Official Marine Corps Photo

Camp Pendleton, California

U.S. Marine Corps, Camp Pendleton

Media	Speed
Printer	
Punched Cards	
Magnetic Tape	
Console Typewriter	

U.S. Marine Corps, Headquarters

Magnetic Tape	
Printed Reports	
Punched Cards (IBM 523)	
Flexowriter	

Punched card output is always off-line.

Magnetic tape speed is effective speed as there is no gap between records.

American United Life Insurance Company

*High Speed Printer	600 lines/min alpha-numeric
	900 lines/min numeric (1)
Paper Tape Punch	60 char/sec
Magnetic Tape	30,000 char/sec
Console Typewriter	10 char/sec

Post reads all write

* Interconnecting device permits both on-line and off-line capability. Slews at 4,200 lines/minute.

S. C. Johnson & Son, Inc.

Media	Speed
Magnetic Tape	30,000 char/sec
Punched Paper Tape	60 char/sec
Console Flexowriter	10 char/sec
High Speed Printer	600 lines/min

National Cash Register Company, Hawthorne

NCR 340 High Speed Line Printer	600-900 lines/min
NCR 370 Punch Paper Tape	60 char/sec
IBM 514 Card Punch	100 cards/min
Magnetic Tape	30,000 char/sec

Card punch is used off line with the 320 Converter.

Bureau of Yards and Docks

Magnetic Tape	30,000 char/sec
3600 ft = 8.5×10^6 char.	
Paper Tape	120 char/sec
2 code option, 10 char/in.	
High Speed Printer	600-1200 lines/min
Console Typewriter	10 char/sec max.

Machine typeout or paper tape punch

The speed of the High Speed Printer varies and depends on the amount of alphanumerical information to be printed.

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Camp Pendleton, California

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	8,000
Transistors	4,000
Magnetic Cores	158,400 - 316,800

24,000 to 48,000 Alpha-numeric characters

The above data applies to the Central Processor only.

CHECKING FEATURES

FIXED

Processor

All transmission of data between the Processor and peripheral units is checked for parity by character, plus echo check for correct number of characters.

All transmission of data in and out of the magnetic core memory is verified by a check character with each word.

Magnetic File Operations

All recording on magnetic tape is immediately checked by re-reading at a check head placed immediately behind the write head. Checks are made for parity on each character, longitudinal parity check over each record, character count on each record, proper bounding of each record, and timing check. These are separate, independent checks with any conceivable out of the ordinary occurrence being detected by at least 2 of these checks.

These same checks are in effect when reading and while the tape to tape transfer (off-line copy) is in progress.

High Speed Paper Tape Reader

Duplicate photo-electric reading, duplicate translation, error halt on inadmissable characters, are fixed checking features as well as automatic detection of paper tape slippage, undue drifting on stops, and broken tape detection - distinguished from end of tape.

High Speed Card Reader

The fixed checking features are duplicate photo-electric reading and duplicate translation, error halt on inadmissable characters, and also automatic verification of clocking and column count, and detection of out-of-registration or slippage.

High Speed Line Printer

Automatic check for non data characters, correct

Official Marine Corps Photo

Camp Pendleton, California

number of characters, correct number printed, and each hammer must fire one and only once per line. Continuous check on the integrity of information stored in the printer buffer during printing, each buffer position printed once and only once-also each hammer. Continuous magnetic reading of special track on print cylinder so that printer electronics "knows" the position of the cylinder with answer-back to printer buffer verifying that the print cylinder position at the moment each hammer is fired is the same as the character stored in the corresponding buffer position. There are two complete individual sets of circuits operating at different voltages-one from buffer positions to activate corresponding hammers and one activated by hammer action back to buffer position. This answer-back verifies not only correct character printed but also that the hammer was fired at the precise instant to print the character clearly and with proper alignment. The vertical format loop will halt the printer if it is parted. Also, all control configurations (15 possible) in the vertical format loop must have even parity, continuously checked.

High Speed Paper Tape Punch

Fixed checking features include echo check off punch dies to verify actual character punched and detection of paper tape exhausted or broken.

OPTIONAL

The Paper Tape Reader and Paper Tape Punch check for character parity on codes that are checkable.

Certain peripheral units contain sequence-controlled circuitry to test for proper operation and insure proper electronic functioning.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer		
Power, computer, basic system	38.5 Kw	48.1 KVA 0.8 pf
Power, air condi, package	12 Kw	15 KVA 0.8 pf
Volume, computer	630.2 cu ft	
Area, computer	133.2 sq ft	
Room size	1,200 sq ft	

Above includes basic system with Tape Controller, six Tape Handlers, a Line Printer and a Card Reader.

Volume, air conditioner	400 cu ft
Area, air conditioner	50 sq ft
Room size, computer	120 sq ft

Capacity, air conditioner	15 Tons
Weight, computer	10,850 lbs
Weight, Air conditioner	2,000 lbs
Floor loading	110 lbs/sq ft

Weight is distributed around perimeter of frames.

Site preparation requirements

The specific site preparation requirements will vary from installation to installation, depending on available facilities, "show case" considerations, and policy.

General requirements for physical environment include air conditioning, humidity control, and provisions for maintenance of equipment. There can be flexibility in construction as pertains to the use of false flooring, ceilings, or conduits. It is usually recommended that false flooring be used, as the area under the false floor serves the dual purpose of protecting cables and eliminates supply ducts for conditioned air. A false ceiling eliminates the need for return ducts. The power specifications call for 120/208 volts, three-phase, four wire, 60 cycles.

U.S. Marine Corps, Camp Lejeune

Power, computer	43.76 Kw	54.7 KVA	0.8 pf
400 N Power	18.24 Kw	22.8 KVA	
Power, air cond	11.0 Kw	12.2 KVA	
Volume, computer		630 cu ft	
Volume, air conditioner		32,630 cu ft	
Area, computer		147 sq ft	
Area, air conditioner		2,190 sq ft	
Capacity, air conditioner		27 Tons	
Weight, computer		15,000 lbs	
Weight, air conditioner		5,000 lbs	

Air conditioning space partitioned off from existing warehouse. False ceiling and new raised-floor designed expressly for computer installation was provided. A remote installation including compressors, air handling units, and evaporative condenser was installed. A new electrical service including 225 KVA transformers capacity installed.

U.S. Marine Corps, Camp Pendleton

Power, computer	35.5 Kw	44.4 KVA	0.8 pf
Power, air condi	32.2 Kw	40.4 KVA	0.8 pf
Volume, computer		635.2 cu ft	
Volume, air conditioner		455 cu ft*	
Area, computer		147.0 sq ft	
Area, air conditioner		51 sq ft*	
Room size, computer		1,860 sq ft	
Room size, air conditioner		350 sq ft	
Floor loading		96 lbs/sq ft (Avg)	
		155 lbs concen max	
Capacity, air conditioner		25 Tons	
Weight, computer		13,150 lbs	
Weight, air conditioner		7,200	

*Does not include air filtering equipment or input/output plenums.

Site is located in a warehouse building. False ceiling, false flooring, air conditioning, power substation installed. Data Processing Installation covers 14,000 sq ft and includes EAM equipment, office space, card and paper storage space, rest rooms, as well as NCR 304 EDP Equipment. Total cost $175,000.

U.S. Marine Corps, Headquarters

Power, computer	46.48 Kw	58.1 KVA	0.8 pf
60 CPS and 400 CPS.			
Power, air condi	28 Kw	35 KVA	0.8 pf
Volume, computer		15,200 cu ft	
Volume, air conditioner		3,360 cu ft	
Area, computer		1,900 sq ft	
area, air conditioner		280 sq ft	
Room size	Between 1600 and 2000 sq ft		
Floor loading		250 lbs/sq ft	
Floor loading, computer		100 lbs/sq ft	
Capacity		25 Tons	
Weight, computer		12,950 lbs	

Site was installed in a brick building with concrete floors. Completely overhead air conditioning delivery concealed by false ceiling. Raised false flooring for concealment of power and logic cables.

American United Life Insurance Company

Power, computer	38.5 Kw	48.1 KVA	0.8 pf
(basic system)			
Volume, computer		650 cu ft	
Volume, air conditioner		600 cu ft	
Area, computer		150 sq ft	
Area, air conditioner		200 sq ft	
Room size, computer		2,000 sq ft	
Room size, air conditioner		600 sq ft	
Floor loading		110 lbs/sq ft	
Capacity, air conditioner		30 Tons	
Weight, computer		11,000 lbs	
Weight, air conditioner		3,000 lbs	

Site preparation requirements

Due to the physical structure of the existing building, the location of the computer area within the building, and the requirement for a separate air-conditioning system, the following additions and modifications were made at this site. A 30 ton air-conditioning and air handling system was installed composed of three ten ton chilled-water coolers and an air handling system capable of moving 9,000 cubic feet of air per minute. This system provided for automatic temperature and humidity controls geared to control the computer room to 40% relative humidity and 74°F temperature. The control system was built around Johnson Controls with Bristol seven-day recording devices. Air was delivered directly under the raised floor with dampered registers around the periphery of the room to properly distribute the incoming conditioned air. Return air was vented through the ceiling in registers into an air plenum between the false ceiling and the existing ceiling and returned to the air-conditioning equipment. The raised floor was set ten inches above the concrete slab. The false ceiling was installed eight and one-half feet above the raised floor, and in the location selected was twenty inches below the previously existing ceiling. A masonry wall was contructed two feet inside the existing brick and masonry walls of the building and supplemented by movable steel and glass partitions where the room was divided away from exterior walls. The raised floor is of cast aluminum in sections eighteen inches square with a vinyl floor covering. Power and water were delivered to the equipment room from existing central supply within the building itself. The computer area itself has been equipped with Muzak installation and an intercommunicating system utilizing the existing speakers.

S. C. Johnson & Son, Inc.

Power, computer	70 KVA
Power, air conditioner	20 KVA
Volume, computer	740 cu ft
Area, computer	160 sq ft
Area, air conditioner	300 sq ft
Room size, computer	1,300 sq ft
Room size, air conditioner	700 sq ft
Capacity, air conditioner	20 Tons

Site preparation included trenching of floor to provide ducts and cable to equipment.

National Cash Register Company, Hawthorne

Power, computer	44 Kw	55 KVA	0.8 pf
Power, air condition	24 Kw	30 KVA	0.8 pf
Volume, computer		790	cu ft
Volume, air conditioner		800	cu ft
Area, computer		166	sq ft
Area, air conditioner		100	sq ft
Room size, computer		1,800	sq ft
Room size, air conditioner		240	sq ft
Floor loading		110	lbs/sq ft
Capacity, air conditioner		30	Tons
Weight, computer		13,560	lbs
Weight, air conditioner		4,000	lbs

Site included along with construction of new building in 1956. False flooring has been installed to support a 304, 320, 330, 9-332s, 340, 360,370, 380, and 514.

Bureau of Yards and Docks

Power, computer	32.0 Kw	40 KVA	70% min pf
Volume, computer		10,440	cu ft
Volume, air conditioner		4,536	cu ft
Area, computer		1,305	sq ft
Area, air conditioner		432	sq ft
Room size, computer		59	ft 4 in long
		22	ft 0 in wide
		8	ft 0 in high
Room size, air conditioner		12	ft 4 in wide
		35	ft 0 in long
		10	ft 5 in high
Floor loading		250	lbs/sq ft
Capacity, air conditioner		30	Tons
Weight, computer		12,950	lbs

New cinder block building of 2,556 square feet was built to house the data processor.

PRODUCTION RECORD

Number produced to date	6
Number in current operation	6
Number in current production	14
Number on order	23
Anticipated production rates	2 per month
Time required for delivery	18 months

COST, PRICE AND RENTAL RATES

Manufacturer

Model No.	Component	Monthly Rental	Purchase Price
304	Data Processor including Control Console (2,000 Word Memory plus 400 Special Words)	$5,730	$366,600
304	Data Processor including Control Console (4,000 Word Memory plus 800 Special Words)	6,560	420,000
304-2	Data Processor including Control Console (2,000 Word Memory plus 400 Special Words); with Micro-Flow, Magnetic Character Input, & Multiple Printer Output	6,240	399,200
304-2	Data Processor including Control Console (4,000 Word Memory plus 800 Special Words); with Micro-Flow, Magnetic Character Input, & Multiple Printer Output	7,070	452,600
320	Universal Off-line Converter	$1,970	$126,000
322	Off-line Printer Converter	710	45,000
330	Magnetic Tape Controller - 30 KC	1,740	111,000
332	Magnetic Tape Handler-30 KC	415	26,300
340	High-Speed Line Printer	1,940	124,300
340-2	High-Speed Line Printer	1,970	126,225
351	Typewriter Printer (Extra)	70	3,400
354-2	Card Punch Buffer	600	28,800
355-2	Sorter Buffer	700	33,550
360	High-Speed Paper Tape Reader	510	32,800
370	High-Speed Paper Tape Punch	280	17,800
380	High-Speed Punched Card Reader	490	31,100
402-1	Magnetic Character Sorter	1,700	62,000

Maintenance/Service Contracting

Maintenance and service will be furnished to suit the individual needs and schedules of each installation. On lease arrangements, the cost of maintenance is included in the rental rates. Where the equipment is purchased, a maintenance contract is available.

U.S. Marine Corps, Camp Lejeune

Basic System

Components		Monthly Rental 1 Jul60 - 30Jun 61
304	Data Processor including Console (2400 word memory)	$5,730
320	Universal Converter	1,970
340	High Speed Printer	1,940
330	Magnetic Tape Controller	1,740
380	High Speed Punched Card Reader	490
332	Magnetic Tape Handler at $520.00 each	
	at $415.00 each	2,075
		$13,945
	Additional Equipment	
	Type 523 Summary Punch	$ 75

Maintenance and service provided by contractor at no additional charge when renting.

U.S. Marine Corps, Camp Pendleton

Rental contracting and rates for basic system
Monthly rental rate effective 1 July 1960 - $13,945.
304 Data Processor (1) $5730 - 330 Mag Tape Controller (1) $1740 - 340 Printer $1940 - 320 Converter (1) $1970 - 332 Mag Tape Handler (5) $2075 - 380 Card Reader $490.
Additional equipment
IBM 523 Card Punch - $88 per month.

Maintenance performed by NCR personnel; cost included in monthly rental.

U.S. Marine Corps, Headquarters

		Eff 1 Jul 60
304	Data Processor including Console (2400 word memory)	$5,730
320	Universal Converter	1,970
340	High Speed Printer	1,940
330	Magnetic Tape Controller	1,740
332	Magnetic Tape Handler, 8 at $415.00 each	3,320
380	High Speed Punched Card Reader	490
523	IBM Gang Summary Punch	85
	Total monthly rental for 176 hours usage	$15,275

Maintenance and service contracting included in rental costs.

S. C. Johnson & Son, Inc.

	Component	Price
304	Processor including Console	$356,800
330	Controller	111,000
340	Printer	109,400
322	Printer Controller	37,300
332	Magnetic Tape Unit (9)	204,300
360	Paper Tape Reader	19,600
370	Paper Tape Punch	15,700
		$854,100

National Cash Register Company, Hawthorne

Monthly rental contracting and rates for basic system are 304 Processor (4800 words) $6560 - 320 Multi Purpose Converter $1970 - 330 Mag. Tape Controller $1740 - 370 Paper Tape Punch $280 - 380 Punched Card Reader $490 - Nine (9) Mag. Tape Handlers at $415 each $3735 - 340 High Speed Line Printer $1940 and a 360 Paper Tape Reader $510.

Additional equipment includes a Universal Interconnecting Device and a Paper Tape Rewinder and Splicer.

Bureau of Yards and Docks

	Monthly Rental
Data Processor	$6,560
Magnetic Tape Controller - 30 Kc	1,740
Magnetic Tape Handler - 30 Kc	2,905
High Speed Line Printer	1,940
Add. Typewriter Printer	70
High Speed Paper Tape Reader	510
High Speed Paper Tape Punch	280
High Speed Punched Card Reader	490
Total Approximate Monthly Rent	$14,495

PERSONNEL REQUIREMENTS

Manufacturer

Since the National 304 System is a new system with the first installation in November, 1959, at the present writing it is difficult to determine normal personnel requirements. It is anticipated that the advanced solid-state design and overall system fabrication will result in most favorable operating experience. The early performance of the initial systems has borne this out.

It is expected that a typical 304 System can be maintained by 3 or 4 engineer-technicians. Two and three shift operation will require some increase.

Training made available by manufacturer to users includes initial and turnover replacement training and executive orientation. These are provided at no cost to the user at mutually agreeable locations.

U.S. Marine Corps, Camp Lejeune

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Programmers	3	5
Librarians	2	2
Operators	3	4
Engineers	6	6
Tape Handlers	2	2

Contractor provides Programmer School periodically. Contractor provides representative to assist in initial stages of implementation.

U.S. Marine Corps, Camp Pendleton

	One 8-Hour Shift		Two 8-Hour Shifts	Three 8-Hour Shifts
	Used	Recomm	Recommended	Recommended
Supervisors		*	**	**
Analysts	1	1*		
Programmers	3	3	3-Prim only	3-Prim only
Librarians	2	2	1 per shift	1 per shift
				***
Operators	3	3	2-Prim; 1-2d	1 per shift
Tape Handlers	2	2	1 per shift	1 per shift
				***

All of our programmers, operators, and tape handlers are equally proficient at programming and operating and we intend to perpetuate this versatility. Librarians are trained on the job for programmer/operator work.

* - Officer-in-charge and Supervisor on Prime Shift.

** - Senior Enlisted Programmer/Operator present is Shift Supervisor.

*** - Requires increase in T/O of one person.

Operation tends toward closed shop.

Methods of training used includes formal training by manufacturer and on-the-job training at the site.

U.S. Marine Corps, Headquarters

	One 8-Hour Shift		Two 8-Hour Shifts	Three 8-Hour Shifts
	Used	Recom	Recommended	Recommended
Supervisors	1	1	1	1
Librarians	1	1		
Operators	1	1	1	1
Engineers	7	7	0	
In-Output Oper	1	1	1	1
Tape Handler	2	2	2	2

Above personnel requirements are shown for Computer System operating personnel only. The number of analysts programmers, coders and clerks is dependent on the peculiarities of the accounting or reporting system to be placed on the computer.

The number of engineers presently being used to operate one shift would stay the same if the operating period was expanded to two shifts. For a three shift operation engineers would be on an "on-call" basis for the third shift.

Operation tends toward open shop.

Methods of training used includes Equipment Manufacturers School and on-the-job training for operating personnel.

American United Life Insurance Company

	One 8-Hour Shift
Supervisors	1
Analysts, Prog. & Coders	7
Clerks	1
Librarians	1
Operators	2
Engineers	NCR
Technicians	NCR
In-Output Oper	24
Tape Handlers	2

Since the equipment was installed only on 2 May 60, and because it has been used primarily for program testing, it is impossible to make intelligent personnel distributions. Since production operating time is required for information of this type it will be some time before valid figures can be accumulated.

Operation tends toward open shop.

Methods of training used include two methods, a formalized programming school, instruction for which was provided by The National Cash Register Company, and on-the-job training for the additional personnel

required. The training of operating personnel was handled by the user with the advice of the manufacturer as required.

S. C. Johnson & Son, Inc.

	One 8-Hour Shift	Two 8-Hour Shifts
Supervisors	1	1
Librarians	1	2
Operators	1	2
In-Output Oper	1	2
Tape Handlers	1	2

Operation tends toward open shop.

Methods of training includes on-the-job training and a Programming School.

The above pertains to requirements for operations.

Systems and Programming Staff for maintenance of existing system and future applications consists of 1 Program Supervisor, 4 Programmers, 1 System Planning Coordinator, and 2 Systems Men.

National Cash Register Company, Hawthorne

	One 8-Hour Shift
Supervisors	1
Programmers - Analysts - Coders	15
Clerks	2
Operators	2
Engineers-Technicians	6
In-Output Oper	1

Operation tends toward closed shop.

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

Bureau of Yards and Docks

	One 8-Hour Shift	
	Used	Recommended
Supervisors	4	
Analysts	7	8
Programmers	7	12
Clerks		1
Librarians		1
Operators	1	4

Operation tends toward closed shop.

Training classes have been held on site.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability and optimum operating experience were basic design objectives with the 304 System. The latest electronic developments and solid state devices have been used throughout. Design tolerances are set beyond those of"worst case" conditions of heat, voltage fluctuation and aging. Standardized plug-in cards are used throughout as well as etched circuit back panels to replace wiring harnesses and cables.

Units are separately powered and contain circuitry which performs a sequence of automatic reliability tests to insure proper operation or to isolate for replacement of circuit cards.

Individual units have extensive features to insure reliability as stated in Checking Features. The High Speed Paper Tape Reader and the High Speed Paper Tape Punch which can handle different codes by switch selection, have a programmable check on the proper code. A mode of the Test instruction can insure that the proper switch is set.

U.S. Marine Corps, Camp Lejeune

Good time 45.6 Hours/Week (Average)
Attempted to run time 52.2 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.87
Above figures based on period 1 Apr 60 to 29 Apr 60
Passed Customer Acceptance Test 4 Mar 60
Time is not available for rent to outside organizations.

During period measured above the system was not afforded perfect temperature and humidity environment due to air conditioning equipment deficiency.

Break-down of Computer time - April 1960

Primary Shift	241.0 Hrs
Production (*)	182.5 Hrs
Down	10.8 Hrs
Idle	22.1 Hrs
Re-run	25.6 Hrs

* Production total breaks down as follows:

Operational Use Time for Rental Purpose	161.3 Hrs
Lunch Time Opr, not subject to rental	7.4 Hrs
Set-up Time, not subject to rental	13.8 Hrs

U.S. Marine Corps, Camp Pendleton

Average error-free running period 39.48 Hours
Good time 36.5 Hours/Week (Average)
Attempted to run time .48 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 76 to 1
Above figures based on period 1 Feb 60 to 30 Apr 60
Passed Customer Acceptance Test 14 Jan 60
Time on 2d and 3d shifts is available for rental to outside organizations.

U.S. Marine Corps, Headquarters

Time will be made available to other government agencies only and on a pro-rated cost basis. Time will be on an "as available" basis.

System was turned over for Marine Corps use on 12 May 60.

American United Life Insurance Company

Average error-free running period 2 weeks +
Good time 79.3 Hours/Week (Average)
Attempted to run time 80 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.991
Above figures based on period 2 May 60 to 25 May 60
Passed Customer Acceptance Test 2 May 60
Time is not available for rent to outside organizations.

The amount of time available for the accumulation of the information requested is too short to prove of much validity. The experience to date has shown that the system is surprisingly solid and that a high ratio of operating time can be expected.

S. C. Johnson & Son, Inc.

Passed Customer Acceptance Test 10 Jun 60
Time is available for rent to outside organizations.

