

# IBM 709

IBM 709 Data Processing System

## MANUFACTURER

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

Photo by International Business Machines Corporation

at Point Mugu, California and one at Point Arguello, California. Land Air is the lessee, and our major commitment 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).

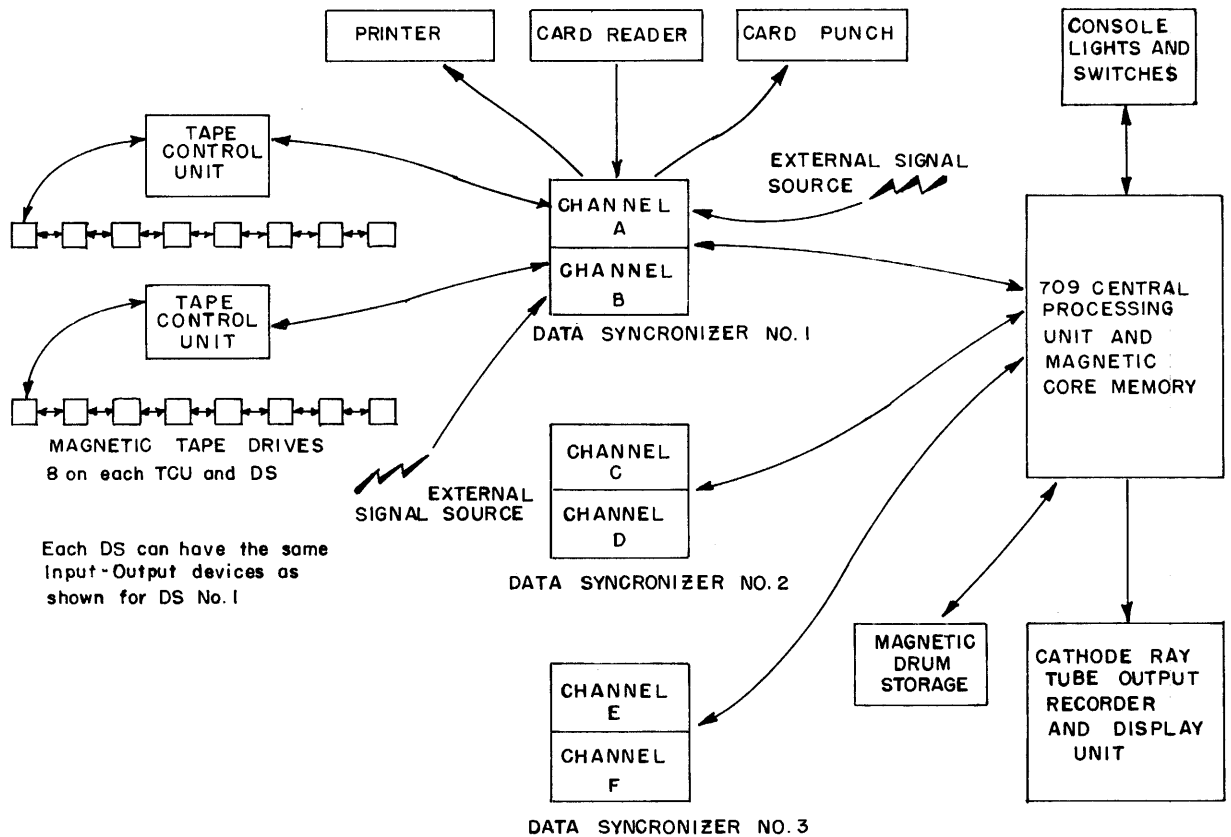
### U.S.N. Pacific Missile Range Pt. Mugu

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 prediction 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

Chart by International Business Machines Corporation

**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.

Photo by International Business Machines Corporation

**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. Administrative 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.

Photo by USAF AMR Cape Canaveral

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.

