POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	37.2 Kw	50.9	KVA
Power, air cond	5.0 Kw	7.5	KVA
Volume, computer		2,600	cu ft
Volume, air conditioner		1,200	cu ft
Area, computer		325	sq ft
Area, air conditioner		100	sq ft
Room size, computer		5,000	sq ft (entire system)
Room size, air conditioner		100	sq ft
Capacity, air conditioner		15	Tons
Weight, computer		26,500	lbs

Plenum. Unit wiring overhead.

PRODUCTION RECORD

Number produced	3
Number operating	3

See BIZMAC I

COST, PRICE AND RENTAL RATES

(1) Computer, (3) file maint. computers (fixed program), (1) interrogation unit, (182) tape stations, (1) system control unit, (1) card transcriber, (1) paper tape transcriber, (2) high speed printers, (1) transcribing card punch, (3) document printers, (10) Flexo-writers for the BIZMAC I cost $4,500,000 to acquire. Maintenance service on BIZMAC I is done by computer installation personnel.

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts
Supervisors	5
Analysts	3
Programmers	4
Coders	14
Clerks & Secretary	2
Librarians	0
Operators	4
Engineers	0
Technicians	1
In-Output Operators	4

Operation tends toward closed shop.

Methods of training used is a combination of formal instruction and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time	102.7 Hours/Week (Average)
Attempted to run time	104.73 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.98

Above figures based on period 1 Jan 60 to 30 Jun 60
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Outstanding features are interrogation unit, a direct on-line paper tape input to computer at 400 char/sec, dual recording on tape, and variable word and message lengths.

Standard security procedures for handling magnetic tape have been adopted.

INSTALLATIONS

Electronic Data Processing Division
Camden EDP Center
Camden, New Jersey

BOGART

Bogart Computing System

MANUFACTURER

Remington Rand Univac
Division of Sperry Rand Corporation

APPLICATIONS

Department of Defense

Located at Fort George G. Meade, Maryland, the system is used for mathematical calculations by the Department of Defense.

STORAGE

Department of Defense

Medium	No. of Words
Magnetic Core	4,096

INPUT

Department of Defense

Media	Speed
Paper Tape (Ferranti)	400 frames/sec
Magnetic Tape (IBM 727)	75 inches/sec
Flexowriter	Manual

OUTPUT

Department of Defense

Media	Speed
Paper Tape	60 frames/sec
Magnetic Tape (IBM 727)	75 inches/sec
Flexowriter	10 char/sec

PERSONNEL REQUIREMENTS

Department of Defense

	One 8-Hour Shift
Supervisors	1
Operators	1
Engineers	1
Technicians	1

Operation tends toward closed shop.
Formal class and on-the-job training is given.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Department of Defense

Good time	38 Hours/Week (Average)
Attempted to run time	38.4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.989

Above figures based on period 1 Dec 59 to 31 Dec 59
Time is not available for rent to outside organizations.

INSTALLATIONS

Fort George G. Meade, Maryland

BRLESC

Ballistic Research Laboratories Electronic Scientific Computer

MANUFACTURER

Ballistic Research Laboratories

Photo by U. S. Army

APPLICATIONS

Exterior ballistics problems such as high altitude, solar and lunar trajectories, computation for the preparation of firing tables and guidance control data for Ordnance weapons, including free flight and guided missiles.

Interior ballistic problems, including projectile, propellant and launcher behavior, e.g. physical characteristics of solid propellants, equilibrium composition and thermodynamic properties of rocket propellants, computation of detonation waves for reflected shock waves, vibration of gun barrels and the flow of fluids in porous media.

Terminal ballistic problems, including nuclear, fragmentation and penetration effects in such areas as explosion kinetics, shaped charge behavior, ignition, and heat transfer.

Ballistic measurement problems, including photogrammetric, ionospheric, and damping of satellite spin calculations, reduction of satellite doppler tracking data, and computation of satellite orbital elements.

Weapon systems evaluation problems, including anti-aircraft and nati-missile evaluation, war game problems, linear programming for solution of Army logistical problems, probabilities of mine detonations, and lethal area and kill probabilities of mine detonations, and lethal area and kill probability studies of missiles.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	68 + 4 parity
Binary digits/instruction	68
Instructions/word	1
Instructions decoded	33
Arithmetic system	Fixed and floating point
Instruction type	Three-address

Instruction word format

4	4	6	14	6	14	6	14
Order type	Parameter	Index	α-Address	Index	β-Address	Index	γ-Address

Number word format — Fixed Point

3	1	4 . .	60
Tag	Sign	Binary Point	

Number word format — Floating Point

3	1	4 .	52	8
Tag	Sign	Binary Point	Coefficient	Biased Exp of 16

Automatic built-in subroutines

In addition to the standard set of jump instructions, three more jump instructions have been included which will be used in connection with the "permanent" storage of "built-in" subroutines. These are Jump to "permanent" instruction, Jump to "built-in" subroutine, and Set index and jump to main memory.

Registers and B-boxes

The machine will have 63-one microsecond access index registers, addressable by the α, β, and γ addresses of the instruction words.

The parameter bits of the instruction word are used to indicate variations of the basic order type.

All three arithmetic registers are 68 bits. Tag bits enter these registers only on the logical instructions and the shift instruction if it is cyclic or is a Boolean shift. On arithmetic orders, the tag bits are saved in a separate three bit register and the three extra bits in the arithmetic registers are used for checking overflow. Thus the range of numbers in the arithmetic unit is $-128 \leq N < 128$.

Add and subtract are performed the same as for normalized arithmetic, except the result is never shifted left at the end of the operation.

Before multiply is done, the coefficient that has the largest absolute value is normalized. There is no left normalization after the operation. Thus the result has approximately the same number of significant digits as the operand that had the smaller number of significant digits. It does tend to retain an average of about two or more bits than it should, however.

Before divide is done, both operands are normalized but the number of divide steps performed is reduced accordingly so that the result has approximately the same number of significant digits as the operand that had the smaller number of significant digits.

ARITHMETIC UNIT

Operation	Microseconds Excl A T	Incl A T
Fixed point add or subtract	1	5
Fixed or floating multiply	20	25
Fixed or floating divide	60	65
Floating add or subtract	3.0	6
Boolean logic operation	1	5
Indexing and control	2	2(Avg)

Construction (Arithmetic unit only)

The arithmetic unit is constructed of standard vacuum tube logical packages, with tube driven, crystal diode logical gating. The arithmetic unit only is constructed of 1727 vacuum tubes of 4 types, 853 transistors of 3 types, 46,500 diodes of 2 types and 1,600 pulse transformers of 1 type.

Arithmetic mode — Parallel

Timing — Synchronous

Logical events are controlled by a five-phase clock, permitting decisions at a 5 Mc rate.

Operation — Concurrent

Indexing and control will be concurrent with arithmetic operations.

Except for arithmetic or Boolean compare instructions, the test overflow instructions with $P_{33} = 1$, or any arithmetic order that stores in any index register or stores in the location of the next instruction, the machine always gets its next instruction from the memory while it is doing the previous instruction. If this next instruction is one of the control and indexing orders, it is immediately done, unless it is an input-output order or a test overflow order. If it is done, it proceeds to get another instruction and do it, if possible. Thus almost all of the control and indexing orders can be done concurrently with the arithmetic or logical orders. Only the arithmetic and logical orders require the use of the main arithmetic unit of the machine.

All types of input-output orders can be done concurrently with other instructions. Automatic interlocks are provided so as to prevent timing conflict. Reference to a main memory position within the range of either an input or output instruction will halt the computer until the input or output transfer has occurred at that memory position. The computer is released as soon as the transfer of that particular word has been made and does not wait for the entire transfer to be completed. There is no interlock on the index memory when it is used as index registers. Only the effective addresses α, β, γ are conflict checked. The programmer can easily make the computer wait until such a transfer is complete by using the last address in the index range of the in-out order in the A, B, or C addresses of a dummy order. An input-output instruction is not started until the previous arithmetic instruction is finished, hence the last arithmetic result may be included in the range of any input-output order.

As many as five input-output orders can be operating concurrently with computing and with each other. There is a separate trunk for reading cards, punching cards, using drum, and two separate trunks for using magnetic tape and all five of these trunks can operate concurrently.

STORAGE

Media	No. of Words	Digits per Word	Access Microsec
Magnetic Core (Main)	4,096	72 binary	2
Magnetic Core (Index)	63	16 binary	1
Magnetic Drums (Two)	24,576		
Magnetic Tapes (Six)			
No. of units that can be connected		16 Units	
No. of chars/linear inch		400 Char/in	
Channels or tracks on the tape		16 Tracks/tape	
Blank tape separating each record		0.80 Inches	
Tape speed		150 Inches/sec	
Transfer rate		120,000 Char/sec	
Start time		3.0 Millisec	
Stop time		3.0 Millisec	
Average time for experienced operator to change reel		60 Seconds	
Physical properties of tape			
Width		1.0 Inches	
Length of reel		2,500 Feet	
Composition		0.43 Magnetic coating	
		1.45 Mil	

Provision is made for up to 16,384 words of high speed memory and system can be expanded to 28 tape stations.

INPUT

Media	Speed
Card Reader	800 cards/min
Magnetic Tape	See "Storage"

OUTPUT

Media	Speed
Card Punch	250 cards/min
Magnetic Tape	See "Storage"

Peripheral equipment. A single unit that is capable of converting alphanumerical characters from cards to tape, tape to high speed printer, tape to cards, cards to high speed printer and paper to magnetic tape.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5847	5,600
6197	110
6C4	110
6AQ5	220
Misc	80
Diodes	
LD70/CTP309	12,600
LD71	100,000
Misc	13,700
Transistors	
2N697	600
2N1143	240
2N398	1,600
Misc	6,300

CHECKING FEATURES

Code checking features will include stopping on any selected address, the display of the contents of any memory cell, the display of normal or abnormal conditions, the ability to manually store in any selected memory cell, and the ability to transfer control to any part of the system. Parity checking is performed in each of the four 17-bit groups in each word.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computing system	35 Kw
Power, air conditioner	20 Kw
Space, computing system	Plenum is 30 ft x 40 ft
Space, air conditioner	Chilled water is sent two flights up to computer site to heat exchanger, transferring heat from computer closed loop air to closed loop chilled water. On ground floor, compressor refrigerant absorbs heat from chilled water. An evaporative system absorbs heat from refrigerant in a cooling tower. Compressor located two floors below. Liquid coolant piped upstairs. Heat exchanger, computer closed-loop air-to-coolant at computer site, and coolant-to-outside air downstairs.
Capacity, air conditioner	25 Tons

PRODUCTION RECORD

Number of systems produced to date 1
Operational date anticipated as 1 April 1961.

COST, PRICE AND RENTAL RATES

The approximate cost, including an additional bank of 4,096 words of high speed memory, 6 tape stations, the system as described, with all peripheral converters and input-output equipment, site preparation, overhead and other related costs will be approximately 2.0 million dollars.

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts
Supervisors	6
Analysts	3
Programmers and Coders	14
Clerks	1
Engineers	1
Technicians	6

No engineers are assigned to the operation of the machine, but are used for development and design of additions to the machine. The technicians consult the engineers when a total break-down occurs.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

A high degree of reliability is achieved by utilizing standard logical plug-in packages, a ruggedized, long life, driver tube, derated components and point-to-point soldered connections.

INSTALLATIONS

Computing Laboratory
Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

BURROUGHS 204

Burroughs 204 Electronic Data Processing System

MANUFACTURER

Burroughs Corporation
(Formerly manufactured by the Electrodata Corporation)

Photo by U. S. Army Ordnance Tank-Automotive Command

APPLICATIONS

Manufacturer
See Burroughs 205 for further details

U. S. Army Tank-Automotive Command
Located at Detroit Arsenal, the system is used for engineering projects (tank firing stability studies, fuel consumption (battlefield day), performance analysis, suspension studies, and data reduction), and for mathematical programs (solution of complex formula and equation, empirical curve fitting, precision simulation of vehicle behavior, land locomotion research support, and mathemetical model development).

U. S. Naval Air Test Center
Located in Armament Test, NATC, Patuxent River, Md., the system is used for reduction of experimental test data concerning naval aircraft and systems. Examples are phototheodolite space positions, aircraft sighting tables, fire control systems test, and aircraft performance - climb, speed, etc.

U. S. Air Force Wright Air Development Center
Located in Bldg. 30, WADD, Wright-Patterson AFB, Ohio, the system is used for scientific data reduction in flight and engineering test field.

American Bosch Arma Corp.
Located at the Arma Division, ABAC, Garden City, N. Y., the system is used for the design, development, testing, and evaluation of inertial guidance systems, airborne digital computers, and other electronic equipment.

California Research Corporation
Located at 527 Standard Avenue, Richmond, California, the system is used for computative work associated with a large petroleum research laboratory. It might be described as calculations resulting from chemical analysis, engineering calculation, and analysis of data.

Convair, Division of General Dynamics Corp.
Located in Building 4, Convair, Pomona (Engineering Computer Laboratories), this machine is used on many varied types of problems, for example, trajectories, evaluation of rational polynomials, finding roots of polynomials, inverse Laplace, heat transfer, optics, regression analysis, scheduling of completion of manufacture of a missile via completion of its parts, etc.

The Dow Chemical Company
Located in A-1201, Room 42, Plant "A", Freeport, Texas, the system is used for the solution of technical and scientific problems.

Great Lakes Pipe Line Company
Located in the Bryant Building, Kansas City, Mo., the system is used to conduct research on product scheduling by computer accounting and administrative control operations.

Socony Mobil Field Research Laboratory
Located in Dallas, Texas, the system is used in theoretical studies in fluid flow, elasticity, geophysics, nuclear physics, reservoir engineering, heat transfer, design of experimental apparatus, data reduction and interpretation and engineering design.

Socony Mobil Oil Company, Inc.
Located in Paulsboro, New Jersey, the system is used for problems of large systems of linear algebraic equations, differential equations, statistics, process simulation, and miscellaneous scientific computation.

United Gas Corporation
Located at 8015 St. Vincents Ave., Shreveport, La., the system is used for scientific computing, including mass spectrometer analyses, reservoir mechanics, pipeline flow calculations, instrument design, flash and K-value calculations, and research problems of a non-recurring nature. It is also used for data processing, including special calculations, non-routine in nature, experimentation with data handling and processing procedures, business games, and statistical analysis.

Purdue University Computing Laboratory
Located at ENAD, W. Lafayette, Indiana, the system is used for undergraduate and graduate instruction and research. It is also used for student scheduling.

Photo by American Bosch Arma Corporation

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer
See Burroughs 205 for further details.

ARITHMETIC UNIT

Manufacturer
See Burroughs 205 for further details.

STORAGE

Manufacturer
See Burroughs 205 for further details.

U. S. Army OTAC
Magnetic Drum 4,000 words (Main); Magnetic Drum 80 words (High Speed Loops); Magnetic Tape 800,000 words.

U. S. Naval Air Test Center
Magnetic Drum 4,080 words; Magnetic Tape 400,000 words, 2 units.

USAF WADC
MD 4,080 words; MT 400,000 words/tape.

Arma
MD 4,080; MT 400,000.

Cal Res Corp
MD 4,080

Convair
MD 4,080 words; Magnetic tape can be construed as additional storage. Three tape transports are "on-line" with the system. Each 2500 ft reel of 3/4 inch

tape can have 10,000 blocks of 20 words-on each of two read/write heads (channels). Approx. 10000X20X2 = 400,000 words.

Dow Chemical

MD 4,080 words; MT 2,000,000 words. The average access time for 80 words of drum memory is 850 microseconds.

Great Lakes Pipe Line

MD 4,080; MT 3 units

Socony - Dallas

MD 4,080; MT 1,200,000 words, 3 units. Tape is addressable. Tape search for a specific location can occur simultaneously with computation. Maximum search time is approximately 7 minutes.

Socony - Paulsboro

MD 4,080 words; MT

United Gas

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum (Main)	4,000	44,000	8,500
Magnetic Drum (Loop)	80	800	850
Magnetic Tape	400,000	4,400,000	240 x 10^6
DataFile	2,000,000	22,000,000	240 x 10^4

4 high speed 20-word drum loops (mean random access 850 microseconds). 4,000 word intermediate-speed (3960 rpm) main drum memory. This system has two magnetic tape transports and one Data File.

Purdue

MD 4,080; MT 400,000/reel. If the entire tape is accessed on a random basis, the average access time will be 3.5 minutes.

Photo by California Research Corporation

INPUT

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

Media	Speed
Paper Tape	540 char/sec

Two independent photo electric readers are available for use, each may be called upon for read-in by machine programming.

U. S. Naval Air Test Station

Paper Tape	540 digits/sec
Keyboard	Manual
Magnetic Tape	6,000 digits/sec

USAF WADC

Media	Speed	
IBM Cards	200 cards/min	
	1,600 - 10 digit words/min	
Auxiliary Tape	400 words/sec	10 digit words
Paper Tape	540 char/sec	optical reader
Keyboard	Manual	
Specialized Inputs		
Low Speed Mag Tape	16 par/sec	on line
High Speed Mag Tape	400 par/sec	off line to Electrodata tape
Dots Converter Tape	70 par/sec	on line

Arma

Media	Speed	
Paper Tape	540 char/sec	Photoelectric reader
IBM Cards	100 cards/min	Via IBM Type 523
Flexowriter	10 char/sec	Commercial Control Equip

Cal Res Corp

IBM Cards	200 cards/min	7 or 8 words/card
Paper Tape	500 char/sec	50 words/sec

Convair

Punched Paper Tape	Max 520 char/sec	
Photoelectric reader		
IBM Cards	200 cards/min	IBM 528 Card Reader
Keyboard	Manual	

Magnetic tape can be used as input to the computer. (No off-line cards or paper tape to magnetic tape equipment).

Dow Chemical

Punched Cards	100 cards/min
Paper Tape	540 digits/sec
Magnetic Tape	2.5 millisec/word

Great Lakes Pipe Line

Cards (IBM 514)	100 cards/min
Paper Tape (Flexowriter)	20 dig/sec
Paper Tape Manual	600 dig/sec

Socony - Dallas

Paper Tape	540 digits/sec	Photoreader
Magnetic Tape	6,000 digits/sec	
Cards (IBM)	133 digits/sec	Use IBM 514
Keyboard	Manual	

Compatible magnetic tape prepared by off-line A→D converter.

Photo by Convair, Pomona, California

Socony - Paulsboro

Media	Speed	
Punched Cards	200 cards/min	IBM 528
Magnetic Tape	2,300 microsec/word	Searching, reading or writing

United Gas

Paper Tape (mechanical reader)	10 char/sec
Paper Tape (photo reader)	540 dig/sec
Keyboard	Manual
Cards (IBM 528)	266 dig/sec
Magnetic Tape	6,000 dig/sec

Input not buffered.

Purdue

Paper Tape	500 char/sec
Cards	200 cards/min

80 column card

OUTPUT

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

Media	Speed
High Speed Punch	60 char/sec
Flexowriter	10 char/sec
12 D-A Converters	
Digital Plotter	Off line

The off line Flexowriters are available for creating printed copy from high speed paper tape output.

The D-A Converters permit 12 channels of digital information to be presented as analog voltages. The principle use of the D-A Converter is for presenting input data to the analog computer.

U. S. N. Air Test Center

Media	Speed
Typewriter	10 char/sec
Paper Tape	60 char/sec
Magnetic Tape	6,000 char/sec

USAF WADC

IBM Cards	100 cards/min	800 - 10 dig words/min
Tabular	150 lines/min	1,200 - 10 dig words/min
Paper Tape	9 char/min	
Auxiliary Tape		Immediate process

Arma

On Line Printer	150 lines/min	IBM Type 407
Cards (IBM)	100 cards/min	IBM Type 523
Paper Tape	60 char/sec	Burroughs Equip
Flexowriter	10 char/sec	Commercial Controls Equip

Cal Res Corp

Flexowriter	10 char/sec
Paper Tape	60 char/sec
IBM Cards	100 cards/min
IBM 407 Printer	150 lines/min

7 or 8 words per card.

Convair

Paper Tape	60 char/sec	Teletype Punch
Cards	100 cards/min	IBM 528 Card Punch
Printer	150 lines/min	IBM 407 Line Printer
Flexowriter	10 char/sec	

Magnetic tape can be used as output from the computer. (No off-line cards or paper tape to magnetic tape equipment.)

Photo by Dow Chemical Company

Dow Chemical

Cards	100 cards/min
Printer	100 lines/min
Paper Tape Punch	60 digits/sec

Great Lakes Pipe Line

Cards (IBM 514)	100 cards/min
Flexowriter (typewriter)	20 digits/sec
Paper Tape (Flexowriter)	20 digits/sec

Socony - Dallas

Printed Page	200 dig/sec	Use on line IBM 407
Printed Page	10 dig/sec	On or off line Flexowriter
Paper Tape	10 dig/sec	Friden tape punch
Cards	133 dig/sec	Use IBM 514
Continuous Curve Plot	33-166 points/sec	Use D → A converter and high speed recorder
F.M. Analog Tape	250 samples/sec	Use D → A converter and computer controlled F.M. tape recorder

Socony - Paulsboro

Punched Cards	100 cards/min	IBM 528

United Gas

Typewriter	10 dig/sec
Paper Tape	20 dig/sec
Magnetic Tape	6,000 dig/sec
Cards (IBM 528)	135 dig/sec
Printer (IBM 407)	200 dig/sec

Output not buffered.

Purdue

Paper Tape	60 char/sec
Cards	100 cards/min 80 col. card
Typewriter (Flexowriter)	10 numeric char/sec
	5 alpha char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

See Burroughs 205 for further details.

CHECKING FEATURES

Manufacturer

See Burroughs 205 for further details.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

Power, computer	19.2 Kw	21.2 KVA	0.9 pf
Power, air cond	15.4 Kw	20.5 KVA	0.75 pf
Volume, computer		388	cu ft
Volume, air conditioner		188	cu ft
Area, computer		133	sq ft
Area, air conditioner		25	sq ft
Room size, computer		30	ft x 22 ft
Room size, air conditioner		4	ft x 15 ft
Floor loading		50	lbs/sq ft
Capacity, air conditioner		25	Tons
Weight, computer		7,295	lbs
Weight, air conditioner		2,596	lbs

Air conditioner: One 10-ton unit and one 15-ton unit. Raised floor to facilitate routing of electrical connectors. Installation of power distribution boxes, etc. Temperature and humidity control (air conditioning). Lighting and acoustic ceiling.

Photo by United Gas Corporation

U. S. N. Air Test Center

Power, computer	26.5	KVA
Power, air conditioner	9.7	Kw
Volume, computer	427	cu ft
Volume, air conditioner	142	cu ft
Area, computer	79	sq ft
Area, air conditioner	18	sq ft
Room size, computer	19	ft x 23 ft
Floor loading	130	lbs/sq ft
Capacity, air conditioner	10	Tons
Weight, computer	7,130	lbs
Weight, air conditioner	2,400	lbs

Computer housed on second floor with wiring ducted under floor (no ceiling under second floor). Motor generator installed outside of building. Air conditioner housed in off-set from computer room.

USAF WADC

Power, computer	20.39 Kw	22.66 KVA	0.9 pf
Power, air cond	13.19 Kw	12.65 KVA	0.9 pf
Volume, computer		615.32	cu ft
Volume, air conditioner		436	cu ft
Area, computer		124.43	sq ft
Area, air conditioner		72	sq ft
Room size, computer		18	x 30 x 14 ft
Room size, air conditioner		15	x 15 x 15 ft
Floor loading		102	lbs/sq ft
Capacity, air conditioner		15	Tons
Weight, computer		8,534	lbs
Weight, air conditioner		4,000	lbs

Insulation, sound-proofing, platform floor, boarded up outside windows, power in conduit under flooring. Temperature and humidity control.

Arma

Power, computer	35 KVA	0.8 pf
Power, air conditioner	29.8 Kw	
Volume, computer	11,106 cu ft	
Area, computer	473 sq ft	
Room size, computer	36 ft x 37 ft	
Floor loading	130 lbs concen max sq ft	
Capacity, air conditioner	40 Tons	
Weight, computer	17,650 lbs	

3/16 inch masonite base covered with Kentile flooring; false ceilings; wall partitions, fluorescent lighting, channels in floor for electrical connectors and cabling, steel superstructure for mounting air conditioning unit.

Cal Res Corp

Power, computer	20 KVA
Volume, computer	530 cu ft
Area, computer	102 sq ft
Room size, computer	20 ft x 35 ft
Floor loading	130 lbs/sq ft
	8,815 lbs concen max
Weight, computer	10,405 lbs

False floor 4 feet above regular floor to provide plenum chamber, cable ways, and at the same time to make floor level with adjacent offices. Entrance and exhaust air ducts installed. Motor generator set installed in basement. Building air conditioning system used.

Convair

Power, computer	37.5 KVA
Power, IBM 407 & 528	3.7 KVA
Power, air conditioner	19.8 KVA
Volume, computer	410.5 cu ft
Volume, IBM 407 & 528	100.0 cu ft
Volume, air conditioner	378.0 cu ft
Area, computer	78.5 sq ft
Area, IBM 407 & 528	25.0 sq ft
Area, air conditioner	54 sq ft
Eoom size, computer	800 sq ft
Floor loading	200 lbs/sq ft
	250 lbs/sq ft concen max
Capacity, air conditioner	14 Tons
Weight, computer	7,867 lbs (Exclud IBM Equip)
Weight, IBM 407 & 528	4,716 lbs
Weight, air conditioner	2,400 lbs

Trenches were cut in floor (concrete) for cables. Steel plates cover trenches. 2-10 ton air conditioning units to supplement main system were installed and ducting rerouted.

Dow Chemical

Power, computer	20 Kw	20 KVA	1.0 pf
Power, air cond	13.5 Kw	15 KVA	0.9 pf
Volume, computer		675 cu ft	
Volume, air conditioner		105 cu ft	
Area, computer		134 sq ft	
Area, air conditioner		15 sq ft	
Floor loading		20 lbs/sq ft	
		215 lbs concen max	
Capacity, air conditioner		15 Tons	
Weight, computer		13,000 lbs	
Weight, air conditioner		1,500 lbs	

Attic painted with fire resistant paint.

Socony - Dallas

Power, computer	35.0 KVA
Volume, computer	181 cu ft
Area, computer	37 sq ft
Room size, computer	870 sq ft
Floor loading	14.9 lbs/sq ft
	704 lbs concen max
Weight, computer	13,000 lbs

Computer room is 29 ft x 30 ft with acoustical treatment of ceiling and walls. Interconnecting cables suspended in trays beneath rubber tile covered concrete floor. Room has temperature and humidity controls. Power distribution made in accordance with manufacturer's recommendations. Air conditioner is main building system with special controls.

Socony - Paulsboro

Power, computer		46 KVA	0.90 pf
Power, air conditioner		10 KVA	0.85 pf
Volume, computer		540 cu ft	
Volume, air conditioner		105 cu ft	
Area, computer		95 sq ft	
Area, air conditioner		14 sq ft	
Room size, computer		24 ft x 20 ft	
Room size, air conditioner		5 ft x 12 ft	
Floor loading		90 lbs/sq ft	
		130 lbs concen max	
Capacity, air conditioner		10 Tons	
Weight, computer		8,700 lbs	
Weight, air conditioner		3,000 lbs	

No special site preparations.

United Gas

Power, computer	29 KVA
Volume, computer	181 cu ft
Volume, air conditioner	105 cu ft
Area, computer	28 sq ft
Area, air conditioner	15 sq ft
Room size, computer	24 x 31 ft
Room size, air conditioner	Not housed separately
Capacity, air conditioner	22 Tons
Weight, computer	4,000 lbs
Weight, air conditioner	2,800 lbs

Cable raceways were installed. Air conditioner is a ArkLa Servel DUT water chiller. Energy source - low pressure steam at 464 lbs/hr. Heat input 450K BTU per hour.

Purdue

Power, computer	22 Kw	23 KVA	0.957 pf
Power, air condit	10 Kw	11 KVA	0.91 pf
Volume, computer		560 cu ft	
Volume, air conditioner		72 cu ft	
Area, computer		80 sq ft	
Area, air conditioner		12 sq ft	
Room size, computer & A/C		760 sq ft	
Floor loading		600 lbs/sq ft	
Capacity, air conditioner		10 Tons	
Weight, computer		6,000 lbs	
Weight, air conditioner		1,000 lbs	

A trench was cut in the concrete floor for the connecting cables. All air conditioner ducting and power conduit was run exposed. Storm windows were installed.

PRODUCTION RECORD

Manufacturer

See Burroughs 205 for further details.

COST, PRICE AND RENTAL RATES

U. S. Army OTAC

The Burroughs 204 Computer, console, high-speed punch, photo electric reader, and Flexowriter cost $150,000.

The magnetic tape control and storage units cost $50,000; the floating point unit cost $21,000; the data plotter cost $9,000; and the tape perforator and verifier cost $4,000.

Maintenance (contractual and inhouse) cost $55,000 per year.

U. S. N. Air Test Center

1	204	Burroughs
1	402	Console
2	446	Typewriter Console
3	458	Modified Flexowriters
1	543	Tape Control
2	544	Data Readers
1	360	Floating Point Control
1	466	High Speed Tape Punch

Total cost is $227,000.
Maintenance cost is $17,800/year.

USAF WADC

Central computer, console, Flexowriter, and photo-tape reader cost $139,582.
The card converter and magnetic tape cost $74,670.
The IBM 407 and 528 rents at $12,466/year.
The IBM 519, 024, 523, and 031 rent at $5,292/yr.

Arma

The basic computer and power control unit cost $119,200.

8 Tape Units	Computer Console
1 Datafile	Code Converter
Floating Point	3 Flexowriters
Tape and Control Unit	2 Tape Preparation Units
Punch Card Converter	

Total cost of additional equipment is $232,000.
2 IBM Type 523 rent at $187/month, and 1 IBM Type 407 rents at $880/month.
$42,000/yr. full two shift coverage maintenance contract.

Cal Res Corp

The 204 Computer, card converter, console, typewriter, floating point unit cost $178,000.
Paper tape reader and punch cost $8,000.
On Burroughs equipment, the maintenance cost $1,010/month.

Convair

Basic System

Digital Computer No. 204	$119,200
Control Console No. 409	11,231
Typewriter Control Unit No. 446	4,560
Flexowriter No. 458	3,135
Keyboard and Reader No. 454	1,500
Total Cost	$139,626

Auxiliary & Additional Equipment

Magnetic Tape Control No. 543	$18,560
2 Magnetic Tape Storage No. 544	29,350
Miscellaneous additional equipment	20,740
Spares Kits	6,453
Digital to Analog Converter	4,950
Flexowriter	3,135
Plotting Board 11" x 17"	1,925
Floating Point Control Unit w/spares	19,528
Paper Tape Reader	600
Photo Reader Assembly	4,180
Total Cost	$109,421

Basic System

2	IBM No. 026 Printing Card Punch at $69.15	$138.30
1	IBM No. 063 Card to Tape Punch	99.00
1	IBM No. 082 Sorter	60.50
1	IBM No. 407 Alphabetic Accounting Machine	912.50
1	IBM No. 519 Document Originating Machine	295.00
1	IBM No. 528 Accumulating Reproducer	258.60
1	Burroughs/EDC No. 500 Card Converter	481.95
1	Burroughs/EDC No. 544 Magnetic Tape Storage	318.75
	Total Monthly Rental	$2,564.60

Additional Equipment

2	IBM No. 066/068 Card Transceiver	
	Total Monthly Rental	$429.00

Dow Chemical

The total basic system cost $242,775 and the rental is $7,702/month.
Do own maintenance and servicing.

Socony - Dallas

Model 204 Computer with power control, control console, photoreader, paper tape punch, Flexowriter, format control, magnetic tape control, 1 tape transport, keyboard cost $169,000.
Model 500 Punched Card Converter, floating point control, 2 tape transports, external switch and output selector purchased for approximately $68,200.
IBM 407 rental approximately $900/month. IBM 514 rental approximately $125/month.
Maintenance and modification performed by Secony Mobil.

Socony - Paulsboro

Burroughs 204, Model 500 Punched Card Converter cost $156,000.
Model 543 Tape Control, Model 544 Datareader, Model 360 Floating Point Control cost $58,000.
Model 544 Datareader rents for $4,500/year.
Maintenance, including parts, is $21,000/year.