Bureau of Yards and Docks

Good time 294 Hours
Attempted to run time 302 Hours
Operating ratio (Good/Attempted to run time) 0.9733
Above figures based on period 11 Jul 60 to 9 Aug 60
Passed Customer Acceptance Test 11 Aug 60
Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Outstanding features include a magnetic tape system which is gapless, with timesharing of off-line tape-to-tape transfer (copy) while searching. High Inputs-Paper Tape - 1800 cps. Punched cards fed at 2000 cpm. Command structure is powerful for ease of coding and debugging.

The 304 System has complete off-line conversion facilities - for input and output transcribing. However, the input speeds of 1800 characters per second for paper tape and 2000 punched cards per minute are so favorable that many businesses will find it unnecessary to go through off-line input conversion. For example, 30,000 transactions of 30 characters each would require only eight and one-half minutes of processing time when reading paper tape on-line. Transcribed transactions could be read from magnetic tape by the Processor in about one half a minute. So the off-line input conversion would not save more than eight minutes a day.

An extensive library of programs were accomplished and ready for use with the installation of the first 304 System. National's Electronic Autocoding Technique --NEAT-- was developed to reduce coding costs and to simplify programming. The purpose of NEAT is to simplify the transition from flow chart to machine code without losing any of the flexibility and power of the actual 304 instructions. It enables systematic organization to a problem. Coding in NEAT can be thought of as the translation of a 304 flow chart into pseudo instructions, employing mnemonic addressing. The result of processing NEAT on a 304 computer, is a completed machine code, which may be produced on magnetic tape, punched cards, or punched paper tape. In the course of the computer run, automatic code checking is done for obvious inconsistencies. COBOL or COBOL-like language is being added to the NEAT process. STEP, the program which takes advantage of the internal logic to handle magnetic file housekeeping, is also in operation. Other programs that are available are a Sort Generator, Librarian, monitoring, tracing, and programs to facilitate program check-out.

Procedures for magnetic tape labelling, storing, shipping, and protection from humidity, temperature, electrical, fire, or other damage are the normal procedures and care that are customary for mylar-magnetic tape.

U.S. Marine Corps, Camp Lejeune

Outstanding features include off-line copy operation for simultaneous processing and read/write, maximum storage of data per reel of tape, and high speed card reading.

Unique system advantages include ease of operation by means of a console, which gives system control and components with a minimum number of controls, a 320 Multipurpose Converter for off-line operations, NEAT - a coding technique, which simplifies programming, and a monitor feature which simplifies code-checking.

Tape labelling is performed by means of STEP, (Standard Tape Executive Program), which labels tape and checks obsolescence of tapes before use.

U.S. Marine Corps, Camp Pendleton

Outstanding features are high speed card reader, high speed printer, and transistorized solid state computer.

Unique system advantages are no inter record gap on magnetic tape and a built-in business command structure.

Procedures have been adopted for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage. Two labels are used; one containing permanent identification, and the other containing information of a temporary nature. Tape is stored in a library which is temperature and humidity controlled. A semi-automatic CO_2 system has been installed for fire protection. A fire proof safe will be used to house Historical Tapes.

U.S. Marine Corps, Headquarters

Outstanding features include no inter-record gaps on tape. This allows an effective read-write speed of 30 K per second, and the ability to address any character or number of characters of a word in storage.

Unique system advantages include transistorized components, which bring about low power and air conditioning requirements, and thereby reduces installation costs.

Procedures have been adopted for magnetic tape labelling, storage, shipping, and protection from himidity, temperature and physical, electrical, fire, or other damage. Tapes are stored in an air conditioned area. Shipment of tape is made in "netic" containers. Any two of three installations can reconstruct tapes of the third. Both outside labelling on reel and writing on tape for positive identification of all records is performed.

American United Life Insurance Company

The NCR 304 System features matched cabinets, console simplicity, input-output computing compatibility, operating ease, transistorized construction, interchangeable components, and up-to-date design philosophy.

The system features variable record length, dual search capability, absence of inter-record gaps, read-back of write magnetic tape, built-in magnetic tape executive routines, mnemonic autocoding techniques, and full checking devices for input, output, and computing.

Procedures have been adopted for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage. These procedures defy brief description but are available for those interested upon request.

The general design and philosophy of the NCR 304 System is based upon the known and proven requirements of business and industry. The philosophy of the system and the compatibility of input, output, and computing make it possible to obtain the maximum amount of flexibility in the operating procedures of the using organization.

National Cash Register Company, Hawthorne

Outstanding features include high input speeds, ease of programming, console designed for operator, and a magnetic tape system.

Unique system advantages include a gap-less magnetic tape system, off line copy, automatic read back after write. STEP-combination of circuitry and programming to handle magnetic tape housekeeping. NEAT Autocoding System - COBOL being incorporated. Emphasis on reliability and checking of data movements.

Normal procedures for properly handling mylar magnetic tape have been adopted.

This was the first in operation of the several National Data Processing Centers. There is a 304 Center in New York City and a Center in Dayton, Ohio.

Bureau of Yards and Docks

Outstanding features include ease of programming and program testing.

A procedure for labelling, storage, temperature and humidity protection and fire has been adopted.

FUTURE PLANS

Manufacturer

While retaining all of the previous features and specifications of the initial 304, an improved model will be available starting in the Fall of 1960. The Central Processor has been designated as the 304-2, and will have MICRO-FLOW, Magnetic Character Input, and allow multiple high speed line printing as output.

MICRO-FLOW is a new mode of single-address operation that essentially expands the instruction repertoire from 37 to 104 instructions. This new mode of operation does not in any way supplant the powerful, business-type instructions. MICRO-FLOW is designed for scientific computation, permitting fixed or floating point arithmetic, and for areas of operation when the single-address mode might be faster or more efficient. The single-address MICRO-FLOW and the three-address business-type instructions may be intermixed within a single program, switching from one to the other to provide the most efficiency.

Magnetic Character Input can be provided with the use of the 304-2 Central Processor in conjunction with the National 402-1 Magnetic Character Sorter. Checks or documents encoded with magnetic ink characters may be read at the rate of 750 documents per minute. There will be input of the information into the Processor memory, control over pocket selection, and jump table control for unusual situations. The Magnetic Character Sorter can be used off-line to sort documents as controlled by a panel on the Sorter.

For high-volume output operations, the 304-2 Central Processor will enable multiple printers on-line, up to four National 340 High Speed Line Printers. Buffering and Busy Jumps will enable a maximum of time-sharing.

U.S. Marine Corps, Camp Pendleton

It is proposed that the number of NCR 332 Magnetic Tape Handlers be increased from 5 to 8, that the NCR 304 Memory Size be increased from 2,400 to 4,800 words, i.e., 24,000 to 48,000 characters, and that the number of computer applications be increased from Personnel Accounting only, to that of Fiscal Accounting (including Disbursing functions) and local Supply Accounting.

American United Life Insurance Company

Future plans with regard to this system include the possibility, at the proper time, of expanding the existing system to include additional magnetic tape units, and perhaps another high speed printer. Procedurally new applications will be added as desired. We are looking forward to performing operations on research, market analysis, and a more thorough analysis of sales and determining standards of sales performance.

INSTALLATIONS

U. S. Marine Corps Base
Camp Lejeune, North Carolina

U. S. Marine Corps Base
Camp Pendleton, California

U. S. Marine Corps, Headquarters
Washington 25, D. C.

Bureau of Yards and Docks
Department of the Navy
Washington 25, D. C.

American United Life Insurance Company
Indianapolis, Indiana

The National Cash Register Company
Hawthorne, California

S. C. Johnson & Son, Inc.
Racine, Wisconsin

U. S. Navy New York Naval Shipyard
Brooklyn 1, New York (Proposed)

U. S. Air Force, Headquarters, Strategic Air Command
Offutt Air Force Base, Nebraska

NATIONAL 315

MANUFACTURER

The National Cash Register Company

APPLICATIONS

The National 315 System has broad application in all types of business and scientific data processing. Modular assembly of components permits a wide range of system organization from low-cost systems up to large-scale capabilities. New design concepts and features provide maximum versatility and flexibility in application.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	3 (or 2 alphanumeric characters)
Decimal digits/instruction	6
Words/instruction	2 or 4
Instructions decoded	90 plus variations
Arithmetic system	Fixed point (Field lengths up to 24 digits)
Instruction type	One-address-roughly 1/3 of instruction list Two address- roughly 2/3 of instruction list
Number range	positive: 24 digits negative: 23 digits

Photo by the National Cash Register Company

Specimen of single-stage instruction (two words):

Op	V	L	X	A
A D D	M	3	2 3	1 0 0

ADD TO MEMORY: Memory address is "100" + (contents of index register 23).
Field length is 3 words.

Op, V, L, X are condensed by bit-wise coding into one word.
A forms the second word.

Specimen of single-stage instruction using a "literal"

Op	V	L	X	A
A D D			D	2 0 0

ADD TO ACCUMULATOR the digit-field "200".

Op	V		X/Y	A/B
L D	R		1 2	9 9 9
			1 5	0 0 6

LOAD six Index Registers, starting with R15; two words into each register.

R15 loaded from memory address "999" + (contents of R12).
R16 loaded from memory address "1001" + (contents of R12).
--etc--

Op, V, X, Y are condensed by bit-wise coding into first and third words.
A forms the second word.
B forms the third word.

Specimen of double-stage instruction using a "literal"

Op	V		X/Y	A/B
S L D	R		D	0 0 0
			1 0	0 2 0

SPREAD-LOAD 20 Index Registers, starting with R10

Load zeros into every register from R10 through R29.

Automatic built-in subroutines include Scan, Move, etc. Load, Spread-load, Store, Move, Augment, Spread-augment: multiple registers.

Automatic coding using COBOL will be available for use with delivery of the first system. In addition, an intermediate language - NEAT assembler-compiler - is available for direct coding, and for optimization of object program after COBOL translation.

Registers and B-boxes include 32 Index Registers of 5 digits each and 32 Jump Registers of 5 digits each. This includes automatic storage of 3 different link addresses. The Sequence Control Register (Instruction Counter) is completely addressible. Automatic input-output tallies are used.

The entire system capable of any degree of polysynchronous operation, wherein any designated collection of peripheral units may each Demand program attention whenever appropriate. Demand interrupt is subject to a simple, flexible system of priorities, and to master control which may forbid interrupt altogether whenever desired.

Automatic program-tracing facilities for code checking are included.

Photo by the National Cash Register Company

Paper Tape and Punched Card input share all time except actual transmission of each character. Paper Tape, Punched Card and Printer output do the same.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	42	36
Mult	294 minimum	
Div	1,044 minimum	
Arithmetic mode	3 digits parallel	
Timing	Asynchronous	
Operation	Concurrent and Polysynchronous	

Peripheral units operate asynchronously with processor

STORAGE

Media	No. of Words	No. of Digits	Microsec
Magnetic Cores	2,000 to 40,000	6,000 to 120,000	6 per word

Magnetic Tape	
No. of units that can be connected	8 Units
No. of chars/linear inch	200,333 & 500 Chars/inch
Channels or tracks on the tape	7 Tracks/tape
Blank tape separating each record	3/4 Inch
Tape speed	120 Inches/sec
Transfer rate	24K, 40K, 60K Chars/sec
Start time	3 Millisec
Stop time	3 Millisec
Average time for experienced operator to change reel	20 Seconds
Physical properties of tape	
Width	1/2 Inch
Length of reel	3,600 Feet
Composition	mylar, 1 mil, laminated

INPUT

Media	Speed
Paper Tape	1,000 char/sec
Any codes whatever, without limit. Inter-character time is sharable.	
Punched Cards	400 cards/min
Any possible codes, including binary. Inter-character and inter-card time is sharable, with Demand Interrupt	
Magnetic Character Reader	750 documents/min
Polysynchronous, with Demand Interrupt	
Buffered Inquiry Units	333 KC alphanumeric
Each Inquiry Unit may be multiplexed to many remote Inquiry Stations, limited only by acceptable queueing. Polysynchronous.	

OUTPUT

Media	Speed
Line Printer	600 lines/min alphanumeric
	900 lines/min numeric
Buffered, sharable, with Demand Interrupt ability.	
Paper Tape Punch	120 chars/sec
Any code whatever. Inter-character time sharable.	
Card Punch	100 or 250 cards/min
Same as Printer	
Buffered Inquiry Units	333 KC alphanumeric
Same as for input.	

Line Printer has Multiple Listing Feature to enable simultaneous printing of three separate listings, each with independent paper transport. An interconnecting device is available to permit push-button switching of peripherals from one 315 Peocessor to another, in multi-processor installations.

CHECKING FEATURES

Checking features include complete parity-checking throughout the entire system.

PRODUCTION RECORD

Number produced to date	1
Anticipated production rates	7 per month initially

COST, PRICE AND RENTAL RATES

PRICE LIST

		Price	Monthly Rental
315-1	Basic Processor	$82,500	$1,300
315-2	Bank Processor	90,000	1,400
315-3	File Processor	90,000	1,400
315-4	Bank File Processor	95,000	1,500
316-1	2,000 Word Memory	37,500	650
316-2	5,000 Word Memory	55,000	1,100
316-3	10,000 Word Memory	75,000	1,600
332-202	40 kc Magnetic Tape Unit	27,500	700
332-203	60 kc Magnetic Tape Unit	36,000	900
340-3	High Speed Printer with 357-1 Buffer	72,500	1,425
354-1	Card Punch Buffer	25,000	450
355-1	Sorter Buffer	23,500	450
362-371	Paper Tape Reader and Punch	15,000	450
383-1	Punched Card Reader	20,000	450

PERSONNEL REQUIREMENTS

Training made available by manufacturer to users include a complete schedule of courses in programming, systems analysis, autocoding, COBOL, etc. All courses are available on the customer's premises.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a wide range of capacity and price with modular components, giving wide provision for future expansion and the Demand Interrupt feature so that under permissive program control peripheral units may interrupt, be reactivated, and continue their operation independently while the Processor returns to the primary program. This processor is unusually economical of memory space for program storage.

In multi-processor installations, all processors are the same with only one coding system. Work may be divided among processors at convenience of user, and each provides on-site backup for the other. Peripheral units may be electronically switched from one processor to another.

Normal procedures for magnetic tape handling are recommended.

FUTURE PLANS

Future plans include one and two degrees of magnetic tape simultaneity, a new concept of random access memory - magnetic cards, optional high-speed inputs, including paper tape at 1800 char/sec and punched cards at 2000 cards/min, and inter-communication, with master-slave relationship among multiple processors.

NATIONAL 390

National Cash Register Company Model 390 Computer

MANUFACTURER

National Cash Register Company

Photo by National Cash Register Company

APPLICATIONS

System is designed to handle all types of accounting records, reports, and statistics, paper tape sorting (Direct and Sequential), engineering calculations, and linear programming problems (Limited to 10 x 15 matrix or less).

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/word	12
Decimal digits/instruction	12
Instructions per word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	Four address
Number range	From -1×10^9 to $+9 \times 10^9$

Instruction word format

Instruction	Mode	Address A Operand	Address B Operand	Address C / Modification	Address D Next Instruction

Two decimal digits each

Automatic built-in subroutines include block transfer, and sum and add pairs of numbers. Variable block instructions perform some functions similar to B-boxes.

ARITHMETIC UNIT

Operation	Incl Stor Access
Time	Microsec
Add	11,000
Mult	250,000
Div	400,000

Above times are "worst case". Because of the 4 address system, command times all include access and storage.

Arithmetic unit is constructed of 48 cores, with transformers and diodes.

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access
Core	200	2400	22 microsec/bit
Magnetic Ledger Cards	200 digits	200	220 char/sec

Variable word length on magnetic cards

INPUT

Media	Speed
Paper Tape (Photoelectric)	400 char/sec
Punched Card (IBM 024 or 026)	18 char/sec
Magnetic Ledger Card	220 char/sec

Speed of reading and writing depends on card length. The average is 1.5 to 2.0 secs.
Console Keyboard (Standard)

The Magnetic Ledger Card is a standard ledger card with standard visible posted information on the front and strips of magnetic tape on the back capable of storing up to 200 digits of information pertaining to that account.

OUTPUT

Media	Speed
Paper Tape	17 char/sec
Punched Card	18 char/sec
Magnetic Ledger Cards	Same as input
Accounting Machine Printer	1200 char/min

The Accounting Machine type printer is completely programmable both horizontally and vertically. It will accommodate continuous forms, journals, cut forms, and ledger cards all simultaneously, if desired and has all accounting machine checking, comparing, and accumulating features.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	4,000
Transistors	1,150
Magnetic Cores	9,792

14 vacuum glow triodes are used as indicators.

CHECKING FEATURES

Among the fixed checking features are a 5 bit parity check, reader and punch check, power supply tolerances auto check, a print-out check, and ledger card read-write failure indicators are used. Test points are available on all logical circuits.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

KVA, computer	4.8 KVA	1 phase	240v
Area, computer	78 sq ft		
Room size	10 ft x 15 ft		
Floor loading	20 lbs/sq ft		
	40 lbs concen max		
Weight, computer	1,000 lbs		
	1,500 lbs, total		

PRODUCTION RECORD

Number produced to date	6
Number in current operation	6
Number on order	100+
Anticipated production rates	600 - 700 annually

Quantity production will commence in the first quarter of 1961.

COST, PRICE AND RENTAL RATES

Basic System	Price	Monthly Rental
390-3 Console and Central Processor	$56,300	$1,395
361-1 Paper Tape Reader	10,000	250
461-2 Tape Recorder	1,735	50
Additional Equipment		
381-1 Punch Card Reader Coupler	$ 2,250	$ 60
468-1 Punch Card Coupler	815	27
417 Paper Tape Rewinder-Splicer	1,215	30
361-2 Paper Tape Reader		

Maintenance service is included in the rental price, or is approximately 5 to 6% of purchase price annually.

PERSONNEL REQUIREMENTS

A typical installation will require a combination supervisor and programmer, an operator, and possibly one clerk. The number of input operators would depend on the volume and type of input media and the method of creating it, e.g. by-product of necessary parent machine operation, off-line separate operation, etc.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Acceptance test specifies 40 hours continuous operation without failure or error. Tests are run under extreme marginal conditions.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include magnetic ledger cards, accounting machine printer, 4 address system, internally stored program, decimal coding, and desk size. The unique Magnetic Ledger Card which combines visible, auditable, historical information posted on the front, with machine language encoded on the back. Up to 200 characters of information pertaining to each account can be stored on the back of each card. The magnetic ledger philosophy provides unlimited external storage facility and immediate random access to a complete, up-to-date historical record.

FUTURE PLANS

Future plans include alphanumerics, a document sorter (MICR) input, optical document and journal readers, automatic ledger handling, increased speed and capacity, and a high speed printer.

NORC

Naval Ordnance Research Calculator

MANUFACTURER

International Business Machines Corporation

Photo by U. S. Naval Weapons Laboratory

APPLICATIONS

General scientific calculation in ordnance research, development and testing. Primary effort has been devoted to scientific computation, including satellite surveillance data reduction, orbital computation, missile ballistics, reactor design, war game simulation. A small portion of the time is spent on business type data reduction and computation.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	16
Decimal digits/instruction	16
Instructions per word	1
Instructions decoded	80
Instructions used	80

Arithmetic system	Floating or fixed point
Instruction type	Three address
Number range	10^{-43} to 10^{+31}
A number may be written as	
$\pm$ x.xxxx xxxx xxxx $\cdot$ 10^{xx}	

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	15
Mult	31
Div	227
Construction	Vacuum tubes and diodes (switching)
Rapid access word registers	2,000
Basic pulse repetition rate	1 Mc/sec

Arithmetic mode	Serial
Timing	Asynchronous
Operation	Concurrent

Multiplication and division are partly performed in parallel. Operation time depends on decimal indices.

STORAGE

Media	No. of Words	No. of Digits (decimal)	Access Microsec
Magnetic Core	20,000	16 per word	8
Magnetic Tape	40,000,000		Variable

The core memory was built by Daystrom Instrument Corp. and installed in March 1960. Original memory was a 2,000 word Williams CRT System with same word size and access time. The magnetic tape system can read or search forward and backward and write forward.

Photo by U. S. Naval Weapons Laboratory

INPUT

Media	Speed
Magnetic Tape (8)	70,000 dec dig/sec
Keyboard	Manual (Serial)

Eight tape units are in service. The packing density on magnetic tape is 500 char/inch, the linear speed is 140 inches/sec. 0.5 inch tape is used.

OUTPUT

Media	Speed
Magnetic Tape (8)	70,000 dec dig/sec
Mechanical Printers (2)	150 lines/min 407 mechanisms
CRT-Microfilm Printer and Plotter	15,000 char/sec

Built by Strombery Carlson; uses Charactron CRT; installed in 1958.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	9,800
Tube types	20
Crystal diodes	30,000
Separate cabinets	6

CHECKING FEATURES

Fixed checks include:
Bit count modulo-4 check on each word transfer
Modulo-9 arithmetic check
Illegitimate character check
Word-length and block-length check on tape reading.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	138 Kw	145 KVA	0.95 pf
Power, air condit	70 Kw	100 KVA	0.70 pf

Above figures are estimated.

Area in existing concrete building was remodeled. Special 12" raised floor used to cover air ducts and cable raceway. 40 ton closed circuit air conditioner used for main racks. 25 ton system used for auxiliary equipment and room cooling. Main computer room approximately 2,000 sq ft, power supply 500 sq ft, air conditioner 700 sq ft and shops 700 sq ft.

PRODUCTION RECORD

Produced	1
Operating	1

COST, PRICE AND RENTAL RATES

$2,500,000 is the cost of the machine as above described (without core memory and CRT printer) plus Card-Tape-Card Converter.

Additional costs were the Core Memory at $500,000 and the CRT Printer at $200,000. Total for the system is $3,200,000.

FUTURE PLANS

The IBM 7090 System and the IBM 1401 System will supplement the computer capability of the Naval Weapons Laboratory.

INSTALLATIONS

U. S. Naval Weapons Laboratory
Dahlgren, Virginia

PERSONNEL REQUIREMENTS

	7 Day/Week Three 8-Hour Shifts/Day
Supervisors	1
Analysts, Programmers, Coders	40
Clerks	4
Operators	13
Engineers	2
Technicians	10
In-Output Oper	12

Operation tends toward closed shop.

Methods of training used includes primarily on the job training, except that for the 7090 System to be installed, advantage is being taken of available instruction from IBM.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	1.2 Hours
Good time	133 Hours/Week (Average)
Attempted to run time	144 Hours/Week (Average)
Operating ratio (Good/Attempted to run time)	0.925

Above figures based on period 1 Jan 60 to 30 Jun 60
Passed Customer Acceptance Test June 1955
Time is available for rent to qualified outside organizations.

Time, when available, is used by Defense contractors as well as government agencies.

This machine is exceptionally well checked, both internally and with regard to input-output. Most errors can be corrected immediately by the machine operator with practically no lost time. Since installation of core memory, error free period is close to 2 hours.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include long word length, high arithmetic speeds, high tape speeds, checking features, CRT printer, three address logic, and ease of programming.