Photo by USN FMR Point Mugu

## 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              | <table> <tr> <td>Floating</td> <td><math>-10^{38} &lt; N &lt; 10^{38}</math></td> </tr> <tr> <td>Fixed</td> <td><math>-(2^{35}-1) \leq N \leq (2^{35}-1)</math></td> </tr> </table> | Floating | $-10^{38} < N < 10^{38}$ | Fixed | $-(2^{35}-1) \leq N \leq (2^{35}-1)$ |
| 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 millisecond 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   |                 |   |

Photo by USAF AFMFC Patrick AFB

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; 15 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

Photo by IBM Space Computing Center Washington

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

Photo by Hughes Aircraft Company

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 monitor 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 record operations - card-to-tape, tape-to-card, and tape-to-print are performed off-line.



Photo by Lockheed Aircraft Corporation, Sunnyvale

| 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 concn 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.

Photo by Lockheed Aircraft Corporation, Sunnyvale

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 peripheral equipment |         |
| Weight, air conditioner    |       | 15,000 lbs                            |         |

Computer is located in a fire-proof area. The computer area is not adjacent to any inflammable or explosive 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.

The entire computer area has its own refrigerated air-conditioning system plus humidity control. Air conditioning equipment located in separate, fire-proof, 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

Photo by Lockheed Aircraft Corporation, Sunnyvale

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 concn 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.

|                           |                   |
|---------------------------|-------------------|
| 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 concn 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.

Photo by McDonnell Aircraft Corporation

Hughes

|                            |        |                     |          |
|----------------------------|--------|---------------------|----------|
| Power, computer            | 205 Kw | 256 KVA             | 0.80 pf  |
| M. G. set                  |        |                     |          |
| Power, air cond            | 99 Kw  | 120 KVA             | †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 concn 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  
 occupancy.

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

Weight, computer 313,000 BTU  
 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 condi-  
 tioning 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, precipitators, 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<br>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

Photo by System Development Corporation

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 |           |        |

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.

Photo by University of California, LRL Livermore

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 conditioned.

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 distribution within building.

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 |                         | Model | Monthly Charge | Purchase Price |
|--------------|-------------------------|-------|----------------|----------------|
| Type         | Description             |       |                |                |
| 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 OIS 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, 729I, 736, 738, 741, 746, 755, 766, and 776 rent for \$50,450.  
 Types 714, 717, 757, 759, and 729I 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          | 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            |
| 759          | 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 I      |                  | 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   |

|  |                               |          |                |
|--|-------------------------------|----------|----------------|
| 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 |
|  | Univac                        | 22       | \$20,980.00    |
|  | Core Storage                  |          | 4,500.00       |
|  | Float Point                   |          | 1,545.00       |
|  | Variable Block                |          | 290.00         |
| A                                      | Total Main Frame              | 27       | 315.00         |
|  | Uniservo (10)                 |          | 3,200.00       |
|  | Read Punch                    |          | 890.00         |
| B                                      | Total On Line                 |          | 4,090.00       |
|  | Total EDP 22 (A+B)            |          | \$31,405.00    |
|  | Univac                        | 27       | 20,980.00      |
|  | Core Storage                  |          | 4,500.00       |
|  | Floating Point                |          | 1,545.00       |
|  | Variable Block                |          | 290.00         |
| C                                      | Total Main Frame              |          | \$27,315.00    |
|  | Uniservo (10)                 |          | 3,200.00       |
|  | Read Punch                    |          | 890.00         |
| D                                      | Total On Line                 |          | \$4,090.00     |
|  | Total EDP 27 (C+D)            |          | \$31,405.00    |
|  | High Speed Printer            |          | 3,300.00       |
|  | High Speed Printer            |          | 3,300.00       |
|  | Card to Tape                  |          | 2,605.00       |
| D                                      | Total Off Line                |          | 9,205.00       |
|  | Total EDP Systems (A+B+C+D+E) |          | \$72,015.00    |
|  | 026 Key punch                 |          | 77.00          |
|  | 026 Key punch                 |          | 71.50          |
|  | 026 Key punch                 |          | 71.50          |
|  | 056 Verifier                  |          | 60.50          |
| A                                      | Total Key punch               |          | \$280.50       |
|  | 077 Collator                  |          | 126.50         |
|  | 082 Sorter                    |          | 68.20          |
|  | 407 Acctg. Machine            |          | 915.75         |

|  |             |        |        |
|--|-------------|--------|--------|
| 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   |             |        |        |

|                               | Qty | Monthly Rental 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           |
|     |             |   | <u>31,668</u> | <u>1,447,590</u> |

