		2	1,850	94,000
7605	Disk Storage Cntrl	1	3,900	174,000
7802	Power Converter	1	400	18,700
7900	Inquiry Station	1	250	10,300

Maintenance contract available

A sample 7070 installation rental is as follows:

Quantity		Machine Type	Monthly Rental
8	729-2	Tape Units	$5,600
1	7150	Console Control Unit	300
1	7301	Core Storage (5,000 words)	3,500
1	7501	Console Card Reader	75
1	7600	Input/output Control	825
1	7601	Arith, & Prog. Control	3,000
1	7602	Core Storage Control	1,600
1	7604	Tape Control (2 channel)	2,700
1	7802	Power Converter	400
			$18,000

This is a tape-oriented system. For card-tape, tape-card, tape-printer operations, a 1401 machine would be used. This equipment is described elsewhere in the writeups.

The above rental rates include customer engineering maintenance and parts and cover the first 176 hours a month the system is in use. Each hour of use thereafter is subject to a rate of 1/176 of 40%.

A maintenance contract is available for components of a purchased system at rates per a published schedule.

Purchase price, typical system: $813,250
Rental price, typical system: $ 17,400 monthly

USA OSA
Rental is $27,950/month.
1-727 Tape Drive, 1-720 II Printer, and 1-760 Printer Control, rents at a total of $4,950/month.
Maintenance included in rental.

USAF MATS

Quantity	Type	Monthly Rental
1	7150	$ 300
2	7300	3,000
1	7301	3,500
1	7500	400
1	7550	550
1	7600	1,400
1	7601	3,000
1	7602	1,900
1	7603	2,050
1	7604	2,700
1	7605	3,900
1	7802	400
1	7900	250
4	729	2,800
1	533	765
2	Typewriter	420
		$27,335

UCC
Basic 7070/card input/card output cost $580,000.
407 Printer, storage for panel boards, keypunch, and above system rental at $12,700/month.
The 407 rents at $850/month.

Brown Univ.
A 7070 System, with 4 tape drives, automatic floating point, on line printer and 407 tabulator is purchased.
Key punches, reproducer and sorter are rented.
Service contract with IBM for purchased system.

PERSONNEL REQUIREMENTS

Manufacturer
The number of people required will vary a great deal based upon type of work (scientific, commercial mix), type of industry coupled with application.

Education training, program testing, technical assistance on all phases is available.

USA OSA

	One 8-Hour Shift	
	Used	Recommended
Supervisors	4	4
Analysts	8	8
Programmers-Coders	12	16
Clerks	1	4

Methods of training used includes internal orientation, IBM programming school and on-the-job training.

USAF MATS

	One 8-Hour Shift	
	Used	Recommended
Supervisors	4	4
Analysts	8	8
Programmers-Coders	20	20
Librarians	1	1
Operators	1	1
Engineers	1	1
In-Output Oper	1	1
Tape Handlers	1	1

Methods of training used includes contractor schools and on-the-job training.

UCC

	One 8-Hour Shift
Supervisors	3
Analysts	2
Programmers	3
Operators	2

Operation tends toward closed shop.
Methods of training used is manufacturer's training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer
System features and construction techniques utilized by manufacturer to insure required reliability include diagnostic programs and marginal checking, to detect and anticipate component failures, and solid state components together with conservative circuit design criteria, to assure a high level of reliability.

UCC
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
One of the most outstanding features of the 7070 is its modularity. For growth, the 7070 System can be quickly and easily converted to the 7074 in the field. The 7074 is 6 to 20 times as fast as the 7070 internally, and completely compatible with programs written for the 7070. The 7070 can be used efficiently for a scientific-commercial mix.

USA OSA
Magnetic tape library on wheels will store input tapes in alternate area. This will allow for re-creation of files as of yesterday. Normal IBM procedures are used for labelling and handling of magnetic tapes. Tape library procedures provide for central control or tape and program set up. Librarian will be focal point of operation.

USAF MATS
The Inventory Control Application will operate on-line from remote input/output stations simultaneously with other periodically processed applications.

Use will be made of the IBM Input/Output Control System (IOCS) for all tape operations. A fireproof vault has been built adjacent to the computer room for magnetic tape storage.

FUTURE PLANS

Manufacturer
See IBM 7074 Data Processing System.

USA OSA

A 1401-C System will replace the 727, 720 II and 760 in about 1 year.

Additional applications will include performing same functions for Mutual Security requirements.

USAF MATS

The system will be modified to provide improved printing capability, either through acquisition of an on-line printer or through acquisition of an IBM 1401 System.

UCC

Use of magnetic tape is planned for the system.

An IBM 7070 is anticipated at the U. S. Naval Ordnance Laboratory, Corona, California.

An IBM 7070 w/8 tapes is anticipated at the General Insurance Company of America.

An IBM 7070 is anticipated at the Western Electric Company.

INSTALLATIONS

U. S. Army Quartermaster Depot
Richmond, Virginia (Proposed)

U. S. Navy Puget Sound Shipyard
Bremerton, Washington (Proposed)

American Airlines
100 Park Avenue
New York, N. Y. (Proposed)

AVCO Corporation
Crosley Division
1329 Arlington Street
Cincinnati 29, Ohio (Proposed)

General Motors Corporation
A. C. Spark Plug Division
1300 N. Dort Highway
Flint, Michigan (Proposed)

The Martin Company
Baltimore, Maryland (Proposed)

Mutual Benefit Life Insurance Company
520 Broad Street
Newark 1, New Jersey (Proposed)

Western Electric Company
77 So. Wacker Drive
Chicago, Illinois (Proposed)

University of Rochester
Rochester, New York (Proposed)

U. S. Army Oversea Supply Agency, New York
Brooklyn Army Terminal
Brooklyn 50, New York

1608th Air Transport Wing (MATS)
Charleston Air Force Base, South Carolina

Union Carbide Chemicals Company
Technical Center
South Charleston, West Virginia

Brown University
Division of Applied Mathematics
Providence 12, Rhode Island

Indiana University
Research Computing Center
Bloomington, Indiana

Yale University
Computing Center
135 Prospect Street
New Haven, Connecticut

Bank of America (2)
500 Howard Street
San Francisco, California

Combustion Engineering, Inc.
200 Madison Avenue
New York 16, N. Y.
(Installation Newark, N. J.)

El Paso Natural Gas Company
P. O. Box 1492
El Paso, Texas

General Motors Corporation
A. C. Spark Plug Division
7929 S. Howell
Milwaukee 1, Wisconsin

The Ohio Oil Company
539 South Main Street
Findlay, Ohio

Universal Oil Products Company
30 Algonquin Road
Des Plaines, Illinois

U. S. Treasury Department (3)
Internal Revenue Service
10th Constitution Avenues
Washington, D. C.

IBM 7074

IBM 7074 Data Processing System

MANUFACTURER

International Business Machines Corporation

APPLICATIONS

For use in commercial and/or scientific applications. This system has the flexibility of componentry and internal speeds to allow for either type of application.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	2 out of 5 fixed-count coded decimal
Decimal digits/word	10 plus sign
Decimal digits/instruction	10 plus sign
Instructions decoded	241
Arithmetic system	Fixed point
Floating point is optional	
Instruction type	One address (with ability of addressing any part of a word)

Number range

$$\text{Fixed point} \quad -10^{10} < x < +10^{10}$$

$$\text{Floating point} \quad |\pm 10^{-50}| < x < |\pm 10^{49}|$$

Instruction word format

Sign	2-Digit Op Code	2-Digit Index Address	Field Control	Address of Data
	x | x	x | x	x | x	x | x | x | x

Automatic built-in subroutines include interrupt system, edit commands, tape compression, table look-up, and record scatter-gather.

Automatic coding: As on the IBM 7070 there is Autocoder, Fortran, Report Generator, and an Input/Output Control System.

There are 99 words which may be designated as index words.

There are three addressable accumulators, an arithmetic register (intermediate storage) and an auxiliary register.

ARITHMETIC UNIT

Operation	Fixed Point Incl Stor Access Microsec
Time	
Add	10
Mult	56 (0-9 by 0-9)
Div	70 (5 digits quotient)
Arithmetic mode	Serial
Timing	Synchronous
Operation	Concurrent in Input/Output

The arithmetic unit is not an isolated unit.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	5,000 or 9,990	50,000 or 99,900	4
Disk Storage	600,000 to 4,800,000	6 to 48 million	

Disc storage access time is 100 to 850 millisec.

Magnetic Tape

No. of units that can be connected	40 Units
No. of chars/linear inch of tape	556 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	112.5 Inches/sec
Transfer rate	62,500 Chars/sec
Start-stop time	7.3 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	0.5 Inches
Length of reel	200-2,400 Feet
Composition	Mylar base

DuPonts registered trademark for its polyester film. The above specifications reflect the IBM 729-IV tape drive. Also available is a 729-II tape drive. A density mode in both tape drives provides four different speed rates and complete interchangeability of data on both drives.

INPUT

Media	Speed
Card Reader	500 cards/min (Control Panel Format)
Magnetic Tape	15,000; 22,500; 41,600; 62,500 chars/sec
Typewriter Remote Inquiry	Manual
Console	Manual
Disk Storage	12,000 dig/sec

OUTPUT

Media	Speed
Card Punch	250 cards/min (Control Panel Format)
Magnetic Tape	Same as input
Printer	150 lines/min 120 char/line (Control Panel Format)
Typewriter	10 char/sec Format selection
Disk Storage	6 K D 6,000 dig/sec, includes write compare check

For tape-oriented systems (no card equipment on line) an IBM 1401 Data Processing System would be used for peripheral operations at speeds of: card read, 800 cards/min; card punch, 250 cards/min; and printer, 600 lines/min.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Magnetic Cores	300,000	5,000 words of memory
	600,000	10,000 words of memory

CHECKING FEATURES

The transfer of information between memory and the arithmetic and programming unit or input/output devices is completely checked for validity. All input/output devices including card readers, card punches, tape units and printers are validity checked on transfer of information. For example, tape units have dual read/write heads which check writing validity at the time the record is created.

All arithmetic operations are checked.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	29.14 KVA
Weight, computer	23,150 lbs

Physical planning manual and assistance available on request. It is suggested that space requirements for the 7074 be extracted from actual installations, as this figure can vary widely.

COST, PRICE AND RENTAL RATES

Machine	Model	Monthly Rental	Purchase Price
729 Magnetic Tape Unit	2	$ 700	$27,500
	4	900	48,500
7150 Console Control Unit	1	300	13,050
7300 Disk Storage	1	975	62,200
	2	1,500	74,800
7400 Printer	1	950	41,500
7500 Card Reader	1	400	18,000
7501 Console Card Reader	1	75	3,700
7550 Card Punch	1	550	24,600
7600 Input-Output Control	1	1,400	63,000
	2	800	33,000
7603 Input-Output Synchronizer	1	1,000	46,050
	2	1,300	59,250
	3	1,350	62,050
	4	1,650	75,250
	5	2,000	91,250
	6	1,700	78,050
	7	1,600	72,450
	8	1,950	88,450
	9	2,300	104,450
7604 Tape Control	1	2,700	122,550
	2	1,850	94,000
7605 Disk Storage Control	1	3,900	174,000
7802 Power Converter	1	400	18,700
7900 Inquiry Station	1	250	10,300
7104 High Speed Processor	1	7,300	313,000
	2	7,400	317,000
	3	7,500	321,000
	4	7,700	329,000
	5	7,800	333,000
7602 Core Storage Control	6	1,200	49,400
7301 Core Storage	3	4,700	208,600
	4	8,000	334,000

Selling Price, Average System	$1,284,350
Monthly Rental, Average System	29,300

Maintenance contract available on request.

PERSONNEL REQUIREMENTS

Number of people required varies according to volume of work and type of applications.

Training made available by the manufacturer to the users includes education, training, program testing, and technical assistance in all phases.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Diagnostic programs and marginal checking are used to detect and anticipate component failures.

Solid-state components, together with conservative circuit design criteria assure a high level of reliability.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include conversion from the IBM 7070 to the IBM 7074 which may take place in the field. (See IBM 7070). The 7074 is completely compatible with 7070 programs. Thus a customer is able to obtain additional processing power to match job growth with minimum effort and expense.

Sales Engineers and texts will be available to assist installations in the area of magnetic tape handling.

IBM 7080

IBM 7080 Data Processing System

Photo by International Business Machines Corporation

APPLICATIONS

This is a general purpose computer designed for both commercial and scientific applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Alphabetic
Alphanumeric chars/word	Variable
Alphanumeric chars/instruction	5
Instructions decoded	69
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-10^{255} < M < 10^{255}$

Instruction word format

Operation	Address with zone bits as indicators

Automatic built-in subroutines includes an interrupt system, a store-for-print, and a transmit.

Automatic coding includes 7080 Processor including Auto coder III, File Maintenance and Report/File Writing, Decision Making and Fortran.

Registers includes one 256 character accumulator, 30 auxiliary storage units (512 characters), and 32 eight character words for communication storage.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add (6+6)	13.08	(6 char + 6 char)
Mult (6x6)	140	(6 char x 6 char)
Div	210	(10 char/6 char)

Construction (Arithmetic unit only)

Transistors	36,000
Magnetic Cores	9,000

Arithmetic mode	Serial	
Timing	Synchronous and Asynchronous	
Operation	Concurrent	

STORAGE

Media	No. of Characters	Access Microsec
Core	40,000; 80,000; 160,000	2.18
Core (Fast Registers)		1.09

Magnetic Tape

No. of units that can be connected	50 Units
No. of chars/linear inch	200 or 556 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	0.75 Inches
Tape speed	75 or 112.5 Inches/sec
Transfer rate 15,000; 22,500; 41,667; 62,500 Chars/sec	
Start-stop time	10.8 or 7.3 Millisec
Average time for experienced operator to change reel of tape	60 Seconds

Physical properties of tape

Width	0.5 Inches
Length of reel	2,400 Feet

INPUT

Media	Speed
Magnetic Tape	See Storage
Card	250 cards/min

OUTPUT

Media	Speed
Magnetic Tape	See Storage
Card	100 cards/min
Console Typewriter	600 char/min

In addition to the above components, an IBM 1401 Data Processing System may be used for peripheral operations. The speeds of the 1401 components are:

Card Reading	800 cards/min
Card Punching	250 cards/min
Printing	600 lines/min
Tapes	The 7080 tapes are completely compatible with the 1401 system

CHECKING FEATURES

Character code check on internal operations and data transmission sign check for arithmetic instructions overflow, character code check during transmission from storage to I/O units, horizontal and vertical parity check on magnetic tape, dual level sensing, two gap head for verification of tape writing, two read stations in card reader, echo checking on line printer, and row-count comparison in card punching.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	14.4 Kw
Area, computer	1,000-1,200 sq ft (approx)
Floor loading	100 lbs/sq ft
Weight, computer	19,700 lbs

Site preparation requirements: Physical planning manual and assistance available.

PRODUCTION RECORD

Time required for delivery   12 months

COST, PRICE AND RENTAL RATES

Type	Description	Model	Monthly Rental	Purchase Price
7102	Arith & Logical Unit	1	$14,500	$685,000
7153	Console Control Unit	1	1,500	75,000
7302	Core Storage	1	17,500	840,000
7305	Ctrl Stor & I/O Ctrl	1	7,300	345,000
		2	8,400	395,000
7800	Power Converter	1	700	25,000
7801	Power Control	1	900	35,000
7621	Tape Control	2	3,300	147,000
729	Magnetic Tape Unit	2	700	27,000
729	Magnetic Tape Unit	4	900	48,500
7622	Signal Control	1	1,500	26.000

The above renatl rates include customer engineering maintenance and parts and cover the first 176 hours a month the system is in use. Each hour of use thereafter is subject to a rate of 1/176th of 40%.

A maintenance contract is available for components of a purchased system at rates per a published schedule.

Purchase Price, typical system:	$2,200,000
Monthly Rental, typical system:	$ 48,000

PERSONNEL REQUIREMENTS

The number of people required to operate this computer system will vary with the configuration, the application and the policies of the user.

Education and training in all phases of computer use are provided by the manufacturer. One week classes conducted for executives at IBM educational departments in Endicott and Poughkeepsie, New York. Comparable classes are available in several major cities across the country. These courses are designed to acquaint executives with the organization, operating characteristics, capacities, and applications of the 7080. Customers who complete this course are better able to evaluate the advantages, economics and wide business applications of the 7080. In addition to the executive class, courses are available to qualified methods personnel. These classes are of longer duration and provide knowledge of programming and necessary operating details. Special representatives offer overall consulting service in connection with the study of possible uses. Sales engineers are available to assist in preparing the site for physical installation. This assistance begins twelve months in advance of delivery. The Programming Service has personnel available for consultation with field representatives and customers. A library of programs common to many problems is available for adoption as sub-routines by customer. Automatic coding, as listed under automatic coding, is available. Symbolic coding methods and assembly programs are available.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

This system is completely compatible with the IBM 705 Data Processing System. The logic of these systems is carried forward with additional features to increase the memory size and the internal speed and usefulness of the data channels.