Magnetic tape stored in computer room in metal cabinets. Since the tape is not compatible with other units there is no reason for it to leave the completely controlled climate of this area. Acetate base tape is used.

Speed increased by taking short cuts in case of zero operands and through the use of previous result as an operand. Provisions for addition, subtraction, and shifting of instruction words make possible programmed synthesis of instructions. A large variety of conditional program transfer instructions are available. Three address-modifier registers make possible the modification of operand addresses without changing the stored instruction. Card-tape-card conversion is used.

NORDEN VOTE TALLY

Norden Electronic Vote Tallying System Model 2602

MANUFACTURER

United Aircraft Corporation
Norden Division
Data Systems Department

Photo by Norden Division, United Aircraft Corp.

APPLICATIONS

The Norden Vote Tallying System is a special purpose electronic system used to tally paper ballots at high speed. Votes are accumulated by candidate and issue in a magnetic core memory, and totals are output to a printer-punch unit. A short length of punched paper tape is used to instruct the processor as to the ballot width, color and format before ballots are read. This same tape establishes the punch-out sequence. Two mechanical paper handlers are attached to a processor. A ballot handler feeds ballots in a fixed length of 24" and varying from 9" to 30" in width at 10 ballots per second. Up to six ballot widths may be individually selected by paper tape instruction without manual intervention.

The ballots are not mechanically registered. The processor contains the necessary skew interpolation circuitry to compensate for a misaligned ballot. This circuitry is shared by the two ballot handlers. Only one ballot handler feeds ballots at a time. While one ballot handler is feeding and totals are being accumulated, the second ballot handler is being reloaded with a spindled tray of ballots and totals are being transmitted for the stack of ballots previously read. The alternate use of the ballot handlers permits the continuous processing of ballots. Each ballot is examined for acceptability in accordance with the Election Code to accept only valid votes. Overvoted offices and incorrectly voted recall issues or recall candidates are not accepted,

but all valid votes are accepted to update totals. This analysis and updating occurs prior to the reading of the next ballot.

PROGRAMMING AND NUMERTCAL SYSTEM

Internal number system	Binary and Binary Coded Decimal
Digits per word	3 decimal, 4 binary, 1 parity
Digits/instruction	one alpha per instruction
Instructions decoded	14 instructions
Arithmetic system	Fixed point

Each operation is defined by an alpha instruction character.

Number range 000 to 999 for each of 540 totals

One alphabetic character defines an instruction operation. For example, one character, followed by appropriate designators, instructs system on specific locations of voting squares on the ballots to be read. Another alphabetic character initiates the actual reading of ballots. Instructions are read from punched paper tape and are executed in sequence as read from the tape.

Essentially all operations in the system are built-in subroutines. These include updating of the totals in memory as each ballot is read, checks on over-voting, punch-out of candidate totals, etc.

All programming is in direct instructions.

Registers include instruction register, memory in-out register, ballot mark input registers, and punch

Photo by Norden Division, United Aircraft Corp.

encode register.

ARITHMETIC UNIT

Add time is 33 microseconds, including storage access, 6.6 for the actual add operation only. Arithmetic operation of updating totals after reading each ballot is an automatic subroutine.

Timing	Synchronous, within data processor
Operation	Sequential
Arithmetic mode	Serial

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core Memory	600	17 bits	3 to 4

INPUT

Media	Speed
Punched Paper Tape	60 char/sec
8-channel tape (7 information plus parity)	
Paper Ballots	10 ballots/sec

Ballots can be up to 30" wide, 24" long.

OUTPUT

Medium	Speed
Cards (80-Column)	18 columns/sec

System uses IBM 526 Printer-Punch

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5651	2
6199	20
Diodes	
DR-385	Approximately 3,500
1N770	Approximately 1,000
Miscl.	Approximately 200
Transistors	
2N426	Approximately 3,000
2N388	Approximately 600
Miscl.	Approximately 300
Magnetic Cores	10,800 in each of two memories

Voltage regulator tubes used as reference tubes in power supplies.

Photomultiplier tubes in optical reading heads.

Follow-on systems will use 1N770 diodes.

Each memory has 18 core planes (one spare), with 10 columns, 60 rows in each.

Cores are General Ceramics.

Data is for Model 2602 Two-handler system.

CHECKING FEATURES

Checking features include paper tape parity, column read, ballot jam, memory parity, format pickup, precinct number agreement, power supply monitoring, double-punch and blank-column detection, and ballot clock-track check.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	4.5 to 5	0.90 pf

Power includes tape reader and output card punch.

One system, employing two ballot handlers, requires approximately 1,200 sq ft of floor area. Total installation load for system is approximately 15,000 pounds. Data processor weighs approximately 2,000 pounds; each ballot handler, about 5,200 pounds. Operator consoles and output printer-punches account for remainder. Floor should be capable of supporting distributed load of 300 pounds/square foot. Site preparation requirements for each system include air compressor, an air fan to provide high-volume low-vacuum air, and a vacuum pump for high-vacuum pressure.

Ballot handlers operate alternately in reading ballots. While reading, drive motors in ballot handler draw approximately 20 KVA from 220-Volt 3 phase line. Air compressor, low-vacuum fan, and high-vacuum pump, required for each system, draw about another 20 KVA per full system from 220-Volt 3 phase line.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	12 months

Production of additional systems to be started soon for use in elections of 1962 and 1964.

COST, PRICE AND RENTAL RATES

Model 2602 System (2 Model 610 Ballot Handlers, 2 Model 620 Control Consoles, 1 Model 640 Data Processor cost approximately $600,000.

A slightly smaller system, Model 2601 System (1 Model 610 Ballot Handler, 1 Model 620 Control Console, 1 Model 630 Data Processor), cost approximately $375,000.

Maintenance contract, issued on annual basis, will be available from the manufacturer.

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to the user include programming and operator training.

Typical election requires two console operators, and requires three ballot personnel per ballot handler. Total of 8 people per system per shift, plus one supervisor for the entire facility (which may be multiple-system facility).

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System employs solid-state construction throughout to attain reliability, and employs modular assembly techniques to facilitate rapid isolation and replacement of malfunctioning module. Indicator lights on each control console provide information on status of each component unit of system.

ADDITIONAL FEATURES AND REMARKS

System reads voter-marked ballots at rate of 10 ballots per second, and tallies ballots in accordance with election codes. Checks for over-voting, and provides for candidate rotation on ballots. Output totals are punched into cards; no manual transcriptions of totals from counters is required. System eliminates long hours of manual tallying of ballots at individual precincts. Handles variety of sizes of ballots. Output cards can be processed by conventional card equipment.

INSTALLATIONS

Los Angeles County, California

NUMERICORD

Numericord Machine Tool Director

MANUFACTURER

Concord Control, Incorporated

Photo by Concord Control, Incorporated

APPLICATIONS

The Numericord Director System is the Giddings & Lewis Machine Tool Company's numerical, continuous-path control system for automatically and electronically controlling a wide variety of multi-axis machine tools. Numericord is the registered trademark of the Giddings & Lewis Machine Tool Company, Fond du Lac, Wisconsin.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary Coded Decimal
Decimal digits/instruction	43
Arithmetic system	Fixed point
Timing	Synchronous
Operation	Sequential

The Numericord Director System utilizes a fixed word length; instruction format and program for all computations.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core Memory	44	334	10

INPUT

Medium	Speed
Paper Tape	600 lines/sec

Utilizes high speed photo-electric one inch wide tape reader for input. Input system can also be modified to accept the magnetic tape output of a general purpose computer in lieu of the punched tape.

OUTPUT

Medium	Speed
Magnetic Tape	Continuous at 60 in/sec

Output information is continuous phase modulated quantized analog control signals on one inch, 14 channel magnetic tape. Magnetic tape output is used as permanent information storage medium between director system and machine tool. Director system can also be modified to control machine tool directly without magnetic tape storage.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	600
Diodes	5,000
Transistors	300
Magnetic Cores	300

CHECKING FEATURES

Fixed self-checking features indicate location of errors to one or more of approximately 12 system areas.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	6 Kw	9 KVA	0.66 pf
Volume, computer		250 cu ft	
Area, computer		45 sq ft	
Weight, computer		4,600 lbs	

No special site preparation required. System designed for operation in any normal office environment.

PRODUCTION RECORD

Number in current production 8 in United States

COST, PRICE AND RENTAL RATES

Director, Power Supply, and Tape Recorder cost approximately $225,000.

Tape preparation desk cost approximately $25,000.

System is normally not available for rental or lease.

Users maintenance personnel are fully trained at manufacturer's plant prior to system installation.

PERSONNEL REQUIREMENTS

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	Used	Recom	Used	Recom	Used	Recom
Operators	1	1	2	2	3	3
Technicians	1	1	2	2	3	3

Operation tends toward open shop.

Equipment operation is relatively simple. Initial personnel are trained on the job by manufacturer. Additional personnel can be quickly trained on the job as required.

The Numericord Director is a special purpose digital computer and although it is sometimes programmed manually, programs are normally prepared by a large general purpose computer. When used in this fashion the Numericord system can usefully be described as a piece of special purpose off-line peripheral equipment used in conjunction with a number of large general purpose computers.

Normal personnel requirements for the system usually consist of a trained operator and a trained electronic technician who is on call but not necessarily present at the equipment at all times. Programming is done by the regular data processing department mathematical programming section.

ADDITIONAL FEATURES AND REMARKS

Purpose - provides fully automatic control of complete work cycles for general-purpose machine tools having as many as five simultaneous axes of movement.

Operation - places all machine movements and auxiliary functions under control of a magnetic tape program which is prepared electronically from numerical data off part drawings.

Significance - provides a "store" of skills which makes workpiece accuracy a function of engineering and methods planning completely independent of machine operator's experience.

Application - while capable of automatically operating any type of machine tool, optimum effectiveness is achieved on multiple-axis, three-dimensional contouring machines.

Machine Scope - controls standard machine movements to generate such geometric shapes as straight lines, circles, ellipses and spirals or any shape that can be mathematically defined or arbitrarily set up in three-dimension coordinates.

Accuracy - tolerances obtainable with the Numericord System of machine control range from ± .0005" to ± .001" on the largest and most intricate workpiece. No cumulative error.

FUTURE PLANS

For several years this system has been used primarily by the aircraft and missile industries. Modifications and adaptations of the system are now being designed for special applications in precision plane and contour map making, coordinatography, precision plotting, flame cutting, X-ray inspection, and riveting.

INSTALLATIONS

Republic Aviation Corporation, Farmingdale, Long Island, New York

Giddings & Lewis Machine Tool Company, Fond du Lac, Wisconsin

Boeing Airplane Company
Wichita, Kansas

Convair, Division of General Dynamics
Fort Worth, Texas

Convair, Division of General Dynamics
San Diego, California

Lockheed Aircraft Corporation
Burbank, California

North American Aviation Inc.
Los Angeles, California

OARAC

Office of Air Research Automatic Computer

MANUFACTURER

General Electric Company

APPLICATIONS

Scientific computation and analysis.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	10 + sign
Decimal digits/instruction	7
Instructions/word	1
Instructions decoded	21
Instructions used	21
Arithmetic system	Variable fixed decimal point location, can be set to any of 11 digit positions initially. It must remain at this location during any given sequence of operations, in order to obtain consistent results.
Instruction type	Two address (The machine originally was a one address machine). The modification to a two address machine facilitated access to storage and permitted execution of special instructions with significant savings in time.
Number range	Variable $\pm (10^{10} - 1)$

Number system used is the 2*-4-2-1 system.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	400-17,000	91
Mult	10,000-26,000	800
Div	10,000-26,000	1,200

Construction

Vacuum tubes	400
Diodes	2,500

Basic pulse repetition rate	150 Kc/sec
Arithmetic mode	Serial by character Parallel by bits
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Drum	10,000	110,000	1,000-17,000
Magnetic Tape	7,200 per 1,200 ft. tape		

INPUT

Media	Speed
Magnetic Tape	1,000 words/min
Keyboard	Manual

Keyboard is located on main control panel.

OUTPUT

Medium	Speed
Magnetic Tape	1,000 words/min

Contents of tape translated by an off-line code transcriber and typewriter.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes	1,200
Tube types	12
Crystal diodes	7,000
Separate cabinets	2

Computer is housed in one cabinet and the magnetic drum is housed in another cabinet.

CHECKING FEATURES

Exceed capacity
Unprogrammed stop
Wrong combination
Synchronized tape
Divide by zero
Product exceed capacity
Tape runout, power and cooling failure fault checks.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	23 KVA
Volume, computer	600 cu ft
Area, computer	80 sq ft
Weight, computer	6,000 lbs
Capacity, air conditioner	10 Tons

The two cabinets measure 15 by 2.5 by 7 ft. and 4 by 5 by 6 ft.

PRODUCTION RECORD

Number produced 1

This system was developed on a research and development contract for the Air Force.

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $185,000.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running period	15 Hours
Good time	13,686 Hours
Attempted to run time	16,733 Hours
Operating ratio (Good/Attempted to run time)	0.82

Above figures based on period from Apr 53 to Apr 56
Passed Customer Acceptance Test Apr 53

ADDITIONAL FEATURES AND REMARKS

The OARAC has been improved. The improved version reportedly uses the same codes and commands as OARAC in order that problems may be run without difficulty.

The problem exists with most computer installations that a considerable amount of machine time is required for checking out problems and it is planned to compensate for this by using the new machine, which is faster than the old OARAC, for running checked-out problems only.

The new machine is supposed to have a 10,000 word core memory, and is supposed to be able to perform additions in 65 microseconds, excluding access time or in 130 microseconds, including access time and playback of the next instruction, multiply in 2.6 milliseconds and divide on an average of 6 milliseconds. This is supposed to result in an operating time savings of approximately 25 to 1 for most programs.

INSTALLATIONS

Aeronautical Research Laboratory
Wright Air Development Center
Wright-Patterson Air Force Base, Ohio

OKLAHOMA UNIV

Oklahoma University Computer 1066

APPLICATIONS

Located in the Merrick Building, North Campus, University of Oklahoma, Norman, Oklahoma, the system is used for general purpose scientific and engineering computation.
This computer is a copy of the Rice University computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	54
Binary digits/instruction	54
Instructions per word	1
Instructions decoded	Approx. 2500 (Micro Programmed)
Arithmetic system	Floating point

Base 2^8; Exponent has sign plus 5 bits; Man., sign plus 47.

Instruction type		One address
With limited three-address options.		
Number range	Floating Pt:	$2^{-295} \leq \lvert n \rvert < 2^{+248}$
	Fixed Pt:	$-1 < n < 1$

Instruction word format

6	15	6	4	8	15
4 Bit Address of One Operand; Sign Modification	Operation Field	Auxiliary Red-Tape Operation	15 Bit Address plus B Modifiers; Indirect Address Option; Sign Modification		

Automatic built-in subroutines
Provision for an entire class of these. Initially will have none. Tests for tags and certain arithmetic conditions are done automatically in the "Trapping Mode" of operation.
Automatic coding
ALGOL Compiler
Registers and B-boxes
7 rapid access 54-bit registers (4 listed also as fast access storage). 8 B-boxes - Instruction uses any combination and gives sum of contents as modifier. 1 fictitious "zero" register. 8 special purpose 15 bit registers.
Number of binary digits per word or instruction is 56 in memory, 2 of which are tags which can be tested when bringing from memory.
About 2,500 combinations in the operation field alone, with room for expansion.
One operand is taken from any of the 16 standard registers; a result from the operation can be stored back into any of the 16 or a B-box can be modified as a final auxiliary operation.
Two of the B-boxes have special designations as Control Counter and Pathfinder; respectively these contain the address of the next instruction, and an address from a previous transfer.

MANUFACTURER

University of Oklahoma
Computer Laboratory

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	7 to 16	3 to 4
Mult	108	100
Div	108	100

Times are estimated.

Construction (Arithmetic unit only)	
Vacuum-tubes	900
Transistors	60
Diodes	5,600
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Bin Dig/Word	Access Microsec
Flip-Flop Register	4	54	< 1
Electrostatic (CRT)	8,192 (present)	63	8(avg)
Diode-Capacitor	4	63	Buffers

Magnetic Tape

No. of units that can be connected	8 Units
No. of char/linear inch of tape	500 Char/inch
Channels or tracks on the tape	10 Tracks/tape
Tape speed	75 Inches/sec
Start time	7 Millisec
Stop time	10 Millisec
Physical properties of tape	
Width	0.75 Inches

The flip-flop registers are located in the arithmetic unit and listed there also. Barrier Grid type CRT is used. 63 bits include 54 word, 2 tags, 6 error correction code, and 1 parity. Diode-Capacitor registers are buffers to and from magnetic tapes.

INPUT

Media	Speed
Paper Tape	400 hexads/sec 44 words/sec
Ferranti T.R.	5 (Photoelectric)
Magnetic Tape	2 to 4 words/millisec
Typewriter	Manual (IBM Input-Output Writer)
Switches	Manual (Can set 4 Special-Purpose Registers)

Operator can type to or from any register.
Sense, Mode, Trapping, Indicator Registers.

OUTPUT

Media	Speed
Line Printer	20 lines/sec (numeric) 10 lines/sec (alphanumeric)
Paper Tape Punch	100 codes/sec 6 levels plus control
Typewriter	10 octal dig/sec
Magnetic Tape	

Printer mechanism is Anelex 56-160.
Punch is Teletype BRPE 11
Paper Tape preparation is by off-line Flexowriter.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type		
Tubes		
5965	About 1,500	
6197	About 300	
S11E12	About 20	A high quality British power pentode.
2D21	About 120	To drive printer hammer solenoids.
1858	63	Barrier-grid storage tube.
Total approx.	2,000	
Diodes		
OMC-537		
SG211		
Other miscellaneous		
	About 16,000	total (estimate)
The majority of these are		OMC-537 which is a Gold-Bonded Germanium Diode
Transistors		
2N585		
2N598		
2N393		
SB101		
Others		
Total	2,000 - 3,000	(estimate) mostly the first two types

Primary uses: instruction decoding and gates, peripheral equipment, and memory preamplifier.

Magnetic Cores	700	Used for pulse transformers

The above quanities include some rather gross estimates for the control unit which is only partially completed.

CHECKING FEATURES

Six bit error correction code plus parity on electrostatic storage and magnetic tape. Corrects singly-occurring bit failures. Exponent, mantissa overflow indicators which can be automatically checked as a trap condition.

Provision for marginal checking of circuits. Rounding is optional on results of certain arithmetic operations.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	12 Kw (estimated)
Capacity, air conditioner	15 Tons

PRODUCTION RECORD

Number produced to date	0
Number in current operation	Sections only, not entire system
Number in current production	1

System operation anticipated in 1961.

COST, PRICE AND RENTAL RATES

Locally produced.

ADDITIONAL FEATURES AND REMARKS

On any instruction the address can be modified by any combination of the 8 index registers (B registers), the control counter as a B register allows easy relative addressing of subroutines. Large exponent base for faster floating point operations, extra long mantissa to minize loss of significance by shifts of 8.

Provision for repeating the same instruction in a 1-word loop. Result of any arithmetic or logic can be returned to memory as a general "add-to-memory" with a block transfer option.

Interchange options allow integer arithmetic, where the fixed point number range can be considered as $\pm 2^{47}$.

Two tag bits in memory on either words or instructions.

A special register of "Mode Lights" allow special modes of machine operation: trapping mode where certain tests are made during the instruction execution; repeat mode for repeating the same instruction; rounding on multiplication and floating point addition and subtraction is optional by "Rounding Mode".

There is provision for using two magnetic tape units concurrent with normal program execution.

The designation 1066 refers to the Battle of Hastings, in as much as the computer is located at Norman.

This computer is a copy of the Rice University Computer, see that description for further comments that are applicable as of 1960-1961.

FUTURE PLANS

Memory size to be increased to full 32,000 word capacity after the system is running.

INSTALLATIONS

University of Oklahoma
Computer Laboratory
Merrick Building - North Campus
Norman, Oklahoma

ORACLE

Oak Ridge Automatic Computer and Logical Engine

MANUFACTURER

Oak Ridge National Laboratory
Argonne National Laboratory, Jointly

Photo by Oak Ridge National Laboratory

APPLICATIONS

Located at X-10 site at the Oak Ridge National Laboratory, use and application has been primarily as a research and development tool for numerical analysis, programming techniques, and problems in physics, chemistry, engineering and biology. Methods have been developed for solving linear equations, matrix inversions, computing eigenvalues and vectors of matrices, solution of reactor problems involving ordinary and partial differential equations. Monte Carlo techniques have been designed and applied to problems in health physics and shielding. Many "one of a kind" problems are solved which involve methods mentioned above as well as function evaluation, interpolation and statistical analysis. In the last few years much effort has gone into data processing, data handling and reduction. System is a large scale and general purpose computer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	40
Binary digits/instruction	8
Instructions/word	2
Arithmetic system	Fixed point
Instruction type	One address
Number range	-1 to $+ (1 - 2^{-39})$

Instruction word format

Order	Break Point	Address
8	1	11

Registers

Accumulator, quotient and storage registers

Photo by Oak Ridge National Laboratory

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	70	8
Mult	370-590	Slightly less
Div	590	Slightly less

Construction (Arithmetic unit only)
Arithmetic unit is constructed of vacuum tubes, transistors, and diodes. Type 2N43 transistors and type 1N68 and 1N191 diodes are used.

Arithmetic mode	Serial
Timing	Synchronous in storage and asynchronous in arithmetic
Operation	Sequential Concurrent in magnetic tape hunting operations

STORAGE

Media	No. of Words	Access Microseconds
Cathode Ray Tube	2,048	18
Magnetic Tape	3×10^6	50,000/block
Four handlers		128 words/block

No. of units that can be connected	4 Units
No. of chars/linear inch	170 Chars/inch
Channels or tracks on the tape	42 Tracks/tape
Blank tape separating each record	1 Inch
Tape Speed	47 Inches/sec
Transfer rate	8000 chars/sec
Start time	5 Millisec
Stop time	5 Millisec
Average time for experienced operator to change reel	30 seconds
Physical properties of tape	
Width	2 Inches
Length of reel	1,000 Feet
Composition	.003" Mylar base
	.001" Oxide coating

INPUT

Medium	Speed
Paper Tape (Ferranti)	200 char/sec

OUTPUT

Media	Speed
Photographic Curve Plotter	2000 char/sec
Used for point plotting also	
Characters are series of points	
Console Typewriter	10 char/sec
Not normally used for output	

Paper Tape	60 char/sec
Teletype BRPE-2	
Magnetic Tape	1000 char/sec

Printed on typewriter at 10 char/sec

Output magnetic tape is run at 60 in/sec on ORACLE and slowed to 0.6 in/sec for printing on typewriter (IBM).