**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 Core 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 Ft 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 FMR 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 OIS 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 includes 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     |
| 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 |             |
|----------------|------------------|-------------|
|                | Used             | Recommended |
| 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 O 2 | 3                          | 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 |             |
|----------------|---------------------|-------------|
|                | Used                | Recommended |
| 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 | 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 following 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 FMR 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 FMR 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 DHL4 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 FMR 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 G, 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

# IBM 1401

IBM 1401 Data Processing System

## MANUFACTURER

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, salesmen's 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

Photo by International Business Machines Corporation

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 location 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 instructions, 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 processing; 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                               |
|              | Magnetic Core  | 4000 char   | 6 bits/char, 1 parity bit, 1 word mark bit. |

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 $\pi$ . 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  
Magnetic Tape IBM 729 II      Speed  
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

## 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  |    | Cost             | Monthly Rental |
|---|----|------------------|----------------|
| Basic System  |    |                  |                |
| 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                                    |    |                  |                |
| 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:

| 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

## MANUFACTURER

International Business Machines Corporation

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)<br>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.

Photo by International Business Machines Corporation

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 4-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)<br>20,000,000 (Model 2) | 100,000 min<br>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)<br>(Maximum) | Service<br>Sides | Clearance (Inches) |      | KVA  |
|---------------------|---------------------|--------|--------|---------------------------|------------------|--------------------|------|------|
|                     | Width               | Depth  | Height |                           |                  | Front              | 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

**MANUFACTURER**  
International Business Machines Corporation

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 millisecc/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   | 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)   |

Manufacturer

| Components                   | Model or Feature No. | Monthly Charge | Purchase Price | Monthly Maintenance Charge Based on Age of Machine in Months |
|------------------------------|----------------------|----------------|----------------|--|
| 1620 Central Processing Unit | 1                    | \$1,375        | \$64,000       | \$76.75  |
| Automatic Divide             | 47                   | 55             | 2,400          | \$78.50  |
| Indirect Addressing          | 493                  | 25             | 1,150          | \$81.00  |
| 1621 Paper Tape Reader       | 1                    | 200            | 9,100          | 2.75   |
| 1622 Card Read Punch         | 1                    | 625            | 30,000         | 2.75   |
| 1623 Core Storage            |                      |                |                | 1.50   |
| (20,000 positions)           | 1                    | 800            | 39,500         | 14.50  |
| (40,000 positions)           | 2                    | 1,275          | 62,400         | 14.50  |
| 961 Tape Punch (8-track)     | 1                    | 25             | 1,400          | 17.50  |

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.

### 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 | 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                 | Model or Feature No. | Monthly Charge | Purchase Price | Monthly Maintenance Charge Based on Age of Machine in Months |
|------------------------------|----------------------|----------------|----------------|--|
| 1620 Central Processing Unit | 1                    | \$1,375        | \$64,000       | \$76.75  |
| Automatic Divide             | 47                   | 55             | 2,400          | \$78.50  |
| Indirect Addressing          | 493                  | 25             | 1,150          | \$81.00  |
| 1621 Paper Tape Reader       | 1                    | 200            | 9,100          | 2.75   |
| 1622 Card Read Punch         | 1                    | 625            | 30,000         | 2.75   |
| 1623 Core Storage            |                      |                |                | 1.50   |
| (20,000 positions)           | 1                    | 800            | 39,500         | 14.50  |
| (40,000 positions)           | 2                    | 1,275          | 62,400         | 14.50  |
| 961 Tape Punch (8-track)     | 1                    | 25             | 1,400          | 17.50  |

# IBM 7070

IBM 7070 Data Processing System

## MANUFACTURER

International Business Machines Corporation  
590 Madison Avenue  
New York 22, New York

## APPLICATIONS

### Manufacturer

System is used in the many areas of management decision criteria such as engineering design and development, research, accounting controls and reports, production, inventory controls and reports, and mathematical 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 requisitions 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 system is used for the solution of problems in materiel, maintenance, personnel, accounting and finance, air operations, vehicle management, and civil engineering.