ADDITIONAL FEATURES AND REMARKS

Reference is made to the 7080 Physical Planning Manual which assists in the preparation of the site.

INSTALLATIONS

International Business Machines Corp., Data Systems Division, Poughkeepsie, N. Y.

International Business Machines Corp., Methods DS Manufacturing, South Road, Poughkeepsie, N. Y.

Eastman Kodak Company, Rochester, N. Y.

Commonwealth Edison Company, 72 W. Adams Street, Chicago, Ill.

International Harvester Co., Motor Truck Div., Box 1109, Meyer Road, Fort Wayne, Indiana

Convair, Fort Worth, Texas (Proposed)

IBM 7080

IBM 7090

IBM 7090 Data Processing System

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer

System is designed and used for scientific and commercial data processing, real time flight control, safety and impact prediction calculations, and message processing.

General Electric-Missile & Space Vehicle Dept. Located at 3198 Chestnut Street, Philadelphia 4, Pa., the system is used for flight test data reduction, for engineering computations, including aerodynamics, flight mechanics space science problems, for trajectory analysis, for data processing including recording, updating and maintaining files on provisioning, reliability, document control, weight and balance, and wiring harness problems, and business data processing routines such as personnel accounting records, cost ledger, general ledgers and budget exercises.

Space Technology Laboratories, Inc. Located at El Segundo, California, the system is used for the full spectrum of scientific computations.

Union Carbide Corporation

Located on the 36th floor of the Union Carbide Building, 270 Park Avenue, New York City, the system is used for sales analysis, financial reporting, product costing, engineering studies, operations research and economic studies, scientific analysis, and others to be added as time goes by.

Westinghouse Electric Corporation, Steam Division Located at Lester Branch P.O., Philadelphia 13, Pa., the system is used for commercial applications, e.g. integrated data processing system including payroll, personnel statistics, labor distribution, inventory control, shop scheduling, shop simulation, manufacturing information, general and cost accounting, dispatch, purchasing, drafting planning, sales negotiation, linear programming, and statistical analyses, and for scientific applications, e.g. turbine performance, testing, and design, numerically controlled machine tools, stress analysis, heat balance, and

curve fitting.
University of California Lawrence Radiation
Laboratories
Located at Livermore, California, the system is used
for the solution of differential equations.

Automatic coding includes the SHARE Operating
System and FORTRAN.
There are three index registers and four arithmetic
registers (full word), i.e. the Accumulator, Multi-
plier-Quotient, Storage and Sense Indicator registers.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer
Internal number system	Binary
Binary digits/word	36
Binary digits/instruction	36
Instructions/word	1
Instructions decoded	205
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	

Floating $\quad - 10^{38} < N < 10^{38}$

Fixed $\quad - (2^{35} - 1) \leq N \leq (2^{35} - 1)$

Instruction word format

Op Code		Flag	Tag	Address	
S 1	11	12 13	18 21	22	35

Format varies with instruction type

ARITHMETIC UNIT

Manufacturer

	Fixed Point Microsec	Floating Point Microsec
Add	4.36	13.08 to 32.70
Mult	4.36-30.52	4.36 - 28.34
Div	6.54-32.70	6.54 - 28.34

Construction (Arithmetic unit only)
The arithmetic unit is constructed of 20,000 tran-
sistors.

Arithmetic mode	Parallel
Timing	Synchronous (Central Proc Unit)
	Asynchronous (Input-Output)
Operation	Sequential (Central Proc Unit)
	Concurrent (Input-Output)

Input and output operations on up to eight data
channels can operate concurrently with the main com-
putational program in the Central Processing Unit.

IBM 7090

STORAGE

Manufacturer

Media	No. of Words	Access Microsec
Magnetic Core	32,768	2.18
Magnetic Tape	2,500,000/reel	7,000 or 10,000

No. of units that can be connected — 80 Units
No. of chars/linear inch — 200 or 556 Chars/inch
Channels or tracks on the tape — 7 Tracks/tape
Blank tape separating each record — 0.75 Inches
Tape speed — 75 or 112.5 Inches/sec
Transfer rate 15,000; 22,500; 41,667; 62,500 Chars/sec
Start time — 10.8 or 7.3 Millisec
Stop time — 10.8 or 7.3 Millisec
Average time for experienced
operator to change reel of tape — 30 - 60 Seconds
Physical properties of tape

    Width — 0.5 Inches
    Length of reel — 2,400 Feet
    Composition — Mylar

Mylar is DuPont's registered trade mark for Polyester Film.

    GE
Magnetic core and 10 magnetic tape units.

Space Tech Labs
Magnetic core and magnetic tape.
    Union Carbide
Magnetic core and magnetic tape.
    Westinghouse
Magnetic core and magnetic tape.
    UCLRL

Media	No. of Words	Access Microsec
Core	32,768	2
Magnetic Tapes 729 IV	6 Tape Units	970
Magnetic Tapes 729 II	4 Tape Units	1,400

The above indicated access time is for reading in low density mode. For writing, it would be 729 II 4400 microsec and 729 IV 2970 microsec. High density operation for 729 II 250 microsec faster and for 729 IV 170 microsec.

INPUT

Manufacturer

Media	Speed
Magnetic Tape	See Storage
Cards	250 cards/min (on-line)
Card to Magnetic Tape	250 or 800 cards/min (off-line)

Higher conversion rate using IBM 1401 for generating input tape.

IBM 7090

GE

Media	Speed
IBM Cards	250 cards/min (Off line Card Reader)
Magnetic Tape	15,000 or 62,500 char/sec

Space Tech Labs

Magnetic tape and punched cards.

Union Carbide

8 729 II Tape Drives	75 in/sec
4 729 IV Tape Drives	112.5 in/sec
1 711 Card Reader	250 cards/min

Also off line 714 Card Reader (250 cards/min) with 727 Tape Drive (75 in/sec).

Westinghouse

Magnetic Tape (IBM 729 II)	75 in/sec 15,000 or 42,000 char/sec
Magnetic Tape (IBM 729 IV)	112.5 in/sec 22,500 or 62,500 char/sec

One of these units may be installed. Character rate varies due to high or low density tape option.

UCLRL

Cards	250 cards/min 24 words/card Binary 72 col/card Decimal
Tapes 729 IV	270 microsec/word low density
Tapes 729 II	400 microsec/word low density

High density values for tapes are 150 microsec/word for 729 II and 100 microsec/word for 729 IV.

OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	See Storage (Recording in BCD or Binary)
Cards	100 cards/min (on-line)
Printed Page	150 lines/min (On-line)
Tape to Printer	150 or 600 lines/min

Tape-to-Card conversion can proceed at 100 or 250 cards/min. The faster rates of conversion are obtained when using the IBM 1401 for off-line tape to card and tape to printer functions.

GE

Cards	100 cards/min
Tape	15,000 or 62,500 char/sec
Printer	150 lines/min (attached to system)
Printer	500 lines/min (tape to printer off line)
Printer	4,000 lines/min (tape to printer off line)

Space Tech Labs

Magnetic Tape	62,500 char/sec
Line Printer	150 lines/min
Cards	100 cards/min (80 column)

Union Carbide

Media	Speed
Magnetic Tape	
1 716 Printer	150 lines/min
1 721 Card Punch	100 cards/min

Also off line 7204 and 717 printers (500 and 150 lines per minute respectively) with a 727 tape drive each, and an off line card punch - 722 at 100 cards/min with a 727 tape drive.

UCLRL

Printer	150 lines/min	72 chars/line
Tapes	729 II low density for off-line printer	
Cards	100 cards/min	24 words/card Binary
		72 col/card Decimal

CHECKING FEATURES

Manufacturer

Checking features include accumulator overflow, divide check, floating point overflow, and underflow, data channel I/O check, horizontal and vertical parity check on magnetic tape, dual level sensing, two gap head for verification of tape writing, and echo checking on the line printer.

Photo by Space Technology Laboratories, Incorporated

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	5.8 Kw	
Weight, computer	17,795 lbs	

Physical Planning Manual available on request - IBM Form No. x21-1209.

GE

Power, computer	5.84 Kw	6.9 KVA
Volume, computer	18,000 cu ft	
Volume, air condition	13,800 cu ft	
Area, computer	2,000 sq ft	
Area, air conditioner	160 sq ft	
Room size, computer	50 ft x 40 ft	
Room size, air condition	8 ft x 20 ft	
Floor loading	200 lbs concen max	
Capacity, air conditioner	30 Tons	
Weight, computer	30,000 lbs	

Site preparations include a steel sub-floor, an acoustical hung ceiling, and a room enclosed by double glass and wall board.

Space Tech Labs

Power, computer	35 KVA
Volume, computer	17,000 cu ft
Area, computer	1,700 sq ft
Floor loading	80 lbs/sq ft

Site preparation included a 24-inch false ceiling

IBM 7090   552

and an 18-inch raised floor. The air conditioning is included in the building system.

Union Carbide

Power, computer	300	KVA
Power, air conditioner	75	Tons
Volume, computer	25,500	cu ft
Volume, air conditioner	3,400	cu ft
Area, computer	3,000	sq ft
Area, air condiioner	400	sq ft
Room size	75	ft x 40 ft
Floor loading	50	lbs/sq ft
	300	lbs concen max
Weight, computer	50,000	lbs

Computer is installed on the 36th floor of an office building which is completely air conditioned and equipped with sealed windows. Structural steel of the 36th floor was lowered 12 inches to allow for raised floor-used for cabling etc. - which was prepared by the Lishe Aluminum Co. and consists of 2 1/2 x 2 1/2 panel. Room will be equipped with false "egg crate" ceiling. Air plenum chamber also used.

Westinghouse

Power, computer	5.84 Kw	6.9 KVA	19.0 pf
Volume, computer	1,030	cu ft	
Volume, air conditioner	96	cu ft	
Area, computer	212	sq ft	
Area, air conditioner	16	sq ft	

Photo by C E I R, Incorporated

Room size	1,000	sq ft
Floor loading	69	lbs/sq ft
	80	lbs concen max
Capacity	3 1/2	Tons
Weight, computer	14,655	lbs
Weight, air conditioner	800	lbs

The air conditioner is to maintain 75°F and 50% relative humidity, assuming 4 persons are in room.

UCLRL

Power, computer	28 Kw	35 KVS	0.8 pf
Power, air cond	22 Kw	32 KVA	0.9 pf
Volume, computer		1,200	cu ft	
Volume, air conditioner		2,000	cu ft	
Area, computer		200	sq ft	
Area, air conditioner		360	sq ft	
Room size, computer		25	ft x 40 ft	
Room size, air conditioner		12	ft x 30 ft x 10 ft	
Floor loading		30	lbs/sq ft	
		500	lbs concen max	
Capacity, air conditioner		30	nominal Tons	
Weight, computer		30,000	lbs	
Weight, air conditioner		16,000	lbs	

Site was previously occupied by an IBM 704, so preparation consisted of drilling some new cable holes in concrete floor and rerouting cope trays.

PRODUCTION RECORD

Manufacturer

Time required for delivery	18 - 24 months
Number of systems produced	Over 8

COST, PRICE AND RENTAL RATES

Manufacturer

Type	Description	Model	Monthly Rental	Purchase Price
711	Card Reader	2	$ 800	$32,000
716	Printer	1	1,200	54,200
721	Card Punch	1	600	25,000
729	Magnetic Tape Unit	2	700	27,500
729	Magnetic Tape Unit	4	900	48,500
7100	Central Process Unit	1	16,975	707,500
7151	Console Control Unit	1	1,225	61,700
7302	Core Storage	1	19,800	950,000
7606	Multiplexor	1	3,900	156,300
7607	Data Channel (Tape and Card)	1	4,500	208,400
7607	Data Channel (Tape)	2	3,500	169,900
7608	Power Converter	1	1,600	60,000

Monthly rental, typical system: $63,500
Purchase price, typical system: $2,898,000
Maintenance contract available.

Space Tech Labs
System cost is $2,949,000 and rental rate is $66,100 per month.

Union Carbide
2 channel IBM 7090, with I/O equipment listed, rents at about $76,000.

Westinghouse
IBM 7100, IBM 7302, IBM 7607, 10 IBM 729 II, IBM 7151, IBM 7606, and IBM 7608 rent for $60,000/month. Maintenance and serive provided by manufacturer included in monthly rental.

UCLRL
IBM 7151, 7302, 7100, 7606, 7607, 7608, 7617, 7617, 7618 purchased for $2,313,800.
IBM 716, 711, 721, ten 729's rent at $11,600/month.
Maintenance contract at $2,500/month.

PERSONNEL REQUIREMENTS

Manufacturer
Education, training, program testing, technical assistance are provided.

GE

| | Three 8-Hour Shifts | |
	Used	Recommended
Supervisors	3	3
Analysts	20	30
Programmers	17	20
Coders	10	12
Clerks	1	1
Librarians	1	1
Operators	3	4
Input-Output Oper	4	5
Tape Handlers	3	4
Scheduler	1	1

Operation tends toward open shop.

Methods of training used include on-the-job training and IBM School.

Space Tech Labs

	Three 8-Hour Shifts
Supervisors	15
Analysts	6
Programmers	60
Clerks	2
Librarians	1
Operators	7
Engineers	1
Technicians	2
Input-Output Oper	2
Tape Handlers	1

Operation tends toward closed shop.

Methods of training used includes IBM local short courses, internal two-week courses, and on-the-job training.

Union Carbide

	One 8-Hour Shift
Supervisors	6
Programmers	16
Operators	2
In-Output Oper	1
Tape Handlers	1

Operation tends toward closed shop.

Methods of training used includes IBM and internal training courses.

Applications programmed outside the department will be accepted for running on the 7090 by EDP personnel. In other words, programming is, if desirable, open shop, operations are closed shop.

UCLRL

	Seven days/week Three 8-Hour Shifts
Supervisors	1
Programmers	21
Coders	5
Librarians	1
Operators	10

Operation tends toward open shop.

Personnel are trained by working with an experienced person.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

GE

Average error-free running period	110 Hours
Good time	110 Hours/Week (Average)
Attempted to run time	120 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.916

Above figures based on period 16 Jun 60 to 14 Aug 60
Passed Customer Acceptance Test 16 Jun 60
Time is available for rent to qualified outside organizations.
Time is made available, on none interference basis, to other government contractors.

Space Tech Labs
Passed Customer Acceptance Test   July 1960
    Westinghouse
System installed in May 1961.
    UCLRL

Good time	110 Hours/Week (Average)
Attempted to run time	150 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.75

Above figures based on period 1 Jul 60 to 15 Jul 60
Passed Customer Acceptance Test 1 Jul 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include high speed, compatibility with IBM 704 and 709 systems, a rich operation code set, and a very fast memory.

Unique system advantages include overlap of input/output operations with computing with very low memory interference rate and automatic interrupting facilities permitting I/O devices to interrupt main program. Many special features and attachments are available on a "Request for Price Quotation" basis: (i.e.) Cathode Ray Tube pictorial output, clocks, extended precision arithmetic, direct data I/O device, tape switch, etc.

Manufacturer's recommendations for the care and handling of magnetic tape:

Storage for frequent or infrequent usage (Mylar Base) at relative humidity 0 to 80% (The upper limit on humidity is given to prevent the formation of fungus and mold growth. This limit may be exceeded by hermetically sealing the tape in a plastic bag.) and temperature 40 to 120°F.

The tape should be stored in a dust proof container. Should the tape be exposed to atmospheric conditions outside the above limits for more than four hours, it must be reconditioned by allowing it to remain at the given condition for a length of time equal to the time it was away. Twenty-four hours reconditioning is necessary if the tape is removed for longer than twenty-four hours.

General Precautions

The tape should not come in contact with magnetic material at any time and should never be subjected to strong magnetic fields. Either of these can cause the loss of information or the introduction of noise.

When shipping magnetic tape, the reel should be placed in a dust-proof container and hermetically sealed in a plastic bag. Additional support should be obtained by enclosing in an individual cardboard box.

GE

Outstanding features include column binary, on line clock, speed necessary to meet schedules, capacity large enough to handle our largest programs, and size (not cumbersome machine to operate).