United Gas

204 Computer	500 Punch Card Converter
406 Console	543 Tape Control
446 Typewriter Console	360 Fl. Point Control
458 Flexowriter	2-544 Datareaders
420 External Switch	1-560 DataFile

Total cost is $275,105.
The IBM 407, IBM 519, IBM 077, IBM 026, IBM 010, IBM 528, IBM 083, IBM 548, and IBM 056 rent at $2,000/month.

Purdue

The computer, console, typewriter control unit cost $139,000.
The 500 Card Converter, two tape transports and tape control unit cost $70,000.
Maintenance cost $17,000/year.

PERSONNEL REQUIREMENTS

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	5	5
Coders	-	1
Technicians	1	1

One additional technician is used for the second and third 8-hour shift. Production problem runs are performed during the second shift utilizing maintenance technicians whenever possible as input-output operators. The third shift is used for machine maintenance only.
Operation tends toward closed shop.
Methods of training used include on-the-job training and facility training courses in machine coding and programming.

U. S. N. Air Test Center

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	2
Programmers	8	8
Coders	3	3

The primary duty of those listed as programmers is the reduction of data from film and oscillograph records. These personnel are rated as mathematicians or mathematics aids. The programming they do is to a

large extent directly related to their assigned data reduction tasks. The training they receive in programming is that which is available from the computer manufacturer.

Operation tends toward open shop.

USAF WADC

	One 8-Hour Shift
Supervisors	1
Analysts, Programmers & Coders	6
Operators	1
Engineers	2
Technicians	2
In-Output Operators	1

Work 2nd shift approximately 1/4 of year. Split up personnel for this. Mostly production type work.

Operation tends toward closed shop.

Formal training provided by Burroughs and IBM and "on-the-job" experience.

Arma

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	1	2
Analysts, Program & Coders	12	14
Operators	2	2
In-Output Operators	1	2

Operation of this system is supplemented by an average of 30 hors/month IBM Type 704/709 time. Portion of personnel whose effort applies directly to this system varies from time to time. Above figures represent total personnel for all digital computer programming and operation.

Operation tends toward closed shop.

Methods of training used is in-plant training by senior personnel.

Cal Res Corp

	One 8-Hour Shift
Supervisors	1
Analysts, Programmers	3
Coders	3
Clerks	1
Operators	2

Above figures are about right for mature organization.

Operation tends toward closed shop.

Methods of training used are vendor training programs and on-the-job training.

Convair

	One 8-Hour Shift	Two 8-Hour Shift
Supervisors	1	
Analysts	8	
Programmers	8	
Coders	2	
Clerks	1	
Operators	1	1
Engineers	1	1
Technicians	1	1
In-Output Operators	1	1

Operation tends toward closed shop.

Methods of training used are self study and work experience with senior personnel.

Dow Chemical

	One 8-Hour Shift
Supervisors	1
Analysts	1
Clerks	1
Engineers	1

Operation tends toward open shop.

Methods of training used is on-the-job training.

Great Lakes Pipe Line

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	2
Operators	1

Operation tends toward open shop.

Methods of training used are manufacturer's training and internal on-the-job training.

Socony - Dallas

	One 8-Hour Shift
Supervisors	2
Analysts	7
Programmers	3
Technicians	5

The above entries must be taken with a grain of salt for two reasons:

We have never been organized under the usual class system. Supervisors are analysts, analysts program and operate the computer, operators program, and programmers operate.

With the above personnel we also use about 10 hours a week of 704 time in the Socony New York Computing Center.

Operation tends toward closed shop.

Methods of training used includes maintenance courses offered by manufacturer, programming courses offered within the group, and on-the-job training.

Socony - Paulsboro

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts, Prog. & Coders	Variable	
Clerks	3	3 or more
Operators	1	1
Technicians	1	1

Operation tends toward closed shop.

Methods of training used are on-the-job training, no formal classes.

United Gas

	One 9-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts & Programmers	2	4
Operators	3	3
Engineers	2	2

Operation tends toward open shop.

Methods of training used are on-the-job and informal classroom.

Purdue

	Three 8-Hour Shifts
Supervisors	1
Analysts, Programmers & Coders	7
Clerks	1
Operators	5
Engineers	1
Technicians	2

Operation tends toward open shop.

Methods of training used are lectures and labs.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

See Burroughs 205 for further details.

U. S. Army OTAC

Good time	90 Hours/Week (Average)
Attempted to run time	100 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.90

Above figures based on period 1 Jan 59 to 31 Dec 59
Passed Customer Acceptance Test Jul 56
Time is not available for rent to outside organizations.

U. S. N. Air Test Center
Figures based on period 1 Feb 56 to 31 Mar 60
Passed Customer Acceptance Test Jan 56
Operating experience is kept on a monthly basis.
The figures below are monthly averages:

Production	91.5 Hours
Program Check	44.1 Hours
Idle	15.7 Hours
Down	18.4 Hours
Demonstration	0.4 Hours

Time is available for rent to outside organizations.

USAF WADC

Good time	43.10 Hours/Week (Average)
Attempted to run time	45.34 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.951

Above figures based on period 1 Jan 58 to 1 Jan 60
Passed Customer Acceptance Test Jan 56
Time is not available for rent to outside organizations.

Arma

Good time	76 Hours/Week (Average)
Attempted to run time	80 Hours/Week (Average)
Operating ratio	0.95

Above figures based on period from Aug 59 to Aug 60
Passed Customer Acceptance Test Mar 57
Time is not available for rent to outside organizations.
2 shift operation.

Cal Res Corp

Average error-free running period	8 Days
Good time	38 Hours/Week (Average)
Attempted to run time	40 Hours/Week (Average)
Operating ratio	0.96

Above figures based on period from 56 to 60
Passed Customer Acceptance Test 16 Jul 56
Time is available for rent to qualified outside organizations.

Convair

Good time	81 Hours/Week (Average)
Attempted to run time	85 Hours/Week (Average)
Operating ratio	0.953

Above figures are based on period from Jan 59 to Jan 60
Passed Customer Acceptance Test Jan 56
Time is available for rent to qualified outside organizations.

Dow Chemical

Good time	33 Hours/Week (Average)
Attempted to run time	35 Hours/Week (Average)
Operating ratio	0.95

Above figures based on period from Feb 60 to Aug 60
Passed Customer Acceptance Test Feb 60
Time is not available for rent to outside organizations.

Great Lakes Pipe Line

Operating ratio	0.90

Above figure based on period from Jan 59 to Jun 60
Passed Customer Acceptance Test Oct 56
Time is not available for rent to outside organizations.

Socony - Dallas
Figures based on period from 15 Mar 55 to 31 Mar 60
System is operated on basis of all up or all down including input/output devices. System has been moved and has had extensive field modification. Entire system is checked out each day prior to use.
Records for system time are kept as follows:

Test routines (for system checkout)	601 Hours
Scheduled maintenance	1,882 Hours
Unscheduled maintenance	781 Hours
System modifications	1,158 Hours
Good operation	12,274 Hours

Time is not available for rent to outside organizations.

Socony - Paulsboro

Average error-free running period	2 Hours
Good time	30 Hours/Week (Average)
Attempted to run time	34 Hours/Week (Average)
Operating ratio	0.882

Above figures based on period from Jan 59 to Jan 60
Passed Customer Acceptance Test Dec 54
Time is not available for rent to outside organizations.

United Gas

Good time	47 Hours/Week (Average)
Attempted to run time	52 Hours/Week (Average)
Operating ratio	0.904

Above figures based on period 1 Jan 56 to 1 Aug 60
Passed Customer Acceptance Test Dec 55
Time is not available for rent to outside organizations.

Purdue

Average error-free running period	15 Hours
Good time	130 Hours/Week (Average)
Attempted to run time	140 Hours/Week (Average)
Operating ratio	0.93

Above figures based on period from Jun 59 to Apr 60
Passed Customer Acceptance Test Jan 55
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
See Burroughs 205 for further details.

U. S. Army OTAC
Outstanding features are ability to use the digital computer for data input to the analog computer and digital plotting board for direct off-line plotting of problem variables as required.
Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage include:
Programmers collectively maintain the necessary tape files. Special precautions are not exercised or required to protect tape files.

U. S. N. Air Test Center
Outstanding feature is the index register, decimal number system, capability of expansion of features, and floating and fixed point arithmetic.
Tape is used largely for storing programs and intermediate results of computation. Small quantities of tape are required. Tapes which will in the near future be prepared from automatic data gathering systems will be property of other groups and storage of tape reels will not be required.

USAF WADC
System is used for conversion of specialized tape inputs, for editing volume data and for computation as required by presentation form; conversion, editing and computation in one system.
Magnetic tapes are stored under temperature and humidity control, and are labeled and stored in a steel cabinet.

Arma
Magnetic tapes are identified by "stick-on" labels, stored in plastic containers, which in turn are stored in metal tape cabinets.

Convair
Outstanding features are alphabetic input via punched card converter; time clock (prints run time on paper tape); B + n modification (permits increasing index register by any number); and B1 → 4 and change control (makes the 4000 loop in memory as usable as the 7000 loops). A second paper tape reader

has been installed to monitor computer operation during unattended operation.

Tape handling:

Plastic cases for each reel of tape are used. The reels are then stored in a steel cabinet. The cabinet is in the computer room which is temperature and humidity controlled.

Socony - Dallas

Outstanding features are versatile input-output systems, an extensive command structure, on line curve output, F.M. analog magnetic tape output, and added commands.

United Gas

Unique system advantages are addressable magnetic tape blocks; modified logic to allow incrementing and decrementing of index register by integers in the range: 001 $\leq$ integer $\leq$ 1000; modified photo-reader logic to allow input from special magnetic tape reader; and modified Model 500 Punched Card Converter to permit 120 alphanumeric characters per line on IBM 407.

FUTURE PLANS

U. S. Army OTAC

Installation of necessary equipment to permit rapid reduction of analog tests data collected in the field and laboratories.

U. S. N. Air Test Center

Need increased printing speed; medium, but not high speed.

USAF WADC

Digital Computation Branch, now in control of this facility, will acquire an IBM 7090 Computer System and shift the computing now done on the Burroughs 204 to the new 7090 System. The 204 will then be surplused or used as a data converter, editor, and data handling facility.

Arma

No changes in this system are presently contemplated. Arma will continue to use this system, supplemented as required by additional time on the IBM Types 704, 709, 7090 Computers, purchased from subcontractors' facilities. At such time when the total cost of all digital computer operations becomes large enough to economically justify the acquisition of a large computer, Arma will acquire such a computer, and return the Burroughs system to the U. S. Air Force.

Convair

Anticipated modifications:

Provide capability for 8 level binary input/output.

New systems:

Data transmission to and from San Diego over leased telephone lines. Present IBM units will eventually be replaced by units capable of higher capacity (speed).

Socony - Paulsboro

Present plans are to dispose of the computer and transfer the present work load to a larger computer within the company, using an IBM transceiver with a 24-hour telephone line.

Purdue

The Sperry Rand Corporation will install a Univac Solid State 80 Computer with magnetic tape adjacent to our existing facility.

INSTALLATIONS

U. S. Army Ordnance Tank-Automotive Command
R & E Directorate, Research Division
Detroit Arsenal
Detroit 9, Michigan

U. S. Naval Air Test Center
Armament Test
Patuxent River, Maryland

U. S. A. F. Wright Air Development Center
Air Research and Development Command
Digital Computation Branch (WWDCD)
Wright-Patterson Air Force Base, Ohio

American Bosch Arma Corporation
Arma Division
Garden City, New York

California Research Corporation
527 Standard Avenue
Richmond, California

Convair
Division of General Dynamics Corporation
P. O. Box 1011
Pomona, California

The Dow Chemical Company
Texas Division, Plant A
Freeport, Texas

Great Lakes Pipe Line Company
P. O. Box 2239
Kansas City, Missouri

Socony Mobil Field Research Laboratory
Applied Mathematics Section
P. O. Box 900
Dallas 21, Texas

Socony Mobil Oil Company, Inc.
Research Department
Paulsboro Laboratory
Paulsboro, New Jersey

United Gas Corporation
Research Laboratory
P. O. Box 1407
8015 St. Vincents Avenue
Shreveport, Louisiana

Purdue University
Computing Laboratory
ENAD
W. Lafayette, Indiana

BURROUGHS 205

Burroughs Model 205 Electronic Data Processing System

MANUFACTURER

Burroughs Corporation

Photo by Burroughs Corporation

APPLICATIONS

Manufacturer

System is designed specifically to cope with the full range of electronic computing problems in the fields of business industry, science and government.

U. S. Army Ballistic Missile Agency

Five systems used for missile research and development.

Army Rocket and Guided Missile Agency

Located at the Test & Evaluation Lab, OML Division, Bldg. 7437, the system is used for data reduction and theoretical investigations.

U. S. Army Chemical Center

Mathematical research - chemical warfare (scientific)

U. S. Naval Shipyard, Boston

Hull deflection (elastic curve afloat), design division project control, hull deflection (in dry dock), plan status report, design division workload (conversions), head loss in fluid piping, prediction of compartment noise levels, gantt charting drawing schedules, vendors drawings and manuals status report, critical speed of rotors, voltage drop in circuits, vent duct sizing, shock mount calculations, tank capacity tables, shafting bearing reactions, pipe stress, design drawing control and scheduling, pipe system sizing, bearing wear down calculation, inventory, work load and payroll.

U. S. Navy Hydrographic Office

Located FOB No. 3, Room 1770, Computation Division, system is used for oceanographic computations for sea water density, sound velocity, specific volume and dynamic dept anomalies, stability and heat index, ice prediction and power spectrum analysis, bathythermograph analysis such as thermocline characteristics, average structure and classification, and navigational computations for such systems as Loran, Lorac, Rafos, Consolan, etc.

U. S. Navy Mine Defense Laboratory

Located at the U.S. Navy Mine Defense Laboratory, Panama City, Florida, system is used for scientific and engineering problems arising from research and development work in naval mine and torpedo warfare; statistical routines; warfare games; acoustic transmission; magnetic field computations; evaluation of navigation systems, etc. Some time is devoted to Laboratory accounting problems.

U. S. Naval Ordnance Laboratory

Located at the U.S. Naval Ordnance Laboratory, Corona, California, system is used for analysis of production and quality control of Navy missiles and missile systems, and for research, development, test and evaluation of Navy missiles and missile systems.

Photo by U. S. Army Chemical Center

U. S. Naval Radiological Defense Laboratory
System is used for scientific problems pertaining to fallout distribution, gamma ray penetration, ship shielding, etc.

U. S. Navy Underwater Sound Laboratory
Applications are scientific and engineering calculations and scientific data processing.

Griffiss AFB, N. Y.
Located at Griffiss AFB, N.Y. (Rome Air Development Center), system is used for statistical reporting and scientific problem solution.

Ames Research Center, NASA
Located at the Ames Research Center, NASA, Moffett Field, California, system is used for on-line wind-tunnel data reduction, off-line data reduction (wind-tunnel, flight, etc.) and scientific calculations (differential equations).

Allstate Insurance Co., Menlo Park, Sacramento, and Atlanta
Used for policy issuance and accounting relative to the policyholder. Policies are stored at random in the datafiles for policy issuance and accounting. Used also for consolidation of accounting and statistical work.

Aerospace Technical Intelligence Center
Located in Bldg. 828, Area A, WPAFB, Ohio, system is used for performance calculations for aircraft and and guided missiles.

Arthur D. Little, Inc.
Located at 35 Acorn Park, Cambridge, Massachusetts, system is used for payroll, labor cost distribution, billing, budget analysis reports, statistical survey analysis, inventory and production control simulations, pipe stress analysis, linear and dynamic programming development, ballistic missile trajectories, and multiple regression analysis techniques.

Atlantic Mutual Insurance Company
Located at 80 Pine Street, New York City, system is used for account checking, cargo billing, premium statistics, payroll cost allocation, budget experience, loss statistics, loss reserves, loss processing, premium billing, account analysis, premium reserve calculations, preparation of rating manual on non-bureau auto policy, and calculation on premium earned by state.

Babcock & Wilcox Research Center, Alliance
Used for experimental data reductions, product design, preliminary project analysis, and statistical evaluation of data.

Babcock & Wilcox Co., Lynchburg
System is located at 1201 Kemper Street, Lynchburg, Va. and is used for nuclear studies, (one dimension, criticality and lifetime calculations); thermal and fluid dynamics, (one and two dimensional heat dif-

Photo by the Boston Naval Shipyard

fusion, transient and steady state analysis of steam generator, heat exchanger, etc); data reduction, (experimental data corrected, normalized and correlated); kinetics, (integration of systems of differential equations) and miscellaneous, (shielding, structural, chemical, economic, statistical calculations).

Burroughs Corporation, Computer Facility
Located at 460 Sierra Madre Villa, Pasadena, California, the system is used for debugging of programs for manufacturer's customers, corporate data processing, and block time rentals to the public.

Celanese Chemical Company
Located at 520 Lawrence Street, Corpus Christi, Texas, the system is used for chemical process analysis, equipment design, sales analysis, inventory control, freight analysis, and accounting.

Citizen Gas and Coke Utility
Located at 2020 N. Meridan Street, Indianapolis, Indiana, the system is used for customer accounting operation, including billing, maintenance of accounts receivable, handling of cash, and all other items necessary in maintenance of customers accounts (160,000 accounts, payroll and materials control.

General Electric, Rome
Located in Rome, Georgia, the system is used for engineering design, drafting design, salary payroll, hourly payroll, general accounting reports, cost accounting reports, employee benefits, issuance of manufacturing paper, inventory control, and work station loading.

General Insurance Company of America
Located in Seattle, Washington, at 4347 Brooklyn, the system is used for rerating of automobile insurance policies, preparation of agents commission statements, preparation of sales and underwriting statistics, preparation of expense distributions, allied accounting reports, and analysis of claims experience.

International Telephone and Telegraph Laboratories
Located at 492 River Road, Nutley, New Jersey, the system is used for scientific studies such as missile trajectories, dynamic stability, miss distance, waveguide analysis, radar error analysis, quality control, vibration studies, communication networks, rocket design, etc.

Kaiser Steel Corporation
Located in Fontana, California, the system is used for accounting (departmental cost statements), stores (stock status, reorder notices), statistical analysis (various), and miscellaneous engineering and research studies.

Linde Company
Located at Tonawanda, New York, system is used for

Photo by the U. S. Naval Ordnance Laboratory, Corona

technical and scientific applications including thermodynamic properties and analysis, cryogenic engineering process and equipment design, structural design, processing of experimental data, and operations research.

Louis Allis Company
Located at 427 East Stewart Street, system is used for engineering designs of electrical motors and motor components, payroll, accounts receivable and payable, cost accounting, production control, and other commercial applications. 25% usage is engineering and 75% usage is commercial.

Minnesota Mutual Life Insurance Company
Located at 345 Cedar Street, St. Paul 1, Minnesota, the system is used for premium billing and accounting, calculating dividends, loan interest, handling, company reserves, mortgage loans, calculating payments and recording, supplementary contract calculations, group proposals, and some scientific analysis (projection on mortality studies). Most jobs require a master record and then a periodic updating.

Northern Natural Gas Company
Located in the main office building of the Northern Natural Gas Company at Omaha, the system is used for calculation of gas measurement through monthly delivery statements, payment for gas purchase including royalty interest payments, gas sales summaries for billing, sales statistics and analyses, sales forecasting, gas supply prorations, pipe line design, distribution network analysis, gathering system analysis, branch line calculations, and cost estimates.

Nuclear Development Corporation of America
Located at Eastview, N. Y., the computer is used for scientific computations of interest to the design of nuclear reactors. On occasion, problems arising in other fields are investigated. Little or no accounting work is done on this computer.

The Ohio Oil Company
Located at the Ohio Oil Company, Denver Research Center, Littleton, Colorado, the system is used to perform research on seismic interpretation methods, secondary recovery techniques, fundamental studies on fluid flow through porous media, reservoir analysis, geologic exploration methods, refinery simulation and optimization, development of refining and petro chemical processes, and new geophysical methods.

Pacific Power & Light Company
Located at Public Service Building, Portland, Oregon, the system is used for customer billing and accounting, payroll, stockholders, sales analyses, rate analyses, and engineering problems.

United States Steel Corporation
Located at the Research Center, Monroeville, Pennsylvania, the system is used for computations for statistical analysis, computations for operations research problems, simulation of processes, and design computations.

Western Electric Company, Inc. I
Located on the 1st Floor, 1600 Osgood Street, North Andover, Massachusetts, the system is used for pay-

roll and associated record keeping and reports, cost accounting, payments to suppliers, credit union, and scientific applications.

Western Electric Company, Inc. II

Located on the 1st Floor, 1600 Osgood Street, North Andover, Massachusetts, the system is used for production control, component assembly analysis and parts explosion, requirements forecasting, and storeroom inventory.

Westinghouse Research Laboratory

Located at the Westinghouse Research Laboratory, Pittsburgh 35, Pennsylvania, the system is used for scientific computation to solve research problems in fields of math, physics, metallurgy, mechanics, etc; simulation of special purpose control devices to imprive their design; statistical computations in connection with design of experiments, analysis of data, etc; and solution of problems in mathematical economics.

University of Nebraska

Located in Nebraska Hall at the University of Nebraska, Lincoln, Nebraska, applications include engineering mechanics, chemistry and chemical engineering, physics (cosmic rays, solid state, etc), and statistical analyses in the fields of Psychology, Sociology, Animal Genetics, Agronomy, Educational Psychology, etc.

Photo by the U. S. Navy Mine Defense Laboratory

University of Denver

Located in Conrad Hall, Denver Research Institute, the system is used for scientific and engineering problem solution and education.

University of Virginia

Located in the Physics Building, University of Virginia, the system is for general University use.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary coded decimal
Decimal digits/word	10 plus sign
Decimal digits/instruction	2 to 10
Instructions/word	1
Instructions decoded	83
Arithmetic system	Fixed and floating point
Instruction type	One address
Number range	Floating $10^{-51} \leq N \leq 10^{49}$
	Fixed $+(1-10^{-10})$ to $-(1-10^{-10})$

Instruction word format

S	1 2 3 4	5 6	7 8 9 0
±	Control Digits	Oper Code	Address

Photo by the U. S. Navy Radiological Defense Laboratory

Automatic built-in subroutines may include special order of table lookup command.

Automatic coding includes Data Code 1, a compiler; Star 0 Assembly Routine; SAC Assembly Routine; Purdue Compiler; Shell Symbolic Assembler; Tape Subroutine Compiler; Shell-Bell Interpreter, etc.

Registers and B-boxes

Registers in the Burroughs 205 consist of the A-Accumulator, capacity of 10 digits and sign which holds arithmetic operand and result. The R register, 10 digits, acts as an extension of the A register where necessary. D register, 10 digits and sign, acts as distributor for transfers to and from storage. C or Control Register, 10 digit register containing command currently being executed. B Register, a four digit register used for modification and tally. All registers act as temporary high speed storage for either arithmetic quantities or control.

ARITHMETIC UNIT

Manufacturer	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	1,019 or 1,188	
Mult	9,300 mean	8,450 mean
Div	12,680 mean	11,830 mean

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	4,080	40,800	850 (Quick)
Magnetic Tape	400,000	400,000,000	240,000,000
Datafile	2,000,000	20,000,000	24,000,000

Access time is for entire contents. Quick access loops store 80 words, (four 20-word loops). Access time can vary from 84 to 16,800 microseconds depending on position of drum at start of computer command. Datafile is two channel tape, 10,000 addressable blocks/channel, 20 words/block. Datafile gives random access search in either direction. Computation continues suring search.

Magnetic Tape

No. of units that can be connected	10 Units
No. of char/linear inch of tape	200 Char/inch
Channels or tracks on the tape	12 Tracks/tape
Blank tape separating each record	0.38 Inches
Tape speed	60 Inches/sec

Transfer rate	6,000 Char/sec
Start time	168 Millisec
Stop time	16 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	0.75 Inches
Length of reel	2,500 Feet
Composition	Plastic Base

Twelve channels are recorded across the width of the tape. Of the twelve, only six are read or recorded at one time. The six channels are called a lane. The six channels or one lane are interlaced with those of the other lane. Each of the two lanes has its own read-write head. 400,000 words are on each reel of magnetic tape.

The following installations utilize Magnetic Drum, Data File (Bin), and Magnetic Tape:

BNS	Burroughs
USNOL Corona	USS
Griffiss AFB	WRL
AIC	

Photo by General Electric Company, Rome, Georgia

The following installations utilize Magnetic Drum and Magnetic Tape:

USN MDL	ITT
USN USL	NDCA
NASA ARC	OOC
ATIC W-P	PP & LC
Little	WE
GICA	

The following installations utilize Magnetic Drum and Data File (Bin):

MMLIC	WE

The following installations utilize Magnetic Drum only:

ABMA	CGC
ARGMA	GE Rome, Ga.
USA CC	KSC
USN HO Washington	Linde
USN RDL	LA
AMIC	NNG
B & W Alliance	U of N
B & W Lynchburg	U of D
CCC	U of V

INPUT

Media	Manufacturer Speed
Paper Tape	540 digits/sec
Keyboard	Manual
Magnetic Tape	6,000 digits/sec
Cards	400 digits/sec each reader

Up to seven card readers per system may be used.

The following installations utilize Magnetic Tape, Paper Tape, Punched Cards and usually have a Manual Keyboard as input media (Paper Tape systems are high speed photo-electric readers):

ABMA	GE Rome, Ga.
BNS	GICA
USN HO Washington	NNG
USN USL	OOC
AIC	PP & LC
Little	WE System I
Burroughs	WE System II
CGC	

The following installations utilize High Speed Paper Tape, Punched Cards, and M l Keyboard:

USN MDL	Griffiss AFB	CCC	U of N
USNOL Corona	NASA ARC	KSC	
USN RDL	ATIC W-P	MMLIC	

Photo by the Linde Company

The following installations utilize Magnetic Tape and Punched Cards as input media:

AMIC

The following installations utilize Magnetic Tape and Paper Tape as input media:

NDCA	WRL

The following installations utilize Paper Tape as an input medium:

USA CC	USS
B & W Alliance	U of D
ITT	U of V
Linde	

The following installations utilize Punched Cards as an input medium:

B & W Lynchburg	LA

OUTPUT

Media	Manufacturer Speed
Electric Typewriter	10 char/sec
Punched Paper Tape	60 digits/sec
Magnetic Tape	6,000 digits/sec
Punched Cards	1,800 char/min
Printer	150 lines/min

Up to seven printers and/or punch card machines may be included per system. Figures are given for each unit. Units can be parallel for increased over all speeds. Printer is an IBM 407 Tabulator.

The following installations utilize Magnetic Tape, Paper Tape, Punched Cards and usually have an electric typewriter as output media:
ABMA (5)
BNS
USN HO Washington (plus printer)
USN MDL (plus printer)
USNOL Corona (plus printer)
USN USL (plus printer)
Griffiss AFB (plus printer)
NASA ARC
ATIC W-P
AIC (plus printer)
Little (plus printer)

Photo by the Minnesota Mutual Life Insurance Company

Burroughs (plus printer)
CGC (plus printer)
GE Rome, Ga. (plus printer)
GICA (plus printer)
NNG (plus printer)
OOC (plus printer)
PP & LC (plus printer)
WE System I (plus printer)
WE System II (plus printer)

The following installations utilize High Speed Paper Tape and Punched Cards:
USN RDL (plus printer)
CCC
KSC (plus printer)
MMLIC (plus printer)
U of N

The following installation utilizes Magnetic Tape, Punched Cards and a Printer as output media:
AMIC

The following installations utilize Magnetic Tape and Paper Tape as output media:
ITT
NDCA
USS
WRL

Photo by the Ohio Oil Company

The following installations utilize Paper Tape as an output medium:

B & W Alliance	U of D
Linde	U of V

The following installations utilize Punched Cards as an output medium:

B & W Lynchburg (plus IBM 402 Tab)
LA (plus printer)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Manufacturer Quantity
Tubes	Approx. 1,202
Diodes	Approx. 3,800

CHECKING FEATURES

Manufacturer

Fixed:

The Burroughs 205 automatically stops upon the appearance of an unanticipated overflow. An alarm light is turned on and computation is stopped by a forbidden combination (binary-coded decimal digit 10 thru 15) in the A, B, D, and R Registers, the Address Register, Control Counter, and Shift Counter. Inspection of the registers on the Control Panel indicates the failure location. An alarm stops the computer if the storage cell counted does not contain all zeros at the start of each drum revolution. This prevents information from being recorded on or read from incorrect locations on the drum. An audible alarm indicates excessive rise in exhaust air temperature in the computer cabinet. After a pre-set interval, up to 15 minutes, DC voltage will be shut off if the temperature stays at or above a predetermined level.

Optional:

The marginal voltage test panel facilities selective lowering of voltages in registers and control section, which, in conjunction with test routines, can detect marginal components before they give trouble in actual operation. Supervisory test panel on front of computer has extensive controls and check features, including access to any flip-flop for manual setting, substitution of manual or low frequency pulse operation for the drum clock, and a switch panel which allows maintenance personnel to force abnormal register behavior and to inhibit certain normal checking functions for diagnostic purposes. Contents of all registers are displayed simultaneously at all times.

Photo by the Pacific Power and Light Company

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer	
Power, computer	16.5 KVA
Volume, computer	181 cu ft
Area, computer	28 sq ft
Weight, computer	3,175 lbs

Special flooring is recommended for the Burroughs 205 System to handle the combined and individual weight of the units and to accommodate the inter-cabling. Since all units of the system are designed to have their cables enter from underneath their cabinets, raceways or ducts in the floor are recommended to accommodate the inter-cabling. There are three types of floors which have been found to be completely satisfactory: (1) raised floor, (2) existing floor with built in cable raceways, and (3) existing floors with cables underneath enclosed in metal conduit. The area should provide adequate lighting, some acoustical treatment, communication equipment, and convenience of access to the equipment. The power line should not be serving other heavy equipment which may generate excessive voltage fluctuation. Vibration from such heavy machinery in the vicinity of the system could shorten the life of certain sensitive components. There should be adequate space to accommodate the necessary refrigeration equipment, and the area should lend itself economically to complete air conditioning. Amount of air conditioning depends upon size of computer system installed. For every 12,000 BTU/hour generated by the system one ton of refrigeration is recommended. Environmental condition should also be taken into consideration. The floor load in the computing center can range from 175 to 200 lbs per sq ft and up to 250 per sq ft under the power supply unit. The site selected for the computing center must have a floor which can support the combined weight of the system as well as the localized weight at each leveling point on the units.

ABMA (5)			
Power, computer	31.5 Kw	45 KVA	0.7 pf
Volume, computer		11,200 cu ft	
Area, computer		700 sq ft	
Room size, computer		700 sq ft	
Capacity, air conditioner		15 Tons	
Weight, computer		18,370 lbs	

ARGMA	
Power, computer	22.7 Kw
Power, air conditioner	11.9 Kw

Photo by the United States Steel Corporation

Room size, computer	25 ft x 25 ft
Floor loading	92.75 lbs/sq ft
	822 lbs concen max
Capacity, air conditioner	15 Tons

Site modification consisted of additional transformer for power, raised floor (locally constructed), air conditioning mounted outside - piped in, and building is of concrete construction.

USA CC

Room size, computer	30 ft x 24 ft
Capacity, air conditioner	25 Tons

False floor

BNS

Power, computer	52.78 Kw
Room size, computer	70 ft 6 in x 22 ft 5 in
Capacity, air conditioner	60 Tons

Existing room for EDPM required new suspended acoustical metal ceiling w/new fluorescent lighting system, new air conditioning system, diffusers, air return registers, plenum system built above ceiling, new vinyl tile floor on existing concrete floor w/recessed conduit chases serving machines. Existing brick walls repainted, new office partitions and new masonry door openings and fire resistant doors installed.

Existing room for air conditioners required new interior partitions (movable), 2 new exterior double doors, repainting, new concrete floor slab and equipment pads, exposed duct system with exterior wall intakes and exhausts, and new lighting.

Power distribution: 400 ampere capacity, 120/208 volts, 3 phase, 4 wire.

USN HO Washington

Power, computer	14.7 KVA at 208V
	12.0 KVA at 115V
Room size, computer	42 ft x 30 ft x 11 ft
Room size, air conditioner	8 ft x 10 ft x 10 ft
	6 ft x 18 ft x 25 ft
Floor loading	175-200 lbs/sq ft
	250 lbs concen max

The site preparations required prior to installation of the Burroughs 205 were raised flooring, the building air conditioning system was "piped in" to the computer room and supplemented by an additional 7 1/2 ton unit; and necessary power lines were brought into the area. The building air conditioning system is 125 tons capacity. It is estimated that the computer realizes only about 1/5 of the available cooling.