Photo by International Business Machines Corporation

### 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, reduction 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 processing, and computer applications and for the conduct 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                             | Fixed $-10^{10} < x < +10^{10}$           |
|  | Floating $\pm 10^{-50} < x < \pm 10^{49}$ |

### 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 lookup, 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                            |
| 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 mill/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<br>(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  
Capacity, air condition 2,800 lbs concen max  
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             |
|          |                                 | <u>\$18,000</u> |

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             |
|          |            | <u>\$27,335</u> |

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 |             |
|-------------|------------------|-------------|
|             | Used             | Recommended |
| Supervisors | 3                | 3           |
| Analysts    | 2                | 2           |
| Programmers | 3                | 3           |
| Operators   | 2                | 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 recreation 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  
     Fixed point  $-10^{10} < x < +10^{10}$   
     Floating point  $|\pm 10^{-50}| < x < |\pm 10^{49}|$

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 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 millisecc.

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 Millisecc  
 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-III 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<br>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

## MANUFACTURER

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 |
|-----------|--------------------------------------|

Photo by International Business Machines Corporation

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<br>Microsec | Exclud Stor Access<br>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<br>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

### 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.

### 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 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 1/176th 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.

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 7090

IBM 7090 Data Processing System

## MANUFACTURER

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.

Photo by International Business Machines Corporation

### 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

Photo by General Electric Company, Missile & Space Vehicle Department

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 - $10^{38} < N < 10^{38}$<br>Fixed - $(2^{35} - 1) \leq N \leq (2^{35} - 1)$ |

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                     | Floating Point |
|   | Microsec                        | 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 transistors.   |                                 |                |
| 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 computational program in the Central Processing Unit. |                                 |                |

Photo by General Electric Company, Missile & Space Vehicle Department

## STORAGE

| Manufacturer   | No. of Words                   | Access Microsec |
|--|--------------------------------|-----------------|
| Media  |                                |                 |
| 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   | Speed                           |
|--|---------------------------------|
| Media  |                                 |
| 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. |                                 |

Photo by General Electric Company, Missile & Space Vehicle Dept.

| GE  | Speed   |
|---|---|
| Media   |   |
| 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                                       | 75 in/sec   |
| (IBM 729 II)  | 15,000 or 42,000 char/sec                                 |
| Magnetic Tape                                       | 112.5 in/sec  |
| (IBM 729 IV)  | 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<br>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  | Speed   |
|---|---|
| Media   |   |
| Magnetic Tape                                       | See Storage<br>(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 ob-   |   |
| tained 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<br>off line)   |
| Printer   | 4,000 lines/min (tape to printer<br>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. |               |   |
| UCRL   |               |   |
| Printer  | 150 lines/min | 72 chars/line                               |
| Tapes  | 729 II        | low density for off-line printer            |
| Cards  | 100 cards/min | 24 words/card Binary<br>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

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 conditioner 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.

Photo by University of California Lawrence Radiation Laboratory

### PRODUCTION RECORD

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

### COST, PRICE AND RENTAL RATES

| Manufacturer |                              |       | Monthly | Purchase |
|--------------|------------------------------|-------|---------|----------|
| Type         | Description                  | Model | Rental  | 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 service 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 specifications 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 compilers 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 systems will be used primarily as input-output equipment 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 CPC

IBM Card Programmed Calculator

## MANUFACTURER

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       |

Photo by International Business Machines Corporation

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

### STORAGE

|                    |       |        |                   |
|--------------------|-------|--------|-------------------|
|                    |       |        | Access            |
| Media              | Words | Digits | 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