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
5844	
5965	
7044	
6211	
3633	
6BC7	
6AL5	
6AK5	
6AH6	
12AT7	
12AU7	
12AX7	
Total	5,000
Diodes	
1N68	
1N191	
Total	200
Transistors	
2N43	100
Magnetic Cores	None

CHECKING FEATURES

Word parity on memory
Word parity on magnetic tape
Character parity on paper and magnetic tape

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	75 Kw 0.9pf
Room size	60 ft x 60 ft
Capacity, air cond., computer	25 Tons
Capacity, air cond., room	15 Tons

A false floor consisting of four plenums covers 0.9 of room. Ducts under false floor and over roof seals in closed loop air conditioning. A separate 4400-volt power line transformer is used.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Arithmetic Unit	
Memory Unit	
Magnetic tape unit	
Input-Output and Console	
Total	$250,000

PERSONNEL REQUIREMENTS

	Three 8-Hour Shifts	
	Used	Recommended
Supervisors	2	
Analysts	4	8
Programmers	40	
Coders	2	8
Clerks	1	
Librarians	1	
Operators	5	
Engineers	1	3
Technicians	6	

Methods of training includes classes in basic coding and algebraic language coding.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Average error-free running time	4 hours
Good time	3,869 hours
Attempted to run time	4,252 hours
Operating ratio (Good/Attempted to run)	0.91
Figures based on period	Jul 55 to Jul 56
Acceptance test	1 Sep 53

ADDITIONAL FEATURES AND REMARKS

Two operating modes are possible in the ORACLE.

Mode 1 is the 1024 word mode in which time multiplex is used between a pair of Williams tubes to determine the stored information for each bit. When either tube reads a dash signal, a dash is replenished to both. This method overcomes the common type of screen blemish which would prevent storage of a "1" (dot-dash).

Mode 2 is the 2048 word mode in which each tube stores 1024 bits. The first tube is regenerated in the first half of a major cycle and the second tube in the second half.

IAS type computer.

INSTALLATIONS

Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, Tennessee

ORDVAC

Ordnance Variable Automatic Computer

MANUFACTURER

University of Illinois

U. S. Army Photo

APPLICATIONS

Ballistic Research Laboratories

Exterior ballistics problems such as high altitudes, 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 anti-missile evaluation, war game problems, linear programming for solution of Army logistical problems, probabilities of mine detona-

Transistorized Arithmetic Unit

U. S. Army Photo

tions, 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 per word	40
Instructions per word	2
Instruction type	One Address
Binary digits in operation code	6 or 9
Binary digits in address	12 or 10
Instructions used	55 or 72
Arithmetic system	Fixed point
Number range	$-1 < x < 1$

Instruction word format

Left Instruction			Right Instruction		
6 Order	2 Unused*	12 Address	6 Order	2 Unused*	12 Address
20 Bits			20 Bits		

*One bit will be used to differentiate flo point numbers from fix point numbers

Rapid Access word registers - 3

Sexadecimal representation is used externally.

Negative numbers are handled as 2 complements.

Magnetic Core Memory

Floating point operation may be programmed.

Dual code - ORDVAC operates on a dual code basis. The codes are, on a two instructions per word basis, i.e. 20 digits per instruction:

Code A - 1,024 words of storage:
  9 digit, command
  1 digit, spare
 10 digit, address
Code B - 4,096 words of storage:
  6 digit, command
  2 digit, spare
 12 digit, address

U. S. Army Photo

This system permits utilization of routines developed previous to the 4,096-word operation change over.

ARITHMETIC UNIT

Arithmetic mode	Parallel
Basic pulse rate	Not pulse controlled
Add time (Basic addition by arithmetic unit)	14 microsec
Multiply time (exclud. stor. access)	700 microsec
Divide time (exclud. stor. access)	700 microsec

Transistorized Channel Selector

U. S. Army Photo

The total add time, including transfer to final register, is 50 microseconds. None of the above figures include access to storage.
Construction, Arithmetic unit only - Transistorized on printed circuit plug-in boards, using 1,000 Type 2N128 transistors.

Timing	Asynchronous
Operation	Parallel

STORAGE

Media	Words	Digits	Access
Magnetic core	4,096	163,840 bits	15 microsec
Magnetic drum	10,032	401,280 bits	80,000 " /48 words

Magnetic drum purchased from ERA Division of Sperry Rand, Incorporated. The track selector for the magnetic drum has been transistorized. Magnetic core storage unit purchased from Telemeter Magnetics, Incorporated. Both above storage units adapted to ORDVAC and installed by Ballistic Research Laboratories personnel.

INPUT

Media	Speed
Teletype tape (5 hole)	2.5 words per sec
Punched cards	40 words per sec (bin) 8 words per sec (dec)
Ferranti Hi-speed Paper Tape Reader	20 words per sec (bin)
Magnetic tape	300 words per sec

The special purpose one inch wide magnetic tape system for transferring telemetered data to ORDVAC has 6 information tracks and 3 control tracks.

OUTPUT

Media	Speed
Teletype page printer	0.4 words per sec
Teletype tape	0.4 words per sec
Punched cards	40 words per sec (bin) 8 words per sec (dec)

Transistorized magnetic core contents display.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes

Type	Quan	Type	Quan
5964	817	C6J	28
5687	420	6X5	4
2C51	568	0C3	4
5965	637	6SF5	4
6AL5	47	6AC7	4
6A67	2	12SN7	12
2D21	160	12AU7	1
6080	21	6AH6	9
6AN5	13	6350	86
0B2	14	6829	2
7AK7	16	6216	2
5963	46	6BJ7	42
6AV6	13	6197	90
5R4	2	6293	193
6L6	26	5998	72
12AX7	22	6336	27
6X4	6	350B	4
5651	12	0A2	3
6AQ5	1	Total	3,430

Transistors

Type	Quan	Type	Quan
2N162	20	2N1056	250
2N140	65	2N113	75
2N128	1300	2N426	25
2N109	346	2N425	10
		Total	2,091

Diodes

Type	Quan	Type	Quan
1N91	418	1N63	15
1N93	162	1N58A	10
1N52	10	1N298	300
		Total	915

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power Consumption

Computer	40 K.W.
Core Memory	15 K.W.
Magnetic Drum	6 K.W.

Air Conditioning

Computer	15 Tons
Core Memory	7.5 Tons
Magnetic Drum	3 Tons

Space

Computer	630 cu ft 80 sq ft

Weight

Computer	3,000 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1

COST, PRICE AND RENTAL RATES

Rental rates for additional equipment
$648.57 per month
The additional rented equipment is:

I.B.M. punch	$ 83.32 per month
I.B.M. reader	$ 82.50
I.B.M. reproducer	$122.50
I.B.M. tabulator	$360.25

Approximate cost of basic system $600,000.

PERSONNEL REQUIREMENTS

Typical Personnel

	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

Average error-free running period	Approx. 6 hours
Good-time	7,475 hours
Attempted to run time	8,760 hours/year
Operating ratio	0.85

The above figures are based on the yearly average of the last 5 years. Approximately 2 hours per week are used for scheduled preventive maintenance and 10 hours per week are used for running computer test programs. The 1,286 hours difference above were used for testing, servicing, bad operating time, general improvement, and the incorporation of new components.

ADDITIONAL FEATURES AND REMARKS

The ORDVAC belongs to the group of computers whose basic logic was developed by the Institute for Advanced Study and utilized in the IAS computer. This IAS family of computers is made up of such machines as the ILLIAC, ORACLE, AVIDAC, MANIAC, JOHNNIAC, MISTIC, and CYCLONE.

The ORDVAC is a direct-coupled machine using three-dimensional construction. A direct-coupled machine is one that connects the voltage level of one component directly to the input of the next, without voltage isolation between. This feature is very helpful in trouble-shooting the system. Three-dimensional construction is sometimes called low-capacitance wiring. In the ORDVAC, three-dimensional wiring is employed by placing the arithmetic unit and other controls on opposite sides, and interconnected wiring running across the open space between. The machine can be remotely controlled from commercial Teletype units.

ORDVAC is equipped with the option of two different instruction codes. Code -9 (nine bits per instruction) makes 1,024 words of high speed core storage available to the operator while Code -6 (six bits per instruction) makes 4,096 words of high speed storage available. Each code shares a common nine-bit decoder; however, when the code -6 option is used the instruction first passes through a code translator which translates the six bit instruction into its 9-bit equivalent. There is no loss of time while making the code translation.

The translator uses the following number of circuit elements

Transistors		
SB 100	135	
2N 43	24	
2N 140	12	
Total	171	
Crystal diodes		253
Resistors		305
Capacitors		23

The above components are mounted on 21 printed circuit boards. Power dissipation is approximately 5 watts.

INSTALLATIONS

Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

FUTURE PLANS

The Floating Point unit for the ORDVAC will be fully transistorized, with a number range of 2^{127} to 2^{-128}, using a seven bit biased exponent. Numbers will be normalized automatically on transfer to storage. The mantissa of the normalized floating-point number will have a range of $1/2 > c > -1/2$. This system will require that an existing register be converted from a one-sided shifting register to a two-sided shifting register.

Fully transistorized control circuitry for new indexing orders will be added in the near future.

General purpose magnetic tape stations will be added to the ORDVAC shortly, with provisions for 8 stations. ORDVAC will control read, write, re-wind forward and backward, move tape forward and back N words, starting at A address of memory, transfer to B address of memory for next instruction, re-record N words, playback N words, check for parity error, transfer on error, and other functions.

Circuit Elements, Entire System

Magnetic Cores

Quan	OD	ID	Thick	
172,032	100	70	30	mils
5,376	375	260	125	mils

PACKARD BELL 250

Packard Bell Computer Model 250

MANUFACTURER

Packard Bell Computer Corporation

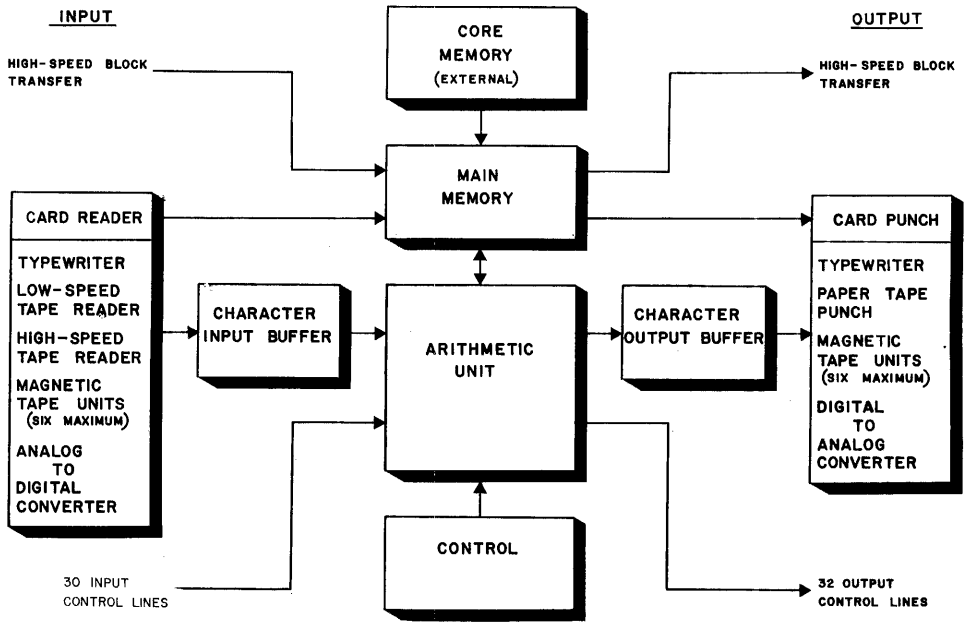
Photo by Packard Bell Computer Corporation

APPLICATIONS

The PB 250 is a high speed digital computer designed to be used for general purpose computing and as a system component for on-line, real-time, data handling.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	21 plus sign
Binary digits/instruction	22
Instructions per word	1
Instructions decoded	63
Arithmetic system	Fixed point
Floating point by subroutine	
Instruction type	One address (Modified)
Number range	6 decimal digits



Block Diagram by Packard Bell Computer Corporation

Instruction word format

22 15	14	13 8	7 3	2	1
Sector Number	Sec Tag	Op Code	Line Number		Index Tag

An index register may be loaded to modify line number of address. (The contents of the index register replaces line number of all instructions where a tag is specified.)

A single instruction can shift the memory location of a specified number of words by one address position thus eliminating the need for address modification while maintaining optimum programming.

Optimum programming is provided for by provision for relative addressing for next instruction.

Automatic built-in subroutines include square root and gray-to-binary conversion.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	108 Avg	12
Mult	372 Avg	276 (max)
Div	348 Avg	252 (max)
Arithmetic mode	Serial	
Timing	Synchronous	
Operation	Sequential or non-sequential	

The PB 250 operates at a clock frequency of 2 Mc giving a word time of 12 microsec. The arithmetic unit is completely serial in operation as is the magnetostrictive delay line memory. The serial approach provides low component count with low cost and high reliability. The 2 Mc clock provides microsecond speed formerly associated only with very large expensive machines. The magnetostrictive delay line memory can be expanded from the basic 1808 words in 1 to 256 word increments to 15,888 words by the simple addition of plug-in units.

STORAGE

Media	No. of Words	No. of Bits	Access Microsec
Magnetostrictive Delay Line	to 15,888	to 349,536	1,540 avg
Magnetic Core	to 16,384	to 360,448	
Magnetic Tape			
No. of units that can be connected		6	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		5, 10	Inches/sec
Transfer rate		1 or 2	Kc/sec
Start time		3	Millisec
Stop time		1.5	Millisec
Physical properties of tape			
Width		1/2	Inches
Length of reel		2500	Feet

INPUT

Media	Speed
Flexowriter	10 6 or 8 bit char/sec
Paper Tape	300 6 or 8 bit char/sec
Magnetic Tape	2,000 7 bit char/sec
Serial	2 Mc bit, 83.3 KC word rate

30 control inputs used with the transfer on external signal command are also available for control applications.

OPERATIONS GROUPING

COMMAND STRUCTURE			
OP Code 6 bits	Address 13 bits	Sequence tag 1 bit	Index tag 1 bit

A and B Registers: One word registers, programmed independently or combined for multiplication, division, square root, and double precision operations.

C Register: For multiplication, division, tally, and control.

Operation	Mnemonic Code	Numeric Code	Description
Arithmetic	ADD	14	Add
	SUB	15	Subtract
	DPA	16	Double Precision Add
	DPS	17	Double Precision Subtract
	SQR	30	Square Root
	VLS	30	Variable Length Square Root
	DIV	31	Divide
	VLD	31	Variable Length Divide
	MUP	32	Multiply
	VLM	32	Variable Length Multiply
	CLA	45	Clear A
	CLB	43	Clear B
	CLC	44	Clear C
	GTB	41	Gray to Binary
	CAM	56	Compare A and M
Transfer	TAN	35	Transfer if A Negative
	TBN	36	Transfer if B Negative
	TCN	34	Transfer if C Negative
	TRU	37	Transfer Unconditionally
	TOF	75	Transfer on Overflow
	TES	77	Transfer on External Signal
Loading & Storing	LDA	05	Load A
	LDB	06	Load B
	LDC	04	Load C
	LDP	07	Load Double Precision
	IAC	01	Interchange A & C
	IBC	02	Interchange B & C
	STA	11	Store A
	STB	12	Store B
	STC	10	Store C
	STD	13	Store Double Precision
	MCL	71	Move Command Line Block
	MLX	26	Move Line X to Line 7
Logical & Shifting	EBP	40	Extend Bit Pattern
	AMC	42	AND M & C
	AOC	46	AND OR Combined
	EXF	47	Extract Field
	NAD	20	Normalize and Decrement
	LSD	21	Left Shift and Decrement
	RSI	22	Right Shift and Increment
	SAI	23	Scale Right and Increment
Control	NOP	24	No Operation
	HLT	00	Halt
Input-Output	DIU	50	Disconnect Input Unit
	RTK	51	Read Typewriter Keyboard
	RPT	52	Read Paper Tape
	RFU	53	Read Fast Unit
	LAI	55	Load A From Input Buffer
	CIB	57	Clear Input Buffer
	WOC	6X	Write Output Character
	PTU	70	Pulse to Specified Unit
	BSO	72	Block Serial Output
	BSI	73	Block Serial Input

NUMERIC ORDER

Numeric Code	Mnemonic Code	Description
00	HLT	Halt
01	IAC	Interchange A & C
02	IBC	Interchange B & C
04	LDC	Load C
05	LDA	Load A
06	LDB	Load B
07	LDP	Load Double Precision
10	STC	Store C
11	STA	Store A
12	STB	Store B
13	STD	Store Double Precision
14	ADD	Add
15	SUB	Subtract
16	DPA	Double Precision Add
17	DPS	Double Precision Subtract
20	NAD	Normalize and Decrement
21	LSD	Left Shift and Decrement
22	RSI	Right Shift and Increment
23	SAI	Scale Right and Increment
24	NOP	No Operation
26	MLX	Move Line X to Line 7
30	SQR	Square Root
31	DIV	Divide
32	MUP	Multiply
34	TCN	Transfer if C Negative
35	TAN	Transfer if A Negative
36	TBN	Transfer if B Negative
37	TRU	Transfer Unconditionally
40	EBP	Extend Bit Pattern
41	GTB	Gray to Binary
42	AMC	And M & C
43	CLB	Clear B
44	CLC	Clear C
45	CLA	Clear A
46	AOC	AND OR Combined
47	EXF	Extract Field
50	DIU	Disconnect Input Unit
51	RTK	Read Typewriter Keyboard
52	RPT	Read Paper Tape
53	RFU	Read Fast Unit
55	LAI	Load A from Input Buffer
56	CAM	Compare A and M
57	CIB	Clear Input Buffer
6X	WOC	Write Output Character
70	PTU	Pulse to Specified Unit
71	MCL	Move Command Line Block
72	BSO	Block Serial Output
73	BSI	Block Serial Input
75	TOF	Transfer on Overflow
77	TES	Transfer on External Signal

Command List by Packard Bell Computer Corporation

OUTPUT

Media	Speed
Flexowriter	10 6 or 8 bit char/sec
High Speed Paper Tape Punch	110 6 or 8 bit char/sec
Magnetic Tape	2,000 7 bit char/sec
High Speed Serial	2 Mc bit, 83.3 KC word rate

The high speed (2 Mc) input and output is through a 2 Mc external shift register which can be loaded or unloaded in serial or parallel from equipment such as A to D, D to A converters, shaft encoders, etc.

Input and output can also be made through an 8 bit character buffer which is used for Flexowriter, Paper Tape, and Magnetic Tape input and output. For example, an adaptor card which connects our Model M3 A to D converter directly to the character buffer is available. 32 control output lines are available for use with the Pulse to Specified Unit command for control applications.

Both punched card and line printing equipment will be available by mid 1961.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

There are 400 transistors, 2,500 diodes, and 4 magnetostrictive delay lines in the system.

COST, PRICE AND RENTAL RATES

Model Number	Item	Sale Price	Monthly Lease Price
PB 250	**COMPUTER** with Flexowriter and 2320-word memory		
	PB 250-T In Free-Standing Case	$40,500	$1,230
	PB 250-R For Rack Mounting	39,500	1,200
	PB 250-R With Shelf & Slides for Rack Mounting Flexowriter	39,900	1,210
MSR-1	**MEMORY MODULE** (up to 256 words)	1,200	40
MTU-1	**MAGNETIC TAPE UNIT**	14,750	445
HSR-1	**PAPER TAPE READER** (300 characters/sec)	7,500	230
HSP-1	**PAPER TAPE PUNCH** (110 characters/sec)	4,950	155
MX-1	**MEMORY EXTENSION CHASSIS**	1,000	35
MT-1-250	**MODULE TESTER** (less oscilloscope)	3,000	——
SK-1	**SPARE PARTS KIT**	3,100	——
RR-1	**RACK**	500	——
PBS-1	**COMPUTER STAND**	250	——
PBD-1	**DESK**	500	——
——	**SIX ADDITIONAL SIGNAL INPUT LINES** (max. 3 sets)	300	10
FX-1R	**FLEXOWRITER** (with shelf & slides for rack mounting)	4,900	150
FX-1T	**FLEXOWRITER** (for table mounting)	4,500	140
PS-8	**BATTERY POWER SUPPLY** when included instead of a-c supply	1,500	45
HSB-1	**BUFFER REGISTER**	4,750	——

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE AND ARE F.O.B. OUR PLANT, LOS ANGELES, CALIFORNIA

CHECKING FEATURES

All operations involving the memory are parity checked. Checking is also done in the assembly program and in the subroutine.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.1 Kw
Volume, computer	7 cu ft
Area, computer	2.8 sq ft
Weight, computer	110 lbs

PRODUCTION RECORD

Number produced to date	3
Number in current operation	3
Number in current production	20
Number on order	30
Anticipated production rates	2 units per week
Time required for delivery	6 months

PERSONNEL REQUIREMENTS

Training made available by the manufacturer to the user includes a two weeks programming course and a two weeks maintenance course which are included in the price of the machine.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The PB 250 uses only solid-state circuitry and is completely modularized. The circuits used were developed for the TRICE DDA which operates at 3 Mc, and have been in operation for over two years.

For applications where power failures and resultant loss of memory cannot be tolerated a battery power supply is available which will operate the computer for several hours without line power.

The low component count less than 400 transistors and less than 2,500 diodes insure maximum reliability. The computer requires only 40 watts of power exclusive of input-output devices. This power is dissipated over a large area providing freedom from failure due to heating problems.

A built-in marginal circuit testing system combined with a diagnostic service routine permits the dynamic testing of all circuits in the computer and the identification of any drifting component. The entire computer consists of 115 plug-in modules, a plug-in magnetically regulated power supply, and a standard paper tape reader, paper tape punch, and electric typewriter. The computer proper requires only 30 watts of d-c power so that air conditioning is not needed. A battery supply is available.

Photo by Packard Bell

ADDITIONAL FEATURES AND REMARKS

Outstanding features include a 2 Mc clock frequency source providing microsecond speed at a price lower than previous microsecond machines, and expandable magnetostrictive delay line memory and a powerful command list including square root and gray-to-binary and double precision commands.

Other advantages include three methods of input-output; control lines, character buffer, and 2 Mc serial, plus inexpensive standard buffer equipment, making the computer adaptable to additional peripheral equipment.

The primary design objective of the PB 250 was to provide a computer that would be used as a standard systems component so that a large number of system requirements formerly satisfied only by a special purpose one-of-a-kind system can be met by the PB 250 plus the proper selection of off-the-shelf input-output equipment. The high speed, powerful command list, versatile input-output, and low price have met this objective.