Customer asks for tapes to be assigned to him although physical use of tapes are under control of tape librarian. The customer maintains a log of what he has been assigned and releases the tapes as data is no longer of any value. Stored in special design plastic containers under humidity and temperature controlled conditions.

Smithsonian Institution

The Smithsonian Institution will use an IBM 7090 System at its Astrophysical Observatory for four hours during the day. The rest of the time is to be made available, by contract, to Computer Services, Inc. of Englewood, New Jersey, for purchase and resale.

General Motors
Allison Division
Indianapolis 6, Indiana

The 7090 is scheduled for shipment. The specifica-
tions and prices are as follows:

Qty	Unit	Monthly Rental
1	711	$ 812.00
1	716	1,218.00
1	721	609.00
18	729 IV	at 913.50
1	7100	19,589.50

The above price includes the 8K nullification RPQ
at $25.00

1	7151	1,243.38
1	7302	17,762.50
1	7606	3,958.50
1	7607-1	4,339.13
1	7607-2	3,324.13
1	7608	710.50
2	7617	228.38
1	7618	913.50

Martin Company
Denver, Colorado

IBM 7090 System to consist of a 7608, 7618, 7607,
(2) 7100's, 7606, 7302, 7607, (20) 729's, (2) 7617's,
7151, 711, and 716.

FUTURE PLANS

GE

The 7090 will be using FORTRAN, SOS, and SAP as
major assembler comilers as well as a generalized
data processing system for technical data systems.

A production monitor with programs on a master tape
as subroutines will be used. This system will have
built-in time checking of an on-line clock and will
work along with the systems mentioned above.

A link to combine MSVD's analog computer with the
7090 is almost ready for operation.

It is anticipated that two IBM 1401 Systems and/or
one GE 225 System will be added in 1961. These sys-
tems will be used primarily as input-output equip-
ment for the 7090.

INSTALLATIONS

U. S. Army Ordnance Missile Command
Redstone Arsenal, Alabama

U. S. Navy David Taylor Model Basin
Washington 7, D. C.

Aerospace Technical Intelligence Center
Wright Patterson Air Force Base, Ohio

U. S. Air Force Flight Test Center
Data Processing and Computing Branch
Edwards Air Force Base, California

U. S. Air Force Mathematical Services Laboratory
Eglin Air Force Base, Florida

Wright Air Development Center, ARDC
Directorate of Systems Engineering
Wright Patterson Air Force Base, Ohio

Allis Chalmers Manufacturing Company
Milwaukee, Wisconsin (Proposed)

Bell Telephone Laboratories
Murray Hill, New Jersey (Proposed)

C E I R, Incorporated
Arlington Research Center
Arlington, Virginia

C E I R, Incorporated
Union Carbide Building
270 Park Avenue
New York, N. Y.

Convair
Fort Worth, Texas

General Electric Company
Large Jet Engine Department
Evendale 15, Ohio

General Electric Company
Evendale Computations Operation
Evendale 15, Ohio

General Electric Company
Missile & Space Vehicle Department
3198 Chestnut Street
Philadelphia 4, Pennsylvania

General Motors Corporation
Research Laboratories
12 Mile and Warren Roads
Warren, Michigan

General Motors Corporation
Allison Division
Indianapolis 6, Indiana

Gulf Research and Development Company
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania (Proposed)

International Business Machines Corporation
Scientific Computation Laboratory
Endicott, New York

International Business Machines Corporation
Data Systems Division
Poughkeepsie, New York

International Business Machines Corporation
Research Center
P. O. Box 218
Yorktown Heights, New York

Lockheed Aircraft Corporation
Missile and Space Division
Sunnyvale, California

The Marquardt Corporation
16555 Saticoy Street
Van Nuys, California

North American Aviation, Inc.
4300 E. Fifth Avenue
Columbus 16, Ohio (Proposed)

Pratt and Whitney Aircraft
Florida Research and Development Center
United, Florida

Rand Corporation
1700 Main Street
Santa Monica, California

Republic Aviation Corporation
Farmingdale, L. I., New York

Sandia Corporation
Albuquerque, New Mexico (Proposed)

Service Bureau Corporation
IBM Plant
San Jose, California

Socony Mobil Oil Company
150 East 42nd Street
New York 17, N. Y.

Space Technology Laboratories, Incorporated
2400 E. El Segundo Blvd.
El Segundo, California

Standard Oil Company of California
Electronic Computer Center
225 Bush Street
San Francisco 20, California

Texaco, Incorporated
P. O. Box 2332
Houston 1, Texas

Union Carbide Corporation
300 Madison Avenue, 1st Floor
New York 17, N. Y.

Westinghouse Electric Corporation
Steam Division
Lester Branch
Philadelphia 13, Pennsylvania

Westinghouse Electric Corporation 4L38
Advance Systems Engineering & Analytical Department
East Pittsburgh, Pennsylvania

Johns Hopkins University
Johns Hopkins Road
Scaggsville, Maryland

University of California
Lawrence Radiation Laboratories
Box 808
Livermore, California

Smithsonian Institution
Astrophysical Observatory

IBM 7090

IBM CPC
IBM Card Programmed Calculator

Photo by International Business Machines Corporation

APPLICATIONS

Manufacturer
Business and scientific calculating.

U. S. Army Ordnance, Frankford Arsenal
Along with a Burroughs E101 and 2 Univac 120's, the following utilization is made: Field Service National Stock Accounting, fire control instruments, gage accounting, production control, payroll accounting, internal arsenal accounting including fiscal, budget, property and cost accounting, scientific computations in the field of fluid dynamics, interior ballistics, theoretical physics and certain aspects of nuclear physics.

The Griscom-Russell Company
Used for both commercial and scientific work.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	3 or 5
Arithmetic system	Fixed point
Instruction type	One to two address
Number range	Dependent upon programming

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	760
Mult	13,180 (average)
Div	15,480 (average)
Construction	Vacuum tubes

Rapid access word registers	4
Basic pulse repetition rate	50 KC
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	Words	Digits	Access Microsec
Electronic Tubes	9	37	760
Accumulator (Mech)	6	80	400,000-800,000
Mechanical	48	480	400,000-1,200,000

INPUT

Medium	Speed
Card Reader	100-150 cards/min

OUTPUT

Media	Speed
Printed Record	100-150 lines/min
Summary Punch	50 cards/min

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	1,500
Tube types	4

CHECKING FEATURES

Checking may be performed through control panel wiring.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	9.57 KVA
Volume, computer	375 cu ft
Area, computer	64 sq ft
Weight, computer	5,755 lbs

The above figures include the 412/418, 605, 527 Group. Special air conditioning is not required.

PRODUCTION RECORD

Number produced	693
Number in production	0
Delivery time	Out of production

COST, PRICE AND RENTAL RATES

Manufacturer
Approximately $2,200/month and up.
The Griscom-Russell Company
Basic system $2,000/month, additional equipment $1,000/month.

PERSONNEL REQUIREMENTS

The Griscom-Russell Company
One 8-hour shift requires one engineer and three technicians or operators.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer
Average service time for all machines is approximately 25 hours/month.

ADDITIONAL FEATURES AND REMARKS

The IBM Card-programmed Electronic Calculator solves problems involving any number of sequential steps to obtain a single solution. It is a combination of several units, including three standard IBM machines, and has many applications in engineering, scientific and actuarial computations. One standard unit is an electronic calculator capable of 2,174 additions and subtractions or 86 multiplications and divisions a second. Other units include an accounting machine for interpreting instructions and for accumulating and printing results, a storage unit for retaining data for later use in a problem and a punching unit for recording results in IBM cards.

Numerical instructions in IBM cards direct the sequence of operations. These instructions tell the electronic calculator where to obtain factors; whether to add, subtract, multiply or divide, and what to do with the result-print it, punch it, hold it for later use, or perform combinations of these possibilities.

When not being used for this type of computation, the accounting machine and electronic calculator may be disconnected and used to perform standard accounting and computing operations.

INSTALLATIONS

U. S. Army Ordnance, Frankford Arsenal
Philadelphia, Pennsylvania

NASA
Langley Field, Virginia

Allis-Chambers Manufacturing Company

Battelle Memorial Institute
Columbus 1, Ohio

Esso Standard Oil Company
New York 19, New York

The Griscom-Russell Company
Massillon, Ohio

Republic Aviation Corporation
Farmingdale, Long Island, New York

United Aircraft Corporation
East Hartford 8, Connecticut

IBM STRETCH

IBM Stretch Computer

MANUFACTURER

International Business Machines Corporation

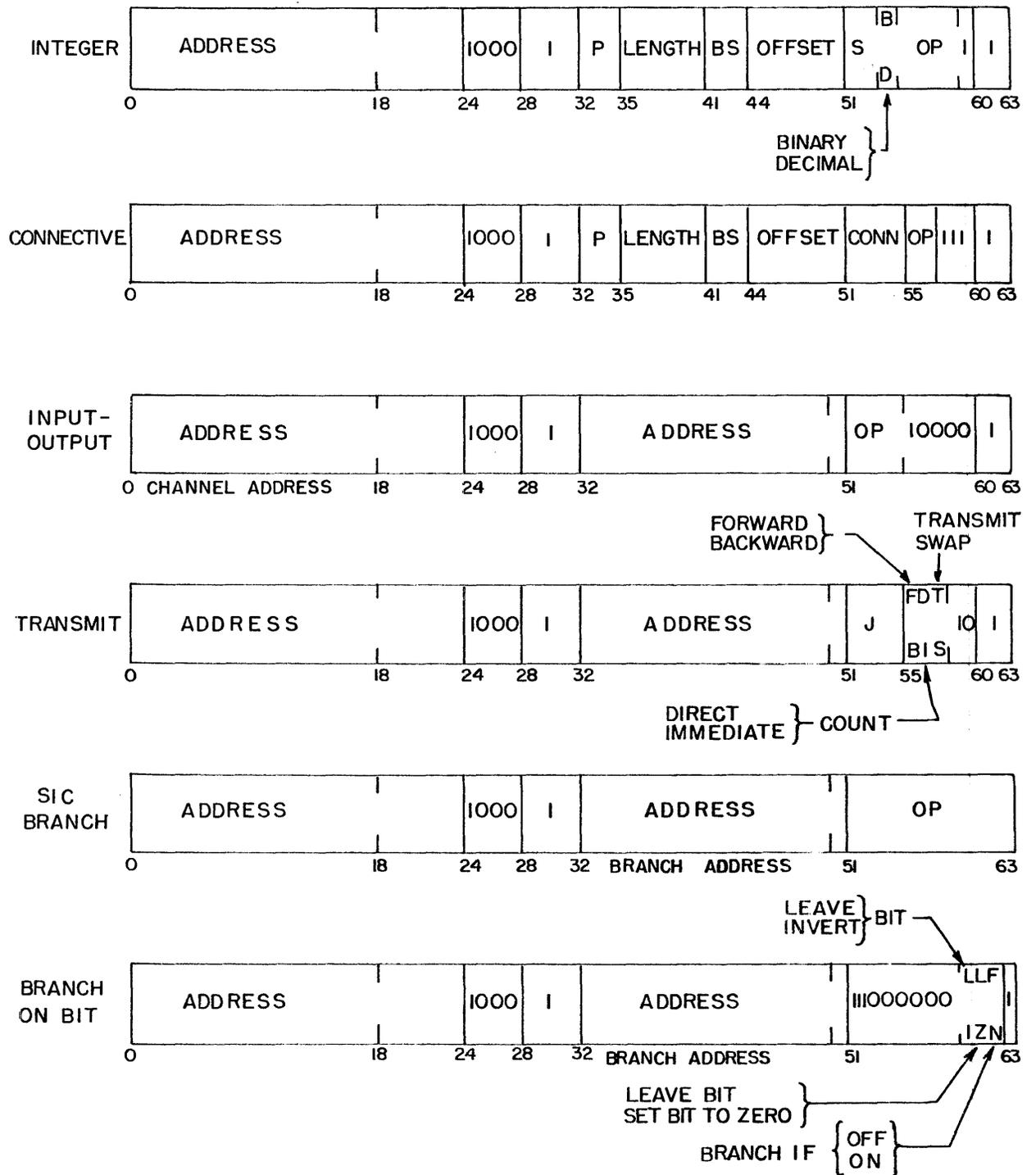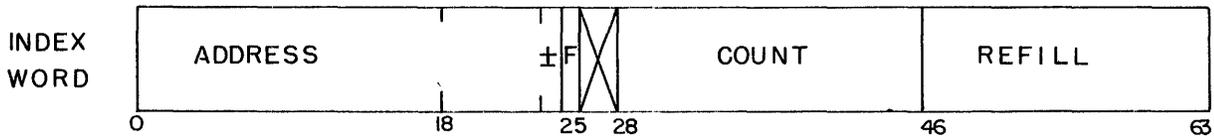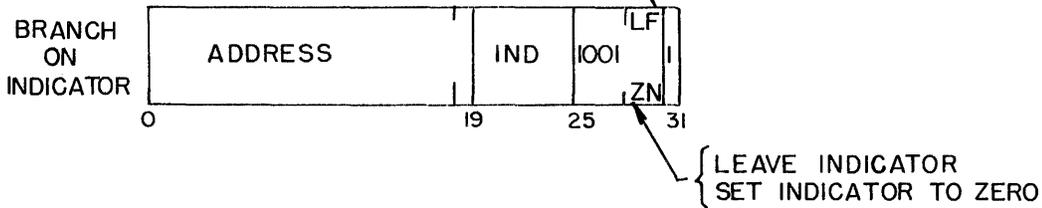Photo by the International Business Machines Corporation
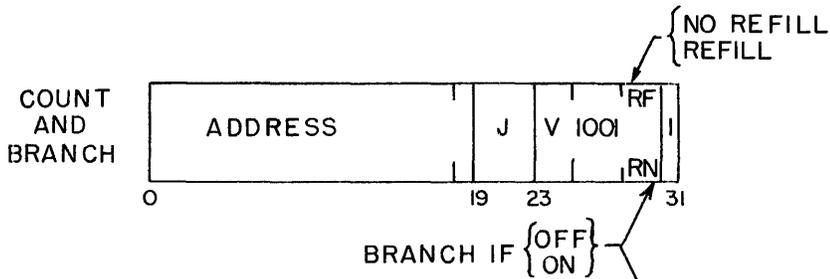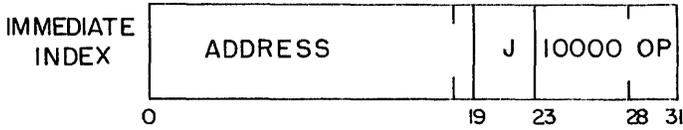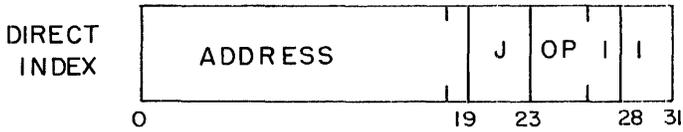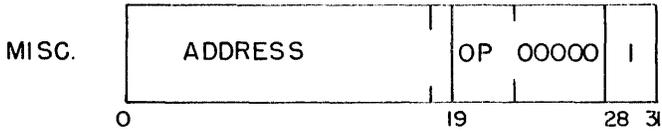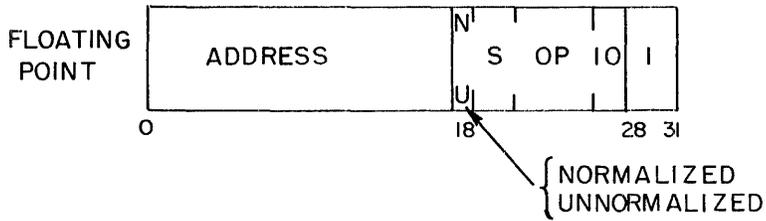
APPLICATIONS

Engineering development, scientific research, real time processing and control, logistics, procurement and supply, production scheduling and control, and other areas of application.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary and decimal
Binary and decimal digits/word	64 bits or 16 digits
Binary digits/instruction	32 or 64
Instructions per word	1 or 2
Instructions decoded	154 basic
Arithmetic system	Fixed and floating point

Binary and Decimal Integer Arithmetic for variable length fields

Instruction type   One and two address

Number range $-2^{1024} < N < 2^{1024}$ for floating point with a 48 bit fraction