### APPLICATIONS

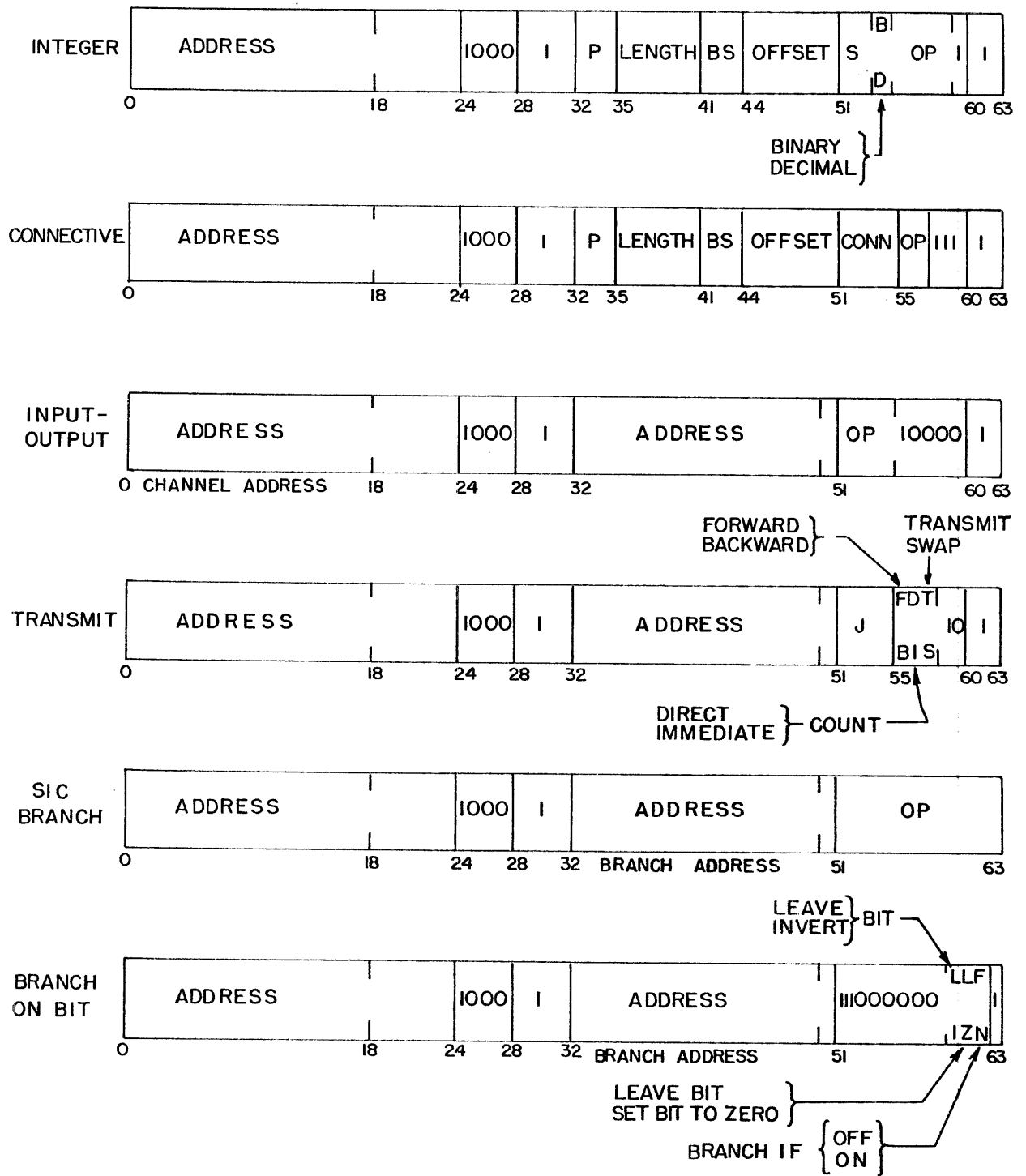
Engineering development, scientific research, real time processing and control, logistics, procurement and supply, production scheduling and control, and other areas of application.