Performance - The PB 250 operates at speeds comparable to those of large scale computers. The maximum operation rate is over 40,000 instructions per second. Typical times for a 22-bit word are:

addition and subtraction	12 microseconds
multiplication	276 microseconds
division	252 microseconds
square root	252 microseconds

The last three commands are variable in length. For example, the product of a 10-bit multiplier and a 22-bit multiplicand requires 132 microseconds. A repertoire of fifty-one commands permits the full speed of the PB 250 to be realized. Among these are double precision commands which automatically operate upon 44-bit words. Floating point routines operating on a 7-bit characteristic and a 37-bit (11 decimal digit) mantissa require less than 3 milliseconds.

Three complete input/output systems are integral to the computer. The first operates on characters of up to 8 bits at a maximum rate of 2,000 characters per second on input and 20,000 characters per second on output. Buffering permits the computer to operate simultaneously with input/output operations. The second system operates upon serial information at rates up to 85,000 words per second. The format of this information is automatically controlled by an internally stored mask. The third system consists of 30 input lines which can be sampled under program control and 32 output lines upon which signals can be placed under program control. These lines permit the computer to sense and control the state of external devices.

Ease of programming - The PB 250 is a single address computer with an index register. Program optimization in the PB 250 is provided by a unique minimum access scheme. If speed is not a consideration, the computer is treated as a straight-forward single address system. If, on the other hand, mini-

Photo by Packard Bell

mum access is a consideration, a sequence tag bit in the command word causes the computer to read the next command immediately following the execution of the indicated operation. The use of this sequence tag permits computation rates of up to 41,666 commands per second.

A special index register permits automatic address modification while optimum programming is maintained by selecting the optimum address in each memory line. Further, a single instruction permits shifting every word in a given line by one address position. Thus, optimum programming may be retained and the need for address modification eliminated.

Flexibility - The flexibility of the PB 250 makes it adaptable to a wide range of application. The memory is expandable from 2,320 words to 15,888 words. Further, the length of the additional memory lines is optional and so may be designed to fit any specific requirement. Magnetic core memory is also available as an option. The PB 250 has the widest range of auxiliary equipment of any general purpose digital computer, including punched card equipment and up to six magnetic tape units.

CINCH, the Floating Point Interpreter for the PB 250 general purpose digital computer, is designed to permit rapid programming of scientific and engineering problems and to allow persons generating problems to do the actual programming of the problems themselves. CINCH's structure permits those who have used the commonly accepted interpretive programs to learn CINCH coding quickly. This is made possible by the fact that CINCH was designed after consideration of other interpreters, combining the best of their features and adding new features that experience has shown to be desirable.

CINCH is a floating point interpretive system, which means "scaling" is no longer a problem. There is no need to keep track of number magnitude. In addition, CINCH offers 7 index registers for looping and program control. Debugging systems are offered, including a selective program trace and memory print. Input and output are convenient to use. Commands are written in an easy to remember notation. CINCH obeys the human law of self preservation in that it will not execute an instruction which would cause it to damage itself.

The CINCH interpretive memory can contain up to 4,095 words. One word is required to represent a command; two words are required to represent a floating point number.

PENNSTAC

Pennsylvania State (University) Automatic Computer

MANUFACTURER

Pennsylvania State University
Electrical Engineering Department

Photo by Pennsylvania State University

APPLICATIONS

System is used primarily for the education of digital computer engineers and the performance of research in digital computer design.

PENNSTAC has been designed to (1) carry out scientific computation and (2) be used in a classroom for teaching computer design and programming. For the second purpose mentioned, the following features have been included in the computer: (1) a visual display of the coded contents of the four registers; (2) a control panel reduced to the essentials for operation and enabling reduced-speed operation; (3) visible and accessible components, easily modified, and (4) an output system enabling instruction concerning communication between the computer and an asynchronous device.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits/word	11
Decimal digits/instruction	11
Instructions/word	1
Instructions decoded	23
Arithmetic system	Fixed point
Instruction type	One-plus-one
Number range	-10^{10} to $+10^{10}$

Instruction word format

Operation Code	Tag	Next Instruction	Operand Address
X X	X	X X X X	X X X X

For example:

22	0	1345	2469

This instruction states: Add (22) the number at (2469) to the number in the A-register, leave the result in the A-register, and take the next instruction from drum location 1345. The tag digit is not used.

Registers

A-register - accumulator
B-register - receives information from drum
C-register - accumulator for holding information to be stored on the drum
D-register - holds instruction

The internal number system is the 2*421 binary coded decimal system. There are four bits per decimal digit.

Photo by Pennsylvania State University

ARITHMETIC UNIT

Operation	Incl. Stor. Access Microsec Average	Exclud. Stor. Access Microsec Average	Exclud. Stor. Access Microsec Maximum
Add	3,445	94	4,700
Mult	5,335	2,985	5,969
Div	7,426	5,076	10,152

Construction (Arithmetic unit only) 117 vacuum tubes
Arithmetic mode — Parallel in binary; Serial in decimal
Timing — Synchronous
Operation — Sequential

STORAGE

Medium	No of Words	No. of Digits	Access Microsec
IBM 650 Drum	2500	27,500	2350 (Average)

INPUT

Medium	Speed
Paper Tape	440 char/sec

Ferranti photoelectric reader. The punched paper tape is standard 7/8 inch tape. Six channels are used. The tape is prepared by a F299MA Burroughs Sensimatic.

OUTPUT

Medium	Speed
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Teletype)	60 char/sec

Teletype model BRPE2

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	
2C51	264
5887	200
12BH7	796
6L6	42
6W6	40
Total	1,342
Diodes	
H02077	5,768
Transistors	
2N94A	6

CHECKING FEATURES

Checking features include sensing for wrong combination in the four registers, exceed capacity, unusually lengthy instruction time, divide by zero, read-in false start, and synchronism alarms.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	7.2 Kw	9 KVA	0.8 pf
Power, air conditioner	7.2 Kw	10.2 KVA	0.7 pf
Volume, computer		320 cu ft	
Volume, air conditioner		72 cu ft	
Area, computer		80 sq ft	
Area, air conditioner		13 sq ft	
Room size		65 ft x 23 ft	
Floor loading		3.3 lbs/sq ft	
		110 lbs, concen max	
Capacity, air conditioner		12.5 Tons	
Weight, computer		3,500 lbs	
Weight, air conditioner		1,500 lbs	

Overhead conduits for power, signal wires, and air conditioning.

PRODUCTION RECORD

Number produced to date	1
Number in operation	1

PERSONNEL REQUIREMENTS

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

ADDITIONAL FEATURES AND REMARKS

General Information

The new system presents two major modifications. First is the Internal Output control by means of which the output is controlled almost entirely by the program. The format switch and the format tape will be eliminated. Second will be the addition of a second output device, a sixty-digit-per-second Teletype Punch. The output information from the Teletype Punch will be in the form of punched paper tape. The programmer can select as the output device either the Teletype Punch or the ten-digit-per-second Flexowriter.

2*421 coded decimal number system used on PENNSTAC

Decimal Equivalent	2*421 Code
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	1 0 1 1
6	1 1 0 0
7	1 1 0 1
8	1 1 1 0
9	1 1 1 1
Wrong Combination	
" "	1 0 0 0
" "	1 0 0 1
" "	1 0 1 0
" "	0 1 0 1
" "	0 1 1 0

COST, PRICE AND RENTAL RATES

Approximate cost of basic system $100,000.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System has been in operation since 1955.

Table of Operations of PENNCODE

Basic PENNCODE

Operation Code	Operation	Description
50	Add	$A + B \rightarrow K$
51	Subtract	$A - B \rightarrow K$
52	Multiply	$A \cdot B \rightarrow K$
53	Divide	$A \div B \rightarrow K$
54	Add Absolute	$A + \lvert B \rvert \rightarrow K$
55	Subtract Absolute	$A - \lvert B \rvert \rightarrow K$
56	Addiply	$K + AB \rightarrow K$
57	Subtiply	$K - AB \rightarrow K$
63	Square Root	$\sqrt{A} \rightarrow B, K$
64	Compare	If $A < \lvert K \rvert$ take next instruction from $\hat{B}$.
65	Move	$A \rightarrow B, K$
67	Transfer Negative	If $K < 0$ take next instruction from $\hat{B}$. If $K \geqslant 0$ take next instruction from $\hat{A}$.
68	Transfer Non Zero	If $K \neq 0$ take next instruction from $\hat{B}$. If $K = 0$ take next instruction from $\hat{A}$.
69	Unconditional Transfer	Take next instruction from $\hat{B}$.
70	Return Jump	Jump from present instruction, which is at $\hat{\theta}$, to $\hat{A}$. Upon reaching $\hat{B}$ return to $\hat{\theta} + 1$.
71	Escape	Take next instruction, which is in PENNSTAC code from $\hat{B}$. On reentering PENNCODE at 2000 the next PENNCODE instruction will be taken from $\hat{A}$.
72	No operation	
73	Read In	Read in from paper tape and then take next instruction from $\hat{B}$.
74	Read Out	Read out $\hat{A}$ words from consecutive locations starting at $\hat{B}$.
75	Stop	
76	Conditional Stop	Stop if code switch 1 is on.
77	Translate In	Convert B from fixed point to floating point using the exponent $\hat{A}$ and $\rightarrow$K., i.e., the floating number $B \cdot 10^{(\hat{A}-50)}$ will be formed.
78	Translate Out	Convert K from floating point to fixed point using the exponent $\hat{B}$ and $\rightarrow$A, i.e. Store $K' \cdot 10^{(Z-B)}$

PENNCODE Functions

58	Sine	Sin $A \rightarrow B, K$
59	Cosine	Cos $A \rightarrow B, K$
60	Logarithm	Ln $A \rightarrow B, K$
61	Exponential	Exp $A \rightarrow B, K$
62	Arc Tangent	Tan^{-1} $A \rightarrow B, K$

Double Precision PENNCODE

40	D. P. Add	$A + B \rightarrow K$
41	D. P. Subtract	$A - B \rightarrow K$
42	D. P. Multiply	$A \cdot B \rightarrow K$
43	D. P. Divide	$A \div B \rightarrow K$
66	D. P. Move	$A \rightarrow B, K$

FUTURE PLANS

Plans call for the addition of an IBM 727 Magnetic Tape Unit, and revision of the input system to accommodate variable-length-of-field read in.

INSTALLATIONS

Pennsylvania State University
University Park, Pennsylvania

PERK I II

Performance Computer Models I II

MANUFACTURER

Automation Management Incorporated

APPLICATIONS

Systems are designed and used for the reporting of percentage of standard performance of production operation; compares actual production rate against standard production rate and records on continuous chart whether efficiency is zero (downtime), below, at, or above normal.

System could also be adapted to compare other ratios, e.g. plane ground speed against air speed or planned speed, same in fuel consumption, steps in checking out launching of missile, et al.

Perk I samples latest rate, while Perk II gives cumulative (integrated) results.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Decimal	
Arithmetic system	Floating point	Perk II
	Fixed point	Perk I

ARITHMETIC UNIT

Arithmetic unit consists of vacuum tubes, diodes, stepping relay, relays, and potentiometers.

Timing	Synchronous
Operation	Concurrent

STORAGE

Media		No. of Digits
Perk I	stepping relay	100
Perk II	potentiometers	500,000

INPUT

Input may be any sensor, e.g. a limit switch, photo cell, transducer, or flow meter. Input speed is at 900 to 10,000 counts/hour. System can count considerably faster on special models.

OUTPUT

Output is on a 2.5 inch pressure-sensitive chart paper in a galvonometer recorder. Paper speed is at 3 inches/hour. Output can be read and/or displayed by any voltage translating device. Other paper feed speeds available on request.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Tubes	5
Diodes	1

Relays, and other standard electronic components are used.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Volume, computer	1 cu ft
Area, computer	1 sq ft
Weight, computer	20 lbs

A wall outlet is required.

PRODUCTION RECORD

Number produced to date	1
Anticipated production rates	10 - 1960
	100 - 1961
Time required for delivery	1 month

COST, PRICE AND RENTAL RATES

Perk costs $1,000.
Sensors and wiring cost $5 to $500.
Perk rents at $50/month.
Sensors and wiring rent at $.50 to $50/month.

User ships Perk unit, air-express collect, to plant. Repair and service is at $8/hour. Automation Management Incorporated will ship air express prepaid, back to user.

PERSONNEL REQUIREMENTS

Only application engineer is needed at installation and is performed by A.M.I. personnel at $15/hour. Automatic operation. Chart paper is replaced after 250 running hours.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability include time-tested, simple, components used to well under their capacity.

ADDITIONAL FEATURES AND REMARKS

System provides for management by exception, instead of demanding computing by foremen, time and motion study engineers, production planners, and other executives. System allows the loss or profit of an operation to be viewed continuously and losses corrected immediately and successful methods of operation strengthened and repeated.

FUTURE PLANS

Plans for new components and anticipated modifications include wider input speed ranges, another model with single input speed and, hence, lower price, and self-correcting systems, i.e. the output will control those factors influencing the input so the process will seek the optimal level of performance. Uses in laboratory and military services are planned.

PHILCO 1000

Philco Transistor Automatic Computer 1000

MANUFACTURER

Philco Corporation

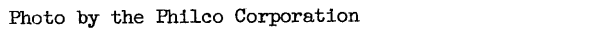


Photo by the Philco Corporation

APPLICATIONS

Manufacturer

Primarily scientific applications, some commercial or industrial applications.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	36
Instructions/word	1
Instruction type	Two address

Code will include two 12-binary digit addresses, two 3-binary digit address modifiers, and a 6-binary digit command.

ARITHMETIC UNIT

	Exclud Stor Access Microsec
Add	5.5
Mult	130 avg.
Div	200
Construction	Transistors
Arithmetic mode	Parallel

Maximum multiply time excluding storage access is 200 microseconds. Ones complement binary arithmetic is used

STORAGE

Medium	Words	Digits
Magnetic Core	4,096	147,456

Cycle time is 12 microseconds.

INPUT

Media	Speed
Perforated Tape Reader	60 char/sec
Teletype Model 28 Keyboard	Manual

OUTPUT

Media	Speed
Perforated Tape Punch	60 char/sec
Teletype Model 28 Page Printer	

Either 5 or 7 level tapes may be used. Punched card equipment, magnetic tape and magnetic drum may be added, if desired.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

All transistor circuits are used in arithmetic and storage units.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

System requires approximately 1.2 Kw. The total volume occupied by the arithmetic section, storage section, power supplies, control panel and ventilating equipment is about 36 cubic feet.

ADDITIONAL FEATURES AND REMARKS

A cathode ray storage address reference indicator is included in the system.

INSTALLATIONS

Philco Corporation
3900 Welsh Road
Willow Grove, Pennsylvania

PHILCO 2000

Philco Transistorized Automatic Computer
(TRANSAC S-2000)

MANUFACTURER

Philco Corporation

APPLICATIONS

Manufacturer

The Philco 2000 Electronic Data Processing System is an all purpose computing system. The design of the system has been planned so that sizes and equipment may be varied to suit the specific installation. This means that the system may be used equally well with data processing and scientific applications. The Philco 2000 Electronic Data Processing System uses asynchronous logic which reduces computer operating time and allows new components to be added without redesigning the equipment.

U. S. Army Signal Missile Support Agency
White Sands Missile Range

Presently located at Philadelphia, Pennsylvania, equipment is used for the solution of differential equations, statistical analysis of scientific data, computation of scientific tables, and additional scientific and engineering uses in connection with Signal Corps research and development activities in support of the Army missile program.

General Electric Company

Located at the General Electric Company Knolls Site, Niskayuna, New York, the system is used for reactor core design, thermal and mechanical problems (associated), shielding studies, power plant systems analysis, maneuvers, accidents, etc, nuclear physics, and data reduction and processing from prototype

Photo by Philco Corporation

operations.

Westinghouse Electric Corporation
Bettis Atomic Power Laboratory

Located at Pittsburgh, Pennsylvania, the system is used for nuclear design calculations, thermal and hydraulic calculations, analysis and experimental data reduction, reactor and plant kinetics, and miscellaneous engineering calculations.

System Development Corporation

System is used for systems simulation research.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary, binary coded decimal and alphanumeric
Binary digits/word	48
Binary digits/instruction	24
Instructions/word	2
Instructions decoded	225, including 59 floating point instructions
Arithmetic system	Floating and fixed
Instruction type	One address

Addressing can be modified by index registers.

Number range Up to 10^{+616} w/floating point option

Instruction word format

0 15	16 22
Address	Command

System uses an automatic assembling and compiling system called TAC which permits the programmer to write programs in a simple mnemonic code. TAC also has an ever expanding library of routines. It also has available ALTAC, an algebraic translator.

There is one 48 bit register, three 24 bit registers, and up to 32 optional index registers.

The program section has asynchronous logic which means that each operation within each instruction starts as soon as the preceding operation is completed.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	3.7 or 11.7	1.7
Mult	42.3 or 50.3	40.3
Div	45 or 53.0	43

Construction (Arithmetic unit only)

Transistors	Approximately 20,500
Condenser-diodes	130
Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Concurrent

Sequential instructions, concurrent input-output.

The arithmetic section employs a carry complete signal which terminates each arithmetic operation as soon as it is completed. This increases the speed of all arithmetic operations.

Photo by the Philco Corporation

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	4,096 to 32,768	196,608 to 1,572,864	10 or 2
Magnetic Drum	32,768 to 1,048,576	1,572,864 to 50,331,648	

Drum access is 25,000 microseconds for the first word and 16 microseconds for each additional word.

Magnetic Tape

No. of units that can be connected	256 Units
No. of char/linear inch of tape	750 Alphanum char/in
Channels or tracks on the tape	16 Tracks/tape
Blank tape separating each record	0.9 Inches
Tape speed	120 Inches/sec
Transfer rate	90,000 Alphanum char/sec
Start time	2.5 Millisec
Stop time	2.5 Millisec
Average time for experienced operator to change reel of tape	30 Seconds
Physical properties of tape	
Width	1 Inch
Length of reel	3,600 Feet
Composition	Mylar base tape

With the multiple processing techniques used with the Philco 2000 System it is possible to have as many as 64 tape units processing data simultaneously. Transfer rate can be increased to 360,000 alphanumeric characters per second if full advantage is taken of the multiple processing techniques.

U. S. A. Missile Support Agency

Medium	No. of Words	No. of Digits	Access Microsec
Magnetic Core	8,192	48 bits/word	10 (max)

Nine magnetic tape units are used "on line" as intermediate storage. Capacity of one 3,600 foot reel is in excess of 2 million characters.

General Electric Company

Magnetic Core	32,768	48 bits/word	10

2 microsecond memory on order for January 1961.

WEC, Bettis AP Lab.

Magnetic Core	32,768	48 (binary)	10
Magnetic Tape	Approx. 40 million	48 (binary)	Serial

Core store will be changed to 2 microsecond unit in December 1960; size will remain 32,768 words.

INPUT

Manufacturer

Media	Speed
Punched Cards	2,000 cards/min

80 columns read in any code.

Punched Tape	1,000 char/sec

Punched in 5, 6, 7, or 8 channel tape

Magnetic Tape	90,000 char/sec
UBC	90,000 char/sec

Characters are alphanumeric characters. Both cards and paper tape may be either on-line or transferred to magnetic tape to make use of 90,000 character transfer rate.

U. S. A. Missile Support Agency

Paper Tape Reader	1,000 char/sec
Magnetic Tape (AMPEX FR 300)	90,000 char/sec

General Electric Company

Magnetic Tape	90 kilocycles/sec

16 tapes are on the system any 4 of which may be multiplexed.

Off-Line Card Reader	2,000 cards/min

WEC, Bettis AP Lab.

Magnetic Tape	6,400 words/sec

Figures are average for each of four channels.

Cards (80-column)	2,000 cards/min

OUTPUT

Manufacturer

Media	Speed
Punched Card	250 card/min
Punched Tape	60 char/sec
Magnetic Tape	90,000 char/sec
High Speed Printer	15 lines/sec

Characters are alphanumeric characters.

The input and output devices used with the Philco 2000 System are connected to a specialized buffering device which permits transfer of data between input and output devices when used off-line and between the computer and any input or output device when used on-line. The buffering device, called the Universal Buffer Controller (UBC) controls the transfers so that the transfers are made at the maximum speed, 90,000 cps.

U. S. A. Missile Support Agency

Paper Tape Punch	60 char/sec
High Speed Printer	900 lines/min

General Electric Company

High Speed Printer	900 lines/min

The Anelex printer is used off line.

WEC, Bettis AP Lab.

Media	Speed
Magnetic Tape	6,400 words/sec

Speed is average on each of four channels.

Cards (80 column)	100 cards/min
Line Printer	900 lines/min

A 64 character alphabet is used.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

Type	Quantity	Use
Tubes	120	Printer Hammer Drivers
	32	Paper Tape Power Supply
	33	Mag Tape Power Supply
	265	Other
Total	450	
Diodes	1,200	
Transistors	56,000	
Ferrite Cores	196,608 to 1,572,864	

Above figures are with ten magnetic tape units.

CHECKING FEATURES

Manufacturer

All input and output devices have comprehensive checking facilities.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

KVA, computer	50
Area, computer	1,600 sq ft
Room size, computer	40 ft x 50 ft
Floor loading	52 lbs/sq ft
	264 lbs concen max
Weight, computer	2,100 lbs

Air conditioner is obtained by user. Capacity of 12 Tons i.e. 136,000 BTU/hr.

U. S. A. Signal Missile Support Agency

KVA, computer	25.9
Power, air conditioner	4.5 Kw
Volume, computer	6,500 cu ft
Area, computer	1,300 sq ft
Room size	1,600 sq ft
Volume, air conditioner	50.75 cu ft
Area, sq ft	7.25 sq ft
Capacity, air conditioner	6 Tons
Weight, computer	16,250 lbs
Weight, air conditioner	876 lbs
Floor loading	32.5 lbs/sq ft
	51.6 lbs/sq ft concen max
	No castor loads

Above figures are for the SMSA configuration. Computer air conditioner is used as standby for room air conditioner. No false floor, false ceilings, or air plenums are required. Humidity controls are required.

General Electric Company

KVA, computer	45.1
Area, computer	1,554 sq ft
Floor loading	60 lbs/sq ft
	115 lbs concen max
Capacity, air conditioner	80 Tons
Weight, computer	21,472 lbs

Only small site preparation and modification were required, since area was previously occupied by an IBM 704. About 13 tons of air conditioning are needed for the system.

PRODUCTION RECORD

Time required for delivery 12 months

COST, PRICE AND RENTAL RATES

Signal Missile Support Agency

GSA No.	Model No.	Description	Monthly Rental
		Arithmetic and Logical Units	
1	210	Arith & Ctl Unit, Console & Typewriter	$7,100
2	1000	Floating Point Option	650
3	1011	Index Registers (Block of 8)	900
		Ten-Microsecond Magnetic Core Storage Units	
8	2208	Magnetic Core Stor. Unit (8192)	$5,800
		Input-Output Units	
11	234	Magnetic Tape Unit	$7,650
12	235	Input-Output Processor (16x1)	3,300
16	240	Punched Paper Tape System	1,800
18	257	Printer System	6,500
		Total	$33,700

General Electric Company

Basic system with 16 magnetic tape stations, a 32,768 word magnetic core memory, and 16 x 4 tape multiplexing (input-output processor) rents at $67,000/month.