Integer arithmetic:
$$0 \leq N < 2^{64} \text{ or } 0 \leq N < 10^{16}$$

INSTRUCTION WORD FORMAT

INTEGER

| ADDRESS | | 1000 | I | P | LENGTH | BS | OFFSET | S | [B][D] | OP | I | I |

0   18   24   28   32   35   41   44   51   60 63

BINARY }
DECIMAL }

CONNECTIVE

| ADDRESS | | 1000 | I | P | LENGTH | BS | OFFSET | CONN | OP | I I I | I |

0   18   24   28   32 35   41   44   51   55   60 63

INPUT-OUTPUT

| ADDRESS | | 1000 | I | ADDRESS | | OP | 10000 | I |

0   CHANNEL ADDRESS   18   24   28   32   51   60 63

FORWARD }
BACKWARD }

TRANSMIT
SWAP

TRANSMIT

| ADDRESS | | 1000 | I | ADDRESS | | J | [FDT][BIS] | 10 | I |

0   18   24   28   32   51   55   60 63

DIRECT }
IMMEDIATE } COUNT

SIC BRANCH

| ADDRESS | | 1000 | I | ADDRESS | | OP |

0   18   24   28   32   BRANCH ADDRESS   51   63

LEAVE }
INVERT } BIT

BRANCH ON BIT

| ADDRESS | | 1000 | I | ADDRESS | | 111000000 | [LLF][IZN] | I |

0   18   24   28   32   BRANCH ADDRESS   51   63

LEAVE BIT }
SET BIT TO ZERO }

BRANCH IF { OFF / ON }

FLOATING
POINT

| ADDRESS | N/U | S | OP | IO | I |

0   18   28 31

{ NORMALIZED
{ UNNORMALIZED

MISC.

| ADDRESS | OP | 00000 | I |

0   19   28 31

DIRECT
INDEX

| ADDRESS | J | OP | I | I |

0   19   23   28 31

IMMEDIATE
INDEX

| ADDRESS | J | I0000 | OP |

0   19   23   28 31

{ NO REFILL
{ REFILL

COUNT
AND
BRANCH

| ADDRESS | J | V | I00I | RF/RN | I |

0   19   23   31

BRANCH IF { OFF
          { ON

BRANCH
ON
INDICATOR

| ADDRESS | IND | I00I | LF/ZN | I |

0   19   25   31

{ LEAVE INDICATOR
{ SET INDICATOR TO ZERO

INDEX
WORD

| ADDRESS | ± | F | ⊠ | COUNT | REFILL |

0   18   25 28   46   63

Automatic built-in subroutines
  Square Root
  Radix Conversion
  Transmit
  Swap
  Automatic Subroutine-entry codes
  Automatic priority processing through interruption system
  Multiply and Add operation for both floating point and integer arithmetic

Automatic coding
  STRAP I
  704-709-7090 Simulator
  STRAP II
  704-709 Simulation
  SMAC (MACRO Generator)
  SMCP (master control program)
  FORTRAN

Registers and B-boxes
  16 index registers
  20 addressable special registers
    Special addressable registers include:
  Interval timer   Function through interrupt
  Elapsed Time clock system to provide elapsed time
                      and time of day indication.

Interruption address - Base address of interrupt system fix-ups routines.

Upper Boundary	Enable protection of areas of
Lower Boundary	main core store to facilitate
Boundary control bit	multiprogramming ability.

Maintenance bits
Channel Address
Other CPU
Left Zeros count
All ones count
Left half of accumulator
Right half of accumulator
Accumulator Sign

Indicators	Set by interrupt system or
Mask	programmer to provide flex-
Remainder	ibility in interrupt hand-
Factor	ling.
Transmit	

A variety of modifiers apply to different instruction classes and lead to a total of 2,975 individual operations e.g., there are two transmit instructions, TRANSMIT and SWAP. Two modifiers, count forwards or backwards, and immediate or direct address of count value, give a total of 8 transmit orders.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	N/A-Overlapped	1.38 to 1.50
Mult	N/A-Overlapped	2.48 to 2.70
Div	N/A-Overlapped	9.00 to 9.90

Timing given for floating point. Precise time unknown. Design incomplete.
Construction (Arithmetic unit only)
  Transistors   Approx 200,000 for complete system
  Magnetic Cores Special index core storage and exchange memory
Arithmetic mode   Serial and parallel
  Index arithmetic unit, 24 bits in parallel; Parallel 48 or 96 bit arithmetic for floating point; Serial binary or decimal integer arithmetic (1 to 8 bits in parallel). Note that instructions address words, fields, or bits for arithmetic operations.

Timing   Asynchronous
  System is asynchronous for input-output devices, central processing unit operation, including instruction preparation, memory operation and execution.
Operation   Concurrent
  Additional Features of Operation: The high degree of overlapped and asynchronous operation, together with two new devices, the instruction processor and look-ahead, not only permit concurrent operation of input-output and external storage devices with the central processing unit, but also several operations are carried on concurrently within the CPU, i.e., instructions and data may be fetched simultaneously from core storage while other instructions are being prepared for processing and while previously prepared instructions are being executed.

STORAGE

Media	No. of Words	No. of Dec/Digits	Microsec
Magnetic Core	16,384 to 262,144	262,144 to 4,194,304	0.5 to 2.18
Magnetic Disk	2,097,152 to 67,108,864	33,554,432 to 1,073,741,824	0 - 215,000

Magnetic core storage unit modules may each operate independently and simultaneously due to an interleaving of addresses within the modules and the operation of the instruction processor and look-ahead. With as many as four modules each of which may be referenced simultaneously, an effective core storage cycle of 1/2 microsecond may be realized for data and similarly with six modules, two for instructions and four for data permit up to 2,000,000 instructions and 2,000,000 data words to be referenced each second, giving an effective storage cycle of 1/2 microseconds for both instructions and data.
Magnetic Tape

No. of units that can be connected	256	Units
No. of chars/linear inch	200 or 556	Chars/inch
Channels or tracks on the tape	6	Tracks/tape
Blank tape separating each record	3/4	Inches
Tape speed	112.5	Inches/sec
Transfer rate	22,500 or 62,500	Chars/sec
Start time	7.3	Millisec
Stop time	7.3	Millisec
Physical properties of tape		
Width	1/2	Inches
Length of reel	2,400	Feet
Composition	Mylar	

INPUT

Media	Speed
Punched Cards	1,000 cards/min

Multiple card readers may be included in the system operating simultaneously.

Magnetic Tapes (8 per channel)	62,500 char/sec

Up to 8 magnetic tape units may be in simultaneous operation (one per channel).

Typewriter, Keys Switches   Manual
  Keyboard, switches, and keys are part of operator's console which functions like I/O devices. Multiple consoles may be attached for simultaneous operation.

Input-output devices are all controlled by the exchange, an asynchronously and concurrently operating component of the system. The exchange may have from 8 to 32 channels, each of which permits the simultaneous operation of its input-output device through

appropriate control units.

OUTPUT

Media	Speed
Magnetic Tapes (8 per channel)	62,500 char/sec
Punched Cards	250 cards/min
High Speed Printer	600 lines/min
Typewriter, direct digital display, lights	

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Solid state construction used throughout.

Tubes	None

CHECKING FEATURES

Checking features include single error correction and double error detection on all information transfers between core storage and the central processing unit, disk synchronizer and exchange, parity checking within the CPU and also in all I/O units, and residue checking of all arithmetic operations in parallel arithmetic unit.

Connective operations including automatic tests and counts allow facile programmed testing of data in the system with various parity and checking features contained within the data.

A unique error scanning and recording device automatically records the entire machine state, should malfunction occur.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	100 Kw	110 KVA	0.9 pf
Power, air conditioner	75 Kw	94 KVA	0.8 pf
Volume, air conditioner	5,400 cu ft		
Area, air conditioner	600 sq ft		
Room size, computer	2,500 sq ft		
Room size, air conditioner	600 sq ft with cooling tower		
Floor loading	100 lbs/sq ft		
	1,000 lbs concen max		
Capacity, air conditioner	60 Tons		
Weight, computer	70,000 lbs		

Figures are for "average" system.

Temperature and humidity requirement with machine power on is 50-80°F and 20% to 80%, relative. Cooling air will, in general, be furnished through plenum chambers under false floor.

Power service requirements include 400 cycle, 208 volts, 3 phase, 5 wire (This 400 cycle power may be derived from a motor generator set supplied by the customer. A five wire service should be provided consisting of three phase conductors, one neutral conductor and one equipment ground. Each phase conductor should be sized to carry 300 amperes).

60 cycles, 208 volts, 3 phase, 5 wire (This 60 cycle power should be obtained from a balanced 208 volts, 3 phase source. Should an MG be used to supply the 400 cycle power, the same 60 cycle source may be used. A five wire service should be provided consisting of three phase conductors, one neutral conductor and one equipment ground, each phase conductor should be sized to carry 210 amperes).

PRODUCTION RECORD

Delivery on contract basis

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Solid state construction is used throughout. Automatic error checking and correction and automatic maintenance scanning and recording facilitates troubleshooting.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include simultaneous operation, high speed of auxiliary storage and high speed of indexing and floating point operations.

Unique system advantages include an ability to run and interrupt several programs simultaneously.

FUTURE PLANS

The exchange and central processing unit provide an adequate set of commands control lines, and data paths to permit the attachment of many types of input output devices. Future I/O devices can be designed for direct attachment to the exchange without requiring alterations of the exchange or central processing unit.

INSTALLATIONS

University of California
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

ILLIAC
Illinois Automatic Computer

MANUFACTURER
University of Illinois

Illiac

Photo by University of Illinois

APPLICATIONS

The following typical use was made of the ILLIAC during September 1959:

Use by Departments

	Hrs:Min
Classes	:24
Agricultural Economics	2:36
Aeronautical Engineering	1:34
Agronomy	20:43
Marketing	:13
Animal Science	8:09
Astronomy (Nonr 1834(22))	:42
Astronomy (NSFG 5512)	:10
Bureau of Educational Research	28:30
U. S. Navy (9840-0383)	:59
Veterinary Medicine (MD 728 Off. Surg. Gen.)	:32
Veterinary Medicine (E 2087)	:14
Veterinary Medicine (Exp. Sta. 70-316)	:06
Chemistry	85:49
College of Medicine	:04
Coordinated Sciences Laboratory	52:53
Botany - Eastern Illinois University	:41
Electrical Engineering (NSFY 32-40-266)	10:35
Electrical Engineering (NSFG 7421)	1:31

	Hrs:Min
Electrical Engineering (AF 6079)	1:02
Electrical Engineering	1:44
Education	2:57
Economics (NSFG 7056)	6:21
Economics	:27
Digital Computer Laboratory (Task 27)	14:09
Digital Computer Laboratory (AEC-AT(11-1) 415)	2:00
Digital Computer Laboratory	:04
I. R. E. C.	:07
Physics (Nonr 1834(12))	:57
Physics (AF 662(46-22-55-302))	:12
Physics	7:47
Music	:05
Stanford Research Center (Nonr 2778(100))	3:14
Psychology (AF 49(638)371)	7:50
Psychology P.H. 1715)	11:49
Psychology (ONR 1834(11))	:26
Psychology	24:24
Sociology (Ford Found. 44-32-69-329)	:38
Sociology	2:31
Structural Research (AF 464)	3:39
Structural Research (A.A.S.H.O. Road Test)	1:52
Structural Research (NSF 6572)	3:05
Structural Research (Hwy. Brdg. 47-22-20-307)	6:58

	Hrs:Min
Structural Research	26:28
Theor. and Applied Mechanics (ORD 593)	:17
Theor. and Applied Mechanics	2:06
State Water Survey (SC 75055)	3:22
State Water Survey	:26
Institute of Communications Research (PH 9067C)	1:07
Mechanical Engineering (Martin Co.)	2:00
Mechanical Engineering	4:10
Mining and Metallurgical Engineering (AF 3789)	:08
Mining and Metallurgical Engineering	3:10
Zoology	7:14
Mathematics	2:36
Michigan State University	2:19
Physical Education	:09
	382:39

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40
Binary digits per instruction	20
Instructions per word	2
Instructions decoded	112
Instructions used	62
Arithmetic system	Fixed point
Instruction type	One address

Number range $\qquad$ -1 to 1 - 2^{-39}

The 20 digits (Half of a word) for the instruction are divided so as to utilize 8 digits for the instruction type (command digits), 10 digits for the address, and 2 digits are unused spares.

ARITHMETIC UNIT

	Inc. Stor. Access Microsec	Excl. Stor. Access Microsec
Add time	93	40
Mult time	665 - 865	620 - 820
Div time	950	900
Construction	Vacuum tubes	
Rapid access word registers	6	
Arithmetic mode	Parallel	
Timing	Asynchronous	
Operation	Sequential	

The figures for operation time including storage access include the access time for the operand and pro-rated access for the instruction.

STORAGE

Media	Words	Digits	Microsec Access
Electrostatic (CRT)	1,024	40,960	18 to 36
Magnetic Drum	12, 800	512,000	1,280 to 16,900

Instructions for drum access require 40 binary digits with 14 binary digit addresses. This address specifies the location of the word desired. Subroutines are employed for block transfers between drum and electrostatic storage.

INPUT

Media	Speed
Punched Paper Tape	300 char/sec

Five hole teletype tape is used. Numerical data is read with a 4-hole code. Alphanumerical data employs a 5-hole code and a special instruction.

OUTPUT

Media	Speed
Punched Paper Tape	60 char/sec
Page Printer	10 char/sec
Cathode Ray Tube	500 points/sec

A teletype BRPE Punch is used. The CRT has a 256 x 256 raster.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	4,427
Tube types	27
Separate cabinets	4

Above figures exclude power supplies.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	27.2 KW
Power, air conditioner	7.0 KW
Space, computer	700 cu ft. 100 sq ft.
Weight, computer	4,000 lbs.
Capacity, air conditioner	10 Tons

PRODUCTION RECORD

Produced	4	Copies at Mich State University, Iowa State University, and University of Sidney
Operating	4	

COST, PRICE AND RENTAL RATES

Approximate cost of basic system	$300,000
Approximate cost of additional equipment (Estimated)	200,000

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
3-8 Hour shifts	4	3

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Error Frequency and Analysis

The ILLIAC is normally used for "engineering" and maintenance between 7 a.m. and 10 a.m., and for a check of its performance between 5:30 p.m. and 6:30 p.m. of each weekday. Since the periods between 7 a.m. and 10 a.m. together with certain irregular periods, such as Saturdays and Sundays,

are devoted to a heterogeneous group of engineering, maintenance and laboratory functions, it is more instructive for an error standpoint to look at the periods between 10 a.m. and 7 a.m. of the next day in order to make an observation of the error frequency in the machine. This is the actual period when the machine is designated for use, although certain engineering procedures frequently require the scheduling of extra maintenance time. With this in mind a summary table has been prepared, using the period between 10 a.m. and 7 a.m. of the next day. This table lists the running time when the machine was operating, the amount of time devoted to routine engineering, the amount of time devoted to repairs because of breakdowns, and the number of failures while the machine was listed as running. During the 5:30 - 6:30 period (when the machine is checked), if no errors are to be found, the time is given to the "running column". Each failure was considered to have terminated a running period and was followed by a repair period in preparing this table. Since the leapfrog code is our most significant machine test, the length of time which it has been used on the machine is listed separately together with the number of errors associated with that particular code. This information for the month is presented in Table II.

It is important to notice that, except during scheduled engineering periods, any interruption of machine time that was not planned is considered a failure in this table. In rare cases, where the failure is not known until a later time, it is possible that no repair period is associated with the failure. This overall system has been adopted because it makes it possible for a machine user to estimate directly the probability that the machine will be "running" any instant of time and the probability of a failure during any given interval of running time.

The following table presents a typical summary of errors or interruptions for June 1959:

Source of Error	Quantity of Errors
Control	2
Arithmetic	1
Memory	3
Drum	13
Reader	5
Punch	3
Unknown	7
Input-Output	1
Run-over from Sched. Main.	1
Total Errors	34

The following table shows the distribution of ILLIAC machine time for the month of September 1959:

	Hrs: Min
Regular Maintenance	84:00
Unscheduled Maintenance	22:13
Drum Engineering	21:06
R.A.R.	:11
Leapfrog	16:18
Library Development	3:04
	146:52

ADDITIONAL FEATURES AND REMARKS

New ILLIAC Codes

During the month of September two new routines were added to the ILLIAC Auxiliary Library.

Aux. P21-268   Data Plotter Output Converter II. Under the control of parameters this routine will convert a data tape output by the standard ILLIAC printing routines into a tape suitable for input to the data plotter.

Aux. X15-269   Maximum Speed Sexadecimal Input Preparation for Magnetic Drum and/ or Williams Memory. This routine permits loading of the drum and/or Williams memory from the reader at maximum speed. Any information previously assembled on the drum or in the Williams memory is punched out in sexadecimal form in such a manner that the tape (provided with its own bootstrap) can be read in and sum checked at some later time.