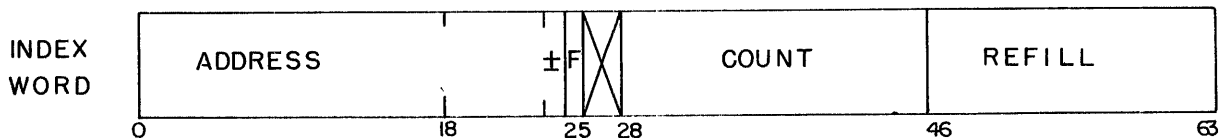
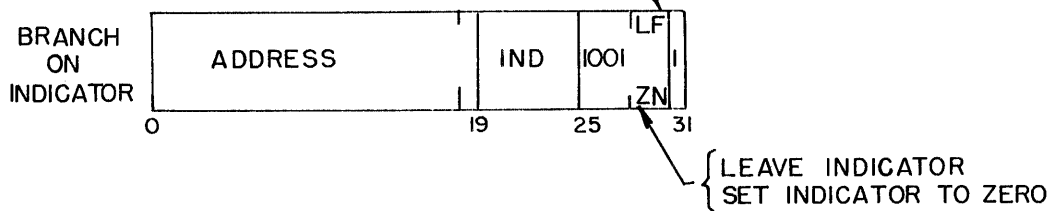
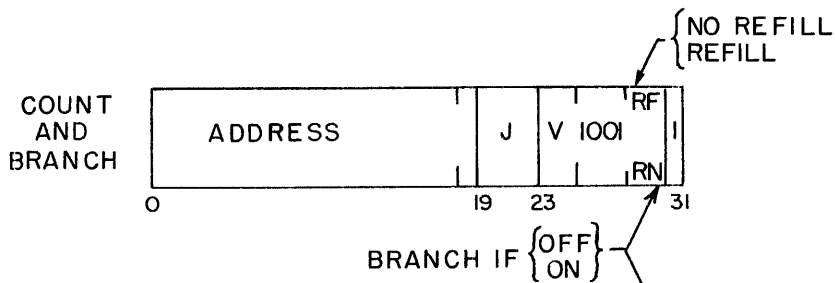
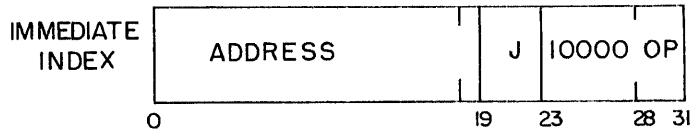
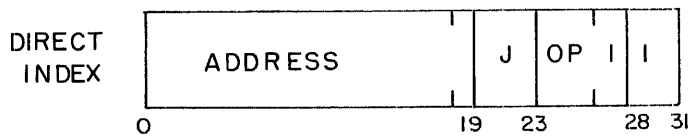
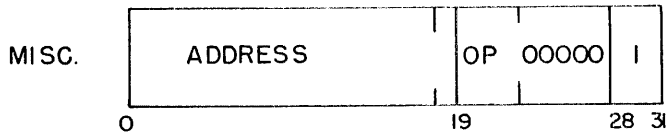
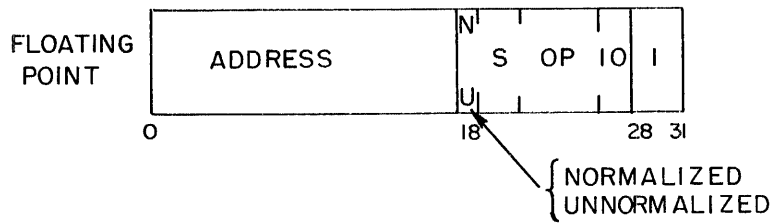
Photo by the International Business Machines Corporation

### 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  |
| length fields                  | Binary and Decimal Integer Arithmetic for variable                    |
| Instruction type               | One and two address   |
| Number range                   | $- 2^{1024} < N < 2^{1024}$ for floating point with a 48 bit fraction |
| Integer arithmetic:            | $0 \leq N < 2^{64}$ or $0 \leq N < 10^{16}$                           |

# INSTRUCTION WORD FORMAT





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 | Exclud Stor Access |
|------|------------------|--------------------|
|      | Microsec         | 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  
 Arithmetic 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    |

ILLIAC

566

|   | 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 -1 to 1 - 2<sup>-39</sup>

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. Sub-routines 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                     | 3                  |
| 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 these.

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 criteria 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 ML5-183.

## 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 originally designed and constructed by the Institute for Advanced Study.

# INTELEX AIRLINE RESERVATION

Intelex Airline Reservation Computer

## MANUFACTURER

Intelex Systems, Incorporated  
Associate of International Telephone and Telegraph Corporation

## 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 Definition | Instruction 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 | Exclud Stor Access |
|                 | Microsec         | 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 20x10 <sup>6</sup> |
|                                    | 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         |                    |                         |

## 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

MANUFACTURER

ITT Laboratories Bank Loan Processor.