Photo by the Westinghouse Research Laboratory, Pittsburgh

USN MDL

Power, computer	15 KVA at 208V
	1.5 KVA at 120V
Room size, computer	1,040 sq ft
Capacity, air conditioner	23.5 Tons

Air conditioning supplied from central system with additional capacity supplied in computer room. The building in which the computer is located is a fireproof, block, steel, and concrete structure. Room modifications were (1) one 208 power supply and 10 individual 120V supplies, (2) air conditioning ducts installed at the ceiling around 2 walls with 10 exhausts, (3) a false floor was constructed over one half the floor area raising the computer approximately 6 inches.

USNOL Corona

Power, computer	49.0 KVA
Power, on-line equipment	11.1 KVA
Room size, computer	132 1/2 ft x 28 1/2 ft x 10 ft
Room size, air conditioner	36 ft x 11 1/2 ft x 8 ft
	16 ft x 20 ft x 8 ft

Site preparations included a secondary floor to provide concealed power cable raceways and safety for operating personnel, an air conditioning system, including a small building for housing air compressors and condensing coils, and power distribution panels and conduit.

USN RDL

Power, computer	42 Kw	60 KVA	0.7 pf
Power, air condi	16.7 Kw	20.9 KVA	0.8 pf
Area, computer		135 sq ft	
Room size, computer		22 ft x 48 ft	
Capacity, air conditioner		15 Tons	

Unit installed in open area of existing building. Movable partitions, 15 ton air conditioner with duct distribution system, humidifier, power distribution system, and cable raceways were installed.

USN USL

Power, computer	30.4 KVA
Room size, computer	34 ft x 20 ft
Floor loading	125 lbs/sq ft
	2,000 lbs concen max
Capacity, air conditioner	20 Tons

Site preparation included shoring of floor to handle increased load, installation of air conditioning, and a separate power service.

NASA ARC

Area, computer	1,450 sq ft
Area, air conditioner	550 sq ft
Floor loading	260 lbs concen max
Capacity, air conditioner	50 Tons

Figures are for 2 systems in one room. The com-

puters are located on 2nd floor on 2 story concrete building. Power distribution and computer cabling is done through false ceiling of lower floor. As the computing facility expanded, it was necessary to install hoods on both main frames and vent the hot exhaust through the ceiling.

ATIC W-P

Power, computer	15 Kw
Power, air conditioner	10 Kw
Capacity, air conditioner	20 Tons

A false floor was constructed. Cool air is fed directly into the room.

Little

Power, computer	38.2 KVA
Power, air conditioner	5.0 KVA
Capacity, air conditioner	20 Tons

Installed on first floor of new building with waterproof raceways for power cables.

AMIC

Raised floor (plenum).

B & W Alliance

Power, computer	20.1 KVA
Room size, computer	25 ft x 22 ft
Floor loading	85 lbs/sq ft
	2,700 lbs concen max

Room was provided by using movable partitions, floor to ceiling. Floor was trenched for cables. Air conditioning system was installed with ducts above ceiling, supply plenum and return over computer, ceiling diffusers over other components. Separate transformer installed for isolated power source. Building stairs and floor were braced while moving computer into the building.

B & W Lynchburg

Power, computer	41.3 KVA
Room size, computer	700 sq ft
Capacity, air conditioner	15 Tons

False flooring and air conditioning were added.

Burroughs

Power, computer	50.3 Kw	55.9 KVA	0.90 pf
Floor loading		175-200 lbs/sq ft	
		250 lbs concen max	

False floor with normal air conditioning piped through floor and ceiling.

Photo by the University of Denver

CGC

Power, computer	50.2 KVA
Room size, computer	1,300 sq ft
Floor loading	110 lbs/sq ft
Capacity, air conditioner	36 Tons

An elevated floor (plenum for air to equipment), false ceiling (to provide return for air power separated from general building), and air conditioning chamber were added.

GE Rome, Ga.

Power, computer	56.4 KVA
Capacity, air conditioner	22.5 Tons Overhead hung

Installed concrete floor 4.5 inches over existing floor with ducts approximately 8 inches wide to accommodate cables. Installed 3 air conditioning units, 7.5 tons each. Installed one hunidity control unit.

GICA

Power, computer	36.6 KVA
Room size, computer	26 ft x 36 ft
Capacity, air conditioner	25 Tons

Raise floor, put in cable troughs. Drop ceiling. Enclose area in glass. Bring in 3 phase 230 power.

ITT

Power, computer	26.6 KVA
Room size, computer	20 ft x 30 ft
Capacity, air conditioner	22 1/2 Tons

200 amp 208V 3 phase line. Raised floor with movable segments. 15 tons of recirculating air conditioning (7 1/2 tons already in room provides all fresh air). Partitions separating computer, from programmers. Twelve foot display window.

KSC

Power, computer	23 KVA at 208V
	6 KVA at 115V
Capacity, air conditioner	18 Tons

Used existing 1,100 sq ft frame stucco building with concrete slab floor. Sealed all openings and installed 1 7 1/2 ton roof air conditioner. 1 7 1/2 ton interior upright air conditioner and 1 3 ton window-type air conditioner-all refrigeration. Brought in power from nearby heavy duty substation and installed transformer.

Linde

Power, computer	24.1 KVA
Room size, computer	32 ft x 16 ft
Capacity, air conditioner	10 Tons

LA

Capacity, air conditioner	75 Tons

When building was built, a special 6 ft thick waterproof, floating type foundation was installed. A motor-alternator was added for power constancy later. A separate power line is being considered. Special air conditioning facilities were designed.

MMLIC

Room size, computer	1,775 sq ft

False ceilings, raised vermicolite floor with built-in raceways, full air conditioning and power.

NNG

Power, computer	50 KVA
Room size, computer	30 ft x 48 ft
Capacity, air conditioner	25 Tons

Raised flooring (Bel Air) and new power supply line were added.

OOC

Power, computer	22.4 KVA
Capacity, air conditioner	15 Tons

Room designed and constructed to house computer. Room has poured concrete floor with crawl space beneath for cables, air conditioning ducts and motor generator set. Conditioned air is fed directly to main frame of computer and is exhausted into plenum chamber in ceiling. The chilled water air conditioning unit is in a location separate from the computer room.

PP & LC

Power, computer	76 KVA
Power, air conditioner	57 KVA
Room size, computer	30 ft x 52 ft
Room size, air conditioner	30 ft x 30 ft
Capacity, air conditioner	25 Ton Units (2)

Put in 4 inch raised floor to provide space for interconnecting cables, etc. Installed air conditioning. Put in separate power circuit to help assure constant voltage.

USS

Power, computer	24.2 KVA at 208V 5.7 KVA at 115V
Room size, computer	21 ft x 39 ft
Capacity, air conditioner	15 Tons 105,000 BTU/hr.

System installed in building recently erected to house this and other research facilities. All requirements for computer installation were handled during building design. False floor in computer laboratory serves as plenum for air conditioning system.

WE Systems I and II

Power, computer	49.0 KVA
Room size, computer	1,500 sq ft
Capacity, air conditioner	13.5 Tons used by computer

Figures are for each system. Site preparations included building type (basement section of office building - no modification to basic structure), ceiling (air conditioning input plenums installed in center with cool air entering through perforations, exhaust at periphery), and floor (8" raised floor with ramp to normal level - accommodates all power and component distribution cables) for each system.

WRL

Power, computer	28.8 Kw	32 KVA
Power, air condit	7.0 Kw	8.8 KVA
Room size, computer		30 ft 6 in x 21 ft x 9 ft
Capacity, air conditioner		15 Tons

Trenches were dug in the floor. MG set installed.

U of N

Power, computer	15 KVA
Capacity, air conditioner	11 1/2 Tons

False ceilings and cable raceways were installed. Building is of reinforced concrete.

U of D

Power, computer	21.5 KVA
Capacity, air conditioner	10 Tons

Reinforced floor, false floor (air conditioning), plenums (air conditioning), and separate power for computer were installed.

U of V

Power, computer	21.0 KVA
Capacity, air conditioner	12 Tons

Large area in basement of building was modified to accept the computer, offices, etc.

PRODUCTION RECORD

Manufacturer

Number in current operation	112
Time required for delivery	4 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Purchase Price	Monthly Rental
Computer, Model 205 Includes cabinet, plug-ins, and 4080 word magnetic drum memory with read-write heads. Also includes Magnetic Electronic Power Supply and Power Control Units.	$135,000	$3,900
Control Consoles Include decimal keyboard, displays of the computer registers, and computer controls. (Control Console Model 406 or 409 is required with a computer system that includes Cardatron.)		
Control Console, Model 406 Includes both a photo-electric reader and a high speed punch (60 characters per second).	14,210	490
Control Console, Model 409 Includes a photo-electric reader only.	11,230	362
Control Console, Model 403 The photo-electric reader and high-speed punch are not included.	7,050	230
Control Console, Model 402 Performs the same functions as the Model 406, except that the punch perforates paper tape at the rate of 20 characters per second.	13,270	423
Consolette, Model 405 Includes decimal keyboard, essential computer controls and indicators, but does not include displays of the computer registers.	1,980	70
Typewriter Control, Model 446 Usable with all consoles, the typewriter control includes the stand which supports the Flexowriter and contains external format control equipment and a relay translator.	4,560	137

	Purchase Price	Monthly Rental
Modified Flexowriter, Model 458 Incorporates the correct code for alphanumeric print-out under computer control; both a tape punch and a tape reader are attached to the Flexowriter. The tape reader may be used for a slow input to the computer.	$ 3,135	$ 95
Tape Perforator & Verifier, Model 454 Includes a decimal keyboard, tape perforator, and tape reader. Used to prepare, verify, or automatically duplicate numeric, perforated tape.	3,790	133
Numeric Code Converter, Model 460 Provides conversion, digit by digit, from one punched paper tape code to another. Includes a motorized tape reader, motorized tape punch, and two matrix cards (ElectroData to teletype and teletype to ElectroData code).	3,680	110
Matrix Cards for other codes	395 ea	15 ea
External Switching & Output Selector, Model 420 Permits the 500 Punched Card Converter to operate with either an IBM tabulator or summary punch as selcted by computer programming.	4,375	155
External Switching, Model 421 Provides selective switching to eight external sources as directed by the computer program, but does not include the output selector unit for use with the 550 Punched Card Converter.	2,890	105
Punched Card Converter, Model 500 Permits use, under computer control, of an IBM summary punch as input and an IBM tabulator or gang punch as output.	18,625	567
Cardatron, Model 506 Control Unit & Auxiliary Power Supply	31,000	770
Input Unit, Model 507	22,500	560
Output Unit, Model 508 (80 character)	26,300	660
Output Unit, Model 509 (120 character) (maximum number of input/output units: seven) Permits simultaneous high-speed communication between standard punched card machines and the 205 Computer. Alphabetic, special, and numeric characters may be intermixed in any manner.	27,550	690
Magnetic Tape Control, Model 547 Master control unit which provides electronic control for any combination of up to ten magnetic tape units and Datafiles.	28,000	875
Magnetic Tape Unit, Model 548 Reel-type magnetic tape storage, includes read-write heads and tape drive mechanism and operates under control of magnetic tape control.	13,500	425
Datafile, Model 560 Multiple magnetic tapes for data storage under control of the Magnetic Tape Control, Model 543 or 547. Includes drive mechanism for 50 lengths of tape (100 logical tapes), partitioned bin, and read-write heads. Tapes are brought out over guide rods and the two recording heads are servo positioned under the selected tape.	$ 25,000	$ 825
Floating Point Control, Model 360 Provides automatic floating-point arithmetic for the operations of addition, subtraction, multiplication, and division.	21,200	725

Burroughs Line Printer, Model 289
For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch	36,000	850
Two triple panel manual plugboards		
Five 2-position pilot selectors		
Eight 5-position co-selectors		
Five 4-position Cardatron selectors		
Two digit selectors		
Twenty symbol selectors		
One half-time emitter		
Ten filters		
Six carriage skipping channels and one overflow channel		
Pluggable zero and asterisk print control		
Optional Features:		
Group of five 2-position pilot selectors	250	10
Group of four 5-position co-selectors	200	5
Group of ten symbol selectors (maximum two groups)	600	15
Group of two digit selectors	200	10
Group of ten filters	70	3
Additional plugboard	100	

Burroughs Card Output Unit - Model 292
For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch	5,800	150
Six 5-position co-selectors		
Five 2-position Cardatron selectors		
One digit emitter		
One half-time emitter		
One single panel manual plugboard		
Optional Features:		
Double punch and blank column detection device (Group of 20-positions-maximum four groups)	740	16
Offset stacker	225	10
Additional plugboard	50	

Burroughs Card Input Unit, Model 293
For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch Five 2-position pilot selectors Eight 5-position co-selectors	14,000	300

Two digit selectors		
One half-time emitter		
One single panel manual plugboard		
Optional Features:		
Group of five 2-position pilot selectors	250	10
One additional digit selector	200	10
Additional plugboard	50	

All prices are subject to change without notice.

Outline of lease policy

Basic monthly rental entitles the customer to a maximum of one hundred and seventy-six (176) hours of use time during each calendar month. Use time of each system component in excess of one hundred and seventy-six (176) hours will be chargeable at the rate of forty percent of the hourly basic rental. The hourly basic rental is 1/176th of the basic monthly rental. Extra use charges will be computed to the nearest half hour.

Use time is defined as follows: "The time during which each component is in operation exclusive of preventive or remedial maintenance time. When components are inter-connected and programmed to operate as a system, all such components shall be deemed to be in use for the entire period when any part of the system is operating. Components which are not included in a given program will not have use time accumulated against them even though the components are inter-connected."

The rental rate is effective at or from the date installation of the equipment is complete and remains in effect thereafter until terminated by either party upon ninety (90) days written notice. The lease price includes personal property tax and insurance coverage on the machines; all additional taxes are paid by the lessee. Machines under lease may be purchased at any time at the prices in effect at the time such option less a credit of forty percent of all rental charges (excluding taxes) are paid on the actual equipment purchased, provided that such credit shall not exceed a maximum of sixty percent of the purchase price in effect.

The 88/60 Plan for Rental of Burroughs 205 Data Processing Systems

The reduced rental charges applicable to system orders under the provisions of this option will be sixty per cent of the basic monthly rental charges and will entitle the lessee to use the system up to eighty-eight hours per calender month. Use of the system in excess of eighty-eight hours per month shall be subject to an extra charge at an hourly additional use rate of one per cent of the regular monthly charge.

Use time is defined as the time during which the system or any components thereof is in operation, exclusive of preventive or remedial maintenance time: when system components are normally inter-connected the sum of the regular monthly charges for these components is to be taken as the regular monthly charge for the system in determining the hourly additional use rate.

The customer at his option may convert from the 88/60 rental plan to the normal one hundred and seventy-six hour rental plan. When this conversion is made the customer may not revert to 88/60. Use of the system for more than one hundred and twenty-eight hours per month would make it advantageous for him to convert.

Burroughs will provide the necessary parts and service to maintain the equipment in good operating condition as required during its regular business hours, eight a.m. to five p.m., Monday through Friday excluding holidays.

Burroughs 205 Data Processing System may be of any configuration, the 88/60 plan applies only to on-line equipment. The tape perforaterand verifier model 454, the numeric code converter model 460, and other similar equipment used off-line must be rented at normal monthly rental rates. The Burroughs input-output equipment, models 289, 292, and 293 are not offered at reduced rental. Custom engineering devices on which charge has been established must be rented at the full rental rates.

Debugging allowance for 88/60 is limited to twenty-hours of machine time.

Maintenance/Service Contracting

Burroughs will keep the machines in good operating condition. All costs of maintenance (except for ribbons and supplies) will be borne by contractor unless the required maintenance is due to the fault or negligence of the lessee.

Burroughs shall provide maintenance service during all periods of operation. Upon mutual agreement, contractor will assign "on site" service engineers.

The lessee will provide adequate storage space for spare parts, and adequate working space including heat, light, ventilation, electric current and outlets, for the use of the service engineers. These facilities will be within a reasonable distance of the machines to be serviced and will be provided at no cost to contractor.

Preventive (scheduled) maintenance for each machine will be furnished on a schedule which is mutually acceptable to the lessee and Burroughs and which is consistent with the operating requirements.

Burroughs will always be responsive to the maintenance requirements of the lessee. All remedial (unscheduled) maintenance will be performed promptly after notification to contractor's nearest service location that a machine is inoperative.

If contractor is unable to restore a machine to good operating condition and the machine remains inoperative for a continuous period of 24 hours during scheduled work days of the installation from the time the lessee notifies contractor that the machine is inoperative, and it is determined that (1) the machine became inoperative through no fault or negligence of the lessee, and (2) the lessee's production requirements were interfered with as a result of the machine breakdown, Burroughs will grant to the lessee a credit for each hour the machine was inoperative. Such credit shall be 1/176th of the monthly charge for the inoperative machine plus 1/176th of the monthly charge for an interconnected machine not usable as a result of the breakdown; provided, however, that the credit granted for each machine shall in no instance exceed 1/30th of the monthly charge for the machine in each 24 hour period.

Burroughs will use its best efforts to assist the lessee in procuring service on equipment compatible with that used by the lessee, to meet emergencies such as a major breakdown, conversion from one system to another, unforeseen peak loads, etc. The lessee, at its option, may accept or reject the offer of use of emergency equipment. If accepted, the cost of such services, if any, will be arranged on an individual installation basis.

Lessee shall not be responsible for loss or damage to the equipment caused by fire, lightning, sprinkler leakage, tornado and wind storm, hail, water damage, explosion, smoke and smudge, aircraft and motor vehicle damage, earthquake, collapse of buildings or structures and strikes, riots or civil commotion. Burroughs

Corporation shall provide transit insurance and comprehensive public liability insurance on the equipment.

Burroughs Corporation will furnish prescribed training of customer employees in programming and operating procedures and techniques. Additional services of a staff of qualified programmers, mathematical analysts and engineers to further improve specific utilization of the equipment may be contracted for.

A standard Burroughs Corporation sales or rental agreement will be executed at the time of sale or lease.

Except for expendable items, such as tubes, diodes, fuses, lamps, and neon indicators, all equipment is guaranteed for one year against defective material or workmanship.

ABMA

Rental for 205, 350, 351, 360, 406, 407, 466, 446, 2-458's, 454, 506, 352, 507, 509, 543, 3-544's is $9,470.00 per month.

ABMA

205, 350, 351, 360, 406, 407, 466, 458, 543, 544, 500, 544, 420, 421 rents at $7,537 per month.

ABMA

205, 350, 351, 360, 406, 407, 466, 446, 2-458's, 506, 352, 507, 509, 543, 3-544's rents at $9,647 per month.

ABMA

205, 350, 351, 352, 406, 407, 466, 446, 458, 506, 507, 509, 360, 543, 4-544's, 454 rents at $10,060/mo.

ARGMA

Burroughs	205	$135,000
	360	21,200
	500	18,625
	543	25,000
	544 (2)	24,000
	406	14,210
	420	4,375
	458	3,135
	446	4,560
IBM	528	$235/month
IBM	407	800/month

Maintenance contract with Burroughs in the amount of $20,000 per year.

USA CC

Computer	$3,900/month
Console	490/month
Flexowriter	95/month
Typewriter Control	137/month
Total	$4,622

BNS

Burroughs 205 Computer with Cardatron (1 in, 3 out), 6 magnetic tape units, tape bin file, paper tape reader and punch, Flexowriter, floating point - $12,740/month.

IBM Type 523, 087 and two 407's - $1,992/month.

USN HO Washington

$10,443/month - basic shift - Main frame, console, Flexowriter, 3 tape units, Cardatron input & output, IBM 089, IBM 407 and IBM 523.

USN MDL

Model	Description	Rental	Cost
205	Burroughs Digital Computer	$3,900	$135,000
406	Control Console	490	14,210
500	Punched Card Converter	567	18,625
446	Typewriter Control	137	4,560
458	Modified Flexowriter	95	3,135
454	Tape Perforator & Verifier	133	3,790
543	Magnetic Tape Control	750	25,000
544	Magnetic Tape Storage	375	12,000

Above equipment manufactured by Burroughs Corporation.

All following equipment manufactured by IBM Corp.

Model	Description	Rental	Cost
523	Card Summary Punch	$ 85	$4,300
407	Accounting Machine	800	42,000
010	Card Punch	10	600
024	Alphabetical Punch	40	1,950
026	Alpha Printing Punch	60	3,200
056	Alpha Verifier	50	2,400
077	Card Collator	115	5,500
082	Sorter	85	2,575
402	Accounting Machine	525	24,500
519	Document Originating Machine	251	6,550
552	Alphabetic Interpreter	108	5,500

USNOL Corona

Burroughs - $300,475.

IBM - $1,644.50 per month (on-line equipment)

IBM - $2,608.50 per month (off-line equipment)

Burroughs maintenance/service contracting is $57,404.33 per year.

USN USL

Burroughs Digital Computer Model 205, Control Console Model 406, Modified Flexowriter Model 458, Typewriter Control Model 446 costs $156,905.

Punched Card Converter Model 500, Magnetic Tape Control Model 543, Datareader Model 544, Floating Point Control Model 360, and Tape Perforator & Verifier costs a total of $92,615.

Burroughs Digital Computer Model 205, Control Console Model 406, Modified Flexowriter Model 458, Typewriter Control Model 446 rents for $4,622.

Punched Card Converter Model 500, Magnetic Tape Control Model 543, Datareader Model 544, Floating Point Control Model 360, and Tape Perforator & Verifier Model 454 rents for $2,925.

Griffiss AFB

Burroughs 205 System rents for $10,914/month.

IBM input, output equipment rents for $1,193/month.

Maintenance/service contract included with rental.

NASA ARC

System 107 - Main frame, console, punched card converter costs $120,000.

System 128 - Main frame, console, punched card converter costs $120,000.

System 107 - high speed punch - costs $5,000.

System 128 - magnetic tape, 2 drives, Cardatron (2 input, 1 output), high speed punches - costs $140,000.

Contract with Burroughs Corporation for maintenance on 2-shift basis costs $57,500 per annum.

ATIC W-P

Main frame, console, punched card converter, and 2 tapes cost $275,000.

4 extra tapes cost $62,000.

3 full time personnel contracted at $47,000 for maintenance.

Little

Computer, control console, typewriter control, and Flexowriter cost $156,905.

Cardatron (Card input & output, printer) $107,350

Magnetic tape control, 2 tape units 49,000

Peripheral IBM equipment (attached) 68,000

Computer, control console, typewriter control, and Flexowriter rents for $4,582.

Cardatron, magnetic tapes, and IBM equipment attached rents for $5,500.

Maintenance included in rental price. Service on purchased equipment - basic system - $867/month; additional equipment - $1,950/month.

B & W Lynchburg

205, 403, 500, 543, 544, (2) 360 cost $260,000.

Additional equipment are IBM 402, 514, 523, and 80.

205, 403, 500, 543, 544 (2) 360 rent for $6,500.

IBM 402, 514, 523, and 80 rent for $650.

CGC

1-205 Burroughs, 1-409 Console, 1-446 Typewriter Control, 1-458 Flexowriter, 1-543 Tape Control, 2-544 Datareaders, 1-560 Datafile, 1-506 Cardatron Control, 1-507 Cardatron Input, 1-509 Cardatron Output; purchase price $308,975 - lease $8,839 per month.

1-087 Collator, 1-407 Tabulator, 1-514 Reproducer, 1-082 Sorter, 3-026 Keypunch, and 2 NCR Add Punches cost $88,000.

Basic system rents for approximately $8,840 per month.

Other equipment rents for approximately $1,500 per month.

GE Rome, Ga.

Computer system, 4 tape transports, Cardatron System (1 input, 2 output), floating point, and tape control unit rents for $9,815/month.

GICA

Central computer (205), console with optical reader and tape punch, Flexowriter, typewriter control and power supply costs $156,905.

Cardatron System: Control, 2 input and 2 output; 2-523, 1-407, 1 tape control, and 4 tape storage units cost $240,500.

Rental rate for 2-089's and 1-407 is $1,280.

Maintenance/service contract is $32,000/year.

ITT

Computer, floating point, magnetic tape, 2 Flexowriters, punch, etc. rents for $7,400.

Maintenance is included in rental.

KSC

205 Computer, power supply, Cardatron, F. P. unit rents for $8,057/month.

Input-output IBM equipment rents for approximately $1,800/month.

Linde

$5,712 basic rental per month.

LA

Main frame, floating decimal, and Cardatron Input-Output rents for $6,085/month.

MMLIC

Power supply, computer, tape control, 7 tape units, card control, 1 card input, and 2 card output costs $356,000.

IBM 523, IBM 407, and IBM 089 rents for $60,000.

NNG

205 central processor with Cardatron (one input-two output), magnetic tape (3 units), and paper tape in and out rents for $8,300/month.

IBM 089, 523, and 407 rents for $1,200/month.

Maintenance contract is included in rental.

NDCA

Computer and 2 tape units cost approximately $200,000. Own maintenance is performed.

OOC

Computer, console and photoelectric reader, Flexowriter and control, automatic floating point unit, magnetic tape control unit, two tape transport units, power control unit, punched card converter and tape preparation unit cost approximately $230,000.

IBM 082 Card Sorter costs $650.

IBM 087 Collator, 402 Accounting Machine, 026 Printing Card Punch and 523 Summary Punch rents for approximately $650/month.

Own maintenance on computer is perfcrmed.

PP & LC

$313,000 for computer, including power supply unit; Input and Output Cardatron Control, 1 input, 2 output Cardatrons; Magnetic Tape Control and 6 Magnetic Tape Units; Flexowriter, Photoelectric punched paper tape reader; high speed paper tape punch,

$57,000 for maintenance equipment, parts and tools, magnetic tape, cabinets, files, shelves, furniture, etc.

IBM 407, 523, and 089 rent for $1,250/month.

Maintenance contract is $2,500/month.

USS

	Cost	Monthly Rental
Central Computer, power supply, power control, console, optical reader, tape punch, Flexowriter, Flexowriter format control, tape preparation unit	$164,905	$4,902
Magnetic tape control, tape transports (2), Datafile (1), floating point unit, Flexowriter, Flexowriter format control	102,895	3,282

Maintenance included in rental costs (resident service engineer).

WE System I

Basic System Component	Cost	Monthly Rental
Main Frame & Power Supply Unit	$135,000	$3,900
Console & Photo-electric Reader	14,210	362
Typewriter Output & Control	7,695	232
Total	$156,905	$4,494
Additional Equipment		
"Datafile" Magnetic Tape Unit	$ 25,000	$ 825
"Reel" Magnetic Tape Unit	13,500	1,700(4)
Magnetic Tape Control Unit	28,000	875
Floating Point Control Unit	21,200	725
"Cardatron" IBM Code Conversion Control Unit	31,000	770
"Cardatron" IBM Conversion Output Unit	26,300	1,380(2)
"Cardatron" IBM Code Conversion Input Unit	22,500	560
IBM 089 Collator (Input)	13,200	228
IBM 523 Punch (Output)	4,300	121
IBM 407 Printer (Output)	48,000	913
Total	$233,000	$8,097

"Reel" Magnetic Tape Unit cost $425 each; and "Cardatron" IBM Code Conversion Output Unit cost $690 each.

Second unit is the same except it does not include the floating point control unit.

WRL

Central computer, power control, motor generator, control console, with photoreader and high speed punch, Flexowriter and control costs $157,000. Floating point unit, two magnetic tape units, 1 Datafile, magnetic tape control, 2nd Flexowriter, paper tape preparation unit costs $106,000.

U of N

Burroughs 205, punch card converter, console and high-speed punch, typewriter control, two Flexowriters, oscilloscope, test equipment, etc. cost $185,000. IBM 528, 024, and 056 rents for about $3,000/year. $957 is the monthly charge by Burroughs Corporation for maintenance.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Analysts	3	3	3
Programmers	4	4	4
Librarians	1	1	1
Operators	2	3	4
Engineers	1	2	3

The contractor, without cost to the lessee, will train an adequate number of operating and programming personnel including the initial staff and replacements at the contractor's training locations or, if mutually agreed to at a lessee location. The contractor's technical personnel shall be available to the lessee for assistance in the implementation, review and improvement of existing data processing systems and for the programming, development and implementation of new systems involving the contractor's equipment.

ABMA

	One 8-Hour Shift
Supervisors	3
Programmers	7
Operators	1

ARGMA

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	5	7
Operators	1	1
Technicians	1	1

Operation tends toward open shop.

USA CC

	One 8-Hour Shift
Supervisors	1
Analysts-Programmers	4
Coders	7
Operators	1
Engineers	1 Burroughs

Operation tends toward open shop.

Method of training used is formal course held at installation.

BNS

	One 8-Hour Shift	
	Used	Recommended
Supervisors	2	2
Analysts	1	1
Programmers & Coders	11	11

Operation tends toward open shop.

Methods of training used includes manufacturer's courses and on-the-job training.

USN HO Washington

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	3	5
Analysts		4
Programmers	8	9
Clerks	1	1
Operators	3	4

Operation tends toward closed shop (limited open shop).

Methods of training used include on-the-job training and manufacturer courses in programming.

USN MDL

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	1	2
Analysts	3	4
Programmers	4	6
Operators	3	4
Engineers	1	1
Technicians	1	1
In-Output Oper	2	2

Operation tends toward closed shop.

Training has been accomplished by company representatives holding two-week training sessions at this installation. This basic training by close supervision and guidance until experience is gained.

USNOL Corona

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Operators	7	7
Engineers	3	3

Operation tends toward closed shop.

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

USN RDL

	Two 8-Hour Shifts
Supervisors	1
Programmers	7

USN USL

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	2	4
Programmers	2	4
Operators	1	1

Operation tends toward closed shop.

NASA ARC

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	Used	Rec	Used	Rec	Used	Rec
Supervisors	2	2	2	2	2	2
Analysts	1	1	1	1	1	1
Programmers	6	6	6	8	7	9
Librarians	0	1	0	1	0	1
Operators	1	2	2	3	3	4
Engineers	1	1	2	2	2	2

Operation tends toward closed shop.

Preinstallation training of two engineers and two programmers at computer factory. Subsequent training of programmers and operators has been on-the-job.

ATIC W-P

	One 8-Hour Shift
Supervisors	3
Analysts	4
Programmers	5
Coders	1
Clerks	1
Librarians	2
Operators	3
Engineers	4
In-Output Oper	2

Operation tends toward open shop.

Little

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

Operation tends toward open shop.

Courses held periodically on premises on machine language programming, assembly and interpretive programs available. In many instances, staff learns programming techniques by home study. Lab personnel supervise actual training on computer, usually 2-3 hours training required.

ADL is an industrial research consulting firm. Per-

sonnel include mathematicians, physicists, chemists, statisticians, engineers, economists, etc. Since they all work for different clients over a period of months, the problems to be solved vary greatly.

The role of the Computing Lab is to provide a facility for out professional staff for the solution of client problems or research projects and to process all internal accounting information. The wide variety of problems to be solved dictated the necessity of training certain members of each division in the company in computer programming and though their work is primarily in their own specialized fields, they also act as computer consultants when the situation arises. Consequently, there are approximately 40 employees scattered throughout the company with programming experience, not only on our computer but other faster and more versatile ones. When a problem arises in their area, they do the analysis, programming and actual debugging work. Most of the problems solved are one-shot programs either simulating data processing problems such as inventory control, production scheduling, etc., or experimental engineering calculations.

The Lab staff mentioned above is primarily involved in operating and editing accounting programs, training personnel and programming small jobs for members of the staff.

AMIC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	5
Clerks	1	1
Operators	1	1
Engineers	1	1
In-Output Oper	1	1

Operation tends toward open shop.

B & W Alliance

	One 8-Hour Shift
Programmers	1
Coders	1
Clerks	1
Operators	1

Operation tends toward open shop.

B & W Lynchburg

	Two 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	-
Programmers	10	-
Coders	8	-
Clerks	1	-
Operators	2	2
Engineers	2	2
In-Output Oper	2	2

Operation tends toward open shop.

Need varies with programming load not machine usage.

One day course in DUMBO autoprogramming system for open shop users. On-the-job training for programmers, coders, (hand computers), and operators.