ILLIAC Usage

During the month of September specifications were presented for 17 new specifications. This list does not indicate how the ILLIAC was used because large amounts of machine time may have been consumed by problems with numbers less than 1488T. Numbers followed by T are for theses.

1488 T   Sociology. Patterns of Inmate Response. The problem is to group questions (55) in terms of common differentiation of 556 subjects. What are some of the common patterns of responses? Which questions can be grouped together? A pattern analysis is used (KSL 294) in which the usual order of persons and responses is reversed.

1489 T   Sociology. Subject Similarities. The problem is to group inmates in terms of how they answer questions about prison life and themselves. A pattern analysis is used in the standard way on each of two subsamples of 50 subjects.

Two subsamples are used:
1. To investigate the reliability of the patterns obtained.
2. To compare samples from two different prisons on differences and similarities in patterns of response.

1490   Civil Engineering. Thermal Stresses in Elastic Shells. This is to solve the problem of an elastic shell subject to the transient temperature input associated with high velocity motion through an atmosphere of variable density, although any temperature history input could be used. Two kinds of thin shells are being studied; spherical dome shells and conical shells.

The significance of this analysis lies in the possibility of treating shells under either applied loads or temperature variations by one unified approach.

The method of solution is a finite difference approach, applied successively as time is increased incrementally.

1491 T Economics. Analysis of the Demand for Coffee. The problem consists of estimating price and income elasticities of the demand for coffee in the United States. Yearly data on the coffee demand, prices, stocks, and imports to the United States will be used. For the estimation of the demand equation a limited estimate will be used. No other than standard library routines are involved.

1492 Mechanical Engineering. Nozzle Design for 4" x 4" Blow Down Tunnel. It is intended to design a pair of nozzle blocks for the blow down tunnel in Aerodynamics Laboratory B. The supersonic nozzle profile will be first calculated by the method of characteristics and then corrected for the boundary layer growth along the nozzle. The complicated step-by-step calculations and iterations can easily be handled by ILLIAC.

The fundamental net calculation has been developed under Problem No. 866 and the general boundary layer calculation has also been developed under Problem No. 1189. It is hoped to adapt and modify the codes from Problem Numbers 866 and 1189 so that the final nozzle profile for a certain supersonic test Mach number can be produced.

1493 Botany - Eastern Illinois University. Analysis of Tree Growth. This is a continuation of an earlier problem, Problem No. 1267, in which daily tree growth measurements are analyzed using the standard program, K 16. The best fitting equation for predicting daily growth is being obtained by attempting multiple correlation using different combinations of factors on different species of trees and for different periods of the season.

Part of this newly submitted data are measurements of growth occurring before leaf enlargement during 1958 and 1959, a period which differs markedly from the later growing season. Part of the data are yearly growth ring measurements from 1901-1951. These are to be analyzed in terms of values ascertained from monthly weather bureau records. This second approach using yearly rather than daily growth measurements was conceived because of an evident influence of the previous season upon the growth of trees. It is hoped that by combining an analysis of daily growth during a given year with an analysis of seasonal growth during a number of years it will be possible to evaluate both the immediate and long-range effects of our weather upon tree growth.

1494 Psychology. Situation-Response Analysis of Anxiety Behavior. This study differs from other studies of anxiety, even though it is based on an inventory, because both situations and responses are specified in the structure of the inventory. Four groups of subjects, a total of 348, were presented with the description of some situation and asked to say whether and to what degree he would show each of a sample of emotional responses.

The K-8 routine is to be used to compute Product Moment Correlations, Means and Standard Deviations for each of the responses for the four groups. A factor analysis for each of the groups is to be computed using KSL-1.90 on the Correlation Matrices.

1495 Animal Science. Potassium Requirement for Baby Pigs. This research is intended to ascertain the amount of potassium required for optimal growth by the baby pig. The mathematical method is the method of least squares.

1496 T Veterinary Medicine and Physiology. Strontium and Calcium Metabolism. The replacement of calcium in the diet of young pigs by strontium is being compared to controls receiving calcium, negative controls receiving neither calcium nor strontium, and pigs receiving both ions. ILLIAC is being used to analyze the variance between the treatment groups for the various criterions used, i.e. weight gain, bone calcium, bone strontium, etc.

1497 Agricultural Economics. A Game Theoretic Model for Cattle Feeding. The feeder cattle enterprise is viewed as a game against nature with nature's choices assumed to be restricted to the price-cost situations generated in the last ten years. The farmer's choices consist of six different feeding systems (or linear combinations of these). Four different situations are considered:

    1. Payoff matrix in terms of returns per $100 feed fed.

        a. Maximize the minimum return.

        b. Minimize the maximum loss or "regret".

    2. Payoff matrix in terms of returns per animal.

        a. Maximize the minimum return.

        b. Minimize the maximum loss or "regret".

This problem may be set up as a linear programming problem with straightforward use of the library routine M15-183.

INSTALLATIONS

Digital Computer Laboratory
168 Engineering Research Laboratories
University of Illinois
Urbana, Illinois (ILLIAC)

University of Sidney
Sidney, Australia (SILLIAC)

Iowa State College of Agriculture and Mechanic Arts
Ames, Iowa (CYCLONE)

Michigan State University
East Lansing, Michigan (MISTIC)

The ILLIAC is a member of the family of machines orginally designed and constructed by the Institute for Advanced Study.

INTELEX AIRLINE RESERVATION

Intelex Airline Reservation Computer

APPLICATIONS

System is designed for the solution of seat reservation and associated problems. It is a special purpose computer designed to solve the problems of data re-arrangement and retrieval.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/word	10
Decimal digits/instruction	10
Instructions per word	One
Instructions decoded	56
Arithmetic system	Fixed point
Instruction type	One address
Instruction word format	

n n n n	I	J	L R	O P
Operand Address	Index Reg No.	Index where Operand Address may be stored	Field Defini- tion	Instruc- tion No.

Registers include one 10-character accumulator register with associated field definition register, and nine 4-digit index registers. There are indirect addressing and add/subtract from memory instructions.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	50 - 140	40 - 130

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	2000 to 10,000	20,000 to 100,000	10
Drums	12,800	128,000	0 to 20,000
Tape Bin	142,800 words/tape	1,428,000 dig/tape	0 to 20x10⁶
	10 tapes/bin	10 tapes/bin	

Magnetic Tape

No. of units that can be connected	48 Units
No. of chars/linear inch of tape	508 Chars/inch
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	0.63 Inches
Tape speed	100 Inches/sec
Transfer rate	50,800 Chars/sec
Start time	6 Millisec
Stop time	6 Millisec
Physical properties of tape	
Width	1 Inch
Length of reel	3,000 Feet

MANUFACTURER

Intelex Systems, Incorporated
Associate of International Telephone and Telegraph Corporation

INPUT

Media
Paper Tape
Telegraph

OUTPUT

Media	Speed
Printer	600-900 lines/min
Paper Tape Punch	
Teleprinter	

PRODUCTION RECORD

Number on order	2
Time required for delivery	24 months

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to users include training in programming.

ADDITIONAL FEATURES AND REMARKS

The tape system will do independent off-line searching. Drums contain address and data channels. Data may be assigned random address which are later used to search for the data.

Unique system advantages include rapid access to large volumes of random-stored data. On drums, direct addressing is possible without constant re-arrangement for changing data. Searches may be done for any information contained on tape without regard to the arrangement of data within a particular tape.

ITT BANK LN PROC

ITT Laboratories Bank Loan Processor.

MANUFACTURER

ITT Laboratories
500 Washington Avenue
Nutley 10, New Jersey

Construction and daily maintenance of magnetic tape
file for personal loan operation of third largest
U. S. bank, processing of daily inputs and answering
of inquiries to this file, print-out of all customer
mailings and of numerous internal reports.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12 + sign
Decimal digits/instruction	12
Instructions/word	1
Instructions decoded	85
Arithmetic system	Fixed point
Instruction type	One address (Modified)

Modified single address (Alpha and Delta, i.e.,
operand and next instruction address)

Number range $-10^{13} < x < +10^{13}$

Instruction word format

+ and check	1	2	3			7	8				12
	OP CODE		DELTA Next Instr.				OPERAND (or alternate next instruction, or special)				

Automatic built-in subroutines include a sort
command, a sequence command, and a merge command.

Automatic coding includes SCP, a Symbolic Conver-
sion Program (One-to-One Compiler for Symbolic Ad-
dress and Op Codes), and MARK II, a utility system.

Registers and B-boxes include a high and low accum-
ulator, a distributor, an in-out register, and an
instruction register.

The system is designed for operating both off-line
and on-line, and at the same time. It can simultan-
eously compute, read tape, write tape, search on sev-
eral tapes, print (on-or off-line), and answer inquir-
ies.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	170	170
Mult	680-10,710	680-10,710
Div	Programmed	

Construction (Arithmetic unit only)

Vacuum tubes	0	0
Transistors	1,000	3,000
Condenser-diodes	3,000	10,000
Magnetic cores	-	5,000

The figures are for the arithmetic unit only, excluding the control. The number of cores includes storage and central control.

Arithmetic mode	Parallel-Serial
Timing	Synchronous

"Synchronous" refers to internal logic circuits; however, operation of central section is simultaneous with various in-out operations, the latter proceeding asynchronously with the former.

Operation	Bits of a digit in parallel
	Digits of a word sequential

STORAGE

Media	No. of Words	No. of Dec Digits	Access Microsec
Magnetic Tape	22×10^6	264×10^6	20,000,000
Magnetic Drum	10,000	120,000	9,000
Magnetic Core	100	1,200	6
Core Buffers	300	3,600	12

No. of units that can be connected	108	Units
No. of char/linear inch of tape	300	Char/inch
Channels or tracks on the tape	22	Tracks/tape
Blank tape separating each record	0.03	Inches
Tape speed	100	Inches/sec
Transfer rate	30,000	Char/sec
Start time	2	Millisec
Stop time	2	Millisec
Average time for experienced operator to change reel	No reels (bin type) Tape exchange is 60 sec.)	

Physical properties of tape

Width	1	Inch
Length of tape in bin	450	Feet
Composition	Mylar sandwich	

The 108 units is an arbitrary design goal, not an actual limitation.

The 0.03 inch inter-record gap is an interleaved recording. The opposite-direction record serves as a gap.

INPUT

Media	Speed
Magnetic Tape (ITTL Bin Transports	30,000 dig/sec
Paper Tape (Potter 907)	600 char/sec
Paper Tape (Flexo Reader)	10 char/sec
Keyboard (Flexo, Inquiry)	Manual

OUTPUT

Media	Speed
Magnetic Tape (ITTL Bin Transports)	30,000 dig/sec
High Speed Printer (Shepard w/ITTL Electronics)	20 lines/sec
Typewriter (Flexowriter)	10 char/sec
Punched Tape (Flexo Punch)	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	
Tubes	0
Diodes	30,000
Transistors	10,000
Magnetic Cores	22,000

Some tubes in drum system and P.S., being replaced by transistorized drum system.

CHECKING FEATURES

Sign redundancy. Mod 3 check in several places (arithmetic, bus, output, tape). Parity check on punched tapes and printer data.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	6 Kw
Volume, computer	400 cu ft
Area, computer	80 sq ft
Room size, computer	900 sq ft
Floor loading	75 lbs/sq ft
	800 lbs concen max
Weight, computer	4,000 lbs

Site preparations include a separate power main, a regulator, and floor ducts. Area air conditioning only.

PRODUCTION RECORD

Number produced to date	1
Time required for delivery	18 months

Special custom system, using stored program computer. Some elements of the system have been produced for other uses (e.g. tapes).

COST, PRICE AND RENTAL RATES

The computer, drum printer system, tape system (18 Transports) rents at $17,000 to $20,000/month.

36 additional tape transports, and 7 inquiry channels rents at an additional $10,000 to $15,000/month.

Maintenance is contracted to Federal Electric Company at about $6,000/month.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift		Two 8-Hour Shifts	Three 8-Hour Shifts	
	U	R	R	U	R
Supervisors	4	2	2		
Analysts	2	1	1		
Programmer	4	3	4		
Coders	2	1			
Clerks	14	14	28		
Operators	1	1	2		3
Engineers	2	1	2	3	3
Technicians	2	1	2	3	3

Operation tends toward closed shop.

Method of training used is by training courses.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Time is not available for rent to outside organizations.

System is under acceptance test.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include transistorization, large processing capacity at medium speed, will maintain 600,000 loans up-to-date daily, about 10^9 bits of data accessible at all times, inquiries answered in less than 20 seconds each, at rate of 20 per minute and simultaneous operation of 12 tape functions, computer processing, and printing. Additional system advantages are that it combines on-line processing and off-line processing by the same equipment. A large data file is in ready access.

Commercial information is available through
Intelex Systems, Inc. (An ITT Associate)
67 Broad Street
New York, N. Y.

FUTURE PLANS

Further applications of this and related hardware to banks, reservations, credit cards, and other commercial and government systems.

ITT SPES 025

ITT Laboratories Stored Program Element System 025

MANUFACTURER

ITT Laboratories
500 Washington Avenue
Nutley 10, N. J.

APPLICATIONS

Located at 54 S, U. S. Route 17, Paramus, New Jersey, the SPES provides automated message handling on a store and forward basis. It employs a multi-sequential stored program computer to handle both routine and complex tasks connected with the message center activity, including standard data processing operations. In this application, the SPES also communicates directly with a large high-speed computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	33
Binary digits/instruction	32 plus parity
Instructions/word	1
Instructions decoded	43
Arithmetic system	Fixed point
One's complement system of	arithmetic is used.
Instruction type	One address
Number range	$-(2^{31}-1)$ to $+(2^{31}-1)$

Instruction word format

Interrupt	Variation	Opera-tion	Main Memory Address	Character Address
0 1	2 7	8 13	14 29	30 31

Automatic coding includes a symbolic compiler.

Registers and B-boxes include an accumulator, arithmetic unit buffer, instruction register, 18 other registers, 256 index registers (special "Index" core memory), and 256 program counters (special "Program" core memory).

Each of four sense instructions can sense 128 devices.

Each of two register transfer instructions can address 11 registers.

Most instructions are indexable and repeatable.

Most instructions will operate on full words or on one character. (There are 4 character's per word).

Computer also has a multisequence feature whereby it will interleave the operation of 256 different programs automatically under control of the instructions' interrupt portion.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	16	3

Construction (Arithmetic unit only)

Transistors	2,100
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Tape	24,000,000	33 bits/word	3,000,000
Magnetic Drum	65,536	33 bits/word	8,000
Magnetic Cores	16,384	33 bits/word	8
Magnetic Cores	256	19 bits/word	6
Magnetic Cores	256	17 bits/word	6

Magnetic Tape

No. of units that can be connected	16	Units
No. of char/linear inch of tape	200	Char/inch
Channels or tracks on the tape	7	Tracks/tape
Blank tape separating each record	0.75	Inches
Tape speed	75	Inches/sec
Transfer rate	15,000	Char/sec
Start time	3	Millisec
Stop time	3	Millisec
Average time for experienced operator to change reel of tape	60	Seconds

Physical properties of tape

Width	0.5	Inches
Length of reel	2,400	Feet
Composition	Plastic	

INPUT

Media	Speed
Magnetic Tape (Potter 906)	15,000 char/sec
Phone Lines	600 char/sec max
Punch Cards (IBM 711)	250 cards/min
Computer to Computer	260,000 char/sec

1 word = 4 characters = 32 bits
1 card = 24 words

OUTPUT

Media	Speed
Magnetic Tape	15,000 char/sec
Phone Lines	600 char/sec
Punch Cards (IBM 721)	100 cards/min
High Speed Printer (Burroughs 301)	5 lines/sec
	300 char/sec
Computer to Computer	260,000 char/sec
Display	260,000 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	50,000
Transistors	51,000
Magnetic Cores	600,000

CHECKING FEATURES

Parity on check at buffer on all memories, instruction register, and at buffers to all input-output units.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	30 Kw
Power, air conditioner	32 Kw
Volume, computer	1,000 cu ft
Volume, air conditioner	1,000 cu ft
Area, computer	150 sq ft
Area, air conditioner	100 sq ft
Room size, computer	1,500 sq ft
Room size, air conditioner	400 sq ft
Floor loading	250 lbs/sq ft
	1,250 lbs concen max
Weight, computer	30,000 lbs

Site preparation includes false flooring (cable and air ducting), separate power mains and distribution boards.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	8
Number on order	10
Time required for delivery	12 - 18 months

COST, PRICE AND RENTAL RATES

Basic System
Computer $500,000
Communications Section $500,000
Additional Equipment
Drums (4), tapes (2), printer, punch, reader, with control $750,000.