ITT Laboratories  
500 Washington Avenue  
Nutley 10, New Jersey

Photo by ITT Laboratories, Nutley

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

|                   |         |   |                         |   |   |   |  |   |   |    |    |    |
|-------------------|---------|---|-------------------------|---|---|---|--|---|---|----|----|----|
| +<br>and<br>check | 1       | 2 | 3                       | 4 | 5 | 6 | 7  | 8 | 9 | 10 | 11 | 12 |
|                   | OP CODE |   | DELTA<br>Next<br>Instr. |   |   |   | OPERAND<br>(or alternate next<br>instruction, or<br>special) |   |   |    |    |    |

Automatic built-in subroutines include a sort command, a sequence command, and a merge command.

Automatic coding includes SCP, a Symbolic Conversion Program (One-to-One Compiler for Symbolic Address and Op Codes), and MARK II, a utility system.

Registers and B-boxes include a high and low accumulator, 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 simultaneously compute, read tape, write tape, search on several tapes, print (on-or off-line), and answer inquiries.

## ARITHMETIC UNIT

|      | Incl Stor Access | Exclud Stor Access |
|------|------------------|--------------------|
|      | Microsec         | 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 x 10 <sup>6</sup> | 264 x 10 <sup>6</sup>     | 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<sup>9</sup> 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 Intellex 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 | Operation | 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 | Exclud Stor Access |
|                                     | Microsec         | 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             |
|--|--------------|-----------------|--------------------|
| Magnetic Tape  | 24,000,000   | 33 bits/word    | 3,000,000 Microsec |
| 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      |
| 301)                               | 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         | Exclud. Stor. Access |
|-----------------------------|------------------------------|----------------------|
|                             | Microsec                     | 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                 |                      |

Photo by the Rand Corporation

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 micro-seconds.

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 micro-seconds. 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

# JUKE BOX

Missile Firing Data Computer JUKEBOX

## MANUFACTURER

Autonetics Division  
North American Aviation, Incorporated

## 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  
O - 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<br>Microsec |            | Exclud Stor Access<br>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<br>20 in/sec |
| Keyboard   | Manual                    |

## 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 concn 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

Leeds and Northrup Computer 3000

# 3000 MANUFACTURER

Leeds and Northrup Company

LEEDS NORTHRUP COMPANY

LEEDS NORTHRUP COMPANY

Photo by 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<br>(000-255 <sub>10</sub> ) |   | Sector Address<br>(000-063 <sub>10</sub> ) |    | Modifier |    | Instruction |    | Type:<br>Single<br>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<br>Microsec | Exclud. Stor. Access<br>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<br>Words | No. of Digits | Access<br>Microsec          |
|---------------|-----------------|---------------|-----------------------------|
| Magnetic Drum | 16,260          | 357,720 bits  | Min. - 130<br>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

## MANUFACTURER

Bell Telephone Laboratories, Incorporated

### 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.

### 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                           |

Photo by Bell Telephone Laboratories, Incorporated

|                   |                 |
|-------------------|-----------------|
| Arithmetic system | Fixed point     |
| Instruction type  | One address     |
| Number range      | $-1 \leq n < 1$ |

### ARITHMETIC UNIT

|                 |                  |
|-----------------|------------------|
|                 | Incl Stor Access |
|                 | Microsec         |
| Add             | 40               |
| Mult            | 375 avg          |
| Div             | 520              |
| Construction    | Transistors      |
| Arithmetic mode | Parallel         |
| Timing          | Asynchronous     |
| Operation       | Concurrent       |

### 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

## 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

Photo by Flight Simulation Laboratory, WSMR, N. M.

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-

Photo by Tennessee Valley Authority

ical integrations,  $n^{\text{th}}$  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 Grisco-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 analyzed 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 IGP 30 has been used extensively to process, reduce and statistically analyze data. A variety of applications to war gaming activities also exist.

Photo by Aircraft Armaments, Inc.

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 interpretive systems. Registers includes an accumulator - double extension, an instruction, a counter, and 4096 memory registers.