Burroughs

Since the computer is on the premises of one of the manufacturer's (Burroughs) plants, there is a section responsible for the activities of the three systems within the computer facilities. The three systems are the Burroughs 205, Burroughs 220, and Burroughs E101. The computer facility consists of the manager, two computer specialists, one operator, and one scheduler. With the exception of the operator who is on swing shift, the rest of the staff is on prime shift.

There are two engineers on duty from 0600 - 1500 hours for the 205. There is an engineer on standby from 0000 - 0900 hours for all systems in the plant. Other hours are covered by 15 minutes on-call engineers. The aforementioned staff is adequate for good system reliability.

CCC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	3	3
Programmers	5	5
Operators	1	1
Engineers	1	1

Operation tends toward closed shop.

Methods of training used includes two weeks schooling and on-the-job training.

CGC

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	3
Operators	1	1
Engineers	2	2

Methods of training used include programmer analyst-manufacturer's school and on-the-job training. Operators - on-the-job training and schools on peripheral equipment.

GE Rome, Ga.

	Two 8-Hour Shifts
Supervisors	3
Programmers	17
Coders	3
Clerks	1
Operators	2

Operation tends toward open shop.

Methods of training used include on-the-job training plus assignment of problems to programmers.

GICA

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	2	2
Analysts, Programmers & Coders	7	7
Operators	3	3
Engineers	3	3

One supervisor for Operations group and one supervisor for Programming group. Programmers combine functions of analysts, programmers and coders. Five programmers are adequate for 205 programming load - additional 2 used in researching new equipment, methods, etc.

ITT

	One 8-Hour Shift
Supervisors	2
Analysts	1
Programmers	5
Clerks	1
Engineers	1

Operation tends toward closed shop.

Training offered by computer manufacturer. Open courses in compiler programming. More recently we have trained our own programmers.

All programmers have degrees in Mathematics, Physics, Engineering, or Statistics. Open shop load is significant and is being encouraged.

KSC

	One 8-Hour Shift
Supervisors	1
Programmers	7
Operators	1

Operation tends toward closed shop.

Methods of training used include manufacturer's course followed by on-the-job training.

Linde

	One 8-Hour Shift
Supervisors	1
Analysts/Programmers	20
Coders	2
Clerks	1
Librarians	1
Engineers	1

Analysts and programmers consist of chemical, mechanical, electrical engineers and mathematicians.

A Burroughs maintenance engineer is assigned to the Linde installation. One operator is assigned to the second shift.

Coding instructions are given by Burroughs personnel and on-the-job training given by Linde's own senior personnel.

LA

	One 8-Hour Shift
Supervisors	2
Analysts	2
Programmers	2
Operators	2
Engineers	1

Methods of training used includes Burroughs schools, on-site training and on-the-job training.

MMLIC

	Three 8-Hour Shifts
Supervisors	3
Analysts, Programmers & Coders	3
Clerks, Librarians & Operators	4
Engineers	2
In-Output Oper	2

Operation tends toward closed shop.

Methods of training used includes manufacturer's courses and company held courses. Also on-the-job training.

NNG

	Two 8-Hour Shifts
Supervisors	2
Analysts	1
Programmers	10
Operators	4

NDCA

	Three 8-Hour Shifts	
	Used	Recommended
Sypervisors	1	1
Analysts	3	3
Programmers & Coders	4	4
Clerks	0	1
Operators	2	3
Engineers	1	1

Operation tends toward open shop.

Methods of training used includes on-the-job training. No formal lectures are given.

OOC

	One 8-Hour Shift
Supervisors	1
Programmers, Analysts, Coders, Librarians, & Operators	6
Engineers	2
Technicians	1

Operation tends toward open shop.

A comprehensive two-week course in programming and computer operation is offered annually (semi-annually when demand warrants) by the supervisor. The 2nd and 3rd 8-hour shifts run unattended.

PP & LC

	One 8-Hour Shift
Supervisors	1
Analysts	14
Technicians	2

Two operators are used on 2nd 8-hour shift.

Operation tends toward open shop.

Methods of training used includes course in programming and on-the-job training.

USS

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	4	5
Coders	1	2
Clerks	1	2
Operators	1	2
Engineers	1	1

Operation tends toward closed shop.

Methods of training used includes manufacturer's courses and on-the-job training.

WE System I and II

	Two 8-Hour Shifts
Supervisors	2
Analysts	6
Programmers	2
Clerks	2
Operators	4

These personnel apply to two (2) computer systems each operated for two 8-hour shifts.

Operation tends toward closed shop.

Programmers and coders are given 2-4 weeks programming school and operators are given 1 week programming school and on-the-job training.

WRL

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	3	3
Programmers	2	3
Coders	3	3
Clerks & Tape Handlers	1	1
Technicians	2	

The two technicians recommended for maintenance are needed only part time. It is necessary to have two, however, so that one man is always available.

Operation tends toward closed shop.

Method of training used is informal "courses" taught by experienced personnel.

U of N

The initial staff personnel is a Director, (half-time appointment; the other half of his time will be given to the Dept. of Mathematics where he will teach appropriate courses.) a maintenance engineer, a secretary-programmer, and two graduate assistants.

Operation tends toward open shop.

Methods of training used includes demonstrations, seminars, courses on computers and on numerical analysis.

U of D

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	1/2	1
Analysts/Programmers	3/4	4
Clerks	2	3
Technicians	1	1 1/2

Operation tends toward open shop.

Methods of training used include University courses given in Mathematic Dept., in-house by experienced personnel, and by Burroughs representatives.

U of V

Operation tends toward open shop.

Methods of training includes programming courses given by staff of center as the need arises.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

ABMA
Good time 18.8 Hours/Week (Average)
Attempted to run time 19.1 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.984

ABMA
Good time 31.5 Hours/Week (Average)
Attempted to run time 31.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 1.0

ABMA
Good time 34.5 Hours/Week (Average)
Attempted to run time 35.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.985
Above figures based on period 1 Jan 60 to 31 Mar 60

ABMA
Good time 34.1 Hours/Week (Average)
Attempted to run time 34.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.988
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 1 Jan 59

ABMA
Good time 30.7 Hours/Week (Average)
Attempted to run time 31.0 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test 1 Sep 58

ARGMA
Good time 60 Hours/Week (Average)
Attempted to run time 63 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Sep 58 to May 60
Passed Customer Acceptance Test Jul 58
Time is available for rent to qualified outside organizations.

USA CC
Average error-free running period Two Weeks
Good time 47 Hours/Week (Average)
Attempted to run time 48 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period 1 Mar 60 to 31 Mar 60
Passed Customer Acceptance Test Jun 58
Time is not available for rent to outside organizations.

BNS
Good time 88.3 Hours/Week (Average)
Attempted to run time 93.6 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.943
Above figures based on period 1 Feb 60 to 31 Jul 60
Passed Customer Acceptance Test 15 Sep 58
Time is available for rent to qualified outside organizations.

A limited amount of engineering work is performed for other Naval activities. Time is not available to commercial organizations.

USN HO Washington
Good time 64 Hours/Week (Average)
Attempted to run time 78 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.82
Above figures based on period 1 Oct 59 to 31 Dec 59
Passed Customer Acceptance Test Jul 56
Time is not available for rent to outside organizations.

The down-time includes not only machine failure but down-time due to air conditioning, electrical power, etc.

USN MDL
Average error-free running period 6 Hour (Average)
Good time 86 Hours/Week (Average)
Attempted to run time 93 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.92
Above figures based on period 1 Apr 60 to 1 Aug 60
Passed Customer Acceptance Test Aug 57
Time is not available for rent to outside organizations.

USNOL Corona
Good time 126 Hours/Week (Average)
Attempted to run time 140 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 1 Jan 59 to 31 Dec 59
Passed Customer Acceptance Test 28 Mar 58
Time is not available for rent to outside organizations.

USN RDL
100, 105, 0.95, 1 Jan 60 to 30 Jun 60, 19 May 58, is not, respectively as above.

USN USL
77, 80, 0.9625, 1 Apr 58 to present time, 1 Apr 58, is not, respectively as above.

Griffiss AFB
39, 40, 0.975, 1 Apr 59 to 1 Apr 60, Jan 58, respectively as above.

NASA ARC
System 107 - 43.8, 46.7, 0.94, 1 Jan 59 to 31 Dec 59, Apr 55, is not; System 128 - 49.5, 52.5, 0.94, 1 Jan 59 to 31 Dec 59, Apr 56, is not.

About 15 percent of the total "on time" on System 107 and about 17 percent on System 128 is scheduled preventative maintenance.

ATIC W-P
100, 110, 0.91, Jul 58 to Mar 60, Jul 58, is not.

AIC
Three systems are operated on a two shift basis. They average 25% maintenance.

Little
42, 48, 0.875, Sep 59 to Mar 60, Feb 58, is available.

We have experienced good operation on the basic computer. Main difficulties occur on card input and output and magnetic tape. Tape systems at first were very unreliable, caused by weak read and write signals abd bad tape. Modifications of tape units in past year as well as introduction of sandwich mylar tape has greatly improved the reliability of tape system. Card input and output, because of inability to check input and output, are main areas of failure now.

B & W Alliance
32 hrs/week available, 1 hr/week unscheduled down time, 0.96, 11 Feb 60 to 1 Aug 60, 11 Feb 60, is.

B & W Lynchburg
50, 51.5, 0.97, Spring 56 to present, Apr 56, is not.

Burroughs
59, 60, 0.983, Jan 60 to Jul 60, Jun 56, is.

CCC
47.3, 49.5, 0.96, Aug 58 to Jul 60, 1 Feb 58, is available to qualified.

GE Rome, Ga.
78, 89, 0.876, Apr 60 to Aug 60, Nov 57, is not.
Good time is total time less down time less any rerun time.

GICA
78, 86, 0.907, L Jan 60 to 18 Apr 60, Feb 56, is not.
On occasion we have made computer available at no charge. In theory we have built up credit hours on another computer but have not used them.

ITT
30+, approx. 0.95, Feb 59 to Jun 60, Feb 59, is.

KSC
15 (Good time), 1 Jul 59 (Passed Customer Acceptance Test), is not.

Linde
60, 0.98, Dec 58 to present, 18 Dec 59, is not.

LA
Time is available. Experience in the past year has averaged about 90% availability. This is considerably

higher than the first two years.

MMLIC

137.5, 142, 0.968, 18 Aug 57 to 14 Aug 60, 18 Aug 57, is not.

NNG

66, 72, 0.92, 1 Jan 60 to 1 Aug 60, 17 May 57, is not.

NDCA

100, 120, 0.80, 1 Aug 59 to 1 Aug 60, Jul 56, is.

OOC

100, 102.7 0.974, Jan 59 to Jan 60, Jul 57, is not. The high reliability of our computer installation is attributed to the daily two hour preventive maintenance schedule maintained by our engineers.

PP & LC

93, 93, 1.0, 1 Apr 60 to 31 Jul 60, Spe 57, is not. Requirements averaged 93 hours of work to be done and it was done. We had an average of 3.7 hours lost time per week from all causes, including material trouble and accessory IBM machine troubles. Scheduled maintenance averaged 11.2 hours per week.

USS

36, 40, 0.90, 1 Jan 60 to 15 Apr 60, 22 Dec 59, is not.

WE System I

12, 71.0, 76.4, 0.93, 1 Jun 60 to 30 Jun 60, 1 Nov 58, is not.

WE System II

14, 67.4, 77.0, 0.88, 1 Jun 60 to 30 Jun 60, 1 Jan 59, is not.

WRL

40, 40+, 0.96, 1 Sep 56 to present, 1 Sep 56, is not.

U of D

4-5 months, 70, 70, 0.999, Jan 59 to Dec 59, 15 Jul 58, is available at $40.00 per hour.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The automatic address-modification features of the B-register along with its automatic tally. Automatic editing provided by the format bands on Cardatron buffer drums, as well as freeing of the central computer as soon as information is transferred. This allows input, output, and processing simultaneously while card machines operate at a maximum rate. Independent search for permanently addressed blocks on magnetic tape, which allows processing of results of previous search while current search is going on. Ability to read from magnetic tape, update information, and write back on the same tape in the same position. Provision of high speed through quick-access loops, which allows straightforward sequential coding and does not require complicated placements of instructions or data for minimal access.

The Burroughs Card Input Unit, Model 293, with a reading rate of 300 cards per minute is now available for use with the Burroughs 205 Cardatron. Also available is the Burroughs Card Output Unit (Model 292), which operates at 100 cards per minute, either reading or punching, and the Burroughs Line Printer, Model 289, which operates at the rate of 150 lines per minute. Editing features of the Cardatron system are complemented by the use of this Cardatron Input/Output Equipment.

Required storage environment for magnetic tape includes temperature 60 degrees to 80 degrees; relative humidity 40% to 60%; magnetic fields, not to exceed three oersteds; radiation, where radiation is not dangerous to people; dust proof containers; reels placed in plastic containers and stored on edge of container in a vertical position; must be rewound on a 205 Tape Storage Unit. Minimum storage life, one year when stored as outlined above.

BNS

Unique system advantages include the Cardatron System and Magnetic Tape Bin File.

Tapes retained in computer room in plastic cases, numbered with 3x5" card index of usage and condition. Computer system is supplemented by 10,000 point EAM (IBM) installation, run on a two-shift basis.

USN HO Washington

The 205 is extensively buffered by the Cardatron system for both input and output. The 205 provides several input-output media, i.e. punched card, punched paper tape, magnetic tape (in & out) plus printed tabulations (out).

Duplicates of all data tapes are filed in a building other than the computer building; all data tapes (originals and duplicates) are stored in areas with temperature and humidity control.

USN MDL

Each magnetic tape reel is assigned a number. Card files are kept on these numbers, recording the entire history of each tape. Tapes are individually packages in hard plastic dust-free containers. Containers are stored in steel storage cabinets. Humidity and temperature are automatically controlled in accordance with the specifications set forth by the magnetic tape supplier.

USNOL Corona

Outstanding features include ease of programming in machine language.

Little

Outstanding features include programmed editing of card input and output and "on-line" printer without using different plugboards, and addressable magnetic tapes.

Tapes on precision reels, stored in plastic, air-tight containers in cabinets in computer room.

AMIC

Outstanding features include input, output buffering, and input, output editing.

Identifying code is put on tape, on box, in book and filed in same air control as computer in box.

B & W Lynchburg

Copies of important tapes are kept in fireproof vault. Working tapes are kept in computer room under standard condition of temperature and humidity.

Burroughs

Outstanding features include buffered search operation on fixed address and length records in the magnetic tape system. High speed memory loops for minimum latency. The use of a Datafile greatly enhances the use of an operating system. Excellent programming systems are available such as: Shell Assembler, FORTRANSIT Algebraic Compiler, and ALGOL 58 Algebraic Compiler.

GE Rome, Ga.

Reels of tape numbered and assigned by number and card indexed. Storage in Remington Rand Tape Cabinets. Humidity control 20% - 60%. Duplicate records maintained in another building.

GICA

Store critical tapes in fire resistant vault. All other tapes stored in plastic reel cans in temperature and humidity controlled room.

MMLIC

Outstanding features include input and output buffer with program edit feature and large random access.

Inserts (labels) in reel containers, controlled temperature and humidity, and storage of master reels in other than computer room.

NNG

Outstanding features include the flexibility of the Cardatron.

For storage of magnetic tape, temperature and humidity control, Avery adhesive labels for magnetic tape reels are used, and Records Reserve Corp. storage plastic containers for tape.

OOC

Outstanding features include high speed storage or quick access loop storage, addressable magnetic tape, and simplicity of programming due to B-register tallying and address modification, automatic sequencing control counter, programmed breakpoint, etc.

Handling of magnetic tape. Reels of magnetic tape (250 ft or 2500 ft) are assigned to research personnel having a need for same. They are used only by the individual to whom assignment has been made. All reels of magnetic tape are stored in the temperature and humidity controlled computer room from which they are never removed. Tape labelling is left to the discretion of each individual.

WE System I

Outstanding features include a large tape storage capacity (permanent - "Datafiles") - 6,000,000 words, large drum storage capacity - 4,080 words, IBM Code - Burroughs code conversion and format editing devices, independent magnetic tape search, and photo electric reader, for program entry (540 digits per second).

Magnetic tape handling: all tapes and duplicates stored in metal cabinets in same room as computer (72^{o}F - relative humidity 45%). Tape labeling variable, depending on job. Usually a revolving numbering system with job title identification. External labeling shows job title and reel number.

FUTURE PLANS

ARGMA

A second Burroughs 205 with same exact configuration is scheduled for installation in the OML Division, Army Rocket & Guided Missile Agency, Redstone Arsenal, Alabama.

USA CC

It is anticipated that a new computer will be installed in the near future. Selection of new computer has not been established at this time.

BNS

Approval for installation of one IBM Type 1401 Data Processing System (no tapes) has been requested from the Bureau of Ships. Upon installation of this system in June/July 1961, sizeable reductions in data processing costs will be effected and the system will be utilized to augment existing equipment on an interim bais pending completion of necessary studies to justify a new transistorized, core storage, central shipyard computer (the feasibility study for this system was submitted to BuShips on 21 July 1960).

New major applications under consideration for application to the 1401 and subsequently to the new centralized computer include total supply inventory, cost accounting, and production planning and control.

Ultimate goal of data processing personnel is the development of a shipyard-wide, fully integrated data processing system in which source data automation techniques will be exploited to the maximum possible extent, and the master file so designed that common data will be reused where possible to effect desired reports in the shortest possible time and in the most economical manner.

USN HO Washington

It is planned to replace the present 205 with a higher speed computer.

USN MDL

Future plans call for purchase of IBM 704 System to replace our present system. This replacement will greatly increase our productivity and make available more time for new applications.

USNOL Corona

Plan to replace the present computer system with an IBM 7070 System.

USN USL

Consideration for the purchase of IBM 704 System, configuration to be Core Memory 8K, Drum Memory 8K, Magnetic Tape Units 4, Card Reader, Card Punch, On-line Printer, Paper Tape Input and Off-line Magnetic Tape to Printer.

NASA ARC

At the present time a building is being designed for the Ames Research Center, primarily for housing computing equipment and the associated staff.

This new facility should be occupied during the first half of 1961. At this time a medium size Honeywell 800 System will be leased to take over all functions of the Burroughs equipment and perform additional scientific calculations.

ATIC W-P

System to be replaced by an IBM 7090.

B & W Lynchburg

There is some talk of doing on line experimental data reduction either with another smaller machine or by creating a data link to connect the laboratory devices to the computer (12 miles distant). A larger machine capable of doing two dimensional nuclear codes would be considered if the work load justified it.

Burroughs

Replacement of present card input-output equipment with Burroughs equipment.

Burroughs Model 289 Line Printer	150 lines/min
Burroughs Model 292 Output Unit	100 cards/min
Burroughs Model 293 Input Unit	300 cards/min

CCC

Add automatic floating point and magnetic tape (Datafile) in the immediate future.

GICA

Delivery schedule for the next two years is as follows:

May 1960	305 RAMAC
May 1961	1401 - 4 tapes
Nov 1961	1401 - 4 tapes
Dec 1961	7070 - 8 tapes
Feb 1962	1401 - 4 tapes

Plans have not been finalized with respect to the balance of the applications among the equipment. There are no definite plans for retiring our Burroughs 205.

KSC

Replace with Univac Solid State 80. Add hourly payroll processing for 7,000 employees.

LA

We are currently conducting a feasability study of the new family of medium scale computers in the microsecond range. We have narrowed the field down to IBM, RCA and NCR in the medium price range. This study was started because we need a faster computer for our current work load, magnetic tape for future applications, and the economy of the new series of computers.

NNG

Feasibility study to determine more computer power in progress.

PP & LC

Within next several years, increased requirements may be greater than present computer capacity. When need for more capacity is foreseen, an additional or a more powerful computer will be ordered as found most feasible at that time.

USS

Probable acquisition of Cardatron for punched card input/output within a year.

Probable acquisition of larger computing system within three to five years.

WE System I

No new applications are planned for this system as the full two shift capacity has been reached. All programming and planning effort is being expended on a new IBM 7070/1401 Tape System due for installation August 1961. At this time all jobs will be cut over in their present form. After cutover, new applications and amplification of present systems can be undertaken, because of the greater speed and capacity of this new system.

U of N

It is expected that in the near future the following items of hardware will be added to the initial equipment:

a floating point device, magnetic tape and a Cardatron.

U of D

A Model 500 Punched Card Converter, IBM 523 Summary Punch, and IBM 514 Reproducing Punch is to be added.

INSTALLATIONS

U. S. Army Ballistic Missile Agency (5)
Computation Laboratory
Redstone Arsenal, Alabama

Army Rocket & Guided Missile Agency
Redstone Arsenal, Alabama

U. S. Army Chemical Warfare Laboratories
U. S. Army Chemical Center, Maryland

Boston Naval Shipyard
Boston 29, Massachusetts

U. S. Navy Hydrographic Office
Washington 25, D. C.

U. S. Navy Mine Defense Laboratory
Panama City, Florida

U. S. Naval Ordnance Laboratory
Corona, California

U. S. Naval Radiological Defense Laboratory
San Francisco 24, California

U. S. Navy Underwater Sound Laboratory
New London, Connecticut

Hq, R.A.D.C.
Griffiss Air Force Base, New York
ATTN: RCCS

Ames Research Center, NASA
Moffett Field, California

Aerospace Technical Intelligence Center
Wright-Patterson Air Force Base, Ohio

Allstate Insurance Company
Menlo Park, California
Sacramento, California
Atlanta, Georgia

Arthur D. Little, Inc.
35 Acorn Park
Cambridge 40, Massachusetts

Atlantic Mutual Insurance Company
45 Wall Street
New York 5, New York

Babcock & Wilcox Research Center
Alliance, Ohio

Babcock & Wilcox Company
1201 Kemper Street
Lynchburg, Virginia

Burroughs Corporation, Computer Facility
460 Sierra Madre Villa
Pasadena, California

Celanese Chemical Company
520 Lawrence Street, P.O. Box 561
Corpus Christi, Texas

Citizens Gas & Coke Utility
2020 N. Meridian Street
Indianapolis, Indiana

General Electric
Redmond Circle
Rome, Georgia

General Insurance Company of America
4347 Brooklyn
Seattle 5, Washington

International Telephone & Telegraph Laboratories
500 Washington Avenue
Nutley, New Jersey

Kaiser Steel Corporation, Box 217
Fontana, California

Linde Company, Box 44
Division of Union Carbide Corporation
Tonawanda, New York

Louis Allis Company
427 E. Stewart Street
Milwaukee, Wisconsin

Minnesota Mutual Life Insurance Company
345 Cedar
St. Paul 1, Minnesota

Northern Natural Gas Company
2223 Dodge Street
Omaha, Nebraska

Nuclear Development Corporation of America
5 New Street
White Plains, New York

The Ohio Oil Company, P. O. Box 269
Littleton, Colorado

Pacific Power & Light Company
920 S. W. Sixth Avenue
Portland 4, Oregon

United States Steel Corporation
Monroeville, Pennsylvania

Western Electric Company, Inc. Dept. 312 (2)
1600 Osgood Street
North Andover, Massachusetts

Westinghouse Research Laboratory
Pittsburgh 35, Pennsylvania

University of Nebraska
Lincoln, Nebraska

University of Denver
Denver 10, Colorado

University of Virginia
McCormick Road
Charlottesville, Virginia

Behr-Manning Corporation
P. O. Box 896
Troy, New York

BURROUGHS 220

Burroughs 220 Electronic Data Processing System

MANUFACTURER

Burroughs Corporation

Photo by the Burroughs Corporation

APPLICATIONS

Manufacturer

The Burroughs 220 is a general-purpose, stored-program, sequentially-controlled, series-parallel, automatic, electronic, data processing system which employs a single-address code, and is equally adaptable for either scientific or data processing applications.

U. S. A. Signal Research & Development Laboratory

Located in Room 1B334, U.S. Army Signal Research & Development Laboratory, the system is used as a computational tool in solution of scientific and technical data processing problems which are submitted to computation center by USASRDL engineers and scientists.

U.S. Navy Long Beach Naval Shipyard

Located at the Data Processing Office, Long Beach Naval Shipyard, Long Beach 2, Calif., the system is used for payroll, bond and leave, financial accounting, inventory and supply, production, planning and control, public works transportation and controlled maintenance programs, personnel accounting, scientific and engineering, and tool control.

USAF Aeronautical Chart and Information Center

Located at the Data Processing Division, Office of the Comptroller, 2nd and Arsenal Streets, St. Louis, Mo., the system is used for civilian payroll, manhour and cost accounting, chart inventory, and technical computations.

USAF DCS/Comptroller, Air Training Command

Located at Randolph Air Force Base, Texas, the system is used for personnel accounting. The master records for all assigned personnel, officer, airmen and civilian, are maintained on magnetic tape. Each group is updated with current data transceived from the bases on a daily basis. Summary reports are prepared from these tape files. These month-end summary reports are for USAF as well as local use. The preparation of the summary reports at this level has relieved the bases of this task. Inquiry service (the capability to make personnel selections from the master files based upon certain criteria) is available to DCS/Personnel. System is also used for personnel

Photo by the Long Beach Naval Shipyard

authorization. The authorized strength of the entire command is maintained (by unit) on magnetic tape. This file is periodically updated with changes received from the Headquarter's Manpower Office. Various reports, including the Unit Manning Documents, are prepared from this file. The many bases of the Command are no longer responsible for the maintenance of the file and preparation of summary authorization reports. In addition, system is used for military personnel manning statistics. Programs are almost completed which will provide DCS/Personnel with up-to-date manning statistics for officers and airmen. The authorized and assigned files will be combined into one tape file with the major control on AFSC. Summary reports as well as inquiry service will be available from this manning file.

Headquarters, Tactical Air Command

Located at the Systems Division, Directorate of Statistical Services, Deputy for Comptroller, Headquarters Tactical Air Command, Langley AFB, Virginia, the system is used for:

Personnel Accounting (Officer, Airmen, and Civilian)

Master File Composition. Centralized master tape records of all officers, airmen, and civilians assigned to TAC. Record Content. Initially: For officers, all items of data in the 901 and Repository Files; for airmen, all items in the 900, OJT and Overseas Volunteer Files; for civilians, all items in the SS800 File. Subsequently: Additional items as required for effective command management of the personnel resources. File Maintenance. Master records updated from personnel data changes furnished directly from the base. Initially, the base will mail changes six times a month. Subsequently, the base wil will transceive changes more frequently (possibly daily). Service to Management. Initially: (1) Summary reports for the local staff and Headquarters, USAF, (2) Complete files "fed-back" to the subcommand headquarters for their local use. Subsequently: (1) Tape interrogation concerning local management queries, and (2) Summary reports "fed-back" to the subcommands.

Stock Number Control

Master File Composition. Centralized master tape records of all stock numbers required to monitor the TAC UAL system and such other related applications as the ECLs (Equipment Component Lists). Also, records cross-referencing stock number conversions, changes, consolidations, etc. Record Content. All items of data required in the UAL document by AFM 67-1. File Maintenance. Master records updated from changes furnished by TAC supply on a semi-monthly basis. Service to Management. (1) A quarterly TAC catalog of selected stock number data furnished to

Photo by the USAF Aeronautical Chart & Information Center

the TAC equipment managers. "Add and Delete" type changes required for catalog maintenance will be furnished during the quarter. (2) Accurate UAL records achieved by screening all UAL changes through the Master Stock Number Control Tape.

Manpower and Organization System Management

Master File Composition. Centralized master tape records reflecting the UMD distribution of all manpower authorizations alloted to TAC. Record Content. Initially, all items of data required by the 2-AF-03 File and the AF-05 Report. Subsequently, additional items as required by the local staff. File Maintenance. Master records updated from changes furnished by the Headquarters TAC Manpower Activity. Initially, updating will be semi-monthly; subsequently, a study will be made to determine the need of more frequent updating. Service to Management. Initially: (1) Summary reports for the local staff and Headquarters USAF, (2) complete punched card files furnished the filed each quarter; punched card "Add and Delete" changes furnished during the quarter. Subsequently: Tape interrogation concerning management queries.

Organization Equipment Management System

Master File Composition. Centralized master tape records of all items of equipment in the TAC UAL system. Record Content. Initially: All items of data required by AFM 67-1, plus certain TAC management codes. Subsequently: Additional items as required by the local managers. File Maintenance. Master records updated from authorization changes furnished by TAC supply, and from in-use changes furnished by the base. Initially, updating will be monthly; subsequently, updating will be more frequent (actual frequency to be determined later). Service to Management. Initially: (1) Periodic CAL (Command Authorization List) to TAC supply managers, (2) summary reports for Headquarters USAF, AMC, and TAC, (3) "Add and Delete" punched card changes to field managers for the maintenance of base and unit UAL decks. Subsequently: Tape interrogation concerning management queries.

Financial

Data developed in this functional area will be based primarily on requirements established by Headquarters TAC. Management information based on shred-out data obtained from the 1 and 2-AF-086 Reports and C-100 Expense Reports by procurement source and regulated codes is under consideration. Expansion into the fields of procurement and budget, monetary inventory of UME/USE equipment, weapon-system monetary statistics etc., will be included as required.

Intelligence Data Processing and Analysis

Summary of Application: Compilation of target lists from catalogs, and listings of these in a multiplicity of factirs bearing on target analysis. Order-of Battle information will be prepared as desired.

Operations Analysis Problems

Summary of Application. Operations analysis problems will be processed on an "as required" basis. Requirements will probably be in the area of iterative computations, interpolation, data reduction, trial

Photo by the Dow Chemical Company

and error solutions and matrix inversion.

U. S. Geological Survey

Located at the Dept. of Interior, 18th and C Streets, N. W. Washington, D. C. - Room 1461, the system is used for scientific computations in such fields as crystallography, water resources topography, and geophysics. System is also used for data processing such as payroll, leave, personnel statistics, accounting and labor distribution.

Abbott Laboratories

Payroll: incentive calculation, gross to net, special personnel statistics; accounts receivable: open file method, cash application statement preparation; finished goods inventory: maintain current branch and combined balances, project gross and net requirements monthly and quarterly, calculate economic shipment amount to branches, analyze book balances to physical counts; work in process inventory: process requisitions, deliveries to stock, calculate progressive biweekly balances; customer statistics: accumulate monthly, quarterly and year to date gross and net sales for all customers, provide monthly, quarterly and yearly sales statistics for certain product groups by customer geographic location, class of customer; salesmen statistics: accumulate monthly product group sales for each salesman, calculate salesman's compensation, provide quarterly sales statistics for salesman, district division, area, etc.; sales department statistics: provide upon demand product sales figures for market research, advertising, new product sales; and production planning: project gross production requirements, explode to raw materials requirements, and compare stock levels against projection.

Allstate Insurance Company

Systems, located at the Allstate Regional Offices in Pasadena, Illinois, Detroit, Murray Hill (NJ) and Harrison (NY), are used for policy issuance and accounting relative to the policy holder.

Babcock & Wilcox Company

Located on Van Buren Avenue, Barberton, Ohio, the system is used for heat transfer, fluid flow, and estimating programs utilized for design of high pressure, high temperature steam generators, stress analysis and vessel design for nuclear equipment, shop scheduling, and production of work sequence sheets for tube bending.

Burroughs Research Center

Located at Paoli, Pennsylvania, the system is used for payroll, labor distribution, missile flight simulation, logic simulation, linear programs, and battery target assignment.

Photo by Smith, Kline and French Laboratories

Burroughs Corporation, Computer Facility
Located at 460 Sierra Madre Villa, Pasadena, California, the system is used for debugging of programs for Burroughs' customers, corporate data processing, and block time rentals to the public.

The Dow Chemical Company
Located in the 687 Bldg., Dow Chemical Company, Midland, Michigan, the system is used for statistics and design of experiments, operations research and linear programming (production scheduling, blending, transportation), chemical engineering (dist., heat transfer, mass transfer, kinetics, design, etc.), thermochemical (thermodynamic properties, fuel evaluation, etc.), physical chemistry (Urey-Bradley Force Fields, spectroscopy, etc.), Polymer chemistry, and general research problems in a variety of the sciences.

Hoffman Military Products Division
Located at 959 South Flower, Los Angeles, California, the system's primary use is as part of AN/ULD-1 Reconnaissance System, processing data of a classified nature. Also being used in mission simulation studies, antenna calibration and Table 202A data processing for same system. System is being made available for running of problems on other government contracts with rental credit reverting to AN/ULD-1 contract.