PERSONNEL REQUIREMENTS

Operation tends toward closed shop.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System tests are in progress.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include multi-sequence operation, permitting up to 256 different programs to run concurrently; built-in executive control; hardware performing jumps in and out of sequences without time loss or programming complication, indexed repeat option; word and character modes; tape and drum transfers to and from core memory under external control; built-in performance monitor sequence; and fully transistorized plug-in construction.

Unique system advantages include on-line operation of up to 256 input-output channels and especially suited as communications message handling center.

FUTURE PLANS

Production for a quantity of duplexed systems being set up under contract, for application in a global message switching network.

Further applications in other areas under planning, such as reservations systems and mail order houses.

Adaptation to variety of communications, data processing, and combined communications and data processing systems.

INSTALLATIONS

ITT Laboratories
54 S U. S. Route 17
Paramus, New Jersey

JOHNNIAC

John (Von Neumann)
Integrator and Automatic Computer .

MANUFACTURER

The Rand Corporation

APPLICATIONS

Scientific and engineering data processing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	40
Binary digits per instruction	20
Instructions per word	2
Instructions decoded	128
Instructions used	Approx. 85
Arithmetic system	Fixed point
Instruction type	One address
Number range	Numerically less than unity.

Negative numbers are represented as complements.

ARITHMETIC UNIT

	Includ. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add time	25	10
Mult time	400	385
Div time	400	385
Construction	Vacuum tubes and transistors	
Rapid access word registers		4
Arithmetic mode	Parallel	
Timing	Asynchronous	

Operation   Sequential

Addition is concurrent with store cycle. Multiply and divide times are maximum. The transistorized logical adder has a full carry time of 1.5 microseconds.

In 1957, the vacuum tube analog adder was replaced with a transistorized logical adder. The maximum carry time of the new 40-stage adder is 0.8 microseconds. There are about 1200 transistors in the unit. The transistor count includes many logical · functions which have been packaged with the adder.

The control has been partly transistorized to gain a significant increase in basic operation rates. Circuit modifications have been limited to control sections affecting basic clear, gate, and shift operations.

STORAGE

Media	Words	Digits	Microsec Access
Magnetic Core	4,096	40/word	15
Magnetic Drum	12,288	40/word	17,000

Drum access time is average access to first word. Sixty microseconds are required for each succeeding address in same channel.

INPUT

Media	Speed
Card Reader	240 cards/min

An IBM collator is used. Both primary and secondary feeds are used.

OUTPUT

Media	Speed
Card Punch	100 cards/min
Printer (ANelex)	1,200 lines/min

An IBM 523 is used. The printer prints 136 columns, 56 char/column (alphanumeric).

During the year 1959 an on-line modified EAI plotter was installed. The 40" x 40" plotter was modified to include straight line drawing ability as well as circle drawing ability. The plotter can be instructed under JOHNNIAC control to go to point X_1, Y_1 and draw a line to point X_2, Y_2. The circle drawing instruction causes the plotter to go to point X, Y and draw a circle of radius r. Point plotting and symbol printing are also available.

In 1959, an on-line ANelex printer was added.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	5,000
Tube types	11
Crystal diodes	500
Magnetic storage cores	163,840
Magnetic switch cores	5,120
Transistors	1,400

CHECKING FEATURES

Manual marginal testing is performed.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	55 KW, 63 KVA, 0.88 PF
Power, air cond.	28 KW
Space, computer	290 cu. ft., 36 sq. ft.
Space, air cond.	180 cu. ft., 50 sq. ft.
Weight, computer	5,000 lbs.
Weight, air cond.	5,000 lbs.
Capacity, air cond.	25 tons

Dimensions of computer are 12 x 3 x 8 feet.

PRODUCTION RECORD

Produced	1
Operating	1

This system was designed and is owned and operated by the Rand Corporation.

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
2-8 Hour shifts	1	2

One technician per shift and one engineer on call is required.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	10 hours
Good time	1,380 hours
Attempted to run time	1,500 hours
Operating ratio (Good/Attempted to run)	0.92
Figures based on period July 1956 to November 1956	
Acceptance test	March 1954

Two transistors of the new arithmetic unit failed during the first year of operation due to defective seals. No failures have occurred since early 1958. This failure record represents two transistor failures in 14,976,000 transistor-hours.

ADDITIONAL FEATURES AND REMARKS

System includes console facilities which report static state of all registers in an octal display, allow manual entry of information via a keyboard, punch contents of all registers and keyboard conditioning switches on a single card, display static state of all toggles and allow manual control over toggle states.

A wired in core store test routine is included which tests all addresses and bits under a variety of information patterns without aid of a stored program.

INSTALLATIONS

The Rand Corporation
1700 Main Street
Santa Monica, California

JUKEBOX

Missile Firing Data Computer JUKEBOX

APPLICATIONS

General purpose computing.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	39 + Sync + sign
Binary digits/instruction	20
Instructions per word	2
Arithmetic system	Fixed point
Instruction type	Two address
Number range	- 1 < N < + 1
Instruction word format	

Sign	Left Command		Sign	Right Command		Sync
+	1 6	7 7 6 0 0	+	1 6	7 7 6 0 0	1
B	0 0	0 0 0 0 B	B	0 0	0 0 0 0 B	
Operation	Location		Operation	Location		

B - Binary
0 - Octal

Computer uses binary coded decimal and command format on input and output devices only.

Automatic coding
Punched tape teletype code to octal or binary coded decimal during tape fill.
Registers and B-boxes
Two 8-word rapid access storage registers. Five 1-word arithmetic registers.

ARITHMETIC UNIT

	Incl Stor Access Microsec		Exclud Stor Access Microsec
	Memory	HS Storage	
Add	9,590	2,040	540
Mult	19,850	12,300	10,800
Div	20,390	12,840	11,340

Average access time 9,050 microseconds.
Construction (Arithmetic unit only)

Transistors	664
Condensers	673
Diodes	4,401
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Disk	4,096	167,936	9,050

INPUT

Media	Speed
Paper Tape	200 char/sec
	20 in/sec
Keyboard	Manual

MANUFACTURER

Autonetics Division
North American Aviation, Incorporated

OUTPUT

Media	Speed
Printer (Typewriter)	11 char/sec (BCD or octal)
Nixie Display Tubes	16 char/17,280 microsec (BCD or octal)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	0
Diodes	5,316
Transistors	885
Magnetic Cores	0

Above figures do not include system and component testers.

CHECKING FEATURES

Component test set: Tests each computer board separately.
Optional in both dynamic and static modes.
System test set: Panel array of neon indicators showing the status of all the flip-flops in a dynamic or static one-shot mode; includes marginal test feature of power supply variation and clock jitter.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.5 Kw	0.9 pf
Volume, computer	4 cu ft	
Volume, parameter	1.25 cu ft	
Volume, tape reader	2.5 cu ft	
Volume, control	1.25 cu ft	
Area, computer	2 sq ft	
Area, parameter	1.25 sq ft	
Area, tape reader	1.25 sq ft	
Area, control	1.25 sq ft	
Room size, computer (weight)	125 lbs	
Room size, parameter (weight)	55 lbs	
Room size, tape read (weight)	45 lbs	
Room size, control (weight)	50 lbs	
Floor loading	35 lbs/sq ft	
	125 lbs concen max	
Weight, computer	275 lbs, total plus 90 lbs auxiliary equipment	

Air conditioner is not supplied with computer.
Computer operating temperature range $55°F$ to $110°F$
Temperature rise approximately $10°F$ above room temperature.
Frequency range 50 to 70 cycles/sec
Voltage range 105v, ac to 135v, ac
Auxiliary equipment
Systems tester 2 cu ft, 2.5 sq ft, 38 lbs 60w
Component tester 3.75 cu ft, 2.5 sq ft, 52 lbs 90 w

PRODUCTION RECORD

Number produced to date   5
In addition to the five computers specified, there exist five R&D models operating on 400 cycle power with half the clock rate and computing speed.

PERSONNEL REQUIREMENTS

One operator per 8-hour shift.
Training made available by manufacturer to users includes maintenance and programming.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Several construction features have been incorporated to enhance reliability. These are all solid-state components, gold-plated pins, connectors, and etched circuitry, epoxy-coated boards, closed-loop wiring; wires to gates, power supplies, clock signals are routed back to the origin to retain operation in case of wire breakage, and extensive use is made of time-shared gates and flip-flops to minimize the total number of components.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include simplicity of operation and programming.
Unique system advantages include high-speed visual display of information in memory, either in binary coded decimal or command format.

FUTURE PLANS

This system has been replaced by the FADAC computer.

INSTALLATIONS

Autonetics, a Division of North American Aviation, Inc.
9150 E. Imperial Highway
Downey, California

LEEDS NORTHRUP 3000 MANUFACTURER

Leeds and Northrup Computer 3000

Leeds and Northrup Company

APPLICATIONS

System is used for industrial process control.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20 + sign bit + parity bit
Binary digits/instruction	6 bits
Instructions per word	1 or 1/2, if 1 + 1 mode
Instructions decoded	16 Basic Up to 64 by use of modifiers
Arithmetic system	Fixed point at extreme left
Instruction type	One address or 1 + 1 by means of programming

Number range $-1 < n < +1$

Instruction word format

1 8	9 14	15 16	17 20	21
Track Address $(000\text{-}255_{10})$	Sector Address $(000\text{-}063_{10})$	Modi- fier	Instruc- tion	Type: Single or 1 + 1

Automatic built-in subroutines include square root. Programming is done in simple pseudo-code with relative addressing facility.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	910	130
Mult	3,600	2,730
Div	3,600	2,730

Construction (Arithmetic unit only)   Transistors
Arithmetic mode   Serial
Timing   Synchronous
Operation   Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	16,260	357,720 bits	Min. - 130 Max. - 16,640

INPUT

Media	Speed
Paper Tape	10 char/sec (Flexowriter)
Analog to Dig Con	5 points/sec (10,000 count ADC)
External counters	50/sec (For integrated measurements, e.g. KWH)
Direct binary inputs	400-600/sec (For reading digital dial and On-Off status of external equipment)

Being a control computer, the design emphasis is on direct inputs from the process under control or analysis.

OUTPUT

Media	Speed
Typewriters	10 char/sec
Flexowriter, punch, IBM electric.	
Digital to Analog Con	6/sec
Stepping motors are used for DAC	
On-Off controls	50/sec
Control state of external equipment.	
Annunciator lights	100/sec

Stepping motors are used for digital to analog conversion, because they have inherent memory.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	3,000
Transistors	1,300

CHECKING FEATURES

Parity bit in each word checks all transfers from drum memory.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.60 Kw	0.65 KVA	0.925 pf
Volume, computer	25 cu ft		
Area, computer	9 sq ft		
Room size	6 x 12 ft		
Weight, computer	400 lbs		

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by the manufacturer to insure required reliability include parity checks, solid state, plug-in components, rugged construction, and extensive checks on input-output equipment.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include powerful command structure, rapid access registers, and memory parity check. Unique system advantages include extensive checks on input-output equipment.

LEPRECHAUN

TRADIC Second Feasibility Computer, LEPRECHAUN

Photo by Bell Telephone Laboratories, Incorporated

Arithmetic system	Fixed point
Instruction type	One address
Number range	$-1 \leq n < 1$

APPLICATIONS

The system was built under a U. S. Air Force contract for programming and logical design research on digital computers for military real-time control applications and as a feasibility model of a direct-coupled transistor logic system and a transistor driven magnetic core storage unit. This solid-state computer features low power and small size. The design emphasizes reliability.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	40
Mult	375 avg
Div	520
Construction	Transistors
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	17, including sign
Binary digits/instruction	17, including two spare bits
Instructions/word	1
Instructions decoded	32
Instructions used	28

STORAGE

Medium	Words	Access Microsec
Magnetic Cores	1,024	8

There are 18 bits/word stored, including an "odd" parity bit. The read-write cycle is 20 microseconds.

INPUT

Media	Speed
Paper Tape (Photoelectric)	200 char/sec
Keyboard	Manual

OUTPUT

Media	Speed
Paper Tape (Punch)	60 char/sec
Typewriter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Crystal diodes	300
Magnetic cores	18,480
Transistors	5,000

The above figures are for the computer proper, and do not include input-output equipment.

CHECKING FEATURES

Odd parity checks on storage and input-output operations.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.160 Kw
Volume, computer	16 cu ft
Weight, computer	450 lbs

Figures are for computer proper and do not include input-output equipment.

PRODUCTION RECORD

Number produced	1
Number in operation	1

This system is a feasibility model and was not designed for production.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

This system has been completed.

ADDITIONAL FEATURES AND REMARKS

LEPRECHAUN features flexibility in the logical interconnections in order to make it useful for logical design research. The operation code has been designed to eliminate the need for many "red-tape" operations. For example, a special unconditional jump operation simplifies the inclusion of subroutines in a program. Address modification is accomplished by direct substitution. This operation, together with a repeat operation, which operates on sequential addresses, gives operation equivalent to a B-box.

The machine contains a manual breakpoint provision, several checking modes of operation and complete marginal checking facilities.

INSTALLATIONS

Bell Telephone Laboratories, Incorporated
Whippany, New Jersey

LGP 30

Librascope General Purpose Computer Model 30

MANUFACTURER

Royal McBee Corporation
Librascope, Incorporated

Photo by Flight Simulation Laboratory, WSMR, N. M.

APPLICATIONS

Manufacturer
System is designed for scientific computations, e.g. statistical analysis, operations research, war gaming, bridge and highway design, aeronautical, chemical, electronic, hydraulic, mechanical, mining, nuclear, optical, biological, physical and mathematical research; and data processing, e.g. payroll; cost accounting, distribution and analysis; inventory control; sales analysis.
ADPS Committee, Officers' Dept., USASCS, Ft. Monmouth
System is located in Myer Hall, Room G05, Fort Monmouth, New Jersey. System is used for instruction.
    Materials Research Laboratory, Watertown Arsenal,
        Watertown, Massachusetts
Located at Watertown Arsenal, Watertown, Massachusetts, system is used for numerical integration, least squares curve-fitting, data processing, finite differences, numerical solution of differential equations, algebraic equations (minimization, etc.), and trial and error solution of equations.
    U. S. A. Watertown Arsenal Laboratories
Located in Building 39, Watertown Arsenal, computer is used for matrix inversion, numerical integrations of definite integrals and differential equations, diagonalization of matrices, solution of transcendental equations, arising from problems in solid state physics, elasticity, and elastic instability, and thin shell theory.
    White Sands Missile Range
Located at the Flight Simulation Laboratory, Building 1526, White Sands Missile Range, New Mexico, the system is used for small problems, mathematical research, and preliminary checkout for problems to be run on large computers.
    Pitman-Dunn Laboratories, Frankford Arsenal
Located at Building 202, 3rd Floor, Optical Branch, Fire Control Division, system is used for design of optical systems and components for fire control instruments and related activities.
    U. S. Navy Hydrographic Office
Located at FOB No. 3, Room G274B, the system is used for mathematical and statistical studies made of the various parameters of the ocean, primarily in connection with anti-submarine warfare but also in connection with ice forecasting and climatology.

U. S. Naval Ordnance Test Station, Pasadena
Located at 3202 E. Foothill Blvd., Pasadena, California, system is used for scientific analysis and data reduction.

NASA-Goddard Space Flight Center
One LGP 30 at the Control Center, Greenbelt, Md. and two LGP 30's at Anacostia Naval Station, Wash., D.C., are used for orbital calculations, trajectory analysis, data reduction, and mathematical studies. The organization is responsible for the provision of equipment and services for tracking satellites and probes in nearby portions of space, for obtaining telemetry data from these satellites and probes, and for computing their orbits and providing station predictions, ephemerides and definitive orbits as required by all participating organizations.

Tennessee Valley Authority, Flood Control Branch
Located at the TVA, 718 Union Building, Knoxville, Tennessee, system is used for principally hydrologic and hydraulic computations for watersheds, streams, and reservoirs. Limited use in design computations.

Aircraft Armaments, Inc.
Located at the Systems Engineering Department, Main Engineering Building, system is used for mathematical solutions for research and advanced engineering problems involving differential equations, simultaneous equations (both linear and differential), numer-

ical integrations, n^{th} degree polynomials, exponentials, and trigonometric functions. Some of the applied engineering problems have been concerned with interior and exterior ballistics, trajectories (projectile and rocket sled), probability studies, stress and weight analyses, etc.

ACF Electronics Division
Located at 11 Park Place, Paramus, New Jersey, system is used for optical design (ray tracing), vibration studies (railroad train coupling), integral transforms (Fourier Analysis), navigation, satellite and missile trajectories, reliability studies, reticle design, and miscellaneous "One Time" problems.