IBM 026's, 407, 519, sorter and interpreter rents at $2,000/month.

Service included in rental.

WEC, Bettis AP Lab.

Computer with 32,768 core memory and 16 x 2 tape stations rent at $53,000/month.

Off-line printer, reader, punch, and 2 tapes rent at $9,000/month.

Service included in rentals.

PERSONNEL REQUIREMENTS

Manufacturer

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Analysts	1	2	3
Programmers	2	4	6
Coders	2	4	6
Clerks	0	0	0
Librarians	1	2	3
Operators	2	4	6
Engineers	2	4	6
Technicians	1	2	3
In-Output Oper	1	2	3
Tape Handlers	0	0	0

Extensive training in programming and operating techniques made available by the manufacturer. In addition, seminars are held periodically at the new computer plant in Willow Grove, Pennsylvania.

Signal Missile Support Agency

	One 8-Hour Shift	
	Used	Recommended
Supervisors	3	3
Analysts	0	0
Programmers	12	12
Coders	0	8
Clerks	1	1
Librarians	0	1
Operators	3	4
Engineers	3	3
Technicians	0	0
Input-Output Oper	0	2
Tape Handlers	0	0

Three engineers are provided by contractor as part of lease agreement.

Operation tends toward closed shop.

Methods of training used includes on-the-job and manufacturer sponsored training.

General Electric Company

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts	
	U	R	U	R	U	R
Supervisors	3	3	3	3	3	3
Programmers	20	30	20	30	20	30
Operators	3	3	5	5	7	7
Technicians	4	4	4	4	4	4
In-Output Oper	1	1	2	1	3	2
Tape Handlers	1	1	2	2	3	3

Operation tends toward closed shop.

Methods of training includes on-the-job and occasional internal courses.

WEC, Bettis AP Lab.

	Two 8-Hour Shift
Supervisors	3
Analysts	3
Programmers	40
Clerks	8
Librarians	1
Operators	4
Technicians	1
In-Output Oper	2

Operation tends toward closed shop.

Methods of training used includes informal seminars and individual study.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

The asynchronous feature of the Philco 2000 System means fewer components and consequently higher reliability.

The modular construction of the system facilitates maintenance.

Comprehensive diagnostic routines are provided to quickly locate any possible malfunction.

The all-transistor construction insures greater reliability.

Periodic preventive maintenance performed by trained Philco customer engineers on all electromechanical devices insures maximum reliability of these units.

Signal Missile Support Agency

Time is available for rent to qualified outside organizations.

During past 6 months 165 hours of computer time have been used on Philco 2000 as part of the customer service provided. No actual operation figures are available since the computer has not been installed at White Sands.

General Electric Company

Passed Customer Acceptance Test 8 Jun 60

There is not sufficient experience to quote figures. The machine does exhibit exceptional reliability.

WEC, Bettis AP Lab.

Good time 70 Hours/Week (Average)

Attempted to run time 80 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.88

Above figures based on period 4 Apr 60 to 30 Aug 60

Passed Customer Acceptance Test 3 Apr 60

Time is not available for rent to outside organizations.

ADDITIONAL FEATURES AND REMARKS

Signal Missile Support Agency

Outstanding features include solid state computer, asynchronous mode of operation, and high tape transfer rate. Unique system advantages include a real time capability.

General Electric Company

Outstanding features include asynchronous operation, fast tapes, and complete transistorization. Complete set of instructions for testing tape errors, or tape unavailability, which allow program action.

Unique system advantages include16 x 4 input-output processor, which allows 4 tape multiplexing, and repeat mode, which allows repetition of any instruction pair without the necessity of an accessing pair each time. This feature is exceptionally good for sorting.

Optional equipment used includes a programmable calendar clock, paper tape input and output, and a real time channel.

WEC, Bettis AP Lab

Outstanding features include flexible tape addressing, a long data word, and very compact programs. Unique system advantages includes flexible tape addressing.

FUTURE PLANS

Signal Missile Support Agency

Eventual modification of the system to include cards is anticipated. The real time capability is to be exploited.

General Electric Company

A printer modification which would allow plotting has been proposed by the user.

WEC, Bettis AP Lab.

A two microsecond (four-section) 32,768 word core store will be installed.

INSTALLATIONS

U. S. Army Signal Missile Support Agency
White Sands Missile Range, New Mexico

General Electric Company
Knolls Atomic Power Laboratory
P. O. Box 1072
Schenectady, New York

Westinghouse Electric Corporation
Bettis Atomic Power Laboratory
P. O. Box 1468
Pittsburgh 30, Pennsylvania

System Development Corporation
Systems Simulation Research Laboratory
Santa Monica, California

U. S. Naval Supply Center
Oakland 14, California

AVCO
Research and Advanced Development Division
201 Lowell Street
Wilmington, Massachusetts

United Aircraft Corporation
Research Laboratories
400 Main Street
East Hartford 8, Connecticut

PHILCO 3000

Philco Model 3000 Computing System

MANUFACTURER

Philco Corporation

APPLICATIONS

The Philco 3000 is a solid-state general purpose digital computer for programmed control and computation applications. A single cabinet houses computer, memory, console and power supply. The computer will accept and transmit control impulses from and to external devices. Elements which might effect a potentially explosive atmosphere are hermetically sealed. The computer may be controlled from the console, a remote console, or a Flexowriter input-output unit.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20 + sign + parity
Binary digits/instruction	20
Instructions per word	1
Instructions decoded	16 basic, expandable to over 60
Arithmetic system	Fixed point
Instruction type	One address or 1 + 1 at option
Number range	$\pm 1 \times 10^{-6}$

Instruction word format

21 15	14 8	7 1	0
Track	Sector	Command	Sign

When bit number 1 is set equal to 0, a single address instruction is interpreted. When bit 1 is set equal to 1, a 1 + 1 address instruction is interpreted.

Automatic built-in subroutines includes a square root command.

Registers and B-boxes include 1 instruction register, 3 arithmetic shift registers, 2 four-word rapid access storage locations, 1 six-bit I/O register, and 1 14-bit program address counter.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	924	132
Mult	4,224	2,772
Div	4,224	2,772

Construction (Arithmetic unit only)

Transistors	1,300
Condenser-diodes	4,000
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	No. of Words	No. of Binary Digits	Access Microsec
Magnetic Drum	8,064-16,256	177,408 to 357,632	8,448
Magnetic Drum	4	88	264

The drum has 64 tracks for recording information - 63 tracks for general storage; 1 rapid-access revolver loop. The general storage tracks contain 128 words of data, the revolver loop 4 words.

INPUT

Media	Speed
Punched Paper Tape (Flexowriter)	10 char/sec
Console Keyboard	
External Shift Register	162 kilocycles/sec

Available with serial input to the accumulator at the basic clock freq. using control signals from external input source.

OUTPUT

Media	Speed
Paper Tape and Page (Flexowriter)	10 char/sec
Cathode Ray Tube	Two register display
External Shift Register	162 kilocycles/sec

Provides serial output of the accumulator at the basic clock freq. with control signals to external device.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
CRT	1
Diodes	4,200
Transistors	1,500

CHECKING FEATURES

Parity check is made on all word transfers to and from the drum. An optional safety device is a control switch which removes write capability for 1/2 drum capacity to protect program storage.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.7 Kw	0.9 pf
Volume, computer	19 cu ft	
Area, computer	4.5 sq ft	
Floor loading	112 lbs/sq ft	
	150 lbs concen max	
Weight, computer	500 lbs	

Above figures do not include Flexowriter, Input or Output Equipment, and console table. No air conditioning is required for operation at ambient temperatures below 104°F. Power is 115 ±5 volts, single phase at 60 cps.

PRODUCTION RECORD

Number produced to date	2
Number in current operation	1
Number in current production	10
Number on order	10
Anticipated production rates	6 per year
Time required for delivery	10 months

PERSONNEL REQUIREMENTS

Device is a process control computer therefore programming is semi-permanent and requires only one (1) operator per shift for monitoring.

PHILCO CXPQ

Philco Transistorized Automatic Computer CXPQ

MANUFACTURER

Philco Corporation

Photo by U. S. Navy David Taylor Model Basin

APPLICATIONS

David Taylor Model Basin

Located at the David Taylor Model Basin, the system is used for the solution of naval engineering problems.

PROGRAMMING AND NUMERICAL SYSTEM

David Taylor Model Basin

Internal number system	Binary
Binary digits/word	48
Binary digits/instruction	24
Instructions/word	2
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(1 - 2^{-47}) \leq x (1 - 2^{-47})$

Registers and B-boxes

7 Index Registers
1 Toggle-switch Intervention Register
1 D-Register (Buffer)

ARITHMETIC UNIT

David Taylor Model Basin

	Incl Stor Access Microsec
Add	45

Operation time assumes an operand is in the accumulator to start the time to fetch an instruction, an operand, execute, and place results in storage.

Arithmetic mode	Parallel
Timing	Asynchronous
Operation	Dequential

STORAGE

David Taylor Model Basin

Media	No. of Words	No. of Bin Dig/Word	Access Microsec
Core	4,096	48	12
Drum	16,384	48	16

Magnetic Tape 5,000 blocks at 128 words/block

No. of units that are connected	3 Units
No. of char/linear inch of tape	210 Char/inch
Channels or tracks on the tape	13 Tracks/tape
Blank tape separating each record	Approx 2 Inches
Tape speed	75 Inches/sec
Transfer rate	15,000 Char/sec
Start time	3 - 5 Millisec
Stop time	3 - 5 Millisec
Average time for experienced operator to change reel of tape	60 Seconds
Physical properties of tape	
Width	1.0 Inches

A single reel contains 4,000 blocks, 128 words/block, 8 char/word.

INPUT

David Taylor Model Basin

Media	Speed	
Paper Tape	200 char/sec	8 char/word
Keyboard (Flexowriter)	10 char/sec	8 char/word
Card (IBM)	200 card/min	10 words/card

OUTPUT

David Taylor Model Basin

Media	Speed	
Paper Tape	120 char/sec	8 char/word
Typewriter (Flexowriter)	10 char/sec	8 char/word
Card (IBM)	100 card/min	10 words/card

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

David Taylor Model Basin

Type	Quantity
Tubes	48
Diodes	115
Transistors	5,500

Tubes are used only in the magnetic tape and paper tape units, about 12 tubes each.

CHECKING FEATURES

David Taylor Model Basin

Magnetic tape error detection and correction.
Improper command.
Overheat alarm.
Non-existent peripheral equipment detection.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

David Taylor Model Basin

Power, computer	10 KVA
Area, computer	540 sq ft
Room size, computer	18 ft x 30 ft
Floor loading	75 lbs/sq ft
Capacity, air conditioner	20 Tons
Weight, computer	10,200 lbs

Building air conditioning of 20 tons is sufficient. System only has built in fans. The ambient temperature is 78°F.

PRODUCTION RECORD

David Taylor Model Basin

Number produced to date	1
Number in current operation	1

One experimental model built.

COST, PRICE AND RENTAL RATES

David Taylor Model Basin

The central computer, drum unit, 3 magnetic tape units, and paper tape units cost $1,600,000.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

David Taylor Model Basin

The computer is being used on an experimental basis at this time.

ADDITIONAL FEATURES AND REMARKS

David Taylor Model Basin

The 100 different commands make the system powerful. Low memory cycle time for this type system. Easy to operate. Excellent for solution of problems involving a large amount of computation time.

INSTALLATIONS

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

PROGRAMMED DATA PROCESSOR

Programmed Data Processor

MANUFACTURER

Digital Equipment Corporation

APPLICATIONS

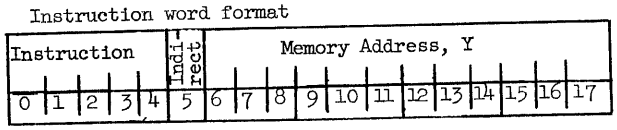
System is designed for general purpose computing, on-line and real-time uses, on-line auxiliary to larger computers, and special applications requiring variety of input-output equipment and/or high operating speed.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	18
Binary digits/instruction	18
Instructions/word	1
Instructions decoded	25 basic, 53 incl. augmented
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(2^{17}-1) \leq N \leq (2^{17}-1)$

Photo by Digital Equipment Corporation

Instruction word format



An advanced computer and other utility programs are being developed.

Registers and B-boxes include a memory buffer, an accumulator, an In-Out Register (and accum extension), a program counter and a memory address register.

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add	5	0.75
Mult	300 avg	300
Div	600 avg	600

Arithmetic mode	Parallel
Timing	Synchronous
Operation	Sequential

Multiply and Divide by subroutine augmented by Multiply Step and Divide Step instructions.

Normal input-output is promarily sequential. An optional in-out system allows concurrent operation of several in-out devices.

STORAGE

Media	No. of Words	No. of Digits/word	Access Microsec
Core	1024 or 4096	18	5 (cycle)

Additional memory banks may be added.

Magnetic Tape

No. of units that can be connected	64	Units
No. of chars/linear inch of tape	200	Chars/inch
Channels or tracks on tape	7	Tracks/tape
Blank tape separating each record	3/4	Inches
Tape speed	75	Inches/sec
Transfer rate	15,000	Chars/sec
Start time	3	Millisec
Stop time	3	Millisec
Physical properties of tape		
Width	1/2	Inches

INPUT

Media	Speed
Paper Tape Reader	300 char/sec
Typewriter	10 char/sec

Many optical input devices are available.

OUTPUT

Media	Speed
Paper Tape Punch	20 char/sec
Typewriter	10 char/sec
CRT Display	20,000 points/sec

Many optical output devices.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	3,000
Transistors	2,700
Magnetic Cores	73,728

Photo by Digital Equipment Corporation

CHECKING FEATURES

Overflow checks are included. The memory parity check system is optional.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.8 Kw
Volume, computer	70 cu ft
Volume, console table	84 cu ft
Area, computer	12 sq ft
Area, console table	21 sq ft
Room size	12 x 12 ft
Weight, computer	1600 lbs

Site preparation not required.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	1
Number on order	1
Time required for delivery	4 months

COST, PRICE AND RENTAL RATES

Computer, with 4096 word memory, typewriter, punch and photoelectric tape reader $110,000

Service contracts available.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

PDP-1 is built of DEC's standard line of reliable digital building blocks.

ADDITIONAL FEATURES AND REMARKS

The machine has an unusually high (>1) operations per second to initial cost ration. It is, thus, well suited to many real time control problems and is an excellent machine for interpetive programming.

Greater than 100,000 operations per second, flexible input-output, and powerful order code for a machine of this size.

FUTURE PLANS

A 36 bit version of this machine is being designed. The new Model (PDP-3) will multiply in 20 microseconds including memory access.

RASTAC

Random Access Storage and Control

MANUFACTURER

Laboratory for Electronics

APPLICATIONS

System is designed for mass information handling, providing integrated random access computer storage. RASTAC was developed to provide large scale digital computers with a random high speed data retrieval capability. Generally speaking, the storage media of most computers is not geared to the requirement for frequent access to segments of its file - the queueing problem tends to reduce the systems usage to that of an electronic file clerk. RASTAC permits considerably more access to information by the computer of an updating station and at the same time, leaves the computer free to perform its prime data processing functions.

Photo by Photo International for Laboratory for Electronics, Inc.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Optional
Digits per word	Variable
Digits per instruction	12
Instructions per word	Variable
Instructions decoded	Two
Instruction type	One address, specifying beginning of transfer point

Instruction word format

12 Character Instruction

IM	TRACK	ADDRESS	SECTOR	NO OF SECTORS	OP	IM

IM = Instruction marker

OP = read or write operation

There are three registers, viz the I/O Register, the instruction register, and the track address register. The RASTAC System is designed to be operated with any large computer installation and therefore the choice of the number system or digits per word is entirely up to the option or the machine characteristics of the user. The only fixed word in this system is the 12 character instruction word.

This instruction word is coded in excess 3 decimal notation.

ARITHMETIC UNIT

No arithmetic unit as such

Timing	Synchronous
Operation	Sequential

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
HD File Drum	Variable	1875 to 62 million	197,000 av.

Up to 33 file drums can be included in the standard system giving a maximum of approximately 62 million characters. The access times given above include drum switching. The file drum rotates at 3 rps and recording is serial. Each file drum has a capacity of 15 x 10^6 bits. The average random access time to any part of the file remains constant, independent of the total number of drums. Each file drum unit contains its own reading and writing mechanism and track selection devices.

INPUT

Media	Speed
Keyboard (Alphanumeric)	Manual
Paper Tape	330 char/sec
From any Computer	20 kc character

The system is designed to work as an input-output device connected to a large computer; as such, its information transfer rate is 20 kc character rate.

OUTPUT

Medium	Speed
To any Computer	20 kc

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Tubes	150	DC and pulse power drivers
Diodes	8,000	Primarily for logic
Transistors	100	Flip-flops and inverter switches
Magnetic Cores	2,000	Logical amplifiers and inverters

The system is composed of nine basic types of highly reliable magnetic modular building blocks, plus a small number of special plug-in counter packages. All packages are readily accessible as well as completely interchangeable within a given type.

CHECKING FEATURES

Operational errors which may occur during a read or write routine and parity errors of the paper tape input are detected. Errors are classified internally as critical or non-critical depending on their effect on information in the storage. Critical errors stop reading or writing instantly. Non-critical errors allow reading to continue to the end of the addressed information.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	13.3 Kw	15.3 KVA
Volume, Central System	300 cu ft	
Volume, File Drums (ea)	35 cu ft	
Area, Central System	48 sq ft	
Area, File Drums (ea)	9 sq ft	
Room size	25 x 30 ft	
Floor loading	200 lbs/sq ft	
	200 lbs concen max	
Weight, computer	3,200 lbs, total	
Weight, File Drums	800 lbs, each	

Clean atmosphere is desirable but not essential, inter-cabinet cables may be run in void beneath floor or in conduits as may be dictated by the site. 3 phase, 110-120v AC power is required.

PRODUCTION RECORD

Time required for delivery from receipt of order
8 months

COST, PRICE AND RENTAL RATES

Central System Controller	$100,000 to $300,000
File Drums	$ 34,000 to $ 38,000

Maintenance and service contracts are available and are customarily negotiated under separate contracts.

PERSONNEL REQUIREMENTS

Training is available to the users by the manufac turer. Since the RASTAC System is normally incorporated into a large computer complex the problem of deciding yhe typical personnel requirements are integrated with those of the large computer installation with maintenance and engineering service on a shared basis with the computer. The actual system users themselves are of many and varied types and need little instruction or operational abilities.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

A similar system, RASTAD has been in operation for a period of approximately 8 months. During this time, the reliability figures have shown a mean-time-to-failure of approximately 200 hours. The previously established reliability figures of the component board types used in the RASTAC System in conjunction with the circuitry technique, etc., have shown this to be a conservative figure.

ADDITIONAL FEATURES AND REMARKS

High capacity bulk storage with low access time, make the RASTAC System suited for integrated operation with a computer.

The unique advantage of the RASTAC System is the flexibility of the storage device. The storage capacity can be raised from the basic 15 million bits to 500 million bits with no change in random access time.

FUTURE PLANS

New developments at Laboratory for Electronics, are concentrated in two main fields with regard to the RASTAC System, that of additional output devices and of newer and better storage devices. In storage development, a new flexible Bernoulli Disk is being used to decrease the cost per list stored and the access times.

RASTAD

Random Access Storage and Display

APPLICATIONS

System is designed for mass information handling. It can function as an integrated random access computer storage and display system and as an information storage and display unit for reference library techniques, such as management sales reports, status of operations, and inventory and production control. RASTAD was developed to provide large scale digital computers with a random, high speed, data retrieval capability. Generally speaking, the storage media of most computers is not geared to the requirement for frequent access to segments of its file - the queueing problem tends to reduce the systems usage to that of an electronic file clerk. RASTAD permits considerably more access to information by either the computer or the output display devices and at the same time, leaves the computer free to perform its prime data processing functions. Additionally, the output rate of the display devices provides data availability rate far in excess of that provided by the usual output devices.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Optional
Digits per word	Variable
Digits per instruction	12
Instructions per word	Variable
Instructions decoded	Two
Instruction type	One address, specifying beginning of transfer point

Instruction word format

12 Character Instruction

IM	TRACK	ADDRESS	SECTOR	NO OF SECTORS	OP	IM

IM = instruction marker
OP = Read or write operation

The RASTAD System is designed to be operated with any large computer installation and therefore the choice of the number system or digits per word is entirely up to the option or the machine characteristics of the user. The only fixed word in this system is the 12 character instruction word. This instruction word is coded in excess 3 decimal notation. There are three registers, the I/O register, the instruction register, and the track address register.

ARITHMETIC UNIT

No arithmetic unit as such	
Timing	Synchronous
Operation	Sequential

Drums are asynchronous.

MANUFACTURER

Laboratory for Electronics, Inc.

STORAGE

Medium	No. of Words	No. of Digits	Access Microsec
HD File Drum	Variable	1875 to 62 million	197,000 av

Up to 33 file drums can be included in the standard system, giving a maximum of approximately 62 million characters. The access times given above include drum switching. The file drum rotates at 3 rps and recording is serial. Each file drum has a capability of 15 x 10^6 bits. The average random access time to any part of the file remains constant, independent of the total number of drums. Each file drum unit contains its own reading and writing mechanism and track slection devices.

INPUT

Media	Speed
Keyboard (Alphanumeric)	Manual
Paper Tape	330 char/sec
From any computer	20 kc char

The system is designed to work as an input-output device connected to a large computer; as such, its information transfer rate is 20 kc character rate.

OUTPUT

Medium	Speed	Remarks
SM-II Viewer System	20 kc	Direct View Storage Tube Device with instruction keyboard

The SM-II is a completely flexible output display device. The information displayed is stored on the face of the tube. This display may consist of a page of information or may take the form of a map, chart, graph or any abstract display desired. The total display capacity for the 21" Viewer is 13,000 characters. Storage time for a display is up to 20 minutes. This retention capability permits the superimposition of the pertinent data over an original display for a more complete evaluation at a single viewing.

Data retrieval and display is accomplished by pressing keys on a keyboard similar to an office calculator. The desired information is retrieved and displayed in less than 2 seconds after the start key is pressed (this occurs where only one viewer is used). Under more severe conditions where ten viewers were requesting information at the same moment, the waiting time for display of information on the lowest priority viewer would be less than 20 seconds.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity	Use
Tubes	150	DC and pulse power drivers
Diodes	8,000	Primarily for logic
Transistors	100	Flip-flops and inverter switches
Magnetic Cores	2,000	Logical amplifiers and inverters

The system is composed of nine basic types of highly reliable magnetic modular building blocks, plus a small number of special plug-in counter packages. All packages are readily accessible as well as completely interchangeable within a given type.