Smith, Kline & French Laboratories
Located at 1500 Spring Garden Street, Philadelphia 1, Pennsylvania, the system is used for selection and listing of doctors' names from a continuously corrected master file (magnetic tape) for mailing or survey applications. The information required consists of name, address, city, state and other coded material such as age, medical specialty, etc., as well as for statistical manipulation of clinical data for medical research and development.

Stanford Research Institute
Located in Building 410B, Stanford Research Institute, the system is used for business data processing (payroll, labor extension, etc.), and scientific calculations.

The Upjohn Company
Located at Upjohn Company, Kalamazoo, Michigan, the system is used for sales analysis, finished goods inventory control, production planning and scheduling.

California Institute of Technology
Located at 1201 East California Street, Pasadena, the machine is used for research in the areas of Astrophysics, Biology, Chemistry, Physics, Applied Physics and Engineering, Mathematical and Numerical Analysis.

Cornell University
Located in Rand Hall, Cornell University, Ithaca, N.Y.,

the system is used for teaching and research in scientific computation and data processing for Engineering, Physical Sciences, Agriculture and Business.

Georgia Institute of Technology
Located at the Rich Electronic Computer Center, Georgia Institute of Technology, Atlanta 13, Ga., the system is used for education and research in all fields of engineering and science. Center provides research assistance to commercial and industrial sponsors.

John Deere Waterloo Tractor Works
Located at 400 Miles Street, Waterloo, Iowa, the system is used for inventory control and analysis, production and purchasing control, product costing, and machine capacity.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer	
Internal number system	Binary coded decimal
Decimal digits/word	10 + sign
Decimal digits/instruction	2 - 10
Instructions/word	1
Instructions decoded	93
Arithmetic system	Fixed and floating point
Instruction type	One address

Photo by the Upjohn Company

Number range Fixed point $-1 < N < +1$
Floating point $10^{-51} < N < 10^{+49}$

S	1 4	5 6	7 0
+ -	Control Digits	Oper Code	Address

Star 1, Star 2, Star 2A, assembly routines and Burroughs Algebraic Compiler routines are available.

In the control and arithmetic sections of the computer are seven electronic display registers. The B register of the 220, is used for automatic modification of instructions, and may be counted either up or down by any amount.

ARITHMETIC UNIT

Manufacturer	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	200	185
Mult	2,070 avg.	2,055
Div	3,985 avg.	3,970

Construction (Arithmetic unit only)
Vacuum tubes approx. 1,800 in central processor

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	10,000	110,000	15
Magnetic Tape Reel	1,367,200	15,039,200	250
Datafile	4,880,000	53,680,000	16,000 avg

Magnetic Tape

No. of units that can be connected	10	Units
No. of char/linear inch	416.33	Char/inch
Channels or tracks on the tape	12	Tracks/tape
Blank tape separating each record	0.26	Inches
Tape speed	120	Inches/sec
Transfer rate	25,000	Char/sec
Start time	5	Millisec
Stop time	5	Millisec
Average time for experienced operator to change reel of tape	90	Seconds
Physical properties of tape		
Width	0.75	Inches
Length of reel	3,500	Feet
Composition	Mylar	

USA-SRDL

4,000 words of magnetic core storage and 4 magnetic tape units.

Photo by Georgia Institute of Technology

USN LBNS

10,000 words of magnetic core and 10 magnetic tape units.

USAF ACIC

5,000 words of magnetic core and magnetic tape.

USAF DCS/C ATC

10,000 words of magneti core, 5 magnetic drums of 29 words each, and magnetic tape.

TAC

5,000 words of magnetic core. In addition, each Burroughs Magnetic-Tape Storage Unit stores information on reels containing up to 3,500 feet of tape with a maximum capacity of approximately 1,400,000 words. The TAC EDP System consists of 5 units (1,400,000 x 5 = 7,000,000).

USGS

10,000 words og magnetic core and magnetic tape.

Abbott

5,000 words of magnetic core and magnetic tape.

AIC

Each system (5) has 5,000 words of magnetic core and six magnetic tape units.

B & W

8,000 words of magnetic core.

BRC

10,000 words of magnetic core and magnetic tape.

BCCF

System has 10,000 words of magnetic core. Magnetic tape reels are 3,500 feet. Two lanes of information. Datafile is 50 tapes in parallel, each 250 feet. Blocks are variable length-from 10 to 100 words per block. All magnetic tape is moved at rate of 25,000 digits per second. System has 9 tape units and 1 Datafile.

Dow

5,000 words of magnetic core and 3 tape units.

Hoffman

5,000 words of magnetic core and 5 magnetic tape units.

SKFL

5,000 words of magnetic core and 8 magnetic tape units.

SRI

5,000 words of magnetic core and magnetic tape.

Upjohn

10,000 words of magnetic core.

Cal Tech

5,000 words of magnetic core and 2 magnetic tape units.

Cornell

5,000 words of magnetic core and 4 magnetic tape units.

Georgia Tech

5,000 words of magnetic core and 4 magnetic tape units. 440 microseconds of magnetic tape access time is based on reading speed of 25,000 chars/sec. It does not include time to search for desired information and begin reading.

INPUT

Manufacturer Media	Speed
Paper Tape	1,000 char/sec
Keyboard	Manual
Magnetic Tape	25,000 char/sec
Cards	400 char/sec

Up to ten photo-electric paper tape readers may be included in a system. Card reader speed is per card reader. Up to seven printers and/or punches and/or readers in any combination may be used per system.

USA-SRDL

Magnetic tape, paper tape, cards and keyboard.

USN LBNS

Magnetic tape, paper tape, cards and keyboard.

USAF ACIC

Punch card input through use of IBM 087 Collator. Card and PPT input buffered through cardatron system. Magnetic tape.

USAF DCS/C ATC

Magnetic tape, paper tape, cards (087 Collator) and keyboard.

TAC

The IBM 089 does not input directly into the Data Processor. The Burroughs EDPS uses a buffering device called a "Cardatron". Input media are also magnetic tape, paper tape and keyboard.

USGS

Magnetic t e, paper tape, and IBM 089 cards.

Abbott

Cards, paper tape, and magnetic tape.

AIC

Magnetic tape and cards.

B & W

IBM 089 cards.

BRC

Magnetic tape, paper tape, and cards.

BCCF

Magnetic tape, paper tape, cards and keyboard.

Dow

Magnetic tape, paper tape, IBM 087 cards and keyboard.

Hoffman

Magnetic tape, paper tape, cards and keyboard.

SKFL

Magnetic tape, paper tape, and cards (Cardatron).

SRI

Magnetic tape, paper tape, and cards.

Upjohn

Two IBM 087 cards.

Cal Tech

Paper tape.

Cornell

Magnetic tape, paper tape, and IBM 087 cards.

Georgia Tech

Magnetic tape, paper tape, and cards. Paper tape reader will stop on a character and is program controlled.

Deere

Paper tape and IBM 087 cards.

OUTPUT

Manufacturer Media	Speed
Supervisory Printer	10 char/sec
Paper Tape	60 char/sec
Magnetic Tape	25,000 char/sec
Cards	1,800 char/ min

Up to seven printers and/or punches in any combination may be used per system. High speed printer may be used either on-line or off-line with a maximum speed of 1,500 lines per minute. As many as ten paper-tape punches may be included per system. Card speed is per card punch.

USA-SRDL

Magnetic tape, paper tape, IBM 407 Tab, cards, and supervisory printer.

USN LBNS

2 IBM Model 407 Printers to be released upon the final acceptance of the Hi-Speed Printer. Cards and magnetic tape are also output media.

USAF ACIC

Card output through use of IBM 523 Summary Punch; printed output through use of IBM 407 Accounting Machines; card, paper tape and print output buffered through Cardatron System.

USAF DCS/C ATC

Magnetic tape, paper tape, 2 IBM 407 Tabs, 2 IBM 523 Cards, and supervisory print-out.

TAC

1 IBM 407 Printer, 1 IBM 514 Card Punch, Magnetic Tape, and Supervisory Printer. Cardatron buffer also used for output.

USGS

IBM Cards, IBM 407 Printer, Magnetic Tape, and Supervisory Printer.

Abbott

Cards, IBM 407 Printer, and supervisory printer.

AIC

Magnetic tape, cards, and printers.

B & W

Cards and IBM 407 Printer.

BRC

Paper tape, punched cards, magnetic tape, and printer.

BCCF

High speed paper tape punch, card punch, printer, high speed printer, and supervisory printer. The high speed printer can be used off or on line. During off-line operations, one or two magnetic tape storage units are used.

Dow

Magnetic tape, paper tape, IBM 407 Printer, IBM 523 Cards and supervisory printer.

Hoffman

Magnetic tape, paper tape, IBM 407 Printer, IBM 521 Cards.

SKFL

Cardatron Punch (IBM 523), Cardatron Printer (IBM 407), magnetic tape, paper tape, supervisory printer, and high speed printer (Model 272).

SRI

Paper tape, IBM 523 Cards, IBM 407 Line Printer, and Teletypewriter. Magnetic tape also qualifies as an output medium (same speeds). It cannot be used off line in our system.

Upjohn

Burroughs high speed printer.

Cal Tech

Teleprinter and paper tape. A high speed line printer (300-500 lines/min) will be added early in 1961.

Cornell

Magnetic tape, IBM 407 Printer, IBM 523 Cards, and paper tape.

Georgia Tech

Supervisory printer, paper tape, punched cards, line printer (IBM 407), and magnetic tape.

Deere

2 IBM 407 Printers and 1 IBM 523 Punch.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Approximately 1,800 vacuum tubes are used in the central processor. Some 88,000 to 440,000 magnetic cores are used in the system.

CHECKING FEATURES

Manufacturer

The occurrence, for any reason, in the low order position of certain of the control registers of a configuration corresponding to any one of the decimal numbers from 10 to 15 is detected automatically.

A program check indicator will be turned on when such conditions as forbidden order code, improper partial word field or Branch on Compare when no comparison has been made.

Automatically halt computer operation when a nonexistent address is specified by an instruction.

Automatic detection of an overflow condition during the execution of instructions which turns on the Overflow Indicator. Complete program control of the data processor's response to an overflow condition is standard on the Burroughs 220.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Model	Manufacturer Name	Kw	Weight	BTU	Inches Width	L	H
220	Data Processor	12.0	2800	41,000	158	29	76
380	Memory Control	4.5	1000	14,200	52.5	29	76
381-1	Core Stor Unit (2000-5000)	6.7	1200	22,800	79	29	76
400-4001	Power Ctl & Supply	10.0	2300	34,000	92	29	76
415	Control Console	0.1	500	340	59	35	49
465	Supervi Printer	0.6	250	2,040	23.5	22.75	39
440	Photoreader	0.7	175	2,380	23.5	22.75	47
470	High Speed Punch	0.3	175	850	23.5	22.75	47
510							
511	Cardatron Ctl U.	3.7	1700	12,600	80	29	76
512	Cardatron Input	2.8	850	9,500	40	29	76
513	Cardatron Output	2.9	850	9,800	40	29	76
550	Magnetic Tape Ctl	5.5	1000	18,700	53.5	29	76
551	Mag. Tape Stor.	4.0	1000	13,600	28	35	55
552	Datafile	1.5	1500	5,100	87	35	59
271	High Speed Printer Control	5.6	2000	16,000	33	60	76

The temperature and humidity must be maintained within the following limits: temperature range: 60 to 80 degrees Fahrenheit; relative humidity range: 40 to 60 per cent.

Amount of air conditioning depends upon size of computer system installed. For every 12,000 BTU/hr. generated by the system one ton of refrigeration is recommended.

USA-SRDL

Power, computer 49.4 Kw	55.5 KVA	0.87 pf	
Plus 21 Kw D.C.			
Area, computer	210	sq ft	
Room size, computer	1,500	sq ft	
Room size, air conditioner	225	sq ft	
Floor loading	180	lbs/sq ft	
	700	lbs concen max	
Capacity, air conditioner	40	Tons	
Weight, computer	21,795		

Raised floor (plywood on 2"x8"'s) for all connecting cables.

USN LBNS

Power, computer 275 Kw	307	KVA	0.90 pf
Power, air condi 93 Kw	102	KVA	0.90 pf
Volume, computer	1,714	cu ft	
Volume, air conditioner (3)	54	cu ft ea.	
Area, computer	321	sq ft	
Area, air conditioner	18	sq ft ea.	
Room size, computer	60	ft x 60 ft	
Room size, air conditioner	20	ft x 20 ft	
	10	ft x 10 ft	
Capacity, air conditioner	70	Tons (Total)	
Weight, computer	32,420	lbs	
Weight, air conditioner	2,800	lbs, 3 Units	

The Shipyard ADP site incorporates the total facility for the centralized data processing function, EDP, EAM, Key Punching and Programming.

The computer facility has been established in a concrete warehouse type building occupied jointly with the Supply Department and Comptroller Department.

The computer room occupies an area 60 ft x 60 ft.

Light-weight concrete approximately 12" high composes the outside perimeter of the plenum floor (40 ft x 40 ft). Floor covering is comprised of 2 ft x 4 ft of honeycombed aluminum sections.

The site is singularly designed to incorporate the latest air conditioning and fire-proofing requirements of the Bureau of Yards and Docks and District Public Works Office Eleven.

Three individual air conditioning units are installed to supply air conditioning from the floor to each individual equipment unit. The air plenum received conditioned air from two sources, 2 twenty ton units providing air from one side and 1 thirty ton umit from the opposite side of the raised floor.

CO_2 nozzles are installed under and into each equipment unit. Each nozzle is individually controlled, with a master valve to avert any accidental direction of the CO_2 into one or more units of the computing equipment.

USAF ACIC

Power, computer 5.20 Kw	8.30	KVA	
Power, air condition 40 Kw	34	KVA	0.85 pf
Volume, computer	202	cu ft	
Volume, chiller & pumps	1,200	cu ft	
Volume, Air Handling Units	5,000	cu ft	
Area, computer	32	sq ft	
Area, chiller & pumps	171	sq ft	
Area, Air Handling Units	624	sq ft	

Room size, computer		800	sq ft
Room size, chiller & pumps		9	ft x 19 ft
Room size, Air Handling Units		24	ft x 26 ft
Capacity, air conditioner		38	Tons
Weight, computer		3,200	lbs

Data processing equipment room approximately 2,300 sq ft, 20,000 cu ft was provided in one-story section of 130 year old warehouse frame and limestone construction, concrete floor slab on the ground. Modification included acoustical insulated ceiling, plastered walls, power wiring, which included ducts in floor for interconnecting wiring of units, new electrical sub-station 225 KVA and 440 volts and 150 KVA at 110 volts. Approximately 75% of the 225 KVA is directly and indirectly for the computer. Construction of housing for 75 HP, 400 cycle converter for computer equipment; 38 tons of air conditioning were provided by a central plant chiller of 65 tons capacity. Chiller, air handling units, exhaust system, humidifier, hot water heating system, cooling tower, 20 HP air compressor and 75 HP motor generator were located outside the computer area.

USAF DCS/C ATC

Power, computer	67 Kw	83	KVA	0.82 pf
Power, air condi	55 Kw	60	KVA	0.91 pf
Volume, computer		1,560	cu ft	
Volume, air conditioner		4,000	cu ft	
Area, computer		295	sq ft	
Area, air conditioner		480	sq ft	
Room size, computer		2,489	sq ft	
Room size, air conditioner		480	sq ft	
Floor loading		180	lbs/sq ft	
		130	lbs concen max	
Capacity, air conditioner		40	Tons	
Weight, computer		19,420	lbs	
Weight, air conditioner		20,000	lbs	

One thousand three hundred (1,300) square feet of the existing building was modified and one thousand one hundred and eighty-nine (1,189) square feet were added. False flooring was installed throughout the entire area. A separate power supply was installed for the EDP installation. Thirty-six (36) tons of effective air conditioning was installed outside of the modified area and is used for the EDP installation only.

TAC

Power, computer	73.43 Kw	57.97	KVA
Volume, computer		3,800	cu ft
Volume, air conditioner		706	cu ft
Area, computer		760	sq ft
Area, air conditioner		122	sq ft
Room size, computer		33	ft x 39 ft
Room size, air conditioner		20	ft x 26 ft
Capacity, air conditioner		75	Tons
Weight, computer		56,525	lbs

The conditioner services rooms other than the computer room. Conditioner footage includes two power transformers. Added a room for the air conditioner, power transformers and boilers, and installed same; installed air conditioning ducts, false ceiling, and "free Access" raised floor; insulated walls; increased transformer capacity. 247,500 BTU must be dissipated.

USGS

Power, computer	34.17 Kw	41.48	KVA	0.82 pf
Volume, computer		233,396	cu ft	
Area, computer		1,439	sq ft	
Area, air conditioner		378	sq ft	
Room size, computer		199.52	sq ft	
Room size, air conditioner		300	sq ft	
Floor loading		175-200	lbs/sq ft	
		250	lbs concen max	
Capacity, compressor		20	Tons	
Capacity, cooling tower		25	Tons	
Weight, computer		14,135	lbs	

Partial acoustical ceiling, raised floor, additional air-conditioning and humidity control, and additional wiring from main building power supply.

Abbott

Power, computer	47.38 Kw	53.38	KVA	0.89 pf
240,250 BTU/hr.				
Power, air condi	35.2 Kw	41.5	KVA	0.85 pf
Area, computer		1,250	sq ft	
Area, air conditioner		240	sq ft	
Room size		40	ft x 40 ft	
Floor loading		200	lbs/sq ft	
		3,286	lbs concen max	
Capacity, air conditioner		30	Tons required	
		40	Tons expansion	
Weight, computer		16,195	lbs	
Weight, air conditioner		3,000	lbs	

Vapor-sealed room located on 3rd floor of 3 story office building (remodeled office area). Raised Unistrut floor acts as air conditioning plenum. False ceiling of acoustical tile acts as return plenum. Room surrounded on three sides with thermopane and metal partitions, fourth side tile and concrete wall. Fire proof tape vault equipped with fire door and metal storage cabinets.

B & W

Power, computer	52 Kw	59	KVA	0.88 pf
Volume, computer		12,000	cu ft	
Volume, air conditioner		3,600	cu ft	
Area, computer		1,500	sq ft	
Area, air conditioner		300	sq ft	
Room size, computer		30	ft x 50 ft	
Room size, air conditioner		30	ft x 10 ft	
Capacity, air conditioner		32	Tons	
Weight, computer		19,600	lbs	

Raised floor acts as cable raceway and as plenum for 20% of air flow. False ceiling provides duct work for return air. Concrete block building.

BRC

Power, computer	85 Kw	57.70	KVA	0.70 pf
Power, air condit	146 Kw	47.5	KVA	0.85 pf
Volume, computer		22,000	cu ft	
Volume, air conditioner		8,800	cu ft	
Area, computer		2,200	sq ft	
Area, air conditioner		550	sq ft	
Room size, computer		46	ft x 48 ft	
Room size, air conditioner		23	ft x 24 ft	
Floor loading		250	lbs/sq ft	
		1,000	lbs concen max	
Capacity, air conditioner		40	Tons	
Weight, computer		30,482	lbs	
Weight, air conditioner		3,430	lbs	

Installed false floor, which is used as a plenum, erected walls and partitions, and added power to the available power.

BCCF

Power, computer	70.6 Kw	78.2	KVA	0.90 pf
Volume, computer		15,200	cu ft	
Area, computer		1,580	sq ft	
Weight, computer		37,805	lbs	

208V, 60 cycle 3 phase, 4 wire, power is required. Raceways only. Normal plant air conditioning piped through ceiling and some through floor.

Dow

Power, computer, w/peripheral equip.		58	KVA/75 amperes
Volume, all equip		9,912	cu ft
Volume, computer		1,965	cu ft
Volume, air conditioner		1,917	cu ft
Area, all equip		1,239	sq ft
Area, computer		312	sq ft
Area, air conditioner		231	sq ft
Room size		21.5	ft x 59 ft
Floor loading		13	lbs/sq ft

Floor loading		400 lbs concen max
Capacity, air conditioner		21 to 25 Tons
Weight, computer		2,850 lbs
Weight, air conditioner		800 lbs

Building is brick. Computer room is on raised floor in basement, with plenum of about 12". Also false ceiling. Power cables are below floor in plenum.

Hoffman

Power, computer	82 Kw	88 KVA
Power, air condition	60 Kw	60 KVA
Volume, computer		12,000 cu ft
Volume, air conditioner		1,600 cu ft
Area, computer		1,500 sq ft
Area, air conditioner		200 sq ft
Room size, computer		50 ft x 30 ft
Room size, air conditioner		20 ft x 10 ft
Floor loading		15 lbs/sq ft
		825 lbs concen max
Capacity, air conditioner		40 Tons
Weight, computer		25,275 lbs

False ceiling with return air ducting above, plenum chamber false floor for entry air, cooling tower on roof for air conditioner, and floor registers behind each unit to regulate inlet air flow have been installed.

SKFL

Power, computer	44 Kw	52 KVA 0.86 pf
Power, air conditioner		16 KVA 0.85 pf
Volume, computer		24,100 cu ft
Volume, air conditioner		9,000 cu ft
Area, computer		2,590 sq ft
Area, air conditioner		750 sq ft
Room size, computer		31 ft 6 in x 66 ft 4 in
		15 ft 4 in x 20 ft 7 in
		15 ft 4 in x 12 ft
Room size, air conditioner		30 ft x 25 ft
Floor loading		60 lbs/sq ft
Capacity, air conditioner		50 Tons
Weight, computer		28,000 lbs
Weight, air conditioner		6,400 lbs

New air conditioning equipment room constructed to house equipment. It is steel framed with asbestos siding and metal deck roof (insulated).

Existing office area was modified to house computer, high speed printer and engineer's office. General description of modifications is as follows: New aluminum raised floor supplies conditioned air. One large return air grill installed at end of room. There is no ceiling supply or return system. New CO_2 fire protection system installed under raised floor. Original acoustical metal pan ceiling, Hauserman partition walls and lighting arrangement are used. New Power feeds installed to computer and air conditioning equipment.

SRI

Power, computer	127 Kw	150 KVA 0.85-0.95 pf
Power, air condi	33 Kw	45 KVA 0.85-0.95 pf
Volume, computer		8,800 cu ft
Area, computer		1,100 sq ft
Room size		30 ft x 40 ft
Floor loading		100 lbs/sq ft
		200 lbs concen max
Capacity, air conditioner		35 Tons

The computer rests on a raised floor which provides space for an air plenum and for cable connections. The return air is conducted through the false ceiling which again acts as a plenum.

Upjohn

Power, computer	129 Kw	147 KVA 0.98 pf
Power, air condi	29 Kw	29 KVA 0.99 pf
Volume, computer		22,000 cu ft
Volume, air conditioner		11,400 cu ft
Area, computer		2,000 sq ft
Area, air conditioner		950 sq ft
Room size, computer		40 ft x 50 ft
Room size, air conditioner		30 ft x 31.5 ft
Floor loading		250 lbs/sq ft
Capacity, air conditioner		86 Tons
Weight, computer		25,000 lbs
Weight, air conditioner		11,000 lbs

False floor installed which acts as air conditioning plenum, provides space for connecting cables and houses the sprinkler heads.

Calif Tech

Power, computer	40 Kw	42.5 KVA 0.94 pf
Volume, computer		200 cu ft
Area, computer		130 sq ft
Area, air conditioner		200 sq ft
Room size, computer		1,000 ft^2
Room size, air conditioner		230 sq ft
Capacity, air conditioner		25 Tons
Weight, computer		

False ceiling, lighting, air plenums, exhaust hoods, floor trenches, floor covering, power inlets, picture window, paint.

Cornell

Power, computer	40 Kw	50 KVA 0.80 pf
Power, air conditioner	28 Kw	34 KVA 0.80 pf
Volume, air conditioner		800 cu ft
Area, computer		2,500 sq ft
Area, air conditioner		100 sq ft
Capacity, air conditioner		45 Tons
Weight, computer		40,000 lbs
Weight, air conditioner		1,100 lbs

False ceiling, elevated floor, motor alternator and compressor room.

Georgia Tech

Power, computer	80.1 Kw	54.4 KVA
Area, computer		254 sq ft
Area, air conditioner		175 sq ft
Room size, computer		1,560 sq ft
Room size, air conditioner		250 sq ft
Capacity, air conditioner		40 Tons
Weight, computer		27,500 lbs

Renovate existing 70-year-old stone building; remove partitions; poured slab floor with raceways; no structural modifications. Air conditioner is shared with IBM 650 and EAM.

Deere

Power, computer	67.43 Kw	61.43 KVA
Area, computer		241.85 sq ft
Room size		1,300 sq ft
Floor loading		250 lbs/sq ft
Weight, computer		27,903 lbs

208V, AC, 60 cycle.

PRODUCTION RECORD

Manufacturer	
Number in current operation	42
Time required for delivery	6-8 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Purchase Price	Monthly Rental
220 Primary System	$320,000	$7,800
Data Processor-Model 220 (includes automatic floating-point arithmetic)		
Memory Control - Model 380		
Core Storage Unit - Model 381-1 (accommodates up to 5,000 words)		
Core Assembly -Model 382 (two assemblies provided)		
Power Control - Model 400		
Power Supply - Model 401		
Control Console - Model 415		
Supervisory Printer - Model 465		
Photoreader - Model 440 (1,000 characters per second)		

220 Primary System further includes:
Numeric keyboard and interval timer (as part of the Control Console), desk and chair; selection of five keynote panel colors - light blue, grey, dark blue, brown, and green.

Cardatron 220 Primary System	107,200	2,735
Cardatron Control I - Model 510		
Cardatron Control II - Model 511		
Cardatron Input - Model 512		
Cardatron Output - Model 513 (120 character)		
Magnetic Tape Control-Model 550	45,000	1,200
Magnetic Tape Storage-Model 551	21,450	635
Datafile - Model 556	49,500	1,475
Photoreader - Model 440 (1,000 characters per second)	8,000	225
Paper Tape Punch - Model 470 (60 characters per second)	3,400	100
Supervisory Printer - Model 465	9,600	300
Supervisory Printer - Model 464 (less-Off-line Reader)	7,000	225
Cardatron Input - Model 512	29,500	715
Cardatron Output - Model 513 (120 character)	31,200	820
Core Storage Unit - Model 381-2 (accommodates second 5,000 words)	27,000	800
Core Assembly - Model 382 (1,000 words each)	18,000	500
High Speed Printer Control-Model 261 (minimal control features)	125,000	3,450
High Speed Printer Control-Model 271	144,000	3,950
High Speed Printer Control-Model 281 (maximal control features)	158,900	4,350
High Speed Printer - Model 272	84,550	2,255
Tape Perforator & Verifier-Model 455	8,100	220
Tape Perforator Format Merger-Model 456	3,300	90
Paper Tape Concerter - Model 472	17,000	500

220 System Expansion

Cardatron system may be expanded to a total of seven (7) input or output units added in any combination.

Core storage may be expanded to 10,000 words in increments of 1,000 words (one (1). Cord Assembly required for each 1,000 words). Core storage beyond 5,000 words requires the addition of one (1) Core Storage Unit.

Paper-tape system may be expanded to ten (10) Photoreaders for input. As many as ten (10) Paper-Tape Punches or Supervisory Printers, added in any combination, may be used for output.

The magnetic tape system may be expanded to a total of ten (10) Magnetic Tape Storage Units, all associated with the single Magnetic Tape Control. A maximum of twelve (12) Magnetic Tape Storage Units may be used with a 220 system that includes High Speed Printers.

Each High Speed Printer can use up to two (2) Magnetic Tape Storage Units. Two (2) High Speed Printers may be used with a 220 system, one (1) of which may be directly coupled to the Data Processor.

Burroughs Line Printer, Model 289

For on-line use in the Burroughs 205 and 220 Cardatron Systems

	Lease (Per Month)	Purchase Price
Standard Features:		
Immediate-access clutch	$850	$ 36,000
Two triple panel manual plugboards		
Five 2-position pilot selectors		
Eight 5-position co-selectors		
Five 4-position Cardatron selectors		
Two digit selectors		
Twenty symbol selectors		
One half-time emitter		
Ten filters		
Six carriage skipping channels and one overflow channel		
Pluggable zero and asterisk print control		
Optional Features:		
Group of five 2-position pilot selectors	10	250
Group of four 5-position co-selectors	5	200
Group of Ten symbol selectors (maximum two groups)	15	600
Group of two digit selectors	10	200
Group of ten filters	3	70
Additional plugboard		100

Burroughs Card Output Unit - Model 292

For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch	150	5,800
Six 5-position co-selectors		
Five 2-position Cardatron selectors		
One digit emitter		
One half-time emitter		
One single panel manual keyboard		
Optional Features:		
Double punch and blank column detection device (Group of 20-positions-maximum four groups)	16	740
Offset stacker	10	225
Additional plugboard		50

Burroughs Card Input Unit - Model 293

For on-line use in the Burroughs 205 and 220 Cardatron Systems

Standard Features:		
Immediate-access clutch	300	14,000
Five 2-position pilot selectors		
Eight 5-position co-selectors		
Two digit selectors		
One half-time emitter		
One single panel manual keyboard		

Optional Features:	Lease (Per Month)	Purchase Price
Group of five 2-position pilot selectors	$10	$250
One additional digit selector	10	200
Additional plugboard		50

All prices are subject to change without notice.

Outline of Sale Policy

A standard Burroughs Corporation sales or rental agreement will be executed at the time of sale or lease.

Prices are F.O.B. Pasadena, California.

Sales, use or other taxes imposed directly on the sale or rental of Burroughs machines by Federal, State, or local governments will be borne by the purchaser or lessee.

Maintenance service for purchased equipment on a continuing or on-call basis is available by contract through a staff of qualified service engineers stationed in major cities across the country. Maintenance service for leased machines is provided as required to keep the equipment in good operating condition.

Rental agreements are effective for one year from the date installation of the equipment is complete, and remain in effect thereafter until terminated by either party upon 90 days' written notice.

Machines under lease may be purchased at any time at the prices in effect at the time the lease is executed, less a credit of 40% of all rentals paid, up to a maximum of 60% of the purchase price.

Guarantee and Installation Policy

Except for expendable items, such as tubes, diodes, fuses, lamps, and neon indicators, all equipment is guaranteed for one year against defective material or workmanship.

The purchase or lease of Burroughs machines includes the following:

1. Necessary manuals which describe operation of the equipment.
2. The services of trained personnel to supervise installation in the customer's plant.
3. Prescribed training of the customer's employees by qualified Burroughs instructors in programming, operation and maintenance procedures and techniques.

The Burroughs "100/70 Plan" for rental of 220 Data Processing Systems

The 100/70 Plan, is a new approach to the rental of major scale data processing equipment. To qualify for rental under the "100/70 Plan", a system which normally rents for at least $15,800 per month must be ordered ($11,100 per month under "100/70").

As long as monthly usage remains at 100 hours or less, only 70% of the monthly rental must be paid. The lessee has the option to convert to the regular 176-hour standard rental plan at any time his work load demands the additional time. However, once the lessee has exercised the option to convert to regular 176-hour monthly contract, he may not revert back to the "100/70 Plan".

The "100/70 Plan" applies to only on-line equipment, excluding the High Speed Printer System, and the Input/Output Cardatron Equipment, however the monthly rental of any off-line equipment may count toward the minimum total rental of $15,800 per month.

Use time for the 100 hours is defined as the time during which the system or any components thereof is in operation, exclusive of preventive or remedial maintenance time: when system components are normally inter-connected the sum of the regular monthly charges for these components is to be taken as the regular monthly charge for the system in determining the hourly additional use rate.

Burroughs Corporation will provide the necessary parts and service to maintain the equipment in good operating condition as required during its regular business hours, eight a.m. to five p.m., Monday through Friday excluding holidays.

Maintenance/Service Contracting

Burroughs will keep the machines in good operating condition. All costs of maintenance (except for ribbons and supplies) will be borne by contractor unless the required maintenance is due to the fault or negligence of the lessee.

Burroughs shall provide maintenance service during all periods of operation. Upon mutual agreement, contractor will assign "on site" service engineers.

The lessee will provide adequate storage space for spare parts, and adequate working space including heat, light, ventilation, electric current and outlets, for the use of the service engineers. These facilities will be within a reasonable distance of the machines to be serviced and will be provided at no cost to contractor.

Preventive (scheduled) maintenance for each machine will be furnished on a schedule which is mutually acceptable to the lessee and Burroughs and which is consistent with the operating requirements.

Burroughs will always be responsive to the maintenance requirements of the lessee. All remedial (unscheduled) maintenance will be performed promptly after notification to contractor's nearest service location that a machine is inoperative.