Convair-Fort Worth, General Dynamics Corp.
Located at Engineering Flight Test, system is used for editing and calibration of flight test data.

General Electric-Missile and Space Vehicle Dept.
Located at 3198 Chestnut Street, Philadelphia 4, Pa., system is used for solution of equations in flight test data reduction; engineering computations, including aerodynamics, flight mechanics, space science, mechanics problems, and trajectory analysis.

The Griscom-Russell Company
Located at Massillon, Ohio, two systems are used for functional design of heat exchangers and general engineering calculations.

Mutual Insurance Advisory Association
Located at 111 Fourth Avenue, New York 3, New York, system is used for actuarial and statistical work in connection with casualty insurance ratemaking. This type of work involves relatively small input used for numerous algebraic calculations.

Raytheon Company-Missile Systems Division
Located in the Aerophysics Design Department, system is used to obtain solutions to scientific problems in the fields of aerodynamics, structures, and system analysis, which would not be economical on larger systems.

Research Division, Servomechanisms, Inc.
Located in Building 114, Santa Barbara Airport, system is used for the mathematical simulation of proposed engineering designs; calculation of special functions arising in particular engineering tasks; laboratory data reduction; and solution of various linear and non-linear equations, many of which cannot be analized by classical methods.

Technical Operations, Inc., Fort Monroe, Virginia
Located at Fort Monroe, Virginia, this computer is used to perform scientific computations in support of operations research and war gaming activities. The LGP 30 has been used extensively to process, reduce and statistically analyse data. A variety of applications to war gaming activities also exist.

As examples, artillery, close combat and tank anti-tank assessment are currently carried out for War Games Division, CD, on the computer on either a pre-computed or "on-line" basis.

Western Electric Company, Inc.
At Winston-Salem, North Carolina, there are two such systems in use by this organization. Both are used to monitor the performance of automated production lines for electrical components. These production lines consist of completely automatic, specially designed manufacturing facilities integrated into a production line by automatic transport feed facilities. At strategic points automatic monitoring devices inspect the product and transmit these data through input equipment into the computer. The computer analyzes these data on a statistical basis and if corrective action is needed at any point on the production, the computer decides both the correction and magnitude and achieves control through the output equipment.

Computation Center, Dartmouth College
As a separate department closely associated with the Mathematics Department, physically located in a small room on campus, the system is used to train undergraduates in the use of a computer, as a laboratory adjunct to several courses, especially numerical

analysis, as a research tool for faculty and student use, and as a basis for computer oriented research (compilers).

Johns Hopkins University
Located in Room 426 of the Computation Center, Homewood Branch, the system is used for research and teaching in fields of Engineering, Science, Social Relations, Economics, Medicine, Biostatistics and Related Studies.

Lehigh University
Located at the Industrial Engineering Department, Packard Lab, Bethlehem, Pa., the system is used for engineering and scientific analysis and design, statistics and curve fitting, data processing, systems simulation, and classwork in problem-solving.

Missouri School of Mines and Metallurgy
Located at the Computer Center on the campus of the Missouri School of Mines and Metallurgy at Rolla, Missouri, the system is used for research in Engineering and the Sciences by the faculty and graduate students of the Missouri School of Mines and Metallurgy, regular scheduled courses in Numerical Analysis, programming of digital computers and the design of digital computers for both undergraduate and graduate students. A very small amount of time is available for commercial use.

Ohio University
Located in Juper Hall, Ohio University, Athens, Ohio, system is used for teaching and research in atomic and nuclear physics and chemistry.

Photo by the Raytheon Company

University of South Carolina
Located at the University of South Carolina, Columbia, South Carolina, system is used for instruction and research.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer	
Internal number system	Binary
Binary digits/word	32
Binary digits/instruction	32
Instructions/word	1
Instructions decoded	16
Arithmetic system	Fixed point
Simulate floating point by programming	
Instruction type	One address
Number range	9 decimal digits - 5 alpha
Instruction word format	

	Command		Address	
1 10	11 15	16 17	18 29	30 31

Automatic coding includes compilers, assemblers, and interpretitive systems.
Registers includes an accumulator - double extension, an instruction, a counter, and 4096 memory registers.

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	2,000 - average	250 constant
Mult	17,000	17,000
Div	17,000	17,000

Construction (Arithmetic unit only)

Vacuum tubes	113
Diodes	1,450
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	4,096	32 binary	Min. 2,000 Avg. 8,500

A complete instruction can be done in 2200 microseconds, including both accesses when optimum programmed. Maximum operation time is 15,000 microsec-

onds (the time for one revolution of the drum which rotates at 4,000 rpm.

All user's systems have a 4,096 word drum.

INPUT

Manufacturer

Media	Speed
Paper Tape (Photo-electric)	200 char/sec
Paper Tape (Typewriter)	12 char/sec
Cards	20 char/sec

The high speed paper tape reader is for input only and makes possible loading the entire drum: 64 tracks of the LGP 30 in a maximum of five minutes.

The following organizations have the high speed photoelectric paper tape reader:

ADPS Committee, Officers' Dept., USASCS, Ft. Monmouth
Materials Research Laboratory, Watertown Arsenal
U. S. A. Watertown Arsenal Laboratories
Ordnance Mission, White Sands Missile Range
U. S. Navy Hydrographic Office
NASA-Goddard Space Flight Center
Tennessee Valley Authority-Flood Control Branch
The Griscom-Russell Company
Mutual Insurance Advisory Association

Raytheon Company- Missile Systems Division
Technical Operations, Inc., Fort Monroe, Virginia
Johns Hopkins University
Missouri School of Mines and Metallurgy
Ohio University
            Western Electric Company, Inc.

Media	Speed
Electronic equipment by Western Electric	140,000/sec. meaningful impulses

Voltage to frequency converter fed into binary
frequency counter. Computer scans counter and ex-
tracts information. Special data gathering and con-
trol equipment designed by Western Electric from on-
line production equipment.

Electric Typewriter	10 char/sec

OUTPUT

Manufacturer

Media	Speed
High Speed Punch	30 char/sec
Tape Typewriter Punch	20 char/sec
Tape Typewriter Print	20 char/sec
X-Y Plotter Servomechanisms	
Typewriter	10 char/sec
Tape Punch	10 char/sec

Punch causes typewriter to print
Automatic plotting equipment includes a separate
tape reader (Friden), a digital analog converter,
and a servo plotting board (Mosely Autograph).

W. E.

Electronic equipment designed by Western Electric	140,000/sec. meaningful impulses

Consists of Diode Logic and transistor flip flops
actuating binary relays.

Electric Typewriter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Tubes	113	(Miniature, computer type)
Tube types	7	Primarily 5687, 5965 and 5915
Crystal diodes	1,500	Subminiature

Printed circuits are used extensively.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	1.15 Kw	1.5 KVA
60 cycle single phase line		
Volume, computer	21.8 cu ft	
Length, computer	44 in	
Height, computer	33 in	
Depth, computer	26 in	
Area, computer	8.19 sq ft	
Room size	5 ft x 5 ft min.	
Floor loading	97.7 lbs/sq ft	
	800 lbs concen max	
Weight, computer	800 lbs	

Normal office power is required.

USASCS
No special site preparation requirements other than
air conditioning.

MRL Watertown Arsenal
We do have air conditioning, but it is a part of a
larger system and was not essential for the opera-
tion of computer. However, room temperature should
be kept below 97°.

USA WAL
No special preparation necessary.

P-DL FA
Required wiring from existing transformer.

USN Hydro
Essentially the only requirement is access to 115
volt, 60 cycle, single phase, 13 ampere alternating
current.

US NOTS
No requirements.

NASA
No requirements.

TVA
No site preparation.

AA
The LGP 30 computer is located in a separate room
(9'x10') on the second floor of the main Engineering
Building. The building is of masonry construction
and the walls of the computer room are dry-wall
(plaster board) construction. An exhaust vent, which
includes a blower, supplements the internal blower
of the computer. The entire building is air-condi-
tioned.

ACF
No site requirements but it would be advantageous to
have sound absorbing material on walls and/or ceiling
of computer room.

Convair
No site requirements.

GE
No site preparation. 220 VAC power outlet installed.

GR
Direct power line for 2 computers. 7 Tons of air
conditioning.

MIAA
No site preparation required for LGP 30 installations.
Advised to have separate 110 ckt. for ideal operation.

Raytheon
No site preparation requirements. Suggested minimum
100 sq ft of space.

Servomechanisms
Acoustic tile on portion of one wall; separately
fused (breaker) for computer only.

TO, Inc.
Since this computer is desk size and requires no
supplementary air conditioning, site preparation and/
or modification is minimized. It is necessary to
install the computer in an area where sufficient ven-
tilation is provided to exhaust 5,000 BTU/hour dissi-
pated by computer electrical components. In the case
of this installation, excess heating of an inside
room where the computer was in use made it necessary
to install a forced air vent system in the wall.
Acoustic tile was also used in the room to reduce the
noise level associated with computer operation.

WE
Isolated 110 volt power circuit.

Lehigh University
No site preparation requirements.

MSMM
No site preparation requirements.

Ohio U.
Installed in a room converted from a machine shop-
is now a class room.

U of S.C.
No special preparations.

PRODUCTION RECORD

Manufacturer

Number produced to date	462
Number in current operation	450
Number in current production	20
Number on order	38
Anticipated production rates	10 per month
Time required for delivery	1 month

COST, PRICE AND RENTAL RATES

Manufacturer
Cost of basic system

Computer and tape-typewriter	commercial	$49,500
	government	49,300
	educational	29,700

Cost for additional equipment

High speed punch and photo-reader	$ 6,360
Photoelectric reader alone	4,800

Punched card control unit and X-Y plotter purchased by special arrangement.
Rental for basic system
$1,100/month, commercial and government, $880 educational.
Rental rates for additional equipment

Punch and reader	$265/mo
X-Y plotter	300/mo
Card input unit	100/mo
Photo-reader	200/mo

Maintenance included in rental; service contract available for purchasers.
USASCS
Cost of basic system is $43,500 for the LGP and Flexowriter, and $4,800 for the tape reader.
Maintenance service contract cost $1,750/annum, without parts.
USA WAL
$1,500 per month for computer, photo-reader and extra tape typewriter.
WSMR
LGP 30 and Flexowriter rent for $1,100 per month. Paper tape reader rents for $200 per month. Additional Flexowriter rents for $150 per month.
GR
Two LGP 30s rent for $1,100 each, total $2,200/month.

Flexowriter	$150/mo
Photo-reader	200/mo
Punch	65/mo
Total	$415/mo

Servomechanisms
LGP 30 with paper tape reader, punch, Friden Typewriter cost $50,000.
Tape reader, digital to analog converter, servo plotting board cost $4,000.
No contract at present; service labor rate is $12.50 per hour.
TO, Inc.
LGP 30 Computer with typewriter rents for $1,150/mo. High speed reader-punch and auxiliary typewriter rents for $365/mo.
"On-call" servicing from Washington, D. C. ($50 service charge).
WE
$70,000 total cost (includes special input and output).

Dartmouth
LGP 30 with attached Flexowriter, extra Flexowriter, and photoreader about $37,000, school cost.
About $2,500 per year, plus parts, plus travel over fifty miles.
Lehigh U.
Cost of basic system

Computer	$49,500

Cost of additional equipment

Photo-reader and punch	6,360

Maintenance service contract is $2,500/year.
MSMM

1 Royal McBee LGP 30 Computer	$29,700

1 Royal McBee Model 342 High Speed Paper Tape Reader and Punch, 1 Off-line tape typewriter (Flexowriter); grant from Royal McBee Corp.
None first year. All addition years will be $4,500 per year including all parts and service for entire system.

PERSONNEL REQUIREMENTS

Manufacturer
Requirements among users will vary widely. Many existing LGP 30 installations are staffed by one programmer and one tape punch operator; others, by one person performing all functions; others, by one person for each function. No maintenance or other technical personnel are required by the user.
Manufacturer trains by programming schools for users (no cost), maintenance schools for users, if desired ($600 per person), and local assistance by applications analysts (no cost).
USASCS

	One 8-Hour Shift
Programmers	5-25
Operators	1

Training is at no cost to the government. Any engr, math, or phy can be taught in 2 weeks. Maintenance course, 5 weeks at $500/person.
MRL Watertown Arsenal
In general the machine runs about 42 hours a week. Six persons from three separate organizations (all located at Watertown Arsenal) use the machine and do their own programming, operating, and preparation of tapes. The operation of the computer is a part time job for all six persons, most of whom are mathematicians.
Operation tends toward open shop.
Twelve hour course given on site by Royal McBee personnel. Also programming school (two weeks course) is available through Royal McBee Corporation, free of charge.
USA WAL

	One 8-Hour Shift
Supervisors	2
Programmers	5

Operation tends toward closed shop.
Courses were given by Royal McBee Corporation.
Occasional two or three-shift operation is necessary, but not enough to warrant hiring extra people.
P-DL FA
The computer is programmed and operated by six individuals engaged in optical design activity with an estimated total time equivalent to that of one full time employee. The majority of programs covering optical ray trace methods and related activities have been provided by the Royal McBee Corporation.
The modifications required to adopt these programs for our particular needs have been completed. Minor modifications to these programs and new programs which are relatively short are developed by optical

personnel.

Any future modifications of a lengthy nature or extensive programs for automatic lens design would be performed by either the mathematics section or by contract. Total cost estimated for this activity would be equivalent to that of using one employee on a half time basis.

Operation tends toward closed shop.

Personnel attended a two week training course offered by Royal McBee's New York office.

TVA

The LGP 30 is used by a staff of approximately 25 engineers as needed. One of the staff engineers acts as supervisor or coordinator of machine activities. This supervision requires approximately 20% of his time.

The number of engineers using the LGP 30 is continually increasing.

Scheduling and time keeping is on an informal basis.

Operation tends toward open shop.

Approximately 40 people were trained by a Royal McBee instructor when the computer was installed. Approximately 20 people have been trained by in-service training and self study. Approximately 35 people were trained recently in a TVA sponsored after hours training class. Other classes will be held as the need arises.

AA

One programmer/operator is required normally, but two often are employed under high computer work load conditions. The computer is used on one standard 8-hour shift (40-hour week) and is in operation approximately 60% of the time.

Operation tends toward open shop.

No formal methods of training have been introduced as of this time. Lectures on programming and operation of the computer have been given to various company personnel and will be continued.

Convair

Complete open shop, no personnel uniquely assigned.

GE

	One 8-Hour Shift
Supervisors	1
Analysts	6
Programmers	6
Coders	5
Operators	1
Engineers	4
Technicians	1

Operation tends toward open shop.
On-the-job training used.

Raytheon

At the present time, there are eight (8) mathematicians and engineers from two (2) departments using this system, for which one person is responsible.

Servomechanisms

	One 8-Hour Shift	
	Used	Recommended
Supervisors	.1	.1
Analysts	.1	.2
Programmers	.4	.7
Clerks	.1	.2
Operators	.5	.7

Operation tends toward open shop.

Company sponsored classes open to all advanced engineering employees, (usually 2 hours per day for one week, each year).

TO, Inc.

The simplicity of LGP 30 operation makes it feasible to train most analysts to use computational facilities, whenever a problem is encountered suitable for computer solution. For the most part the analyst will program, code, and "debug" his own particular problem. In those cases where problems will involve more detailed programming or extensive coding and "debugging", programmer-coders are available to assume responsibility for the problem. This open shop operation is tailored to the requirements of this organization and has, thus far, proved to be quite efficient.

Operation tends toward open shop.

Two procedures have been used at this installation. These are 1. attendance at a two week LGP 30 programming course and 2. on-the-job training supervised by experienced personnel. Option 2 is generally used in those cases where analysts or programmers have prior computer experience.

Dartmouth

One machine supervisor is used. All our programming is done by students. About 10 of them keep the machine busy all week one full shift by putting in about 6 hours apiece.

Operation tends toward open shop.

Training is "sink or swim" with help given as needed. We give the students a simple problem, a machine manual, a few words of advice and let them work on their own. We do not give extensive lectures, but may give one or two hours when computing is part of regular course where the students do not have the time to learn by themselves.

Lehigh U.

	One 8-Hour Shift		Two 8-Hour Shifts	
	Used	Recomm	Used	Recomm
Supervisors	1	1		1
Analysts	1	2		1
Programmers	2	2		
Coders	1	2	1	1
Clerk-Librarian	1	2		1
Operators		1	1	1

Operation tends toward open shop.