## ARITHMETIC UNIT

| Manufacturer                        | Incl Stor Access<br>Microsec | Exclud Stor Access<br>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  | No. of<br>Words | No. of<br>Digits | Access<br>Microsec       |
|---------------|-----------------|------------------|--------------------------|
| Magnetic Drum | 4,096           | 32 binary        | Min. 2,000<br>Avg. 8,500 |

A complete instruction can be done in 2200 micro-seconds, including both accesses when optimum programmed. Maximum operation time is 15,000 microsec-

Photo by Servomechanisms, Inc.

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                | Speed        |
|-----------------------------|--------------|
| Media                       |              |
| 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 140,000/sec. meaningful  
 Western Electric 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  | Speed  |
|---|--|
| Media   |  |
| 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<br>tape reader (Friden), a digital analog converter,<br>and a servo plotting board (Mosely Autograph). |  |
| W. E.   |  |
| Electronic equipment  | 140,000/sec. meaningful<br>designed by Western Electric impulses |
| Consists of Diode Logic and transistor flip flops<br>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 IGP 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 IGP 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 |             |
|-------------|------------------|-------------|
|             | Used             | Recommended |
| Supervisors | 1                | 1           |
| Analysts    | 6                | 6           |
| Programmers | 6                | 6           |
| Coders      | 5                | 5           |
| Operators   | 1                | 1           |
| Engineers   | 4                | 4           |
| Technicians | 1                | 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 IGP 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 IGP 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 |             |
|-------------|------------------|-------------|
|             | Used             | Recommended |
| Supervisors | 1                | 1           |
| Analysts    | 1                | 1           |
| Programmers | 1                | 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) 0.92
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 NOTES

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 organiza-  
tions.

Excellent reliability since installation. Hours/week  
running time is approaching full single shift opera-  
tion as computational requirements continue to in-  
crease.

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 organiza-  
tions.

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 organiza-  
tions.

We have about one breakdown every two weeks. We will  
then remain down for about two days since the repair-  
man 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 organiza-  
tions.

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 or-  
ganizations.

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 or-  
ganizations.  
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, out-  
put; no special site preparation; relatively simple  
programming. Several compilers are available for the  
IGP 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 program-  
ming 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 waste-  
ful 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 IGP 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 pro-  
gramming 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, rela-  
tively 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 IGP 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 WAI

It is possible that the present system will be replaced by the slightly larger and faster RPC 4000 at an undetermined 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 than 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.  
3500 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

## MANUFACTURER

General Precision, Inc.  
Librascope Division

## 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 |            |           |           |      |
|---------------------|------------|-----------|-----------|------|
| $\alpha_s$          | $\alpha_t$ | $\beta_s$ | $\beta_t$ | Oper |

| Next Instruction |            |            |            |      |
|------------------|------------|------------|------------|------|
| $\gamma_s$       | $\gamma_t$ | $\delta_s$ | $\delta_t$ | Oper |

Operands are  $\alpha$ ,  $\beta$ , and  $\gamma$

Next instruction is  $\delta$

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

|        |        |               |
|--------|--------|---------------|
|        | No. of | No. of Binary |
| Medium | Words  | 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

## APPLICATIONS

System meets general purpose data processing requirements 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 prediction, 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/<br>instruction | 8                                      |
| Instructions per word                       | 1 (includes field<br>specification)    |
| Instructions decoded                        | 31                                     |
| Arithmetic system                           | Fixed point (Magni-<br>tude plus sign) |
| Instruction type                            | One address                            |

Maddocks Photo for Librascope Division, GP, Inc.

## Instruction word format

|             |         |              |                 |   |   |   |   |
|-------------|---------|--------------|-----------------|---|---|---|---|
| -           | C       | X            | Y               | M | M | M | M |
| Not<br>used | Command | Field Specif | Operand Address |   |   |   |   |

Automatic built-in subroutines include an error mode, entered by detection of an error. It interrupts program, stores instruction address, and R register contents.

## ARITHMETIC UNIT

|                                     | Incl. Stor. Access<br>Microsec   | Exclud. Stor. Access<br>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 character |                                  |
|                                     | Parallel by bit                  |                                  |

Maddocks Photo for Librascope Division, GP, Inc.

### 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                            |