If contractor is unable to restore a machine to good operating condition and the machine remains inoperative for a continuous period of 24 hours during scheduled work days of the installation from the time the lessee notifies contractor that the machine is inoperative, and it is determined that (1) the machine became inoperative through no fault or negligence of the lessee, and (2) the lessee's production requirements were interfered with as a result of the machine breakdown, Burroughs will grant to the lessee a credit for each hour the machine eas inoperative. Such credit shall be 1/176th of the monthly charge for the inoperative machine plus 1/176th of the monthly charge for an interconnected machine not usable as a result of the breakdown; provided, however, that the credit granted for each machine shall in no instance exceed 1/30th of the monthly charge for the machine in each 24 hour period.

Burroughs will use its best efforts to assist the lessee in procuring service on equipment compatible with that used by the lessee, to meet emergencies such as a major breakdown, conversion from one system to another, unforeseen peak loads, etc. The lessee, at its option, may accept or reject the offer of use of emergency equipment. If accepted, the cost of such services, if any, will be arranged on an individual installation basis.

USA-SRDL

2,000 words storage, paper tape input, supervisory printer output, additional 2,000 words of storage, 4 magnetic tapes, paper tape punch, Cardatron (1 input, 2 output), all rent for $17,000/month, including service.

USN LBNS

Central Processor, 10,000 words core storage, supervisory printer, photoreader, paper tape punch, Cardatron with one input and four output units, ten magnetic tape storage units and high speed printer, printer control (medium) and one magnetic tape storage unit cost $1,209,117.

USAF ACIC

Purchase price for basic system, consisting of, data processor, memory control (2,000 words), power control, control console, supervisory printer, and photoreader is $320,000.

Purchase price for additional equipment, consisting of Cardatron Control I, Cardatron Control II, Cardatron Input, Cardatron Output, Cardatron Output for IBM 407, Cardatron Output for IBM 523, paper tape punch, additional core memory (3,000 words), magnetic tape control, and six magnetic tape storage units is $320,000.

USAF DCS/C ATC

220 Primary System and Cardatron I and II rents for $9,000/month.

Model 550, seven 551's, 470, 512, four 513's, 381-2 and 382 rent for $14,540/month.

TAC

$7,800/month (includes the data processor, control console, memory control, 2,000 words of core storage, supervisory printer, paper tape reader, power control), and $10,020/month includes the Cardatron Subsystem, magnetic tape control unit, magnetic tape storage unit, 3,000 words additional core, IBM 407 Printer, IBM 089 Card Read, and IBM 514 Card Punch.

USGS

The primary system, including 220 Data Processor, 380 Memory Control, 381-1 Core Storage Unit, 382 Core Assembly (2,000 words), 400 Power Control, 401 Power Supply, 415 Control Console, 465 Supervisory Printer, 440 Photo-Reader, rents at $7,800 per month, and the Cardatron Primary System, including the 510 Cardatron Control I, 511 Cardatron Control II, 512 Cardatron Input Unit, 513 Cardatron Output Unit, rents at $2,735 per month.

Abbott

220 Primary System with 5,000 words, Cardatron Primary System (1 in - 1 out), and magnetic tape control and 6 units cost $643,200.

Additional Cardatron output and peripheral equipment (IBM), i.e. 2-087, 2-523, 1-407 cost $129,950.

220 Basic System with Cardatron and 6 magnetic tapes rent at $16,005/month.

Additional Cardatron output and IBM peripheral equipment rent at $3,107/month.

B & W

Basic system including magnetic tape, printer, punch, reader and Cardatron rents at $21,500/month.

Off-line printer, sorter, reproducer, key punches, and verifier rent at $1,500/month.

Rents include maintenance.

BRC

1 Data processor, 1 memory core, 1 core storage unit, 1 core assembly, 1 power control, 1 power supply, 1 control console, 1 supervisory printer, and 1 photoreader cost $320,000.

1 Cardatron Control I, 1 Cardatron Control II, 1 Cardatron input, 2 Cardatron output, 1 magnetic tape control, 6 magnetic tape storage, 1 photoreader, 1 paper tape punch, 1 supervisory printer, 1 Cardatron output, 1 core storage unit, and 8 core assembly cost $484,400.

These rent for $7,800/month and $10,270/month respectively.

Maintenance cost $39,528 per year.

Dow

Primary system $7,800/month with 40% applicable to purchase price. Price approximately $320,000.

Rental/lease of peripheral equipment $6,220/month. Purchase price approximately $200,000 less 40% of rental price.

Basic computer was rented/leased for $7,800/month.

Rental rates for additional equipment

Punches	$100/month
Printers	300/month
Magnetic Tape Control	1,200/month
Magnetic Tape Storage	535/month
Cardatron	2,735/month
Magnetic Tape Storage	635/month.

Maintenance charges on peripheral equipment.

Hoffman

A 5,000 word Core Memory, a Cardatron, 5 Magnetic Tape Units, 2 1 KCPS Photoreaders, Supervisory Printer, IBM 407, 087, 521, and Paper Tape Punch cost approximately $840,000.

The X-Y Plotter cost $32,000.

Maintenance cost approximately $3,000/month.

SKFL

Rental Contracting and Rates for Basic System

Components - Basic System	Type	Monthly Rental
Data Processor	220	
Core Storage	381-1	
Memory Control	380	
Control Console	415	$ 9,300
Paper Tape Punch	470	100
Magnetic Tape Control	550	1,200
Magnetic Tape Storage	551	4,445
Cardatron Control	510	1,200
Cardatron Input	512	715
Cardatron Output (2)	513	1,640
High Speed Printer Control	271	3,950
High Speed Printer	272	2,255
	Total	$24,805

Rental Rates for Additional Equipment

Components - Additional Equip.		
IBM Printer	407	$ 880.00
IBM Card Punch	523	97.90
IBM Card Reader	548	242.00
	Total	$1,219.90

SRI

Power supply, arithmetic unit, console, paper tape reader, paper tape punch, console typewriter output, 2,000 word memory cost $320,000.

$18,000/1,000 words memory (to a total of 10,000 words), card equipment-buffer with read, write and punch facilities, approx. $138,400; magnetic tape control, approx. $45,000; magnetic tape units $21,450 (to a total of 10).

IBM 407, 523, 087, approx. $1,200/month rental.

Maintained by Burroughs (5 tapes, Cardatron 1 in-2 out, primary system) at approx. $2,900/month.

Upjohn

$1,090,000 for the system, which is maximum.

$29,075 per month for the system which is maximum.

Cal Tech

Gift from Burroughs.

Cornell

Data processor, 4 magnetic tapes, memory, Cardatron, paper tape equipment - $600,000.

$18,000 per year for maintenance.

Georgia Tech

Power supply, power control, data processor, memory, Cardatron, paper tape punch, supervisory printer, photoreader, magnetic tape control unit, four magnetic tape storage units, $310,000 (educational rate).

IBM 089, IBM 523, IBM 407, IBM 026 (2), IBM 056 $1,288 per month. 60% educational discount given by IBM.

Maintained by Georgia Tech personnel.

Stanford

Computer, console, photoreader, 2,000 words core, supervisory printer, power control and supply: $320,000.

Paper tape punch, Cardatron (1 input; 2 output), 6,000 words core, 5 magnetic tape storage units: $420,000.

IBM 523, 87, 407: approx. $1,100/month.

Maintenance $40,000/year.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	1	1
Analysts	6	6	6
Programmers	6	6	6
Coders	2	2	2
Librarians	1	1	1
Operators	2	3	4
Engineers	2	4	6
In-Output Oper	1	2	3
Tape Handlers	1	2	3

USA-SRDL

	One 8-Hour Shift
Supervisors	1
Analysts & Programmers	9
Clerks	5
Operators	3

Operations tends toward open shop.

Courses in programming given monthly for technical personnel.

USN LBNS

	One 8-Hour Shift Used	Recommended
Supervisors	3	3
Analysts	6	7
Programmers	11	10
Clerks	3	4
Librarians	1	1
Operators	2	2
In-Output Oper	7	7
Tape Handlers	1	1

Operation tends toward closed shop.

On-site 200 hour course, developed by Shipyard, conducted by Burroughs Corporation. Trainees selected from composite Civil Service Examination (portions applicable from FSEE, EDP, Math, etc.). On-site 40 hour High Speed Printer Course by Burroughs. On-site 80 hour EDP-HSP Course in Operations by Burroughs. On-site courses in Tape and Program Principles by Shipyard - total 120 hours.

All personnel were selected and hired from within the Shipyard. Centralized analysis, programming and operations of all EAM and EDP. EAM personnel excluded (key punch and tabulating). Librarians assist tape handlers.

USAF ACIC

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	5	
Analysts	2	
Programmers	12	
Clerks	5	
Operators	3	3
Engineers	2	
Technicians	5	
In-Output Oper	6	5

Programmers. The programming personnel are divided into groups, each group performing in various fields of application, such as Civilian Payroll, Manhour and Cost Accounting, Chart Inventory and Technical Computations.

Operators. Consists of two console operators and four computer operators. Personnel are divided into two groups and work split shifts. Console operators are also responsible for Tape Library duties. Computer operators, in addition to operating computer, are also responsible for operating supporting EDP equipment.

Engineers & Technicians. Are employees of Burroughs Corporation located at this installation to maintain the 220 computer.

Operation tends toward closed shop.

Methods of training used include courses in Programming, Coding and Operating Techniques presented by manufacturer, various related courses presented by the Air Force, and on-the-job training.

USAF DCS/C ATC

Operation tends toward closed shop.

A combination of formal programming training provided by the manufacturer and on-the-job training.

ATC

	One 8-Hour Shift Used	Recommended
Supervisors	3	5
Analysts	3	5
Programmers	11	17
Clerks	1	2
Librarians		1
Operators	2	2

Operation tends toward closed shop.

Classroom instruction by a Burroughs Corporation instructor and closely supervised on-the-job training.

USGS

	One 8-Hour Shift	
Supervisors	2	
Analysts, Programmers & Coders	8	
Clerks	2	
Librarians-Operators	2	
Engineers-Technicians	2	Burroughs Corp. personnel

Operation tends toward open shop.

Methods of training includes schools sponsored by Manufacturers of equipment and on-the-job training.

Abbott

	One 8-Hour Shift Used	Recommended
Supervisors	1	1
Analysts, Prog. & Coders	8	12
Librarians	1	1
Operators	1	2
Engineers	2-3	3

Methods of training analysts is three week formal course and work with experienced analyst. Operators are given on-the-job training with programmers and engineers.

B & W

	One 8-Hour Shift
Supervisors	3
Analysts-Programmers	12
Operators	3
In-Output Oper	3

Operation tends toward closed shop.

Methods of training used includes two weeks lectures followed by on-the-job training.

BRC

	One 8-Hour Shift Used	Recommended
Supervisors	2	2
Analysts	2	3
Programmers	4	6
Coders	1	2
Clerks	2	2
Librarians	1	1
Operators	3	3
Engineers	3	3

Operation tends toward open shop.

Programmers are trained by supervisory personnel and operators are trained by Burroughs Corporation. They are capable of operating the computer, input and output equipment and all other peripheral equipment.

BCCF

Since the computer is on the premises of one of the manufacturer's (Burroughs) plants, there is a section responsible for the activities of the three systems within the Computer Facilities. The three systems are the Burroughs 205, Burroughs 220, and Burroughs E101. The Computer Facility consists of the manager, two computer specialists, one operator, and one scheduler. With the exception of the operator who is on swing shift, the rest of the staff is on prime shift.

There are three engineers on duty 0400 - 1300 hours for the 220. There is one engineer on standby from 0000 - 0900 hours for all systems in the plant. Other hours are covered by 15 minute on-call engineers. The aforementioned staff is adequate for good system reliability.

Dow

	One 8-Hour Shift
Supervisors	1
Analysts	7
Programmers	2
Clerks	1
Operators	1
In-Output Oper	1
Tape Handlers	1

Operation tends toward open shop.

Training classes for programmers 2 or 3 times a year. Also current information on programming is released regularly.

Hoffman

	One 8-Hour Shift	
	Used	Recommended
Programmers	1	1
Operators	1	1
Engineers	1	1
Technicians	3	3
In-Output Oper	1	1

Operation tends toward open shop.

Methods of training used includes manufacturer's school.

HMPD is authorized to sell computer time to other government contracts at a rate of approximately $50 per hour, which is about one-third the rate normally charged on a service bureau basis for a similar configuration of equipment.

Interested parties are advised to contact:

Edmund M. DiGiulio
Hoffman Military Products Division
3717 South Grand Avenue
Los Angeles 7, California

SKFL

	One 8-Hour Shift	
	Used	Recommended
Supervisors	3	3
Analysts	6	6
Programmers	8	8
Operators	4	5
Engineers	3	2

Operation tends toward open shop.

Methods of training used includes basic punched card indoctrination, formal programming training, formal principles of operation, on-the-job training, and miscellaneous related courses.

SRI

Operation tends toward open shop.

Methods of training used is tutorial, since we add only one or two persons at a time.

The staff is small. Programmer encompasses parts of positions called analyst, programmer, coder, operator.

SRI has a permanent 1 shift clerk-scheduler-librarian-operator (1 person) and a 1 shift (second shift) operator.

Upjohn

	One 8-Hour Shift
Supervisors	1
Analysts	9
Librarians	1
Operators	2

Operation tends toward closed shop.

Methods of training used includes lectures plus time on the system. Only 2 additional operators are required for the second shift.

Cal Tech

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	1	1
Clerks	1	1
Engineers	1	1

Operation tends toward open shop.

Non-credit coding courses given continuously to all interested school personnel.

Operation completely open-shop. All analysis and coding done by users.

Cornell

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

Georgia Tech

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	2	2
Programmers	3	4
Librarians	1	1
Operators	2	2
Engineers	2	2
Technicians	1	

Operation tends toward open shop.

For the most part on-the-job training prevails. Some personnel are sent to schools operated by the manufacturer's of the equipment concerned.

Stanford

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

Operation tends toward open shop.

Methods of training used includes formal classroom.

Deere

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1/2	1
Analysts	2	3
Programmers	2	3
Clerks	1/2	1/2
Operators	1	2
In-Output Oper	1/2	1
Tape Handlers	1/2	1/2

Operation tends toward open shop.

Method of training used is primarily on-the-job with some Burroughs technical training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USA-SRDL
Good time 34 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 1 Oct 59 to 31 Mar 60
Passed Customer Acceptance Test 1 May 59
Time is available for rent to qualified outside organizations.
Arrangements can be made by other government organizations for computer time.

USN LBNS
Average error-free running period 8 hr. operating shift
Good time 69 Hours/Week (Average)
Attempted to run time 76 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.91
Above figures based on period 1 Jul 60 to 31 Jul 60
Passed Customer Acceptance Test 1 Jun 60
Time is not available for rent to outside organizations.

USAF ACIC
Good time 34.3 Hours/Week (Average)
Attempted to run time 36.7 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period 15 Jan to 15 Apr
Passed Customer Acceptance Test Feb 59
Time is not available for rent to outside organizations.

USAF DCS/C ATC
Average error-free runnung period 20 Hours
Good time 57 Hours/Week (Average)
Attempted to run time 59 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.965
Above figures based on period from Jan 60 to Mar 60
Passed Customer Acceptance Test 30 Jun 59
Time is not available for rent to outside organizations.

TAC
Good time 50 Hours/Week (Average)
Attempted to run time 51.9 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.963
Above figures based on period 1 Dec 59 to 30 Apr 60
Passed Customer Acceptance Test 21 Aug 59
Time is available for rent to qualified outside organizations.
Time can be made available to other government activities if an emergency arises.

USGS
Good time 42 1/4 Hours/Week (Average)
Attempted to run time 48 3/4 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.87
Above figures based on period 1 Jul 60 to 30 Jul 60
Passed Customer Acceptance Test 10 Nov 59
Time is available for rent to qualified outside organizations.

Abbott
Good time 72 Hours/Week (Average)
Attempted to run time 87 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.83
Above figures based on period 1 May 60 to 31 Aug 60
Passed Customer Acceptance Test Nov 59
Time is not available for rent to outside organizations.

B & W
Good time 43 Hours/Week (Average)
Attempted to run time 45 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.96
Above figures based on period from Dec 59 to Aug 60
Passed Customer Acceptance Test 4 Dec 59
Time is available for rent to qualified outside organizations.

BRC
Good time 53 Hours/Week (Average)
Attempted to run time 55 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.97
Above figures based on period 6 Jun 60 to 7 Aug 60
Passed Customer Acceptance Test 6 Jun 60
Time is available for rent to outside organizations if the system is not being used for in-house work.

BCCF
Good time 133 Hours/Week (Average)
Attempted to run time 140 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Jan 60 to Jul 60
Passed Customer Acceptance Test Jun 59
Time is available for rent to outside organizations.

Dow
Good time 98 Hours/Week (Average)
Attempted to run time 100 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period from Jan 60 to May 60
Passed Customer Acceptance Test Aug 59
Time is available for rent to qualified outside organizations.
At present we are using computer about 470 hours a month and will probably continue to do so for 6 months.

SKFL
Average error-free running period 5.5 Hours
Good time 38.7 Hours/Week (Average)
Attempted to run time 49.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.786
Above figures based on period 1 Feb 60 to 31 Jul 60
Passed Customer Acceptance Test 31 Dec 59
Time is available for rent to qualified outside organizations.
Renting of computer time to outside concerns is on an "as available" basis. Currently have separately negotiated time buy-back agreement with manufacturer and cooperative time rental agreements with three additional organizations.

SRI
Average error-free running period approx. 12 Hours
Good time 36.80 Hours/Week (Average)
Attempted to run time 40.27 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.914
Above figures based on period 8 Feb 60 to 25 Jul 60
Passed Customer Acceptance Test 1 Mar 60
Time is available for rent to outside organizations.

Upjohn
Good time 64 Hours/Week (Average)
Attempted to run time 75 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period from Jul 60 to Aug 60
Passed Customer Acceptance Test 13 Oct 59
Time is not available for rent to outside organizations.

Cal Tech
Good time 151 Hours/Week (Average)
Attempted to run time 153 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.987
Above figures based on period 15 Mar 60 to 15 Apr 60
Passed Customer Acceptance Test 7 Mar 60
Time is not available for rent to outside organizations.

Cornell
Passed Customer Acceptance Test 15 Sep 59
Time is available for ent to outside organizations.

Georgia Tech
Average error-free running period 3 Hours
Good time 18 1/4 Hours/Week (Average)
Attempted to run time 19 1/4 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period 1 May 60 to 1 Aug 60
Passed Customer Acceptance Test 12 Aug 59
Time is available for rent to outside organizations.

The above figures were taken during an extensive modification period. The entire system is available for rent at $100 per hour for research projects requiring the use of our staff.

Stanford

Time is available for rent to qualified outside organizations.

Deere

Good time 45.6 Hours/Week (Average)
Attempted to run time 53.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 4 Jan 60 to 28 Aug 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Parallel access to storage (11 digits per word).

Automatic storage to storage transfer at 184,000 digits per second.

Direct storage addition, tallying, and program loop control.

Multi-functions instructions, B register, partial word arithmetic, and automatic tallying-reduces program length.

Specially designed logic instructions and controls to simplify programming.

Automatic program "float in".

Facilities for inspection and storage of information on the control console.

Ten program control switches provides flexible manual-control of the computer operation.

An interval timer is available for problem timing.

Magnetic tape subsystem provides file capacity of over 500 million digits, any one of which is readily available in seconds.

Independent bi-directional searching on any part of the first word of any record (for fast file access).

Independent "scanning" on any part of any of the first 10 words of any record.

Updated records may be recorded on the same tape area (selective updating for low-volume file access processing).

Updated records may be recorded on new tape area (total updating for high-volume file access processing).

Selectable record length - 110 to 1,100 digits.

Tape flow areas automatically bypassed.

Automatic parity checking, digit count, and word count.

A complete buffering and editing system connects card readers, card punches, and line printers to the 220 Data Processor.

Complete facilities for input and output with paper tape are available.

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

220 Magnetic Tape Handling: BMTR1 is a general-purpose tape-handling routine which is provided to any installation by the Burroughs Corporation, to insure the most efficient handling of any problems in regard to the use of the magnetic tape system. The operating environment is the same as that specified for the 220 System.

Required storage environment: Temperature, 65 degrees to 80 degrees Fahrenheit; relative humidity, 40% to 60%; electromagnetic fields, not to exceed three oersteds; where radiation is not dangerous to people; free from excessive vibration; dust proof containers; reels placed in boxes and stored on edge in a vertical position. Minimum storage file at least one year when stored as above.

USN LBNS

Magnetic tapes are stored in a fire resistant plaster wall vault built in a concrete warehouse building with automatic overhead sprinkler system. Tapes are filed in individual plastic dustproof containers in an upright position in steel filing cabinets. Tape reels have been numbered serially to identify tapes of varying lengths and block size. Plain masking tape is used to label reels to indicate the pertinent computer application, tape file identify, day's business and tape unit on which created. The storage and operating environment is:

Temperature: 65° to 80° F
Relative Humidity 40% to 60%

USAF ACIC

Magnetic-core internal storage results in high computing speeds and multiple input-output devices provide considerable flexibility in the system. Full-dimensional expansion allows for additions to the system as need arises, such as multiple tape data file, etc.

Magnetic tapes are maintained in the computer room, which is controlled for the proper temperature and humidity. Equipment requirements for fire resistant tape storage have been surveyed and will be submitted for procurement action, subject only to fund limitations.

Remote duplicate storage of critical data and program tape records is in the process of being accomplished. Negotiations are in progress to obtain a surplus underground ammunition storage location from the Department of the Army.

TAC

Outstanding system features include Cardatron system for buffered on-line input and output. This system (Cardatron) also offers complete 80 column alphabetic input and 120 column alphabetic output. Magnetic tape system with ability to search for records independent of main computer operation, and to do selective updating (i.e., to write an updated record back onto the same area of tape from which it was previously read. This precludes the necessity of completely copying a tape during an updating run. High-speed paper tape reader as additional input to system. Very comprehensive control from console for operator intervention and debugging. Magentic tape system with two separate data lanes per tape with independent search and selective update features.

Tapes are identified by a Job Number. Tapes are stored in cabinets commercially produced solely for such purpose. "Original" tapes are protected from humidity and temperature by storage in the computer room. "Duplicate" (copies) tapes are stored in an alternate location to provide for reconstruction of operation in the event of destruction of the "original" tapes (fire, etc.)

Abbott

Unique system advantages include magnetic tape search and scan are not computer interlocked.

B & W

Magnetic tapes are stored in a controlled atmosphere computer room.

BRC

Outstanding features include decimal operation, built-in automatic floating point, partial-word oper-

ation, two-way index register, record transfer, and programmed decisions.

Unique system advantages include complete register display, information entry and inspection, ten program switches, simultaneous, independent operation, automatic editing and format control, choice of formats, and unrestricted alphanumeric operation.

Tapes are labeled, stored, re-edited and pre-blocked periodically. They are wrapped in aluminum foil when shipped. The tapes are stored in the computer room which has temperature and humidity control.

BCCF

Outstanding features include a very compreehnsive magnetic tape system. There are 18 distinct commands, variable length records, buffered searching and scanning without having fixed addresses. The use of a Datafile greatly enhances the use of an operating system. Excellent programming systems are available, such as the Burroughs Assembler - Compiler, Blessed Assembler - Compiler, ALGOL 58 Algebraic Compiler, and the Star 2 Assembler.

Dow

System is an inexpensive high speed computer. Tapes are stored in the computer room. System needs magnetic tape to high speed printer and cards to magnetic tape conversion facility.

SKFL

Outstanding features includes a sophisticated tape sub-system.

Unique system advantages include a forward and reverse search and scan on tape sub-system dual lane tape.

Handling magnetic tape includes the following procedures:

Labelling

Job Identification

Internal Positive Labelling

External Physical Labelling

Storing

Computer site - open 52 reel racks

Retention site - open 52 reel racks

Protecting

Continuous conditioned atmosphere

Computer site protected with semi-auto. CO_2 subfloor system plus CO_2 hand extinguishers

Automatic power shutdown in event the site fire alarm is actuated

98% of site construction and components are of fire proof materials.

Upjohn

Outstanding features include a large core storage.

Magnetic tape is stored under same conditions as computer room - in a tape library. Each reel numbered and a history maintained by this number.

Georgia Tech

Outstanding features include a completely buffered card input and output, completely buffered magnetic tape sub-system, and the ability to simulate the Burroughs 205 System with a speed-up of about 3 to 1.

Magnetic tape is stored in the computer room where the humidity stays between 40 and 60% and the temperature between 70°F and 80°F. It is not protected from fire damage but is stored in metal cabinets.

Deere

Magnetic file label on beginning of tape and physical file label on reel containing file number, reel number, program origin, date, size and type of record. Current files stored in Remington Rand portable storage trucks in air conditioned and humidity controlled computer room. Historical files and unused tape stored in fireproof air conditioned vault.

FUTURE PLANS

USA-SRDL

Plans are being made to do the Laboratory's technical reporting by means of the computer.

USAF ACIC

At present, work effort is being concentrated on conversion of card programs to magnetic tape programs. In addition to the present programs, proposed systems will include personnel administration, consisting of strength reports, workload and staffing, employment requirements, turnover, wage schedules, retention lists, etc.

It will also include mechanization if Air Force film distribution. Air Force projection films are provided for training purposes to the Air Force and to other organizations upon request. This operation will provide for maintenance of film, inventory of film, process of film requisitions and returns.

A new component under consideration is the Burroughs Datafile, a magnetic tape storage device designed for applications requiring large-volume storage. With a maximum capacity of approximately 50 million digits, the Datafile has the ability to skip from one part of a file to another without searching through all the records stored.

Consideration is also being given to substituting the IBM 1401 input-output system for the input-output components presently being used. It appears a substantial increase in capability can be obtained at no increase in cost.

USAF DCS/C ATC

Certain of the existing programs will be refined so that they will operate more efficiently.

The inquiry service provided DCS/Personnel will be expanded duting the coming fiscal year.

TAC

The Burroughs 220 System currently installed will be augmented with additional components (additional core memory, additional tape units, etc.) as required by the increased workload.

A study is currently underway to determine the feasibility of supplementing the Burroughs 220 System with an IBM 1401 System, using a "black box" for language translation.

Abbott

New components are to be card reader 300 cards/min, card punch 200 cards/min, additional core storage (to 10,000 words), and additional tape storage units.

BRC

There is a possibility we may obtain additional peripheral equipment such as a high speed printer and/or another line printer.

BCCF

Replacement of present card input-output equipment with Burroughs equipment. Burroughs Model 289 Line Printer at 150 lines/min, a Burroughs Model 292 Output Unit at 100 cards/min, and a Burroughs Model 293 Input Unit at 300 cards/min.

SKFL

Proposed applications include financial (billing, sales analysis, and payroll), marketing (professional representative expense accounting, listing and selection for international markets, and statistical manipulation of data), manufacturing (inventory reporting and control), and research (statistical manipulation of laboratory data).

Georgia Tech

Plans are being considered to increase the internal speed of the system by about 20%. Some form of off-line magnetic tape equipment is being considered.

INSTALLATIONS

U. S. Army Signal Research & Development Laboratory
Fort Monmouth, New Jersey

Long Beach Naval Shipyard (Code 110)
Long Beach 2, California

USAF Aeronautical Chart & Information Center
2d and Arsenal Streets
St. Louis 18, Missouri

Statistical Services Directorate, DCS/Comptroller
Headquarters Air Training Command
Randolph Air Force Base, Texas

Headquarters, Tactical Air Command
Langley Air Force Base, Virginia

U. S. Geological Survey
Department of Interior
18th and C Streets, N. W.
Washington, D. C.

Abbott Laboratories
1400 Sheridan Road
North Chicago, Illinois

Allstate Insurance Company
Pasadena, California
Detroit, Michigan
Murray Hill, New Jersey
Harrison, New York

The Babcock and Wilcox Company
Van Buren Avenue
Barberton, Ohio

Burroughs Research Center
Paoli, Pennsylvania

Burroughs Corporation, Computer Facility
460 Sierra Madre Villa
Pasadena, California

The Dow Chemical Company
Computations Research Laboratory
687 Building
Midland, Michigan

Hoffman Military Products Division
3740 So. Grand Avenue
Los Angeles 7, California

Smith Kline & French Laboratories
1500 Spring Garden Street
Philadelphia 1, Pennsylvania

Stanford Research Institute
Menlo Park, California

The Upjohn Company
7171 Portage Road
Kalamazoo, Michigan

California Institute of Technology
1201 East California Street
Pasadena, California

Cornell University
Rand Hall, Computing Center
Ithaca, New York

Georgia Institute of Technology
Rich Electronic Computer Center
Atlanta, Georgia

Stanford University
Stanford, California

John Deere Waterloo Tractor Works
400 Miles Street
Waterloo, Iowa

The First Pennsylvania Banking & Trust Company
15th and Chestnut Streets
Philadelphia 1, Pennsylvania

BURROUGHS D 103

Burroughs D103 Computing System

MANUFACTURER

Burroughs Corporation

APPLICATIONS

Real-time control computer

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20
Binary digits/instruction	7
Instructions/word	1
Instructions decoded	64
Arithmetic system	Floating point
Instruction type	One address

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec
Add	5
Mult	65
Div	80
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Dig/Word	Access Microsec
Drum	3,770	96	
Core Registers	20	20	5

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	2,200
Diodes	14,000
Magnetic Cores	1,200

CHECKING FEATURES

A diagnostic program is performed every 19 milliseconds.

Parity checks are made on memory read-in and read-out.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	29 Kw
Volume, computer	450 cu ft
Capacity, air conditioner	9 Tons

ADDITIONAL FEATURES AND REMARKS

Outstanding features are real-time, control designed for installation in an experimental army air defense system. This computer evaluates and controls assignment of up to 20 batteries.

Computing system performs many laborious, detailed calculations to assist commanders in getting maximum effectiveness for their weapons.

BURROUGHS D 104

AN/FST-2 Coordinate Data Transmitter

MANUFACTURER

Burroughs Corporation

APPLICATIONS

Special purpose digital data processor for real time processing of radar data, as input to SAGE Central Computer. Dual equipment. System was designed for U. S. Air Force. All data given is for simplex equipment, except for power, space, weight and sight preparation requirements. These data are given for the duplex equipment.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Digits per output word	52
Timing	Synchronous
Operation	Concurrent

System is wired to perform a special purpose program.

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum	512	48	3,000
Core	512	32	3,000
Drum	1,536	48	9,000

Access times are for cyclic address

INPUT

Media	Pulse Period Microsec
Radar Surveillance Video	3 or 6
Radar Surveillance Video	3 or 6
Radar Height Video	0.5
Radar Height Video	2

Input information is in real-time from radar.

OUTPUT

Medium	Speed
Telephone Line	1300 cycle carrier

600 52-bit words are transmitted on telephone line per 12 second antenna scan.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	7,000
Diodes	25,000
Transistors	4,200

The total component count is 160,000 elements.

CHECKING FEATURES

System has built-in automatic parity and logic alarms.

Marginal checking may be performed at the operator's option.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Data is given for a duplex system

Power, computer	60 Kw	67.5 KVA
Power, air conditioner	100 KVA	
Volume, computer	1,775 cu ft	
Area, computer	943 sq ft	
Room size, computer	23 ft x 41 ft	
Room size, air conditioner	20 ft x 36 ft	
Weight, computer	39,750 lbs	

A false floor has been installed to cover cable runs and air conditioning ducts.

The building is RF shielded to reduce field strength from nearby radar sets.

PRODUCTION RECORD

Number produced to date	100
Number in current operation	85
Number in current production	134
Number on order	134

Time required for delivery from receipt of order 12 months

Data is as of 31 July 1960.

PERSONNEL REQUIREMENTS

Personnel requirements include one engineer and 2, 5, and 7 technicians for one, two and three 8-hour shifts respectively.

Training includes U. S. Air Force sponsored schooling and on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The duplex equipment gives an availability of over 99.7%.

Worst-case design is utilized in digital circuitry.

FUTURE PLANS

U. S. Air Force sponsored improvement program intends to add new state of the art features modifications to increase capability.

BURROUGHS D 105

Atlas Model III Guidance Computer

MANUFACTURER

Burroughs Corporation

APPLICATIONS

The Model III Computer is a special purpose machine designed primarily for real time missile guidance. During the guidance operation, inputs to the computer come from a radar tracking system in the form of velocity and position information. Computed outputs (steering and discrete commands) are transmitted to the radar tracking system for ultimate action by the missile. The computers have been used in a real time range safety system for impact prediction, in addition to missile guidance. Although these are special purpose computers, their logical organization is similar to the general purpose scientific computer.