CHECKING FEATURES

Operational errors which may occur during a read or write routine and parity errors of the paper tape input are detected. Errors are classified internally as critical or non-critical depending on their effect on information in the storage. Critical errors stop reading or writing instantly. Non-critical errors allow reading to continue to the end of the addressed information.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	13.3 Kw	15.3 KVA
Volume, Central System		300 cu ft
Volume, File Drums (ea)		35 cu ft
Area, Central System		48 sq ft
Area, File Drums (ea)		9 sq ft
Room size		25 x 30 ft
Floor loading		200 lbs/sq ft
		200 lbs concen max
Weight, computer		3,200 lbs, total
Weight, File Drums		800 lbs, each

Clean atmosphere is desirable but not essential, inter-cabinet cables may be run in void beneath floor or in conduits as may be dictated by the site. 3 phase, 110-120v AC power is required.

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Number in current production	1
Time required for delivery	8 months

COST, PRICE AND RENTAL RATES

Central system controller	$100,000 to $300,000
File Drums	$ 34,000 to $ 38,000
Viewers, displays	$ 20,000 to $ 30,000
Additional equipment	
Viewers	$ 20,000 to $ 30,000
File Drums	$ 34,000 to $ 38,000

Maintenance and service contracts are available and are customarily negotiated under separate contract. Rental is negotiable.

PERSONNEL REQUIREMENTS

Training is available to the users by the manufacturer.

Since the RASTAD System is normally incorporated into a large computer complex the problem of deciding the typical personnel requirements are integrated with those of the large computer installation with maintenance and engineering service on a shared basis with the computer. The actual system users themselves are of many and varied types and need little instruction or operational abilities. The display units simply require a request and location of information and proceed from there automatically.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

The RASTAD System has been in operation for a period of approximately 8 months. During this time, the reliability figures have shown a mean-time-to-failure of approximately 200 hours. The previously established reliability figures of the component board types used in the RASTAD System in conjunction with the circuitry techniques, etc., have shown this to be a conservative figure.

ADDITIONAL FEATURES AND REMARKS

Outstanding features include high capacity bulk storage with very low access time, coupled with the ability to display large sections of information for long periods with minimum access to the files. The RASTAD System is suited for integrated operation with a computer.

The unique advantages of the RASTAD System is the extreme flexibility of the storage and display devices. The storage capacity can be raised from the basic 15 million bits to 500 million bits with no change in random access time. The display generation equipment allows an unlimited number of viewers to be driven from one symbol generator at speeds an order of magnitude greater than the fastest mechanical output devices. The characters displayed can be either alphanumeric or abstract synbols and can be changed in a matter of minutes.

The high output speeds of the display devices coupled with the access times of the central storage enable up to 100 output devices to be coupled with the RASTAD System before queueing times become a serious problem.

FUTURE PLANS

New developments at Laboratory for Electronics, are concentrated in two main fields with regard to the RASTAD System, that of additional output devices and of newer and better storage devices. With regard to the output of display devices, systems are being developed to enable wall displays for the briefing room applications of the integration of access systems for microfilm archival storage and systems for hard copy read out devices. In storage development a new flexible Bernoulli Disk is being used to decrease the cost per list stored and the access times. The access times of these disks will allow many hundred viewers to be coupled into one system without overload. New low cost types of viewers are being developed using stored video techniques for display recirculation.

RCA 110

RCA 110 Electronic Industrial Computer System

MANUFACTURER

Radio Corporation of America
Industrial Computer Systems Department

APPLICATIONS

The system is designed to perform industrial control functions, on-line in real-time. The RCA 110 was designed not as a "package" but as a total system - which can be tailored to the exact data control needs of each user.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary or binary coded decimal
Binary digits/word	24
Arithmetic system	Fixed point
Instruction type	One address

There is a limited two address feature. There are 71 wired-in instructions.
Registers include 7 indexable address modifier registers and 8 high speed input-output registers.

ARITHMETIC UNIT

	Incl Stor Access Microsec
Add	56
Mult	728
Div	868
Timing	Synchronous

Word time is 28.89 microseconds. Clock frequency is 936 kilocycles/sec.

STORAGE

Media	No. of Words	Access Microsec
Magnetic Core	256 to 4,096	
Magnetic Drum	4,096 to 51,200	8,300 avg.

Drum transfer rate is 200 kilocycles/sec. Up to 12 buffer tracks are available for input-output.

INPUT OUTPUT

Industrial control

CHECKING FEATURES

Computer free time is automatically assigned to self checking routines.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	5.0 KVA 220 Volts
Size, computer	82 x 34 x 105 inches

ADDITIONAL FEATURES AND REMARKS

The system automatically responds to off-limit or emergency situations and handles them on a priority basis with a complete analysis of priority after each instruction. This eliminates the delay between the occurrence and the recognition of an emergency condition. The system will correct the most urgent situation first, but if more than one trouble-spot should occur at the same time, it automatically appraises the urgency of each and handles it in turn.

INSTALLATIONS

Radio Corporation of America
Industrial Computer Systems Department
Electronic Data Processing Division
21 Strathmore Road
Natick, Massachusetts

RCA 200

RCA Series 200 Guidance Computer

APPLICATIONS

Interial navigation and guidance digital differential analyzer.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	20
Arithmetic system	Twos complement

Instruction type

Single instruction - integrate; coding specifies integrator interconnections.

Number range $-1 \leq N < +1$

Instruction word format

ΔY Address	Y Register	Mem. Plane 0
		Mem. Plane 1
ΔX Address	R Register	Mem. Plane 2
		Mem. Plane 3

Programming capability consists of selecting up to 12ΔZ's as components of ZΔY, selecting a ΔZ to be used as ΔX, and specifying lengths of Y and R registers.

ARITHMETIC UNIT

Time for processing one integrator is 850 microseconds.

Construction (Arithmetic unit only)

Transistors	1,500
Diodes	300
Magnetic cores	1,024
Other components	2,100
Arithmetic mode	Serial
Timing	Asynchronous

Operation: Arithmetic unit is serial, operating on 2 bits at a time. Computer is a digital differential analyzer.

STORAGE

Medium	No. of Words	No. of Digits
Coincident Current Core Memory	16 integrators	20 bits/ integrators

INPUT OUTPUT

Input consists of error signal in accelerometer control loop; computer converts this signal to digital form in conjunction with a digital velocity meter. The computer is part of the accelerometer control loop.

Core memory is loaded with a photoelectric reading head, through which a 25" length paper tape is pulled by hand.

Output consists of increments of desired quantities, which are used to drive stepping motors.

MANUFACTURER

Radio Corporation of America
Missile Electronics and Controls Division

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	300 Zener diodes

Zener diodes to be replaced by resistors in subsequent models.

Transistors	1,500

Types 2N404 and 2N357

Magnetic cores	1,024

CHECKING FEATURES

All checking is performed through programming. A pluggable checkout panel is used to display all important computer signals as an aid to programmed checkout.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.02 Kw
Volume, computer	0.06 cu ft
Weight, computer	4.5 lbs

Power, space and weight specifications are for micromodular version.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System has been operating for over 3 months and is about to go on flight test.

FUTURE PLANS

System to be micromodularized in early 1961. Present operating version contains "mini-modules", having the two base dimensions the same as those of RCA's micromodule, but with a height of 1 to 2 inches, depending on the module.

RCA 300

RCA Series 300 Central Computer

MANUFACTURER

Radio Corporation of America
Missile Electronics and Controls Division

APPLICATIONS

Real time control, airborne and shipboard applications (guidance, navigation, fire control, etc.); sensor signal data processing, air or shipboard (trajectory analysis, target keeping, etc.); and missile-space applications - guidance, on-board checkout, data reduction, etc.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary
Binary digits/word	13
Binary digits/instruction	13
Instructions/word	1
Instructions decoded	33
Arithmetic system	Fixed point
Instruction type	One address

Instruction word format

Sign	1 3	4	5 12
	Command	B Box	Operand Address

All input and all output proceeds automatically upon recognition of "Start Input/Output" instruction. There is one B-Box of 8 bits. Modular nature of parallel machine permits word length to suit problem.

ARITHMETIC UNIT

	Incl Stor Access Microsec	Exclud Stor Access Microsec
Add	24	12
Mult	96	86
Div	168	156

Construction (Arithmetic unit only)

Transistors	1,418
Diodes	518
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

STORAGE

Media	No. of Words	No. of Digits	Access Microsec
Transfluxors	8,192 max.	106,300	3
Cores	1,024 max.	13,330	4

Transfluxors are used in non-destructive read-out mode for program storage; cores are used for data storage.

INPUT

Media	Speed
Tape Reader	20 char/sec
Voltage Analog-to-Digital Con	50,000 bits/sec
Direct Digital	41,667 words/sec

The tape reader loads programs only. There are 3 A-D converter channels in prototype. Up to 32 are available. Up to 32 words of direct digital inputs (from shaft of A-D converters, etc.) can be accepted.

OUTPUT

Media	Speed
Flexowriter	10 char/sec
Analog/Digital Conversion	41,667 words/sec
Direct Digital	41,667 words/sec

Up to 32 channels of A-D conversion are available. 5 channels are operative in the prototype. The direct digital output is used for discrete control of external devices.

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type	Quantity
Diodes	
S4096	1,346
650C3	64
651C0	670
653C9	212
Transistors	
2N357	1,692
2N404	3,708

Above counts are for a configuration consisting of 1,024 words transfluxor memory, 1,024 words core memory, 18 analog input words, and 18 analog output words.

CHECKING FEATURES

Checking is accomplished by repeat programming.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer	0.135 Kw
Volume, computer	3.0 cu ft
Weight, computer	100 lbs

PRODUCTION RECORD

Number produced to date	1
Number in current operation	1
Time required for delivery	12 months

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Computer operating in laboratory for over twelve months.

ADDITIONAL FEATURES AND REMARKS

Outstanding feature is the transfluxor memory.

INSTALLATIONS

Radio Corporation of America
Missile Electronics and Controls Division
Burlington, Massachusetts

RCA 301

Radio Corporation of America 301

MANUFACTURER

Radio Corporation of America
Electronic Data Processing Division

Picture by Radio Corporation of America

APPLICATIONS

The computer is a general purpose, digital, stored program, transistorized machine consisting of high speed storage, program control, a control panel, and a power supply.

The program control unit contains circuitry for the interpretation and execution of the instructions. The high-speed storage unit is a magnetic core, decimally addressed, random-access device which provides the storage for data and programs. Memory cycle time is 7 microseconds. The basic unit contains 10,000 or 20,000 alphanumeric characters. The control panel contains the controls and indicators necessary for the operation and maintenance of the computer.

The power supply unit supplies power for operation of the control panel, the high-speed storage, and the program control, and standard voltages for the control of the input-output equipment. Transistor and diode logic techniques are employed throughout the system.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Number of binary coded decimal digits per word	Variable
Number of characters per instruction	10 RCA 301 characters
Number of instructions per word	Variable
Number of instructions decoded	40
Arithmetic system	Fixed point Programmed Floating point
Instruction type	Two-address
Number range	Limited by size of memory

Instruction word format

1	1	4	4
Operation Code	N Character	A Address	B Address

Automatic coding RCA Narrator - COBOL (COmmon Business Oriented Language)

A variety of general-purpose service programs are provided. These include distribution-sorting, trace, memory dump, on-line input-output service routines, the RCA 301 Interpretar and the RCA 301 COBOL Narrator.

ARITHMETIC UNIT

	Microseconds
Add time (decimal), including instruction acquisition	210
Programmed multiply time, average	7,800
Transfer instruction	126
Compare	56 to 161
Basic cycle time	7
Arithmetic mode	Serial
Timing	Synchronous
Operation	Concurrent

Above times assumes 6-character fields.

Multiply time assumes average multiplier digit is 5.

STORAGE

Media	No. of Char.	Access Microsec
Magnetic Core	20,000	7
Record File	Over 4.6×10^6, each	4.25×10^6

The number of words of storage is variable due to variable word length. The Record File is random access. Up to 5 files may be used. Access to files is simultaneous.

Magnetic Tape — Hi Data tape

Type 580 Tape Station, with Tape Adaptor, records 222 char/inch at 100 inches/sec. The type 581 Tape Station, with Tape Adaptor, records at 333 char/inch at 100 inches/sec.

No. of units that can be connected	12 Units
No. of chars per linear inch of tape	250 Chars/in
Channels or tracks on the tape	1 Track/tape
Blank tape separating each record	Inter-Block gaps = approx. one inch
Tape speed	30 Inch/sec
Transfer rate	7,500 Chars/sec
Start time	Up to 20 Millisec
Stop time	Not exactly established (overlaps computation)
Average time for experienced operator to change reel	45 Seconds
Physical properties of tape	
Width	1/2 Inches
Length of reel	1,200 Feet
Composition	Mylar

INPUT

Media	Speed
Punched Paper Tape	100 chars/sec
Punched Cards	600 cards/min
Magnetic Tape	See Magnetic Tape
Record File	2,500 char/sec (transfer rate)

OUTPUT

Media	Speed
Punched Paper Tape	100 char/sec
Punched Cards	100 cards/min
Magnetic Tape	See Magnetic Tape
Record File	2,500 char/sec (transfer rate)
Hi-Speed Printer	600 lines/min (120 char/line)

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Types
Transistors
3656
3680
Diodes
8510674-D3

Quantity depends on system.

CHECKING FEATURES

Accuracy control is accomplished on the RCA 301 system by the following methods:

Processor, Models No. 303 and No. 304

Program Control

The following conditions will stop computer operations:

Incorrect parity in memory address register
Incorrect parity in memory register
Incorrect parity in operation register
Incorrect parity in N register
Incorrect parity in N R (repeat) register

Input/Output

Any of the following conditions will stop computer operation:

Device not operable or not responding to applicable computer command
Parity error in data received from input device
Non-verification of data sent to an output device

Paper Tape Reader - Punch Control - Model No. 311

The computer is caused to stop whenever any of the following conditions occur:

Failure to receive the write-verify pulse
Incorrect parity of information being read
Characters in a gap space
Reader not following command
Punch not following command

Card Reader Control - Model No. 314

The card is read at two stations and a hole count check is made. An error will stop the computer, and the Card Reader.

Punch Card Control - Model No. 315

The cards are automatically read after punching.

On-Line Printer Control - Model No. 316

Signals are returned to the printer control module from the On-Line Printer, so that corrective measures can be taken whenever any of the following conditions occur:

Low paper supply
Ribbon failure
Printer motors off
Power supply off

Record File Control - Model No. 317

Any of the following conditions will cause the computer to stop:

Incorrect parity of address sent to Record File
Non-verified write information
Record file not following command
Incorrect parity of information being read

Hi-Data Tape Group Control - Models No. 318 and No. 319

Monitors the write-verify check, the address-verify parity check, the operability, and the response to commands of the Hi-Data Tape Group.

Paper Tape Reader-Punch - Model No. 321

The information received at the punch is checked; and when parity is correct, a write verify pulse is returned to the Paper Tape Reader-Punch Control.

Card Reader - Model No. 323

Each card is read twice to permit an accuracy check.

On-Line Printer - Model No. 333

Signals are sent to the Computer so that corrective measures may be taken which cause the Printer-operation to stop whenever any of the following conditions occur:

Low paper supply
Ribbon failure
Printer motor off
Printer in non-operable condition

Card Punch - Model No. 334

The cards are read after punching to permit an accuracy check of the punched data.

Record File - Model No. 361

Parity check is performed on the information to be written and on the address received from the Record File Control for the selection of records.

Hi-Data Tape Group - Model No. 381

Automatic stop of tape at end of reel
Write lockout
Write verify
Address verify
Operable indication

Record File Mode Control - Model No. 391

Parity checks of data and address are performed.

Simultaneous Mode Control - Model No. 392

Parity checks are performed on SOR and M registers. An error will stop the computer. However, the other modes will complete their operation before they stop.

580/581 Adaptor - Model No. 393

The write-verify pulse is received when the head-write current is of correct parity. Operability and response to commands are also checked.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Estimated Area (Average System)

Data Processing Equipment Area	825 sq ft
Additional Area Consumed by Aisles, Exits, structural columns and unusable corners	425 sq ft
Engineering Service	300 sq ft
	1,550 sq ft

Above estimate does not include any space for Analysis, Programming Personnel, Magnetic Tape Reel Library, Operating Supplies, Air Distribution or Power Equipment.

Estimated Power	KW	KVA
Data Processing Equipment	25.9	32.2
Engineering Service Requirement	3.5	4.5
	29.4	36.7

Above power requirement should be 208V, 4-wire system at a constant voltage to insure proper power for the equipment, and does not include any power requirements for the computer system and engineering service area.

Estimated Cooling	Tons
Data Processing Equipment Requirement	8.4
Engineering Service Equipment Requirement	1.0
	9.4

The above cooling is based on the requirement to remove the heat dissipated by the equipment. This equipment will give satisfactory operation in an environment of 72 degrees F temp. and 50% relative humidity.

Estimated Floor Loading

The installed RCA equipment can be placed on a floor which will support a loading of 100 lbs/sq ft. Most office buildings have floors that meet this loading requirement.

It must be understood that above estimates are not to be considered complete or final in any respect. Final specifications on power, cooling and floor loading will be issued.

Site Preparation

The layout and installation are very flexible. Site preparation is a customer responsibility normally accomplished by electrical, mechanical and structural contractors employed by the customer in arrangements that are not part of the EDP equipment purchase lease or service.

State and local laws and regulations require that a professional engineer or architect take responsibility for preparation of the site and procurement of necessary permits.

PRODUCTION RECORD

Prototype under construction
Time required for delivery from receipt of order
18 months

COST, PRICE AND RENTAL RATES

RCA 301 Card System

		Selling Price	Basic Monthly Rental
1	623 Card Reader	$ 15,850	$ 350
1	314 Card Reader Control	6,900	130
1	634 Card Punch	8,900	200
1	315 Card Punch Control	13,750	275
1	361 Record File	14,900	300
1	317 Record File Control	6,250	125
1	632 On-Line Printer	32,200	700
1	316 On-Line Printer Control	7,850	150
1	303 Basic Processor (10,000 char.)	89,400	1,750
	Total	$ 196,000	$ 3,980

RCA 301 System and Components

1	301 Basic Processor with 20,000 characters of core storage	$ 112,900	$ 2,350
1	321 Paper Tape Reader/Punch (100 char/sec)	7,800	170
1	311 Paper Tape Control	5,900	120
1	381 HiData Tape Group (6 tape stations 7,500 char/sec)	74,900	1,520
1	318 Hi Data Control	17,900	375
1	391 Record File Mode Control (Permits simultaneous operation of up to five Record Files)	32,800	690
1	329 Simultaneous Mode Control (Permits simultaneous read-write and under some conditions read-write-compute)	27,900	590
1	393 Tape Station Adaptor (Permits use of 22,222 or 33,333 char/sec tape stations)	15,900	320

Equipment lease and service agreements available

PERSONNEL REQUIREMENTS

Typical Personnel Required per Shift

	One 8-Hour Shift	Two 8-Hour Shift	Three 8-Hour Shift
Supervisors	1	1	1
Analysts	*	*	*
Programmers	*	*	*
Coders	*	*	*
Clerks	0.5	0.5	0.5
Librarians	0.5	0.5	0.5
Operators	2	1	1
Engineers	0	0	0
Technicians	0	0	0
In-Output Oper	0.5	0.5	0.5
Tape Handlers	0.5-1.5	0.5-1.5	0.5-1.5
Totals	10	7	6

The number of persons working in an RCA 301 EDP center is dependent upon the work and complexity activity of the system.

*If it is desired to accelerate the system development and programming, this area should be augmented until the initial peak is overcome.

Training made available by manufacturer to users:

RCA offers, without charge, courses in the application and use of the RCA 301 Transistorized EDP System equipment. RCA will provide training of personnel or representatives of the users in the analysis of data processing tasks to be assigned to the equipment, in the development of procedural systems and of computer programs, and in the revision and correction of the procedures and programs developed by trainees.

This training of analysts will be performed at mutually agreed upon locations beginning 15 days after selection of equipment. A continuous education program is also available to prospective users.

ADDITIONAL FEATURES AND REMARKS

Features include:

a. Variable item and record length
b. Building block concept
c. Large internal magnetic core storage for its size
d. Random access file
e. Low installation cost

System advantages are:

In addition to the library, RCA provides the customer with an Automatic Assembly System designed to simplify and therefore expedite the writing of programs.

The system is "machine oriented", i.e., its format is designed to accept instructions closely analogous to actual machine instructions.

English language programming (COBOL) will be available to users of this equipment.

FUTURE PLANS

RCA continues electronic research in support of this system.

INSTALLATIONS

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

RCA 501

Radio Corporation of America 501

MANUFACTURER

Radio Corporation of America
Electronic Data Processing Division

Photo by Radio Corporation of America

APPLICATIONS

Manufacturer

A general purpose, self checking, readily expandable system in the intermediate and large-scale performance class. The system design uses the "building-block" philosophy which results in an expandable, flexible integrated data processing operation, which can be tailored to the customer's needs at the time of delivery and expanded whenever future needs require it. The system may include both on-line and off-line input and output devices in addition to the Computer with High-Speed Storage. On-line equipments are electrically connected to the Computer and are controlled by the Computer Program. Off-line equipments are not electrically connected to the Computer and they are operated independently of the latter. Both on-line and batch data-processing are available in the System.

U.S. Naval Propellant Plant

The NPP system located in Bldg. 749 (JATO Test Area), Naval Propellant Plant will be an ordinary five-tape digital computer system which will be used with an Automatic Data Acquisition System on-line to monitor firings of solid propellant rocket motors and to calculate immediate quick-look parameters to indicate to monitoring personnel corrective action required. All applications of the computer will be strictly scientific. It will be used to compute theoretical specific impulse, experimental specific impulse from ballistic firings, heat transfer, and burning rate. The tapes to be used in on-line firings are non-gap type.

Scott Air Force Base

Located in Building 1604 at Scott AFB, Illinois, the system is used for traffic control, personnel, traffic analysis, manpower authorization accounting, programmed communications, unit authorization list, and circuit directory.

Air Reserve Records Center

Located at 3800 York Street, Denver 5, Colorado, the system is used for maintenance of personnel data on USAF reservists, preparing statistical reports reflecting the reserve military personnel strengths and skills, controlling military reserve manpower requirements and allocation of skills in the event of mobilization, preparation and control of questionnaires sent to individual reservists and to the Selective Service Boards, control of the Reserve Officer Promotion Act promotion program, preparation of mailing labels for periodicals, preparation of rosters for personnel assignment control, and determination of those eligible for discharge and preparation of applicable discharge certificates.

Fidelity-Philadelphia Trust Company

Located at 135 S. Broad Street, Philadelphia, the system is now processing 42,000 Special Checking Accounts. On July 1, 1960 accounting for 30,000 Personal Loans will begin. Cut-over of 50,000 Regular Checking Accounts will begin late this year with completion planned during the first half of 1961.