Methods of training used includes Compiler (short informal course), Interpreter (short, formal course), Basic Language (intensive course with extensive, informal practice) and Operation (intensive course with extensive, informal practice). Plan to teach operation with special "Automated Program".

MSMM

1 supervisor 2/3 time - recommended 1 full time
1 combination programmer and operator - recommended 2
1 combination coder and clerk - recommended 2

Operation tends toward open shop.

Regular scheduled university courses in Numerical Analysis, Programming, and operation of the computer. Occasionally short courses in programming and operation are taught.

Ohio U.

A course (1 semester, 3 hour credit) is offered in the Mathematics Department.

Operation tends toward open shop.

U of S. C.

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1

Operation tends toward open shop.
Individual instruction to students.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Operating ratio (Good/Attempted to run time) 0.95
Figure based on user performance records.

MRL Watertown Arsenal
Good time   39 Hours/Week (Average)
Attempted to run time   42 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.93
Above figures based on period from May 59 to May 60
Time is not available for rent to outside organizations.

USA WAL
Good time   21 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period 27 Sep 59 to 12 Dec 59
Passed Customer Acceptance Test 5 May 59
Time is not available for rent to outside organizations.

WSMR
Good time   39.5 Hours/Week (Average)
Attempted to run time   40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period from Jun 58 to Apr 60
Passed Customer Acceptance Test Jun 58
Time is not available for rent to outside organizations.

P-DL FA
Good time   34.2 Hours/Week (Average)
Attempted to run time   37.4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.932
Above figures based on period from Nov 59 to Apr 60
Passed Customer Acceptance Test Apr 59
Time is not available for rent to outside organizations.

USN Hydro
Good time   36 Hours/Week (Average)
Attempted to run time   40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Apr 59 to 20 Apr 60
Passed Customer Acceptance Test Apr 59
Time is not available for rent to outside organizations.

US NOTS
Good time   25 Hours/Week (Average)
Attempted to run time   29 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.86
Above figures based on period 1 Dec 59 to 1 May 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.
This is a small computer but it is capable of handling a large number of general engineering and scientific problems. It presently complements an IBM 709 located at the Naval Ordnance Test Station at China Lake, Calif.

NASA
Good time   23.0; 36.0; 25.7 Hours/Week (Average)
Attempted to run time 33.4; 38.9; 34.2 Hours/Week
Operating ratio   0.689; 0.925; 0.751
Above figures based on period from 1 Feb to 10 Apr
Time is not available for rent to outside organizations.

TVA
Good time   36 Hours/Week (Average)
Attempted to run time   40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period from Dec 57 to May 60
Passed Customer Acceptance Test Dec 57
Time is not available for rent to outside organizations.
Down time varies considerably. There was one six month period of no down time. Service men come from out of town, so down time is largely travel time of the service man.

AA
Good time   24 Hours/Week (Average)
Attempted to run time   25 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Oct 59 to Apr 60
Time is available for rent to outside organizations.
The LGP 30 has been a very reliable computer with little or no down time except for periodic preventive maintenance checks. The Flexowriter (standard input-output unit) has given only those minor difficulties usually encountered with typewriters.

ACF
Good time   24 Hours/Week (Average)
Attempted to run time   30 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.80
Above figures based on period from Jul 59 to Jul 60
Time is available for rent to qualified outside organizations.

Convair
Good time   40 Hours/Week (Average)
Attempted to run time   44 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period 1 Jan 59 to 31 Dec 59
Passed Customer Acceptance Test 1 May 58
Time is available for rent to outside organizations.

GE
Average error-free running period   34 Hours
Good time   34 Hours/Week (Average)
Attempted to run time   35 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period from Jan 60 to Aug 60
Passed Customer Acceptance Test Jan 60
Time is not available for rent to outside organizations.

GR
Average error-free running period   190 Hours
Good time   37.3 Hours/Week (Average)
Attempted to run time   41.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.905
Above figures based on period 1 Jan 60 to 30 Mar 60
Time is not available for rent to outside organizations.
1st LGP 30 installed Aug 57 and replaced Mar 59.
2nd LGP 30 installed Mar 59

Raytheon
Good time   28 Hours/Week (Average)
Attempted to run time   32 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from May 60 to Aug 60
Passed Customer Acceptance Test Aug 58
Time is not available for rent to outside organizations.
Since the operating costs of this machine are extremely inexpensive, since this system is open shop not emphasizing programming skills, and since long production runs are left running unattended all night, we do not try to schedule work to obtain 100% utilization during regular working hours; however, it is utilized at least 70% of this time with as much all night productions as necessary. It is not uncommon to have the machine running 24 continuous error-free hours.

Servomechanisms
Average error-free running period   6 - 7 Weeks
Good time   38 Hours/Week (Average)
Attempted to run time   40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period Apr 59 to 26 Apr 60
Passed Customer Acceptance Test May 58
Time is available for rent to qualified outside organizations.

TO, Inc.
Average error-free running period   2 Months
Good time   34.3 Hours/Week (Average)
Attempted to run time   35.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98

Above figures based on period 25 Feb 59 to 25 Apr 60
Passed Customer Acceptance Test 24 Feb 59
Time is not available for rent to outside organizations.
Excellent reliability since installation. Hours/week running time is approaching full single shift operation as computational requirements continue to increase.

WE
Average error-free running period   360 Hours
Good time   35 Hours/Week (Average)
Attempted to run time   40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from Dec 58 to Jul 60
Passed Customer Acceptance Test 18 Dec 57
Time is not available for rent to outside organizations.

Dartmouth
Good time   One week (Average)
Operating ratio   0.90
Above figures based on period 1 Jun 59 to 12 Apr 60
Time is not available for rent to outside organizations.
We have about one breakdown every two weeks. We will then remain down for about two days since the repairman must make it a days trip from Boston.

JHU
Average error-free running period   1 Week
Good time   35 Hours/Week (Average)
Attempted to run time   40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.875
Above figures based on period from Feb 60 to Sep 60
Time is not available for rent to outside organizations.
General performance of computer has been good.
Flexowriter input-output unit has been responsible for most of the computer down time.

Lehigh U
Good time   36 Hours/Week (Average)
Attempted to run time   37 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 1 Jun 59 to 31 May 60
Passed Customer Acceptance Test 1 Dec 57
Time is available for rent to qualified outside organizations.

Ohio U
Good time   40 Hours/Week (Average)
Attempted to run time   40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from 58 to 60
Passed Customer Acceptance Test   1957
Time is available for rent to qualified outside organizations.
Open shop - we keep no records of who uses it, when, or what for.

U of S.C.
Good time   60 Hours/Week (Average)
Attempted to run time   60 Hours/Week (Average)
Above figures based on period from Jun 59 to Apr 60
Passed Customer Acceptance Test Jun 59
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
Outstanding features include low cost; compactness; ease of programming; large users' organization with well-stocked program library; alphanumeric input-output including full format control; large memory; no special installation requirements; nation-wide maintenance and service network.

MRL Watertown Arsenal
Outstanding features include an internally stored program; large memory; flexibility with input, output; no special site preparation; relatively simple programming. Several compilers are available for the LGP 30, interpretive systems in floating point are extremely useful, and almost all of our work is done in floating point and there are a large number of subroutines available.

WSMR
Outstanding features include high reliability and simple programming.

USN Hydro
Outstanding features include compactness, low heat dissipation, and reasonable rental.

TVA
Outstanding features include simplicity of programming and operation and a practical manual input. Good machine for informal, open shop operation. The computer serves present needs very well. However, service from out of town is inconvenient and wasteful of time.

AA
Compact, desk-sized, completely mobile. Speed equal to many room-sized computers. Plugs into any regular wall outlet (110V). Compared to computers in its class, the LGP 30 has the largest capacity (4096 words) for data and program. Paper program tapes and data tapes are labeled on the Flexowriter and stored in circular containers which are likewise labeled. These tape containers are stored in a metal cabinet with other computer literature and programming forms.

ACF
Outstanding features include ease of programming and large memory for machine of this price.

GE
Outstanding features include ease of programming, small size and sufficient speed.

Raytheon
Outstanding features include low cost computations, simplicity in programming and operating, and may be used as a desk calculator.

Servomechanisms
Outstanding features include ease of programming and operating.

TO, Inc.
Outstanding features: This is a simple computer to program and operate. 4,000 words of fast access storage make this computer competitive with others renting for substantially higher rates. Input is easily accomplished using typewriter or tape input. Specific storage locations can be interrogated. Programming and "debugging" is simplified through the use of a single operation option which allows the coder to step through a program instruction by instruction. System is limited to paper tape input-output, 16 basic orders in fixed point operation, 1 logical order, one address, lack of MQ register makes double precision computation difficult, relatively slow, stops on accumulator overflow, and the requirement for "spacer bit" complicates programming.

WE
Outstanding feature is its simplicity of programming.

Dartmouth
System is small and inexpensive, binary, homogeneous memory, able to do logical operations on symbols easily.

Ohio U
Outstanding feature is its ease of use.

U of S.C.
This LGP 30 is extremely reliable except for some Flexowriter troubles.

FUTURE PLANS

Manufacturer
Production of basic system to continue with electronic improvements as developed.

MRL Watertown Arsenal
Present plans indicate renting a larger small scale computer to replace the LGP 30. The RPC 4000 is the latest machine developed by Royal Precision Corporation and has double the memory, double the number of instruction of the LGP 30, is fully transistorized and is much faster. Our computing needs demand the larger machine now.

USA WAL
It is possible that the present system will be replaced by the slightly larger and faster RPC 4000 at an undeterminate future date, but nothing definite has gotten underway on this.

P-DL FA
Contract with University of Rochester to develop a program for automatic lens design.

US NOTS
It is proposed to install a Digital Equipment Corporation PDP-3 Computer in the Simulation and Computer Center at NOTS, Pasadena. This would be a medium size (16K) very high speed computer which will be used for real time, physical, and computed simulation problems, in conjunction with the existing analog facility of over 600 amplifiers.

Convair
The function of the LGP 30 is being absorbed by the IBM 704. The LGP 30 will be eliminated.

GE
It is anticipated that one additional LGP 30 will be put into service.

TO, Inc.
The increased computational requirements of this organization during the past year, specifically in support of war gaming activity is indicative of a trend which will continue. A concentrated effort is being made to relieve the war gamer of the computational burden associated with combat assessment and thus improve and accelerate war gaming activity. This gradual automation of war game control functions is currently taxing our computational facilities. It is apparent that in the near future these facilities must be expanded.

No specific system has been selected at this time, however, we are currently surveying the computer field in an effort to determine which is the system best tailored to our future needs.

Dartmouth
We plan to move in about a year to more suitable quarters. The Center will then consist of the machine room 20 by 30, an adjoining work 12 by 16, a store room 6 by 10. This room will be equipped efficiently for student and open shop operation. We have no plans at present for new equipment, though we would naturally want to keep approximately up to date as new developments are made.

MSMM
Plans for the immediate future include the purchase of an extra tape typewriter, card input-output equipment and high accuracy analog computer equipment. Future plans also include the purchase of another digital computer with considerable more speed and capacity then the present LGP 30 computer system. All of this equipment to be installed in the Campus Computer Center.

U of S.C.
It is anticipated that a photoreader for the LGP 30 will be added.

INSTALLATIONS

ADPS Committee, Officers' Department, USASCS
Fort Monmouth, New Jersey

Materials Research Laboratory
Watertown Arsenal
Watertown, Massachusetts

Watertown Arsenal Laboratories
Watertown 72, Massachusetts

Ordnance Mission
White Sands Missile Range, New Mexico

Pitman-Dunn Laboratories, Frankford Arsenal
Philadelphia 37, Pennsylvania

U. S. Navy Hydrographic Office
Washington 25, D. C.

U. S. Naval Ordnance Test Station, Pasadena
3202 E. Foothill Blvd.
Pasadena, California

NASA - Goddard Space Flight Center
c/o Anacostia Naval Station
Washington 25, D. C.

Tennessee Valley Authority, Flood Control Branch
712 Union Building
Knoxville, Tennessee

Aircraft Armaments, Inc.
Cockeysville, Maryland

ACF Electronics Division
11 Park Place
Paramus, New Jersey

Convair-Fort Worth
Division of General Dynamics Corp.
Fort Worth, Texas

General Electric-Missile and Space Vehicle Dept.
3198 Chestnut Street
Philadelphia 4, Pennsylvania

The Griscom-Russell Company
Massillon, Ohio

Mutual Insurance Advisory Association
111 Fourth Avenue
New York 3, N. Y.

Raytheon Company
Missile Systems Division
Bedford, Massachusetts

Research Division, Servomechanisms, Inc.
Building 114, Santa Barbara Airport
Goleta, California

Technical Operations, Inc.
Fort Monroe, Virginia

Western Electric Company, Inc.
3300 Lexington Road, S. E.
Winston-Salem, North Carolina

Dartmouth College, Computation Center
Hanover, New Hampshire

Johns Hopkins University
34th and Charles Streets
Baltimore 18, Maryland

Lehigh University
Bethlehem, Pennsylvania

Missouri School of Mines and Metallurgy
Rolla, Missouri

Ohio University
Athens, Ohio

University of South Carolina
Columbia, South Carolina

LIBRASCOPE 407

Librascope   407

APPLICATIONS

General purpose, airborne, guidance and navigational computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Number binary digits/word	22
Number binary digits/instruction	44
Number instructions per word	1
Arithmetic system	Fixed point
Instruction type	Four address
Instruction word format	

Current Instruction				
α_s	α_t	β_s	β_t	Oper

Next Instruction				
γ_s	γ_t	δ_s	δ_t	Oper

Operands are α, β, and γ

Next instruction is δ

System includes 2 accumulators, 1 multiplicand, 1 multiplier register, and 2 instruction registers.

ARITHMETIC UNIT

	Exclud. Stor. Access Microsec
Add	100
Mult	2000
Div	4000

Construction (Arithmetic unit only)	
Transistors	500
Resistor-Diodes	5000
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Binary Digits
Drum	3000	66,000

INPUT

Media	
Pulse	
Analog-Digital	
Key Punch	

OUTPUT

Medium	
Digital-Analog	

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.25 Kw
Volume, computer	0.9 cu ft
Weight, computer	56 lbs

INSTALLATIONS

General Precision, Inc.
Librascope Division
808 Western Avenue
Glendale, California

Photo by Librascope Division, General Precision
Corporation

LIBRASCOPE
AIR TRAFFIC

Librascope Air Traffic Control Central Data
Processor (ATC)

MANUFACTURER

Librascope Division
General Precision, Incorporated

Maddocks Photo for Librascope Division, GP, Inc.

APPLICATIONS

System meets general purpose data processing re-
quirements where high speed, large capacity random
inquiry files are required and large numbers of
different types of input-output systems are connected.
Specifically, it is designed for on-line, real time
use in the control of air traffic. Some functions
are those of flight plan breakdown, conflict predic-
tion, conflict resolution, flow prediction, flight
strip preparation and updating, flight plan updating,
etc.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Binary coded decimal digits/word	8
Binary coded decimal digits/ instruction	8
Instructions per word	1 (includes field specification)
Instructions decoded	31
Arithmetic system	Fixed point (Magni- tude plus sign)
Instruction type	One address

Instruction word format

-	C	X	Y	M	M	M	M
Not used	Command	Field Specif		Operand Address			

Automatic built-in subroutines include an error
mode, entered by detection of an error. It inter-
rupts program, stores instruction address, and R
register contents.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	32	22 Max.
Mult	366	356 Av.
Div	380	370 Av.

Construction (Arithmetic unit only)

Transistors	3,000
Arithmetic mode	Serio-parallel
Timing	Synchronous
Operation	Serial by alphanumeric char- acter Parallel by bit

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Core Memory	4,000	32,000	10
Magnetic drum	256,000	2,032,000	16,000
Magnetic tape	Multiple FR 300 units		
No. of units that can be connected		32 Units	
No. of characters/linear inch		200 Chars/inch	
Channels or tracks on the tape		7 Tracks/tape	
Blank tape separating each record		1/2 Inch	
Tape speed		75-150 Inches/sec	
Transfer rate		30,000 Chars/sec	
Start time		3 Millisec	
Stop time		3 Millisec	
Physical properties of tape			
Width		1/2 Inches	
Length of reel		2,400 Feet	
Composition		Oxide on paper or plastic	

INPUT

Media	Speed	No. of Multi-plexed Channels
Flexowriter	10 char/sec	
Photo Reader	330 char/sec	
Teletype via buffer	10 char/sec	12
Keyboard via display console	15,000-20,000 ch/s	30
Data Link	50 char/sec	4
Analog-Digital Conv from Radar	50 char/sec	2
Inter Computer via Buffer	200,000 ch/s	1