ARITHMETIC UNIT

Timing	Synchronous
Operation	Sequential

Photo by Burroughs Corporation

INPUT

Medium
- Tracking Radar
- Punched Mylar Tape

Tape is used for checking purposes

OUTPUT

Medium
- Missile Steering and Discrete Commands
- Punched Mylar Tape

Tape is used for checking purposes

CHECKING FEATURES

System includes automatic package and packet test equipment.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufactured in accordance with MIL-E-4158A and other Military Specifications.

BURROUGHS D107

Burroughs Model D-107

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is used for general purpose computation, on line or off line.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	33 + 1 parity
Instruction/word	1
Instructions decoded	64
Arithmetic system	Fixed point
Instruction type	One address

Number range

Thirty three bits, with binary point at the left

Instruction word format

Tag	Com'd Type	Com'd Var.	Address First Modif	Address Second Modif	Register Address	Memory Address	Parity
1	2 - 5	6 - 9	10-12	13-15	16-19	20 - 33	34
1	4	4	3	3	4	14	1

Automatic coding will be available

There are 7 index registers

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec
Add	40
Mult	230 average
Div	426

Construction (Arithmetic unit only)

Transistors	2,750
Diodes	9,350
Registers	6,850
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Bits/Word	Access Microsec
Magnetic Core	4,096 to 16,384	34	0.2

Memory consists of non-destructive, random access, Fluxlok magnetic core. Read time is 0.2 microseconds. Write time (cycle-time) is 13.3 microseconds.

The Fluxlok memory provides a non destructive read feature which guarantees that the program or constants can not be lost due to transient errors.

Magnetic Tape 4 Units

Magnetic tape is not presently included in the system. Provisions are included for its additions.

INPUT

Media	Speed
Paper Tape	300 5-bit char/sec Photo reader
Keyboard	10 char/sec
Parallel Register	0.66 microsec transfer time for 34 bits
Serial Register	23 microsec transfer time for 34 bits

OUTPUT

Media	Speed
Paper Tape Punch	110 dig/sec
Parallel Register	0.66 microsec transfer time for 34 bits
Serial Register	23 microsec transfer time for 34 bits
Teletype Model 28	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	13,160
Transistors	3,470
Magnetic Cores	139,264

Figures are for a 4,096 word system

CHECKING FEATURES

Checking features include parity on all transfers

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1 Kw 1.1 KVA 0.9 pf
Volume, computer	6.75 cu ft
Area, computer	2.1 sq ft
Floor loading	120 lbs/sq ft
	80 lbs, concen. max
Weight, computer	240 lbs

The only requirement is the availability of a lighting type power outlet.

PRODUCTION RECORD

Time required for delivery from receipt of order

12 months

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

"Worst case" circuit design and construction in accordance with military specifications, plug in-subassemblies and Fluxlok memory all contribute to producing an extremely reliable computer design with a mean time between failures of 243 hours.

ADDITIONAL FEATURES AND REMARKS

Unique system advantages include non-destructive read on a random access memory.

BURROUGHS D 201

Burroughs D 201 (NADAC)

MANUFACTURER

Burroughs Corporation

APPLICATIONS

General purpose airborne computer designed to be used in a closed loop system with analog inputs and outputs for real time computations. It may be effectively used as a process control computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	21
Binary digits/instruction	14
Instructions/word	1
Instructions decoded	32 (20 presently used)
Arithmetic system	Fixed point
Instruction type	One address
Number range	19 bits plus sign (fractional)

Instruction word format

Operation	Address	Parity
7 - 11	12 - 19	20
5	8	1

Automatic built-in subroutines includes loading of drum from paper tape.

Registers

Input-Output Register, A Register (accumulator), B Register (Buffer), C Register (auxiliary register and extension of A Register), Operation Register, and Address Register.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	25	3
Mult	75	56
Div	75	68

Construction (Arithmetic unit only)

Transistors	4,761
Diodes	6,500
Magnetic Cores	135
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum	5,225	83,415	5,000
Magnetic Core	128	2,688	2.5

The computer proper has no tape units. However, provisions are made for use of one tape unit. This one channel has the capability of writing 10 binary digits plus sign every 25 microseconds.

INPUT

Media	Remarks
DC Voltage	± 2.000 volts full scale
	32 input channels (multiplexed)
Code Wheel	18 (10 bit plus sign)

OUTPUT

Media	Remarks
DC Voltage	10 channels (multiplexed)
	± 20 volts full scale
Digital to tape recorder	10 bit plus sign

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	6
Diodes	5,200
Transistors	6,600
Magnetic Cores	3,000

CHECKING FEATURES

Checking features include parity check, echo check on loading and diagnostic checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.9 Kw	400 cps
Power, air conditioner	0.25 Kw	400 cps
Volume, computer	6 cu ft	
Volume, air conditioner	2 cu ft	
Area, computer	3 sq ft	
Area, air conditioner	1 sq ft	
Floor loading	100 lbs/sq ft	
	300 lbs, concen max	
Weight, computer	300 lbs	
Weight, air conditioner	100 lbs	

Air conditioner is capable of dissipating 1,000 watts. No special site preparation required.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	10 months

PERSONNEL REQUIREMENTS

Training is made available by the Burroughs Corporation's Military Field Service Division.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Worst case design of all circuits insuring continuing operation with wide drift in parameters.

Extensive heat sinking because of high density packaging and lack of cooling air.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include D to A and A to D conversion at high accuracies and speed. Compact, fast and flexible for limited space requirement. Designed to meet MIL E 5400 Specifications.

BURROUGHS D 202

Airborne Bomb Navigation Computer D 202

MANUFACTURER

Burroughs Corporation

APPLICATIONS

The system is a general purpose airborne computer designed primarily for bombing and navigation computation. System is used in real time, on line.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	22
Binary digits/instruction	15
Instructions/word	1
Number of instructions decoded	36
Arithmetic system	Fixed point
Instruction type	One address
Number range	20 bits plus sign (fractional)

Instruction word format

Command	Address
1 - 5	6 - 14
5	9

Automatic built-in subroutines; include a load drum sub routine.

Registers include an A (accumulator), B (buffer), C (auxiliary register of A), Input-Output, Address, and a Command register.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	10	3
Mult	40	34
Div	80	73

Construction (Arithmetic unit only)	
Transistors	3,000
Condenser-Diodes	18,000
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Drum	12,256	205,288	5,000
Ferrite Core	512	11,264	2

INPUT

Media	Speed	Remarks
Synchro	Continuously Addressable	3 wire servo
Code Wheels	Continuously Addressable	

OUTPUT

Media	Speed	Remarks
Synchro	Continuously Addressable	3 wire servo
DC voltage	Continuously Addressable	
Decimal Display	Continuously Addressable	

Computer is part of a closed loop system. As such inputs and outputs in many cases cannot be specifically specified.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Remarks
Diodes	12,000	Silicon
Transistors	5,000	Silicon

Components are all silicon to meet environment of -55°C to +100°C.

CHECKING FEATURES

Checking features include parity and echo check on loading. Diagnostic checking can also be performed.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.8 Kw
Volume, computer	4.3 cu ft
Area, computer	3.75 sq ft
Floor loading	50 lbs/sq ft
	220 lbs concen max
Weight, computer	220 lbs

No special site preparation requirements.

PRODUCTION RECORD

Number in current production	1
Number on order	1
Time required for delivery	12 months

Machine presently in final stages of test.

PERSONNEL REQUIREMENTS

Training is made available by the Burroughs Corporation, Military Field Service Division.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability includes potted sub assemblies (logi mods) for improved heat dissipation and ease of replacement, all silicon components, and worst case circuit design to insure operation with change in circuit parameters.

System utilizes a unique side entry connector with much higher pin pressure and is designed to MIL E-5400.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include high speed, capacity and flexibility for extremely small size.

Unique system advantages include a variety of inputs and outputs, extreme temperature tolerance, and input-output built on spearate unit to easily modify for other applications.

BURROUGHS D 203

Burroughs Model D 203

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is used for special purpose, small scale, computation and process control.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	26
Instructions/word	1 arithmetic plus 2 memory transfer
Number of instructions decoded	9
Arithmetic system	Fixed point fractional binary
Instruction type	One operand address plus four memory transfer addresses plus next instruction address
Number range	$-2^{-23} + 1$ to $+2^{-23} - 1$

Instruction word format

0 - 9	10 - 15	16 - 19	20 - 25
Memory Control	Op Address	Operation	Next Inst. Address

Registers include an accumulator, multiplier, distribution, instruction, and 2 Buffer Registers.

By means of preselecting operands and placing them in fast access loops, (re memory transfer control above) access time problems are eliminated.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	86	86
Mult	3,000	3,000
Div	3,000	3,000

Construction (Arithmetic unit only)

Transistors	2,400
Diodes	2,800
Resistors	4,900
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Dig	Access Microsec
Magnetic Drum	5,000	160,000	av. 2500
Fast Access loops	14	448	

Minor modifications allow addition of magnetic tape units

INPUT

Media	Speed	
Serial digital	2 words/200 microsec	24 bits
Parallel digital	1 word/200 microsec	24 bits
13 bit synchro inputs	continuous	
10 Discrete inputs		Relay closures

OUTPUT

Media	Speed	
Six Synchro Outputs	continuous	19 bits
Eleven 400 Cycle Voltage	continuous	13 bits
Serial Digital	1 word/200 microsec	24 bits
Parallel Digital	1 word/200 microsec	24 bits

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
T6G	6,900
Transistors	
2N404	6,500
Resistors	10,000

CHECKING FEATURES

Diagnostic routine

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.860 Kw 860 KVA 1.0 pf
Volume, computer	15 cu ft
Area, computer	10 sq ft
Floor loading	200 lbs/sq ft
Weight, computer	600 lbs

Forced air cooling included

ADDITIONAL FEATURES AND REMARKS

Outstanding features include highly accurate analogue output and continuous updating of analogue outputs by means of incremental computing unit.

Unique system advantages include complete solution of access time problems associated with drum by means of novel memory transfer system. System provides highly accurate digital element for essentially analogue systems.

BURROUGHS D 204

Burroughs Submarine Computer Model D 204

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System can be used as a general purpose, solid state, fractional binary, signed magnitude computer. It is currently utilized for stabilization of submarine periscope and radiometric sextant in on-line, real time applications. It has a non-destructive program and constants memory of the linear select Random Access Memory (RAM) type. A-D and D-A conversions, utilizing automatic 10 KC extrapolation, are included.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	29 including sign and parity
Binary digits/instruction	17 including parity
Arithmetic system	Fixed point
Instruction type	One address
Number range	Fractional 0 - 1.0

Instruction word format

Operation	Address	Parity
5	11	1

Automatic built-in subroutines include square root, multiply, division, shift right and left, gray code conversion, real time clock operation, sub routine entry and return.

Automatic coding includes the IBM 704 computer simulator.

Registers

Accumulator	25 bit encoded register
Buffer register	Input-Output register
Program counter	6 Increment register
Address register	8 Total registers
Multiple Quotient register	Operation register
Shift register	Real Time register

There are approximately 40 holding flip flops used for control.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	10.2 - 12.6	2.0
Mult	30 - 108	25 - 100
Div	108	100

Construction (Arithmetic unit only)

Transistors	3360 (2N269, L5129, GA533242 and others)
Condenser-Diodes	8400 (Diodes-T6G and others, capacitors are mostly fixed with porcelain dielectric)
Magnetic -Cores	34,000
Other elements	12,000 (primarily resistors)
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

System is asynchronous in that operations are completed in varying times, concurrent in that main arithmetic solutions are concurrent with incremental output updating.

STORAGE

Media	No. of Words	No. of Digits
Magnetic Core		
Wired core program	1,536	17
Wired core constants	128	29
Random Access Memory (Linear Select)	128	29

INPUT

Media	Speed Microsec	Remarks
Analog to Digital	10.2	3 bit auto shift conversion
Digital	10.2	Maximum 25 bits, serial, parallel operation
Optical Encoder	6.5	3 multiplex 23 bit parallel inputs speed is limited by optical encoder
Manual Switches		25 bits of coded digital, parallel automatically addressed

Computer contains serial-parallel input-output

Register also contains automatic interrupt and start from outside control as a function of data transmission.

Computer has analog to digital converters, optical encoder code wheel inputs, gray code converter, digital input and outputs, six incremental and total extrapolators, 8 channels of digital to analog 10 KC converters, and manual switch inputs.

OUTPUT

Media	Speed Microsec	Remarks
Analog	50	10 KC Converter
Digital	10.2	25 bits parallel - serial

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
TGG	9,890
1N658	130
SG-22	520
Other	550
Transistors	
2N269	1,980
L5129	4,670
2N584	600
Other	1,250
Magnetic Cores	34,000

Includes cores for RAM and program and constants memories.

CHECKING FEATURES

System has parity, overflow and incrementing overflow, and self confidence checking features. Analog to digital null meter and displacement checks are made. Diagnostic program utilizing card reader, analog output voltage or difference checks can be made. Computer contains signals to indicate above

mentioned errors with manual and automatic reset controls.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	1.87 Kw	2.18 KVA	.86 pf
Volume, computer	22.6 cu ft		
Area, computer	4.2 sq ft		
Floor loading	552 lbs/sq ft		
	1,160 lbs concen max		

Computer has been designed to operate in ambient of 75 ± 10°F

Weight, computer 1,160 lbs

System utilizes 2 kilowatts of 400 cycle, 3-phase power and 200 watts of 60 cycle, single-phase power.

PRODUCTION RECORD

Number produced to date	5
Number in current operation	4
Number in current production	5
Number on order	5
Anticipated production rates	one per month
Time required for delivery	7 months

COST, PRICE AND RENTAL RATES

Approximately $160,000 depending on quantity.

PERSONNEL REQUIREMENTS

One technician is required for each 8-hour shift.

Burroughs has provided formal training to naval personnel in operation and maintenance of the SDC. Installation, operation and maintenance personnel can be provided as required.

Computer is designed to operate automatically in real time applications. Operator is required only for turn-on, and turn-off, and to insert data into machine in the event of failure of associated equipments.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Machine essentially satisfies requirements of MIL-I-983B.

Mean time between failures has been calculated to be above 88 hours and appears to be validated by limited field experience.

Worst-cast design philosophy has been used throughout.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include self checking feature, extrapolators, 10 KC digital-analog converters, 8 parallel channels, card reader testing, easily modified for other uses, and easily programmed.

Unique system advantages include word length, speed of operation, input-output accessability, ease of maintenance, and over-under voltage regulation.

FUTURE PLANS

Because of its high computation speed, modifications are planned to extend the function of the machine in its present application. Modifications will include substitution of an 8192, 20 bit word electrically alterable program memory, and a 512 word, 29 bit electrically alterable constants memory for the wired core memories currently used, and increasing the working (RAM) memory to 512 words. Logic changes are to be incorporated which will increase the ease and speed of programming, and will allow operation with additional inputs and outputs on a time shared basis.

INSTALLATIONS

Two machines have been installed and are operating on submarines. Two machines are ready for installation.

BURROUGHS D 208

Burroughs Model D 208

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is suitable for small scale special purpose computing, process control, and missile guidance.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	24
Binary digits/instruction	16
Instructions/word	1
Number of instructions decoded	13
Arithmetic system	Fixed point fractional
Instruction type	One address
Number range	$-(1 - 2^{-23})$ to $(1 - 2^{-23})$

Instruction word format

Operation	Index Bits	Address	Parity
1 - 3	5-6	7 - 15	16
4	2	9	1

Registers include 3 arithmetic registers, 1 Shift Counter, and two 6 bit "orring" index registers.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	26	26
Mult	700	700
Div	750	750

Construction (Arithmetic unit only)

Transistors	1,100
Condenser-Diodes	4,750
Resisters	1,850
Inductances	230
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Non-destructive Ferrite Core Memory	512	8,192	2
Non-destructive Ferrite Core Memory	192	4,608	2
Destructive Ferrite Core Memory	64	1,536	2

Although tape units are not presently associated with the design, minor modifications could allow addition of such equipment.

INPUT

Media

Five D.C. voltages with continuous conversion up to 13 bits
Four parallel digital inputs up to 24 bits
Capacity exists for 256 input channels

OUTPUT

Media

Seven D. C. voltages, continuous, with 13 bits precision
Fifteen Relay inputs
Four parallel digital outputs, up to 24 bits
Capacity exists for 256 output channels

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	7,000
Radio Recepter Type DP834 and DP835	
Transistors	1,820
Philco Type 2N496 and Fairchild Type 2N697	
Magnetic Cores	14,436
30-50 mil cores	
Resistors	3,250
Capacitors	1,150
Inductances	420

Packaged in Burroughs Logi-Mod Technique

CHECKING FEATURES

Parity and diagnostic checking techniques are used.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.225 Kw
Volume, computer	0.52 cu ft
Area, computer	3 sq ft
Weight, computer	33 lbs

Although some cooling is required, no special air conditioning facilities are necessary.

PRODUCTION RECORD

Time required for delivery 18 months

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by the manufacturer to insure required reliability include completely modular construction. All components are encapsulated to Logi Mods to withstand shock, vibrations, and high temperature gradients. Support structure provides heat removal. Cooling is provided by air flow through structure. All semiconductors are silicon.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include compactness, high performance, suitability for general purpose applications, and minimum cooling requirements.

BURROUGHS D 209

Burroughs Digital Differential Analyzer (MADDAM) D 209

MANUFACTURER

Burroughs Corporation

APPLICATIONS

System is a small DDA using advanced packaging techniques. It may be used in a real time control system, specifically missile born guidance system. It may be defined as a high speed serial 16 integrator DDA using a non-destructive read core memory. System has been referred to as MADDAM.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	16
Binary digits/instruction	32
Instructions per word	1/2
Instructions decoded	16
Arithmetic system	Fixed point

Twos complement arithmetic is performed at binary rates.

Masks are used to select integrator inputs

Two one-word masks are used to select precessing dz's.

Number range $1 - 2^{-14}$ to - 1

There is one memory buffer register. Standard DDA organization of controls are used, with the memory acting like a drum.

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec
Add	32 integrator

Construction (Arithmetic unit only)

Transistors	250
Condensers	1,000
Resistors	350
Capacitors	150
Inductors	60
Arithmetic mode	Serial

STORAGE

Media	No. of Words	Access Microsec
Non-destructive Read Magnetic Core	48	0.5
Destructive Read Magnetic Core	33	0.5

INPUT

Media

Analogue

Delta modulation conversion to digital

OUTPUT

Medium

Analogue

Delta de-modulation conversion from digital

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
PD202-P.S.I.	1,626
Transistors	700
2N718	
2N706	
Fairchild	
Magnetic Cores	1,296

CHECKING FEATURES

Parity checking and error recovery

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	Battery operated
Volume, computer	0.1 cu ft
Area, computer	0.3 sq ft

System is desk size

Heat sinks in frame preclude need for air conditioner

Weight, computer 12 lbs

Battery operation precludes need for site preparation

PRODUCTION RECORD

Number produced to date	1
Number in current production	several/month
Anticipated production rates	10/month

PERSONNEL REQUIREMENTS

Computer programs for special purposes are supplied.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Reliability is achieved by macro-module construction, Fluxlok permanent memory and HTDL logic. First unit was completed in October 1960.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include the fact that this extremely small, fast DDA can be used in missile systems.

Unique system advantages include advanced packaging techniques and Fluxlok memory.

System operates up to 125°C at 100% humidity.

Machine memory is expandable if desired.

BURROUGHS E 101

Burroughs Model E 101 Electronic Digital Computer

MANUFACTURER

Burroughs Corporation

Photo by the Burroughs Corporation

APPLICATIONS

Manufacturer
Scientific and business

U. S. A. Corps of Engineers, Cincinnati
Located in Room 450, 315 S. Main Street, Cincinnati, Ohio, the system is used for Hydrology, Hydraulics, and Statistics.

U. S. A. Corps of Engineers, Huntington
Located at 502 Eighth Street, Huntington, West Virginia, the system is used for Hydrology, Hydraulics, Statistics, and Structures.

U. S. A. Corps of Engineers, Philadelphia
Located at Operations Division, U. S. Army Engineer District, Philadelphia, the system is used for Dredging Quantities, Survey Traverse Closure Adjustments, Sextant Chart Layout, Reservoir Operations, Back water Profile (subcritical) including overbank flow, Cross Sectional Areas - Beach Profile, Deviation, Mean and Skew Computation on Concrete Samples, Quantity Take-off for Earthfill Dam, and Payroll Computation and Distribution.

U. S. A. Corps of Engineer, Tulsa
Located at Tulsa, Oklahoma, the system is used for Hydraulic, Hydrologic, Civil Engineering and Payroll Computations.

U. S. A. Corps of Engineers, Washington
Located at 1st & Douglas Streets, N. W., Washington D. C., the system is used for Hydraulics & Hydrology (Engineering), Statistics (Engineering), Structural Design (Engineering), and Cost Distribution (Accounting).

NATC, Patuxent River
Located at Armament Test, the system is used for problems previously done on desk calculators, and preliminary calculation required on larger problems prior to entry into the Burroughs 205.

City & County of San Francisco
Located at City Hall, system is used by the Department of Public Works.

Automobile Carriers, Inc.
System is used to prepare daily billing, compute payroll data, and to compile mileage and tonnage statistics.

Burroughs Military Electronic Computer Division
Located at the Military Electronic Computer Division, 14300 Tireman, Detroit 28, the system is used for the generation of SAGE AN/FST-2 performance parameters such as Availability, Reliability, Maintainability, and Mean-time-between-failures; for the SAGE AN/FST-2 critical part and assembly removal rate analysis: Units that were removed at an excessive rate during a given period are determined and listed; and for miscellaneous tabulations, such as Public Voucher Accounting tabulations listing total expenditures on a given contract by account number for material, labor, burden, % G&A, etc.

Hudson Engineering Corporation
Located at 5900 Hillcroft, Houston, Texas, the system is used for process design calculation, structural design, and pipeline design.

Morgan Guaranty Trust Company of New York
Located at 140 Broadway, New York 15, N. Y., the system is used for loan bookkeeping.

United States Rubber Company Research Center
Located at U. S. Rubber Company Research Center, Alps Road, Wayne, New Jersey, the system is used for maximization of polynomials representing rubber properties, evaluation of theoretical functions over wide ranges, contour plotting of polynomials, correlation and regression analysis, curve fitting, real and complex roots of polynomials, and solutions to special functions.

ZOOMAR Inc.
Located at Zoomar Inc., 55 Sea Cliff Avenue, Glen Cove, N. Y., system is used for optical design calculations, especially ray tracing.

Bucknell University
Located at the Engineering Building, system is used for education at all levels.

Photo by U. S. Army Corps of Engineers

Colorado State University
Located at Colorado State University, the system is used for statistical analysis and for training in computer operating and programming.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer	
Internal number system	Binary coded decimal
Decimal digits/word	12 + sign
Decimal digits/instruction	3
Instructions per word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-10\ (1-10^{-11}) \leq n \leq +10\ (1-10^{11})$

ARITHMETIC UNIT

Manufacturer

	Incl Stor Access Microsec
Add	50,000
Mult	250,000
Div	250,000

Construction (Arithmetic unit only)
Constructed of vacuum tubes and diodes

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	220	2,640	8,500
Paper Tape			
Punch Cards			

External pinboard programming, 128 program steps.
Drum makes one rotation in 16.9 milliseconds.

INPUT

Manufacturer

Media	Speed
Keyboard	Manual
Paper Tape	0.5 sec to read
Cards	20 char/sec

U. S. A. Corps of Engineers, Philadelphia

11 column Keyboard	24 char/sec

Sensimatic Model F-1

Punched Paper Tape Input, Model A531	20 char/sec

8 channel tape

Duplex Paper Tape Input, Model A532	20 char/sec

8 channel tape
Duplex Unit permits reading of two input tapes alternately and provides program extension.

U. S. A. Corps of Engineers, Tulsa

Keyboard	533 Milliseconds
Paper Tape	50D + 133 Milliseconds, where D = Number of digits.

U. S. A. Corps of Engineers, Washington

Punched Paper Tape	20 char/sec
11 Digit Keyboard	

NATC, Patuxent River

Keyboard	Manual
Paper Tape	0.5 sec to read

The Tape Input Unit, Model A531, is capable of accepting a seven channel punched paper data tape prepared in the Burroughs 204 code or standard E101-3 code. Choice is made with an externally mounted, manually operated switch. Entries regarding input are from manufacturer's specifications.

Automobile Carriers, Inc.

Keyboard	7 char/sec, plus sign
Paper Tape	20 char/sec, plus sign

Burroughs Military Electronic Computer Division

Card (A536)	17 digits/sec
Keyboard	

Not suitable for data reduction programs for large quantity of input. Adequate for wide range of application in research, design, and business.

ZOOMAR Inc.

Media	Speed
Full 11 Column Keyboard	
Paper Tape (Duplex)	20 char/sec

2 reading heads permit simultaneously use of 2 program-or data-tapes. Instructions are executed directly from tape and therefore do not require storage space.

Colorado State University

Cards	20 char/sec

OUTPUT

Manufacturer

Media	Speed	
Printer (Sensimatic)	24 digits/sec	
Paper Tape	0.33 secs to punch	Buffered
Punch Card	20 char/sec	Buffered

U. S. A. Corps of Engineers, Huntington

Printer	24 dec dig/sec
Paper Tape	600 dec dig/min

NATC, Patuxent River
The Tape Punch, Model A516, is capable of preparing a data tape in the seven channel Burroughs 204 code in addition to punching a program or data tape in E101-3 code.

Automobile Carriers Inc.

Posting Machine	20 char/sec
Paper Tape	10 char/sec (For data)
	13 char/sec (For instructions)

ZOOMAR Inc.

Printer (ganged)	Two 12-digit words/sec
Tape Punch	20 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity
Tubes	160
Diodes	1,800

CHECKING FEATURES

Manufacturer
Checking features include plug-in circuitry, marginal voltage checking, internal program checking, parity check on paper tape input and output, and automatic error detection in printing circuits.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	3 Kw
Room size	Desk size
Weight, computer	1,800 lbs

U. S. A. Corps of Engineers, Cincinnati

Power, computer	3 Kw
Volume, computer	60 cu ft
Area, computer	20 sq ft

U. S. A. Corps of Engineers, Huntington

Room size	10.5 Ft x 19.0 ft

U. S. A. Corps of Engineers, Philadelphia
Enclosed 12 1/2 ft x 16 ft space and extended existing power service to provide 2 - 220 volt service lines in room.

U. S. A. Corps of Engineers, Tulsa
Capacity, air conditioner 2 Tons
Air conditioner 2 one-ton window units
Ran 220 volt line for computer and air conditioners.

U. S. A. Corps of Engineers, Washington
Floor loading 110 lbs/sq ft
400 lbs concen max
Does not require air conditioning in excess of normal office air conditioning.

NATC, Patuxent River
The E101-3 was installed in a room 16.5 ft x 39 ft already housing some data reduction equipment. The floor was reinforced to meet load requirements. Existing air conditioning was adequate to absorb E101-3 heat generated, therefore existing air conditioner is used.

Automobile Carriers Inc.
Room size 12 ft x 12 ft minimum
115-230 volt 3 wire single phase plus a ground wire. Terminate line in a 2 pole 20 amp circuit breaker. For small room, 2 window air conditioning units are recommended.

Burroughs Military Electronic Computer Division
Voltage: 230V, three phase, 115V three phase power line, 25 amps. 6 seven inch fans are used for ventilation.

Hudson Engineering Corporation
Acoustical treatment of walls, ceiling and floor. Exhaust ducts and hoods to remove air directly from machines.
Two tons of air conditioning was added to central unit.

U. S. Rubber Company Research Center
Floor loading 67 lbs/sq ft

ZOOMAR Inc.
Room size 10 ft x 10 ft minimum
220V single phase special power line.

Bucknell University
Air conditioner Window size

Colorado State University
Floor loading 20 lbs/sq ft
500 lbs concen max

PRODUCTION RECORD

Manufacturer
Number in current operation 127
Time required for delivery 4 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost	Monthly Rental
Basic System	$29,750	$875
Computer, Model E-101. (Includes Magnetic Drum Memory of 220 words of 12 digits each, 16 removable pinboards for external programming (eight pinboards may be used with the E-101 at one time) and Keyboard Printer with 11-column keyboard for input, and 12 digit + sign output		
Additional equipment		
Punched Paper Tape Input	2,950	85
Punched Paper Tape Output	2,950	85
Punched Card Input	3,450	105
Punched Card Output	2,375	70

Preventive maintenance is performed monthly by the Burroughs engineers, other service is on an "ON-CALL" basis.

U. S. A. Corps of Engineers, Cincinnati
Basic system
G. S. A. Contract $1,000/month.
Additional equipment
G. S. A. Contract Tape Input $100/month.
Maintenance/service contracting is included in the rental.

U. S. A. Corps of Engineers, Philadelphia

	Cost	Monthly Rental
Computer, Model E-101	$38,325	$1,000
Punched Paper Tape Input, Model A531	3,765	100
Duplex Paper Tape Input, Model A532	2,375	65

Maintenance/service contracting is included in monthly rental; $2,600 is paid annually on purchased equipment.

U. S. A. Corps of Engineers, Tulsa
Flexowriter cost $2,623.50.
E-101 Computer rents at $1,000 per month.
Tape Input Unit rents at $165 per month and Tape Output Unit rents at $100 per month.
Flexowriter service is $150 per year.

NATC, Patuxent River
1 E101-3 Computer, 1 Punched Paper Tape Input Unit, Model A531, and 1 Punched Paper Tape Output Unit, Model A516 cost $33,100.

Automobile Carriers Inc.
Rental rate for basic system is $875 per month.
Rental rates for additional equipment per month
Tape Input $100
Tape Outputs 100
Additional pinboards 50

Burroughs Military Electronic Computer Division
The E 101-3, A536, and A516 is rented at $1,300 per month.

Hudson Engineering Corporation
Two of the following systems were purchased:
Computer $30,000
Tape Input 2,500
Tape Output 3,500
A Flexowriter was purchased at $2,500.
Maintenance/service is $2,500/year on each system.

U. S. Rubber Company Research Center
Computer $37,730
Tape Input Unit 6,810
Tape Output Unit 4,010
Additional Pinboard Units 360
Maintenance service at $2,780 per annum.

ZOOMAR Inc.
System cost $36,550.
Additional equipment rents at $3,480 per annum.
Maintenance service cost $2,400 per annum.

Colorado State University
Computer only, with educational discount $30,000
Cost of input 2,500
IBM-EAM 220/mo.
Burrough Service Contract $2,400/year.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift
Programmers	1
Operators	1
Engineers	1

Programming and operating instructions will be given at no cost to the customer either at his installation or at the manufacturer's facilities.

U. S. A. Corps of Engineers, Cincinnati

One part time supervisor and one operator.
Operation tends toward open shop.
Manufacturer's training is used.

U. S. A. Corps of Engineers, Huntington

	One 8-Hour Shift	
Supervisors	1	part time
Programmers	1	part time
Operators	1	

Manufacturer's training is used.

U. S. A. Corps of Engineers, Philadelphia

	One 8-Hour Shift	
	Used	Recommended
Programmers	1/2	1/2
Operators	1/2	1/2
In-Output Opera	1/2	1/2

Operation tends toward closed shop.
Classroom instruction by Burroughs Corporation in basic programming and operating techniques. On-the-job training for operators and programmers as required.

U. S. A. Corps of Engineers, Tulsa

	One 8-Hour Shift		
	Used	Recommended	
Supervisors	1	1	part time
Operators	1	1	part time

Operation tends toward open shop.
Two day programming schools conducted by Burroughs Corporation are utilized.

U. S. A. Corps of Engineers, Washington

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1/4	1
Programmers	1/2	1
Engineers	1/2	1

Operation tends toward open shop.
Training accomplished by manufacturer at no cost.

NATC, Patuxent River

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	14	14

Operation tends toward open shop.
The training received by programmers is that which is available through the computer manufacturer. Programming is not a primary duty of mathematicians or mathematics aids.

Automobile Carriers Inc.

	One 8-Hour Shift
Programmers	1
Operators	1

Operation tends toward open shop.

Burroughs Military Electronic Computer Division

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	1	1
Clerks	1	1

Operation tends toward closed shop.
Classroom type grouped training is given.

Hudson Engineering Corporation

	One 8-Hour Shift
Supervisors	1
Programmers	1
Operators	2

Operation tends toward open shop.
On-the-job training is given.

U. S. Rubber Company Research Center

	One 8-Hour Shift
Supervisors	1
Analysts	1
Programmers	1

Operation tends toward closed shop.
Methods of training used include on-the-job training and partial tuition refund plan.

ZOOMAR Inc.

	One 8-Hour Shift
Analysts-Programmers	1
Operators	1

Operation tends towards closed shop.

Colorado State University

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	
Analysts	1	4
Programmers	6	6
Coders	0	10
Clerks	2	2
Librarians	0	1
Operators	1	2
Engineers	1	1
Technicians	0	1

Operation tends toward open shop.
Methods of training used:
Seminars for staff personnel
Regular classes for students
System is used for instruction in computer programming, coding, and operating.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

U. S. A. Corps of Engineers, Cincinnati

Good time 41 Hours/Week (Average)
Attempted to run time 42 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period from Apr 57 to Jun 60
Passed Customer Acceptance Test Nov 56
Time is available for rent to certain qualified outside organizations.

U. S. A. Corps of Engineers, Huntington

Good time 39 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) .0975
Above figures based on period from Feb 58 to Jun 60
Passed Customer Acceptance Test Feb 58
Time is not available for rent to outside organizations.

U. S. A. Corps of Engineers, Philadelphia

Average error-free running period 18 months
Operating ratio (Good/ Attempted to run time) 1.0
Above figures based on period 1 Jan 60 to 30 Jun 60
Passed Customer Acceptance Test 18 Jul 60
Time is available for rent to qualified outside organizations.

Information based on rental on a service bureau E-101 computer used exclusively by this organization. This organization has experienced only one occasion in 18 months of operation of service bureau machine wherein the E-101 made an undetected error. Time would be made available for rental to outside organizations on a second shift basis. Qualified opera-

tors would normally be expected to be provided by user.

U. S. A. Corps of Engineers, Tulsa
Average error-free running period 1 Week
Good time 34 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.85
Above figures based on period 1 Feb 58 to 31 Jun 60
Passed Customer Acceptance Test L Feb 58
Time is not available for rent to outside organizations.

U. S. A. Corps of Engineers, Washington
Average error-free running period 1 Month
Good time 21 Hours/Week (Average)
Attempted to run time 22 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.96
Above figures based on period from Jun 58 to Jun 60
Passed Customer Acceptance Test 1 Jul 60
Time is available for rent to outside organizations.
Running time data based on E-101 installation.
Current system installed 1 July 1960.

NATC, Patuxent River
Operating experience is kept on a monthly basis. The figures below are monthly averages:

Production	54.1
Program Checking	13.8
Idle	72.9
Down	11.6

Above figures based on period 1 Jan 60 to 31 Mar 60
Passed Customer Acceptance Test Aug 59

Automobile Carriers Inc.
Good time 31 Hours/Week (Average)
Attempted to run time 33 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period 1 Aug 60 to 31 Aug 60
Time is available for rent to qualified outside organizations.

Burroughs Military Electronic Computer Division
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 Jan 58 to Jan 59
Time is not available for rent to outside organizations.

Hudson Engineering Corporation
Operating ratio (Good/Attempted to run time) 0.90
Time is available for rent to qualified outside organizations.

Morgan Guaranty Trust Company of New York
Time is not available for rent to outside organizations.

U. S. Rubber Company Research Center
Good time 21.4 Hours/Week (Average)
Attempted to run time 23.1 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.926
Above figures based on period 1 Oct 59 to 1 Jul 60
Passed Customer Acceptance Test Dec 57
Time is not available for rent to outside organizations.

ZOOMAR Inc.
Good time 32 Hours/Week (Average)
Attempted to run time 40 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.80
Above figures based on period 1 Jan to 31 Jul
Time is not available for rent to outside organizations.

Bucknell University
Operating ratio (Good/Attempted to run time) 0.8
Passed Customer Acceptance Test Jul 58
Time is available for rent to qualified outside organizations.

Colorado State University
Good time 15 Hours/Week (Average)
Attempted to run time 18 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.833
Above figures based on period from Aug 58 to Apr 60
Passed Customer Acceptance Test Aug 58
Time is available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer
Card output adapter permits connection of a keypunch to enable output data only from the computer accumulator. The multiple input adapter enables the simultaneous connection of a punch paper tape input and a punch card input, a duplex paper tape input and a punched card input or a duplex paper tape input and a second paper tape input.
Unique system advantages include ease of programming and complete formatting ability with the Burroughs Sensimatic Printer.

U. S. A. Corps of Engineers, Huntington
Outstanding features include ease of programming.

U. S. A. Corps of Engineers, Philadelphia
Outstanding features are operating flexibility - automatic or operator intervention, external pinboard programming permits program modification or alteration with minimum of delay, and automatic address modification by means of 2 counters for sequencing in repetitive operations. External pinboard programming is unique with the E-101; provides a means of quickly and easily modifying program based on intermediate results, experience and judgment.

U. S. A. Corps of Engineers, Washington
This machine is very easy to program and operate, thus enabling engineering personnel to program and run their own programs.

NATC, Patuxent River
Unique system advantages include tape input and output compatibility with other systems, such as semi-automatic film readers, Datatron 204, and electric plotter.

Burroughs Military Electronic Computer Division
Outstanding features include ease of operation. The system brings advantages of electronic computation into the area of small calculating problems.

U. S. Rubber Company Research Center
Outstanding features include programming simplicity and ease of operation.
Unique system advantages include rapid program development, which permits economical use of computer for many "one-shot" programs as well as standard routines.
Paper tape is stored in special loose-leaf binder.

ZOOMAR Inc
Outstanding features are ease of programming and operation. System can be operated like a desk calculator, but at much greater speed. Allows the economical handling of problems, usually not assignable to larger digital computers.

Colorado State University
An outstanding feature is its simplicity. It serves as an excellent training device.

FUTURE PLANS

U. S. A. Corps of Engineers, Huntington
We will expand to two shifts.

U. S. A. Corps of Engineers, Philadelphia
Plan to obtain Punched Paper Tape Output, Model A516 ($100/monthly lease) to be able to handle additional accounting applications.

NATC, Patuxent River
Purchase of a duplex paper tape input unit for use with the installed Model A531 Tape Input Unit. This will form a system whereby commands and data in E101-3 or Burroughs 204 code may be read alternately without changing tapes.

INSTALLATIONS

U. S. Army Chemical Center
Edgewood, Maryland

Army Ballistics Missile Agency
Redstone Arsenal
Huntsville, Alabama

Army Ballistic Missile Agency
Cape Canavaral, Florida

U. S. A. Corps of Engineers, Ohio River
315 -335 Main Street
Cincinnati, Ohio

U. S. A. Corps of Engineers, Huntington
502 8th Street
Huntington 1, West Virginia

U. S. A. Corps of Engineers, Philadelphia
2635 Abbottsford Avenue
Philadelphia 29, Pennsylvania

U. S. A. Corps of Engineers, Tulsa
Tulsa, Oklahoma

U. S. A. Corps of Engineers, Washington
First and Douglas Streets NW
Washington 25, D. C.

Frankford Arsenal
Philadelphia, Pennsylvania

White Sands Missile Range
New Mexico

Bureau of Yards and Docks
Washington, D. C.

Armament Test, NATC,
Patuxent River, Maryland

David Taylor Model Basin
Carderock, Maryland

U. S. Naval Research Laboratory
Vanguard Project
Cape Canaveral, Florida

Edwards Air Force Base
California

Wright Air Development Center
Wright-Patterson Air Force Base
Fairborn, Ohio

Defense Supply Service
Washington, D. C.

California Institute of Technology
Jet Propulsion Laboratories (NASA)
Pasadena, California

Space Technology Laboratories
Los Angeles, California

Department of Public Works
City and County of San Francisco, City Hall
San Francisco, California

Aerojet-General Corporation
Azusa, California

Beech Aircraft Corporation
Wichita, Kansas

Bell Helicopter Corporation
Fort Worth, Texas

Boeing Airplane Company
Flight Test Division
Seattle, Washington

Convair
San Diego, California

Douglas Aircraft Company
El Segundo, California

Fairchild Guided Missiles
Astrionics Division
Wyandauch, Long Island, New York

Hughes Aircraft Company
Culver City, California

McDonnell Aircraft Corporation
St. Louis, Missouri

North American Aviation
Los Angeles, California

Pratt and Whitney Aircraft
East Hartford, Connecticut

Federal Reserve Bank of Chicago
Chicago, Illinois

First National City Bank
New York City, New York

Morgan Guaranty Trust Company of New York
140 Broadway
New York 15, New York

Wachovia Bank and Trust Company
Winston-Salem, North Carolina

Aetna Life Insurance Company
Hartford, Connecticut

Colonial Life Insurance Company
East Orange, New Jersey

General Insurance Company of America
Seattle, Washington

Mutual Insurance Advisory Association
New York City, New York

Mutual Insurance Company of New York
New York City, New York

National Bureau of Casualty Underwriters
New York City, New York

The Travelers Insurance Company
Hartford, Connecticut

Ethyl Corporation
Detroit, Michigan

Humble Oil Company
Baytown, Texas

Standard Oil Company
Cleveland, Ohio

Sun Oil Company
Philadelphia, Pennsylvania

Alega Engineers Incorporated
Houston, Texas

All American Engineering Company
Wilmington, Delaware

American Research Corporation
Atlanta, Georgia

American Totalisator Company
Baltimore, Maryland

Automobile Carriers, Inc.
P. O. Box 128
Flint, Michigan

Burroughs Military Electronic Computer Division
14300 Tireman
Detroit 28, Michigan

Edgerton, Germeshausen and Grier, Inc.
Boston, Massachusetts

General Electric Company
Philadelphia, Pennsylvania

General Electric Company
Syracuse, New York

Hudson Engineering Corporation
5900 Hillcroft
Houston, Texas

Kollmorgen Optical Corporation
Northampton, Massachusetts

Minneapolis-Honeywell Regulator Company
Philadelphia, Pennsylvania

Morgan Construction Company
Worcester, Massachusetts

Olin Mathieson Chemical Corporation
New Haven, Connecticut

Paoli Research Center
Burroughs Corporation
Paoli, Pennsylvania

Praeger-Kavanagh Engineering
New York City, New York

Radio Corporation of America
Waltham, Massachusetts

Smith Kline and French Laboratories
Philadelphia, Pennsylvania

Tung - Sol Electric Incorporated
Newark, New Jersey

The Upjohn Company
Kalamazoo, Michigan

U. S. Rubber Company Research Center
Alps Road
Wayne, New Jersey

U. S. Steel Corporation
Monroeville, Pennsylvania

Ward Baking Company
Chicago, Illinois

Westinghouse Electric Corporation
Aviation Gas Turbine Division
Kansas City, Missouri

Westinghouse Electric Corporation
Sharon, Pennsylvania

ZOOMAR Incorporated
55 Sea Cliff Avenue
Glen Cove, Long Island, New York

Bucknell University
Lewisburg, Pennsylvania

Colorado State University
Computing Center
Fort Collins, Colorado

Georgetown University
Washington, D. C.

Institute of Textile Technology
Charlottesville, Virginia

Massachusetts Institute of Technology
Cambridge, Massachusetts

New York University
New York City, New York

Syracuse University
Syracuse, New York

University of Cincinnati
Cincinnati, Ohio

University of Detroit
Detroit, Michigan

University of Missouri
Columbia, Missouri

University of Pennsylvania
Philadelphia, Pennsylvania

BURROUGHS E 102

Burroughs Model E 102 Electronic Digital Computer

MANUFACTURER

Burroughs Corporation

Photo by U. S. Army Engineer District, Kansas City

APPLICATIONS

Manufacturer

Scientific and business. System is similar to the BURROUGHS E 101.

U. S. Army Engineer District, Kansas City

Located on the Mezz. Floor, Federal Office Building, Kansas City 6, Missouri, the system is used for engineering, mathematical and scientific applications, including structural analysis and design, hydraulic and hydrological studies, soils, earthwork and dredging, and topography and geodetics.

Burroughs Corporation

Located at the Burroughs Corporation, Military Electronic Computer Division, 14300 Tireman, Detroit 28, Michigan, the system is used for the generation of SAGE AN/FST-2 performance parameters such as availability, reliability, maintainability, and mean-time-between-failures; for the SAGE AN/FST-2 critical part and assembly removal rate analysis. Units that were removed at an excessive rate during a given period are determined and listed; and for miscellaneous tabulations such as public voucher accounting tabulations listing total expenditures on a given contract by account number for material, labor, burden, % G and A, etc.

Burroughs Corporation

Located at the Burroughs Corporation, Methods and Procedures Division, 6071 Second Avenue, Detroit 32, Michigan, the system is used for inventory extension, sales quota calculation, master card part cost extension, and miscellaneous engineering design problems.

Edgerton, Germeshausen & Grier, Inc.

Located at 160 Brookline Avenue, Boston, Mass., the system is used for photogrammetric data processing (triangulations, dimensional measurements), statistical calculations (correlation coefficients, least squares curve fitting, etc.), and occasional business statistical uses.

Photo by Edgerton, Germeshausen & Grier, Incorporated

Space Technology Laboratories, Inc.
Located at the Computation and Data Reduction Center, 2400 E. El Segundo Blvd., El Segundo, California, the system is used for small scale scientific computations.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	12 + sign
Decimal digits/instruction	3
Instructions/word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-10\ (1-10^{-11}) \leq n \leq +10\ (1-10^{11})$

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	50,000
Mult	250,000
Div	250,000

Construction (Arithmetic unit only)
Constructed of vacuum tubes and diodes

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	220	2,640	8,500
Paper Tape			
Punch Cards			

External pinboard programming, 128 program steps.
Drum makes one rotation in 16.9 milliseconds.
All of the above five reporting users utilize the 220 word magnetic drum memory.

INPUT

Manufacturer

Media	Speed
Keyboard	Manual
Paper Tape	0.5 sec. to read
Card	20 char/sec

All of the five reporting users utilize the 11 column keyboard and punched paper tape input.

OUTPUT

Manufacturer

Media	Speed
Printer (Sensimatic)	24 digits/sec
Paper Tape	0.33 secs to punch Buffered
Punch Card	20 char/sec Buffered

All of the five reporting users utilize the Sensimatic Printer.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	160
Diodes	1,800

CHECKING FEATURES

Checking features include plug-in circuitry, marginal voltage checking, internal program checking, parity check on paper tape input and output, and automatic error detection in printing circuits.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer		3 Kw	
Room size, computer		Desk Size	
Weight, computer		1,800 lbs	
USAD, Kansas City			
Power, computer	3.0 Kw	3.0 KVA	1.0 pf
Volume, computer		50 cu ft	
Area, computer		17 sq ft	
Room size, computer		18 ft x 23 ft	
Floor loading		82.5 lbs/sq ft	
		1,400 lbs concen max	
Weight, computer		1,400 lbs	

Basically the only site preparation was the installation of an adequate power supply. (115-230 volt, 3-wire, single-phase circuit) If building air conditioning is not available, about 1 1/2 tons would be required for the space utilized.

Burroughs Corp., 14300 Tireman

Power, computer	2.8-5.7 KVA
Volume, computer	Desk Size
Area, computer	100 sq ft
Room size, computer	144 sq ft

Voltage: 230 three-phase, 115 three-phase; 25 amps. No installation preparations other than electrical power line. Six 7 inch fans.

Burroughs Corp.

Power, computer	2.8-5.7 KVA
Area, computer	100 sq ft
Room size, computer	144 sq ft

No installation preparations other than electrical power line. Six 7 inch fans.

E, G & G, Inc.

Power, computer	3.5 Kw
Area, computer	20 sq ft
Room size, computer	12 ft x 12 ft

Computer generates 12,000 BTU. We have no special air conditioner. The computer is located in standard air conditioned environment. No special building modifications. Installation of power cable required; 115 230 volt, 3 wire single phase plus ground.

STL

Power, computer	2.5 KVA
Volume, computer	1,500 cu ft
Area, computer	150 sq ft
Floor loading	80 lbs/sq ft

Air conditioner is included in house system. No special site preparation required.

PRODUCTION RECORD

Number in current operation	127
Time required for delivery	4 months

COST, PRICE AND RENTAL RATES

USAD, Kansas City

E-102 Computer rents at $1,000/month.
Model A531 Punched Paper Tape Input Unit rents for $100/month.
Maintenance is furnished along with the basic rental price of the system.

Burroughs Corp., 14300 Tireman

The E-102 and A531 rents at $1,175/month.

Burroughs Corp.

The E-102 and A531 purchase cost was $42,090.

E, G & G, Inc.

The E-102 cost $30,000.
The tape input unit cost $10,000.
No contract - service as required.

STL

System cost $28,000 and rents at $1,100/month. Service is included in rental.

PERSONNEL REQUIREMENTS

Manufacturer

	Each 8-Hour Shift
Programmer	1
Operator	1
Engineer	1

Programming and operating instructions will be given at no cost to the customer either at his installation or at the manufacturer's facilities.

USAD, Kansas City

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	1	2
Clerks	1	1

The supervisor is also a programmer.

Operation tends toward open shop. The installation is operated as an "open shop" with "closed shop" programming assistance as required. The semi-open shop method of operation is desirable due to the simplicity of machine operation and due to the fact that open shop operation stimulates interest at the problem solving level and permits our design engineers to telescope years of design experience into a few months.

Methods of training used includes formal programming training by manufacturer, individual instruction by installation employees, and on-the-job training.

Burroughs Corp., 14300 Tireman

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	1	1
Programmers	1	1
Clerks	1	1

Operation tends toward closed shop.

Method of training used is classroom type training.

Burroughs Corp.

One part time operator is required.

Operation tends toward open shop.

Method of training used is personal instruction.

E, G & G, Inc.

	One 8-Hour Shift
Supervisors	1
Analysts	2

Operation tends toward closed shop.

Methods of training used is two day programming and operators course given by our own personnel to indoctrinate new analysts.

STL

Two programmers used and recommended.

Operation tends toward closed shop.

Method of training used is on-the-job training.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

USAD, Kansas City

Good time 40.2 Hours/Week (Average)
Attempted to run time 40.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.992
Above figures based on period 1 Jan 60 to 1 Jul 60
Passed Customer Acceptance Test Jan 58
Time is not available for rent to outside organizations.

Good time includes production and testing. Attempted to run time includes production and testing and wasted effort due to machine errors.

Burroughs Corp., 14300 Tireman

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 Jan 58 to Jan 59
Time is not available for rent to outside organizations.

Burroughs Corp.

Good time 9.5 Hours/Week (Average)
Attempted to run time 10 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.95
Above figures based on period from Nov 57 to Jul 60
Time is available for rent to outside organizations.

E, G & G, Inc.

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 from Feb 57 to Aug 60
Passed Customer Acceptance Test Feb 57
Time is not available for rent to outside organizations.

We used this computer at Las Vegas, Nevada, for nuclear weapons test data processing April-October, 1957. During that time it was on a two shift, seven day week operation. Performance was excellent.

STL

Good time 38.5 Hours/Week (Average)
Attempted to run time 36 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.94
Above figures based on period from Apr 60 to Jun 60
Passed Customer Acceptance Test Feb 57
Time is available for rent to qualified outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Card output adapter permits connection of a keypunch to enable output data only from the computer accumulator. The multiple input adapter enables the simultaneous connection of a punch paper tape input and a punch card input, a duplex paper tape input and a punched card input or a duplex paper tape input and a second paper tape input.

Unique system advantages include ease of programming and complete formatting ability with the Burroughs Sensimatic Printer.

USAD, Kansas City

Outstanding features are ease of programming, operation and debugging. A complete ADPS installation is contained in the basic machine.

The addition of a tape input unit increases the capacity of the E-102, but the machine is, in most cases, too slow for long and complex problems that require large amounts of data input.

Burroughs Corp., 14300 Tireman

Outstanding features are ease of operation and it brings advantages of electronic computation into the area of small calculating problems.

Burroughs Corp.

Outstanding features are ease of operation and electronic speed on small calculating problems.

E, G & G, Inc.

Unique system advantages are compactness, high amount of up time with minimum service requirements.

FUTURE PLANS

USAD, Kansas City

A request to discontinue rental of the Burroughs E-102 Electronic Computer with tape input unit and to install an IBM 1620 Data Processing System is under consideration. This new system would increase the problem solving capacity of the district and will also lend itself to the solution of more complex problems which, at this time, due to machine limitations (storage and speed), are not feasible or practical.

The new system, if approved, would include:

Quantity	
1	IBM 1620 Data Processing System
1	IBM 046 Tape to Card Converter
1	IBM 063 Card to Tape Converter
1	IBM 022 Printing Card Punch
1	IBM 056 Card Verifier
1	IBM Series 50 Card Sorter
1	Model FPC-8 Flexowriter

E, G & G, Inc.-Possibility exists of replacing current computer with newer versions in same operating and price ranges.

INSTALLATIONS

U.S. Army Engineer District, Kansas City, Mo.
Burroughs Corporation, 14300 Tireman, Detroit, Mich.
Burroughs Corporation, 6071 2nd Ave., Detroit, Mich.
Edgerton, Germeshausen & Grier, 160 Brookline, Boston
Space Technology Laboratories, El Segundo, Calif.
University of Pennsylvania, 200 S. 33rd St, Phila 4, Pa.

BURROUGHS E 103

Burroughs Model E 103 Electronic Digital Computer

MANUFACTURER

Burroughs Corporation

Photo by the Burroughs Corporation

APPLICATIONS

Manufacturer

Desk size system for general purpose computing.

David Taylor Model Basin

Located on the second floor of the Hydromechanics Laboratory building, the system is used for solving engineering and scientific problems by the engineer an scientist in order that he get a feel for the problem, particularly if the problem is not sufficiently complex to justify programming on a larger computer, such as the IBM 704.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Decimal
Decimal digits/word	12 plus sign
Arithmetic system	Fixed point
Instruction type	One address

Instruction word format

Operation Code	Tens level of address	Units level of address
W	1	5

W - Write contents of accumulator into cell 15, leaving copy in accumulator

Accumulator - 12 digits plus sign, "Clearing House" for all data to and from memory.

B register - 11 digits plus sign. Holds the multiplicand or the divisor during multiplication or division, respectively.

The E 103 is an externally programmed machine through replaceable pinboards. Metal contact pins dropped through the pinboard, provide the contacts to an internally wired program. 29 different commands are available before being modified by mechanical stepping switches. A maximum of 128 program steps can be stored on the machine at any one time.

Floating point may be programmed.

Photo by the U. S. Navy David Taylor Model Basin

ARITHMETIC UNIT

Manufacturer	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	51,000	42,500
Mult	250,000	241,500
Div	300,000	291,500

Construction (Arithmetic unit only)	
Vacuum tubes	180
Diodes	1,400
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Manufacturer Medium	No. of Words	No. of Digits	Average Access Microsec
Drum	220	12 plus sign	8,500

INPUT

Manufacturer Media	Speed
Keyboard	Manual
Paper Tape	20 char/sec
Card	20 or 17 card columns/sec

Field modified IBM Style 024 or 026 Keypunch with Burroughs Transiator. An 11 column keyboard is used.

OUTPUT

Manufacturer	
Semi-Ganged Printer	24 digits/sec
Punched Paper Tape	10 char/sec
Punched Card	20 or 17 card column/sec

Field modified IBM Style 024 or 026 Keypunch with Burroughs Transiator

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Vacuum tubes	250
Diodes	2,000

CHECKING FEATURES

Manufacturer

Checking features include pin check (missing pins), print check, overflow alarm, memory alarm in case of failure to read or write properly, and keyboard check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

Power, computer	1.85 Kw	2.2 KVA	0.85 pf
Volume, computer		40 cu ft	
Area, computer		16 sq ft	
Room size		10 ft x 10 ft	
Floor loading		93 lbs/sq ft	
Weight, computer		1,500 lbs	

Air conditioning is required if room temperature is higher than 90°F. 1 1/2 tons of air conditioning is recommended when the room temperature is higher than 90°F. Two 3/4 ton window units are satisfactory.

David Taylor Model Basin

Room size	Small office approx. 50 sq ft
Air conditioner	Window type unit
Capacity, air conditioner	1 Ton

Required 220 volt, single phase, 3 wire line.

PRODUCTION RECORD

Manufacturer

Number produced to date	210
Number in current operation	166
Number in current production	54
Anticipated production rate	60/year
Time required for delivery	3 months

COST, PRICE AND RENTAL RATES

Manufacturer

	Cost	Monthly Rental
E 103 Computer	$29,750	$875
Paper Tape Input	2,950	85
Duplex Tape Reader	2,150	65
Punched Card Input	3,450	105
Punched Card Output	2,375	70
Multiple Input Adapter	575	20
Punched Tape Output	2,950	85

First year maintenance is rendered gratis on purchase, $2,000/year including maintenance, parts, travel time, thereafter. Maintenance is included in lease rate.

David Taylor Model Basin

Basic computer expanded memory drum, tape input and tape output rent at $1,380/month.

PERSONNEL REQUIREMENTS

Manufacturer

Training is made available by the manufacturer to the user. No assigned personnel are required if system is operated on an open shop basis.

David Taylor Model Basin

The machine is a simple programmed desk size computer that requires no specialized operators. The engineer and physicist programs and runs his own problem.

Classes are held (less than a week long) whenever the occasion demands.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Design of machine coupled with preventive maintenance schedule has provided experience of 97.3% up-time.

David Taylor Model Basin

Good time	16.7 Hours/Week (Average)
Attempted to run time	17.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.97

Above figures based on period 1 Apr 59 to 31 Mar 60
Passed Customer Acceptance Test 11 Jun 57
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include low cost, external programming, and a great variety of input-output adjuncts. Printer versatility, due to design, includes a semi-ganged printer, front feed carriage, and an accounting machine carriage movement. Unique system advantages are that the system is an ideal open shop computer and is perfectly suited for business, engineering, statistical and scientific computing.

FUTURE PLANS

Manufacturer

System will be up-dated on a continuing basis.

INSTALLATIONS

David Taylor Model Basin
Hydromechanics Laboratory
Washington 7, D. C.

CCC REAL TIME

General Purpose Real Time Tracking Computer

MANUFACTURER

Computer Control Company, Incorporated

Front View

Photo by Computer Control Company, Incorporated

APPLICATIONS

The system was specifically designed for use in providing real-time command signals to position two 85' parabolic antennas from various input sources. The computations involve parallel correction, orbital integration, coordinate translation, rotation and conversion. The computation must be slaved to real time and solution time must be extremely fast to reduce system real time phase shift. Flexibility and future system requirements are provided by the general purpose stored program philosophy.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	25
Binary digits/instruction	25
Instructions per word	1
Instructions decoded	48
Arithmetic system	Fixed point
Instruction type	One plus one
Instruction contains one operand address and next instruction address	
Number range	± 1

Rear View

Photo by Computer Control Company, Incorporated

Instruction word format

Operation Code	Address 1	Address 2	Index Control

Automatic built-in subroutines include sine/cosine resolver, octant reduction, and Binary Coded Decimal-Binary conversion.

There are 3 index registers which may be incremented, replaced or cleared and are capable of modifying either address under control of two index control bits located in each instruction.

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	25	25
Mult	75	50

Construction (Arithmetic unit only)
Transistors 540
Arithmetic mode Serial-parallel

Additions are performed in serial, multiplication is performed in serial-parallel to achieve 50 microsec multiply time.

Timing Synchronous
Operation Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Acoustic Delay Line (Instruction Storage)	320	8,000	500 Avg.
Acoustic Delay Line (Data Storage)	160	4,000	250 Avg.
Electromagnetic Delay Line	8	200	25

INPUT

Media	Speed
Paper Tape	60 octal digits/sec

Program input tape and position command tape
Antenna Readout 4,000 18 bit words/sec
4 registers containing antenna positions of azimuth, elevation, hour angle, and declination
Theodolite 1,000 readings/sec
Keyboard

The read time from central range timing system is also made available to the computer for programming utilization.

Digital Servo

Photo by Computer Control Company, Incorporated

OUTPUT

Media	Speed
Readout to Digital Servo	1 reading/sec
Computer output drives for each antenna.	4 command registers, two
Printer	4 words/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	22,000
Transistors	2,700

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.4 Kw
Volume, computer & digital servos	105 cu ft
Area, computer & servos	15 sq ft
Floor loading	150 lbs/sq ft
	150 lbs concen max
Weight, computer	2,200 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

The cost of the entire system, including 2 digital servo racks and all development, installation and programs is $330,000.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Operators	1
Engineers	1

Training made available by the manufacturer to user includes operation and maintenance. The programs having once been prepared are utilized without need of further programming unless the computer is to be used for new and different modes of operation. Since the existing programs meet the present system needs, no current programming effort is utilized.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability includes completely transistorized and modularized construction. Package types are limited to 8. 98% of the systems utilize 4 package types.

ADDITIONAL FEATURES AND REMARKS

The arithmetic unit is designed to perform fast computation of trigonometric functions. The quantity $a + bx + c$ may be formed in 50 microsec. The system operates in real time and is synchronized to external range timing system.

CDC 160

Control Data Corporation Model 160

MANUFACTURER

Control Data Corporation

APPLICATIONS

The fields of application include off-line data conversion, data processing - scientific, data processing - commercial, construction, machine tool design, optical design, data acquisition and data reduction, and as a satellite system with the CDC 1604 Computer.

Photo by Control Data Corporation

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	12
Binary digits/instruction	12
Instructions/word	1
Instructions decoded	63
Arithmetic system	Fixed point Mod $2^{12} - 1$
Instruction type	One address

Flexible addressing modes include no address, direct address, indirect address, and relative address. Information in registers shown on projection display in Arabic numerals.

Instruction word format

Function	Address
6 bits	6 bits

ARITHMETIC UNIT

Operation	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	6.4, 12.8, 19.2	6.4
Mult	Programmed	1,000
Div	Programmed	1,800

Construction (Arithmetic unit only)
Transistors and Diodes

Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

Diagram by Control Data Corporation

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Core Storage	4,096	49 and 52 bits	6.4
Magnetic Tape			
No. of units that can be connected		30	Units
No. of chars/linear inch of tape		200	Chars/inch
Channels or tracks on the tape		7	Tracks/tape
Blank tape separating each record		0.75	Inches
Tape speed		75 or 150	Inches/sec
Transfer rate		15,000 or 30,000	Chars/sec
Start time		5	Millisec
Stop time		5	Millisec
Average time for experienced operator to change reel of tape		45	Seconds
Physical properties of tape			
Width		1/2	Inches
Length of reel		3,600	Feet
Composition			Mylar

INPUT

Media	Speed
Paper Tape (Ferranti)	350 char/sec
Typewriter	

OUTPUT

Media	Speed
Teletype Punch	60 char/sec
Typewriter	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	7,000
Transistors	1,400
Magnetic Cores	49,152

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer only	0.7 Kw	1.0 pf
Volume, computer	20 cu ft	
Area, computer	10 sq ft	
Floor loading	700 lbs concen max	

Room size is dependent on peripheral equipment selected.

Weight, computer 700 lbs

Air conditioner is dependent on room size and peripheral equipment. System uses 110v, 60 cycle power.

PRODUCTION RECORD

Number produced to date	7
Number in current operation	4
Number in current production	25
Anticipated production rates	1 per week
Time required for delivery	6 months

COST, PRICE AND RENTAL RATES

	Purchase Price	Lease Price/ Month
160 Computer	$60,000	$1,500
Electric Typewriter	10,500	262
1609 Card Read & Punch Unit	47,000	1,175
Basic Magnetic Tape Unit (30 KC)	37,000	925
Additional Magnetic Tape Units (30 KC)	20,500 (ea)	512 (ea)
Basic Magnetic Tape Unit (15 KC)	32,000	800
Additional Magnetic Tape Units (15 KC)	15,500 (ea)	390 (ea)
1606 High Speed Printer	110,000	3,300

All prices are f.o.b. Minneapolis, Minnesota, and do not include Federal, State and Local Taxes which may be applicable. Subject to change without notice.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift
Programmers	2
Technicians	1

Training made available by the manufacturer to users includes regularly scheduled training courses are made available to customer personnel. Cost of training is included in the equipment price.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability includes solid state unitized construction and wide tolerances designed into all circuits.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include high speed input-output, flexible address features, low cost, and magnetic core memory.

Unique system advantages include satellite operation with Control Data Corporation 1604 Computer, small size, and high speed.