General Tire and Rubber Company

Located in Akron, Ohio, the system is used for

Photo by Fidelity-Philadelphia Trust Company

billing, inventory control, sales analysis, and accounts receivable within the Tire Division.

State Farm Life Insurance Company

Located on the 9th Floor at 112 East Washington Street, Bloomington, Ill., the system is used for consolidated records of life insurance policyholders for purposes of premium billing and accounting, policy reserve and dividend liability, policy termination benefits, policy loans, summary accounting and statistics, agents' compensation and production statistics, budget setting and compliance reports, unit costs, and actuarial studies.

Electronic Data Processing Division, RCA

Located at Camden, N.J., the computer is used for justification of engineering change notices, providing technical information for changes in the field, customer reliability studies, testing of special features resulting from configuration modifications, develop long term maintenance techniques, procedures and techniques, analysis of methods costs, and debugging service routines, diagnostic routines, and customer reliability routines.

RCA Electronic Systems Center

Located at the Cherry Hill Plant, RCA Electronic Systems Center, Merchantville, N.J., the system is used for customer program testing (preparatory to customers receipt of leased or purchased system), presentations (demonstration for potential customers), training (RCA and customer personnel in programming and operation), and revenue work (data processing for customers not presently in the market for data processing equipment of their own).

RCA Service Company-Electronic Data Processing Sales Department

Located at 1725 "K" Street, N.W., Washington 6, D.C., the system is used for sales demonstrations, debugging, and computing and calculating operations for governmental agencies, commercial and industrial business organizations.

EDPD-New York Electronics System Center

Located at 45 Wall Street, New York, N.Y., the system is used for a complete back office data processing system for brokerage firms, national election predictions, and investment analysis for investment advisory firms.

RCA Astro Electronics Division

Located at Locust Corners, N.J., the system is used for scientific and engineering investigations, information retrieval, intelligence processing studies, and electronic production schedules.

RCA Service Company, EDP Administration

Located at Cherry Hill, Camden 8, N.J., the system is used to conduct theoretical and practical courses in the site utilization of electronic test equipment for the maintenance of computer installations, devise special methods whereby sub-moduals are tested in order for instructors and trainees to develop new test methods for the computer and peripheral

Two RCA 501 Systems

Photo by New York Electronic Systems Center

equipment, and conduct computer courses of instruction to develop trainees ability to interrogate the logic of the equipment.

Ordnance Weapons Command

Located at the Headquarters, Ordnance Weapons Command, Rock Island, Ill., the system is used by the National Inventory Control Point for supply management of Ordnance materiel, major weapon components and spare parts, by the Production Equipment Agency for inventory management of Army owned production equipment, by the Rock Island Ordnance Depot for stock accounting, by the Rock Island Arsenal for production, planning, scheduling, and control and the performance of reporting and comptroller activities and by the NICP for cataloging.

Atlantic City Electric Company

The system, located at Accounting and Data Processing Center, Egg Harbor Township, N.J., is used for Customers Accounting - includes preparation of bills and centralized receivable operation, Payroll-includes all normal payroll functions and labor and automotive cost distribution, and Stores Accounting-includes maintenance of master files of material and supplies, pricing of material used, application of overheads and cost distribution of material and supplies consumed. Other applications will follow.

Ordnance Ammunition Command

Located at the Ordnance Ammunition Command, Joliet, Ill., the system is used for scientific and engineering applications pertinent to the reliability assurance program for ammunition and special weapons.

Raytheon Company - Missile Systems Division

Located at the Raytheon Company, Andover Plant, Andover, Mass., the system is used for engineering documentation, generation breakdown and parts list, with changes, and for major item repair parts list provisioning.

PROGRAMMING AND NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary
Binary digits/word	Variable
Characters/instruction	8 (Octal equivalent)
Instructions/word	Variable
Instructions decoded	49
Arithmetic system	Fixed point (Programming techniques make floating point features available
Instruction type	Two address
Number range	No limit (Depends on number of characters in the memory)

Instruction word format

X	XXX	X	XXX
Op Code	"A" Address	N Char	"B" Address

Automatic coding	Automatic Assembler RCA Narrator (COBOL)
Registers and B-boxes	Included

Decimal information is automatically decoded during input to its octal equivalent. It is stored in memory in binary form.

ARITHMETIC UNIT

Manufacturer

Due to variable word length feature, time depends on "n". Storage access is 15 microseconds for 4 characters.

All time is in microseconds.

Addition Time

Decimal $15n_1 + 45n_2 + 30n_3 + 90$

Binary $45n$

where

n_1 = total number of spaces and/or minus characters found to the right of both operands

n_2 = number of digits in the shorter operand

n_3 = difference in number of digits of the operands

For negative sums, add $30(n + 1) + 15$ where n = number of digits in the sum.

n = number of characters in augend for binary addition

Multiplication Time (Microseconds)

Decimal $15\left[10 + (12n_1 + 32)\,n_2\right] + 15n_3$, for $n_1 > 0$ and $n_2 > 0$

$15\ (n_2 + n_3 + 3)$, for
$n_1 = 0$ and $n_2 > 0$

$15\ (n_1 + n_3 + 3)$, for
$n_2 = 0$ and $n_1 > 0$

$15\ (n_3 + 3)$, for
$n_1 = 0$ and $n_2 = 0$ (Item Separator Symbol alone or all spaces plus I.S.S.)

where

n_1 = number of digits in multiplicand

n_2 = number of digits in multiplier

n_3 = total number of spaces (including sign) and/or minuses to the right of the least significant digits of the operands

Division Time (Microseconds)

Decimal $15\left[26n_1 - 7n_2 + 15n_2(n_1-n_2)+41\right] + 15n_3$
for $n_1 \geq n_2$

Photo by Atlantic City Electric Company

$15\ (3n_1 + n_2 + 12) + 15n_3$ for
$n_1 < n_2$

$15\ (n_2 + 7) + 15n_3$, for
$n_1 = 0$ (i.e., the dividend missing)

where

n_1 = number of digits in the dividend

n_2 = number of digits in the divisor

n_3 = total number of spaces (including sign) and/or minuses to the right of the least significant digits of the operands

The figures below serve to indicate general relative speed. For a specific case the formulas can be applied (Microseconds).

Add	240	to	420
Multiply	1,900	to	9,600
Divide	1,300	to	2,400

Construction		
Transistors	135	
Diodes	400	
Magnetic Cores	4,096	(one matrix)
Magnetic Cores	114,688	(one module)
No tubes are used		
Arithmetic mode	Serial	
Timing	Synchronous	
Operation	Concurrent	

Operands may be any length that does not exceed memory size.

STORAGE

Manufacturer

Media	No. of Words	No. of Digits	Access Microsec
Magnetic Core	Variable	262,144 (max)	15 (4-char)

Magnetic Tape

No. of units that can be connected			62	Units
No. of chars/linear inch			333.33	Chars/inch
Channels or tracks on the tape			16	Tracks/tape
Blank tape separating each record			0.34	Inches
Tape speed			Approx 100	Inches/sec
Transfer rate	22,222	33,333 66,666		Chars/sec
Start time			3.5	Millisec

Photo by U.S. Army Ordnance Ammunition Command

Stop time	2.5 Millisec
Average time for experienced operator to change reel	45 sec or less
Physical properties of tape	
Width	3/4 Inches
Length of reel	2,400 Feet
Composition	Mylar Base

U.S. Naval Propellant Plant

Medium	No. of Chars	Access Microsec
Magnetic Core	32,768 chars or 65,536 octal digits	15 microsec/char

The magnetic core memory can be expanded to 262,144 locations. A random access drum with 1.5 million characters is optional equipment. In certain instructions, four characters may be brought out in parallel with a total access time of 15 microseconds, i.e. 15/4 microseconds per character. There is no "word" concept in this computer. It is a variable word length computer.

Scott Air Force Base

Medium	No. of Chars	Access Microsec
Magnetic Core	16,384	15

Photo by Raytheon Manufacturing Company

Mitchel Air Force Base

Medium	No. of Chars	Access Microsec
Magnetic Core	32,768	15

Expandable from 16,384 to 65,536 character locations in steps of 16,384 character locations.

Fidelity-Philadelphia Trust Company

Media	No. of Char	Access Microsec
Magnetic Core	16,384	15
Magnetic Tapes	9,000,000 per reel	30

General Tire and Rubber Company

Medium	No. of Char	Access Microsec
Magnetic Core	65,152	15

State Farm Life Insurance Company

Medium	No. of Char	Access Microsec
Magnetic Core	49,152	15

Electronic Data Processing Division, RCA

Medium	No. of Char	Access Microsec
Magnetic Core	65,536	15

EDPD - New York Electronics System Center

Medium	No. of Char	Access Microsec
Core	65,536	15

RCA Astro Electronics Division

Media

Random Access File

High Speed Storage (Core Memory)

RCA Service Company, EDP Administration

Medium	No. of Char
Magnetic Core	Variable

Ordnance Weapons Command

Media	No. of Char	Access Microsec
Magnetic Tape	65,536	15

Magnetic tape for bulk storage.

Atlantic City Electric Company

Media	No. of Char	Access Microsec
Magnetic Core	16,384	15
Magnetic Tape	9,400,000	30

Reading from tape potentially simultaneous operation

Ordnance Ammunition Command

Medium	No. of Char	Access Microsec
Magnetic Core Type	32,768	15

Raytheon Company - Missile Systems Division

Medium	No. of Char	Access Microsec
Magnetic Core Memory	32,968	15

Octal numbering system makes this memory comparable to systems with much larger memory capacities.

Photo by Air Reserve Records Center

INPUT

Manufacturer

Media	Speed
Paper Tape (Read)	Approx 1,000 char/sec
Magnetic Tape 22,222 33,333 66,666	char/sec
File Control	Approx 18,700 char/sec
On-Line Card Buffer	Up to 33,333 char/sec

U.S. Naval Propellant Plant

Paper Tape	1,000 char/sec
Magnetic Tape	33,333 char/sec

Speeds of 22 KC or 66KC are other options.

Magnetic tape start-stop time is 3.5 milliseconds. Up to 62 magnetic tape stations can be connected on-line. Information is recorded twice on the magnetic tape for accuracy control purposes.

Scott Air Force Base

Paper Tape	1,000 char/sec
Magnetic Tape	33,000 char/sec

Mitchel Air Force Base

Paper Tape (7 channel)	1,000 char/sec

On-line equipment

Magnetic Tape	33,000 char/sec

2300' usable tape per reel

Cards	400 cards/min

Off-line transcription

Punched paper tape density is 10 char/in.

Magnetic tape density is 333 1/3 char/in.

Fidelity-Philadelphia Trust Company

Media	Speed
Punched Paper Tape	1,000 char/sec

Add Punches have been greatly improved by refinements made recently by the manufacturer (Friden).

General Tire and Rubber Company

Paper Tape	1,000 char/sec

Speed excludes time required to pass gaps.

State Farm Life Insurance Company

Magnetic Tape (8)	33,333 char/sec
Paper Tape (1)	1,000 char/sec

Electronic Data Processing Division, RCA

Paper Tape	1,000 char/sec
Magnetic Tape	33 KC

RCA Electronic Systems Center

Paper Tape	1,000 char/sec

7 level code variable word length

Magnetic Tape	33,333 char/sec

3/4" Mylar 7 level code w/parity parallel dual recording.

RCA Service Company - E D P Sales Dept.

Magnetic Tape
7 channel Paper Tape
EAM Cards (80 Col.)

EDPD - New York Electronics System Center

Paper Tape	1,000 char/sec
Magnetic Tape	33 KC

High Speed Magnetic Core Storage

Photo by Air Reserve Records Center

RCA Astro Electronics Division

Media	Speed
Cards	
Paper Tape	
Magnetic Tape	

RCA Service Company, EDP Administration

Magnetic Tape	
7 channel Paper Tape	
EAM Cards (80 Col.)	

Ordnance Weapons Command

Magnetic Tape	33,333 char/sec
Completed variable item of record length	
Paper Tape	1,000 char/sec
On-line	
Punch Cards	400 cards/min
Off-line	

Magnetic tape speed - 100 inches/sec, packing at 333 1/3 chars/inch. Dual recording. Approximately 2400 ft per reel. Read reverse.

Atlantic City Electric Company

Punched Paper Tape	1,000 char/sec
Magnetic Tape	33,000 char/sec

7 level code (even parity) on 1 inch paper tape

Ordnance Ammunition Command

Paper Tape	1,000 char/sec
Magnetic Tape	33,000 char/sec

Raytheon Company - Missile Systems Division

Magnetic Tape	33,000 char/sec
3.5 mil sec start - stop time	
Paper Tape Reader	1,000 char/sec
On-line	
Card Reader	400 cards/min
Off-line	

OUTPUT

Manufacturer

Media	Speed
Magnetic Tape	Approx 16,667 22,222 33,333 66,666 char/sec
File Control Unit	Approx 18,700 char/sec
On-line Printing	Up to 900 lines/min (120 chars)
Monitor Printing	Up to 10 char/sec
On-line Card Buffer	Up to 33,333 char/sec
Paper Tape (Punch)	Up to 100 char/sec

U.S. Naval Propellant Plant

Paper Tape	10 char/sec
Monitor Printer	10 char/sec
Magnetic Tape	33,000 char/sec

Scott Air Force Base

High Speed Printer	600 lines/min
Magnetic Tape	33,000 char/sec
Card Punch	150 cards/min

Mitchel Air Force Base

High Speed Printer	600 lines/min
Off-line equipment. 120 characters per line.	
Computer Monitor Printer	10 char/sec
On-line electric typewriter	
Magnetic Tape	33,000 char/sec
Used with EMP off line or subsequent operation	

Punched paper tape can be produced with simultaneous operation of Monitor Printer.

Random Access Drum Storage

Fidelity-Philadelphia Trust Company

Media	Speed
High Speed Printer	600 lines/min

Down time has been negligible

General Tire and Rubber Company

High Speed Printer	600 lines/min
On-line	
Magnetic Tape	33.3 KC
Monitor Printer	10 char/sec

State Farm Life Insurance Company

Magnetic Tape (8)	33,333 char/sec
On Line Printer	600 lines/min
	120 char/line
Monitor Typewriter	10 char/sec
Paper Tape	10 char/sec

Electronic Data Processing Division, RCA

Card	150 cards/min
Magnetic Tape	33 KC
Monitor Printer (Flexowriter)	600 char/min

RCA Electronic Systems Center

Magnetic Tape
Electro-Mechanical Printer
Monitor Printer

RCA Service Company - EDP Sales Dept.

Magnetic Tape
Paper Tape - (7) channel
EAM Cards
Monitor Printer
High Speed Printer

Photo by Air Reserve Records Center

EDPD - New York Electronics System Center

Media	Speed
Magnetic Tape	33 KC
Electro Mechanical Printer - On Line	600 lines/min
Electro Mechanical Printer - Off Line	600-900 lines/min

RCA Astro Electronics Division

Card
Magnetic Tape
On Line Printer

RCA Service Company, EDP Administration

Magnetic Tape
Paper Tape (7) Channel
EAM Cards
Monitor Printer (Flexowriter)
High Speed Printer

Ordnance Weapons Command

Magnetic Tape	33,333 char/sec
Punch Cards	150 cards/min
Off-Line	
Hard Copy	600 lines/min
Off-Line	120 char/line

Tape speed is 16,667 char/sec if destined for the Transcribing Card Punch.

Atlantic City Electric Company

Magnetic Tape	30 microsec/char
Printer (off line)	600 lines/min-Alpha Numeric
	900 lines/min-Numeric only
Punched Paper Tape	100 char/sec

Magnetic Tape Storage

Photo by Air Reserve Records Center

Ordnance Ammunition Command

Media	Speed
Monitor Printer	10 char/sec
On-Line Printer	600 lines/min
Magnetic Tape	33,000 char/sec

A printer line consists of 120 characters.

Raytheon Company - Missile Systems Division

On-line Printer	600 lines/min
Card Punch (Off-line)	150 cards/min
Magnetic Tape	33,000 char/sec
Monitor Printer (Part of Console)	10 char/sec

CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Type
Transistors
2N583
2N269
2N585
2N270
2N579
2N301
2N586
2N581
2N247
2N301
2N277
2N469
Diodes
1N97
1N270
1N91

Quantity depends on System.

CHECKING FEATURES

Accuracy Control is assured in the RCA 501 System by the following methods:

Computer - Model No. 503

Program Control

The following Program Control conditions cause the Computer to stop:

Incorrect parity in memory address register (3 characters)
Incorrect parity in memory register (4 characters)
Arithmetic unit malfunction
Incorrect parity in output of bus adder
Incorrect parity in normal operation register
Incorrect transfer of operation from normal to simultaneous mode
Time pulse generator malfunction
Malfunction of previous result indication
Illegal operand in decimal operation

Automatic Rerun

When selected, incorrect parity detected on reading from magnetic tape will automatically cause entrance to a routine which will back up the tape and re-read it. The computer will stop if incorrect parity is detected on re-reading.

Input-Output

The following input-output conditions cause the computer to stop:

Tape station reading extra bits in the gap
Missing timing bit when reading a character from the tape station
Tape station does not obey control signals
Odd number of characters from paper tape block read
Incorrect parity from tape read (see automatic re-run)
Incorrectly selected tape
Incorrect start message - end message sequence
Incorrect parity at the output of computer write buffer or absence of Write-Verify signal from tape station
Incorrect paper tape parity
On-line printer not operable
On-line Printer paper supply low

Tape Station - Model No. 581

Remote lockout
Local lockout
Inoperable indication
Automatic stopping of tape at end of reel
Write lockout
Write verify
Write-to-read switching time
Dual Recording

Punched Card Input

Photo by Air Reserve Records Center

On-Line Printer - Model No. 533

The printer operation stops automatically under the following conditions, and signals are sent to the computer in order that corrective measures may be taken:

Low paper supply

Printer Unit inoperative (Motor switch is off or ribbon is inoperative)

A visual indication is given of the number of lines printed

Off-Line Printer - Model No. 535

Provisions are made for corrective measures to be taken when the following conditions occur:

Failure to print in a selected column or printing in an un-selected column (Print Error)

Low paper supply

Line overflow

Incorrect parity

Tape station inoperative

Printer unit inoperative

A visible indication is given of the number of lines printed or the number of messages printed depending on the plugboard connections.

Card Transcriber - Model No. 527

The following conditions initiate stopping of the equipment:

Incorrect parity at the input or output of the Card Editor or at the output of the Card Reader

Incorrect SM, EM sequence

Tape station inoperable

Failure of write verify check

Failure of comparison check

Failure of multi-punch check

Input hopper empty or output hopper full

E T W (End Tape Warning)

Card Reader - Model No. 528

The following conditions initiate stopping of the equipment:

Incorrect parity at the output of the Card Reader

Tape station inoperable

Failure of "Write Verify" check

Failure of comparison check

Input hopper empty or output hopper full

E T W (End Tape Warning)

Transcribing Card Punch - Model No. 537

The following conditions cause stopping of the equipment:

Incorrect parity at the input or output of the Electronic Unit Storage

Incorrect SM - EM sequence

Incorrect punching check

Input hopper empty or output hopper full

Tape station inoperable

Punched Card Output

Photo by Air Reserve Records Center

Card Punch - Model No. 538

The following conditions cause the machine to stop:

Incorrect punching
End file
End data
Feed failure
Output hopper full
Tape station inoperable

Tapewriter - Model No. 523

A parity check is included, which assures correct parity of all characters punched into the paper tape.

Detection of incorrect parity by the parity check mechanism will lock the keyboard and the Check Indicator will be illuminated until the Code Delete Key is depressed.

Simultaneous depression of two keys will neither print nor punch either character.

Tapewriter-Verifier - Model No. 525

Same as above.

Computer Punch - Model No. 512-5 and No. 512-7
Computer Punch - Model No. 513-5 and No. 513-7

Information and control signals required to control the computer punch are derived from the computer. The required electrical returns from the computer punch to the computer are produced by the computer punch. Parity is checked at the computer punch; if incorrect parity is detected, the computer will stop and an indicator lamp on the computer console will light.

POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer				
Power, system	5.6 Kw	230v	8.0 KVA	24,200 Btu/hr
Power, computer (excl high speed stor)	1.5 Kw	115-120v	2.1 KVA	
Volume occupied	300 cu ft			
Area occupied	64 sq ft			
Room size	375 sq ft			
Floor loading	13 lbs/sq ft, distributed 78 lbs/sq ft, concentrated			
Weight, computer	5,000 lbs, total			

Site preparation

The layout and installation criteria are flexible for the RCA 501 EDP System. Site preparation is a customer responsibility normally accomplished by electrical, mechanical and structural contractors employed by the customer in arrangements that are not part of the EDP equipment purchase lease or service. State and local laws and regulations require that a professional engineer or architect take responsibility for preparation of the site and procurement of necessary permits. RCA engineers are avail-

On-line Printer

Photo by Air Reserve Records Center

able to assist the customer in the installation planning.

U.S. Naval Propellant Plant

Power, computer	13.6 Kw	15.6 KVA, including tape stations and other peripheral equipment
Power, air conditioner	22 Kw	27.5 KVA
Volume, computer system		770 cu ft
Volume, air conditioner		1,000 cu ft
Area, computer system		98 sq ft
Area, air conditioner		100 sq ft
Room size, computer		27 ft x 27 ft
Room size, maintenance		17 ft x 13 ft
Room size, air conditioner		13 ft x 8 ft
Capacity, air conditioner		20 Tons
Air conditioner includes ADA system		
Weight, system		10,000 lbs
Weight, air conditioner		2,000 lbs

Raised floor for cable runs, false ceilings, air conditioning through ducts in ceiling; existing building is earth-covered reinforced concrete; modifications required removing existing partitions, some electrical and other utility services but essentially no external modifications; power distribution new: 37.5 KVA single phase 2400/4160, 120/240v transformer.

Scott Air Force Base

Power, entire system	32.5 Kw	42.5 KVA
Volume, computer	11,664 cu ft	
Volume, air conditioner	6,048 cu ft	
Area, computer	1,296 sq ft	
Area, air conditioner	504 sq ft	
Room size, computer	36 ft x 36 ft x 9 ft	
Room size, air conditioner	28 ft x 18 ft x 12 ft	
Capacity, air conditioner	40 Tons; 10 Tons required for computer system	
Weight, computer	13,300 lbs, total computer and components	

Installed false ceiling, raised floor, and power requirements used existing room.

Mitchel Air Force Base

Model No.	Description	Equipment Area Sq Ft	Recommended Facility Area Sq Ft	Weight Lbs.	Concentrated Loading Lbs/Sq Ft	Distributed Loading Lbs/Sq Ft	Operational Kw	Max KVA	Prop KVA 208/120	BTU/Hr
503	Computer	64.0	375	5,000	78	13	7.1	10.1	8.0/2.1	24,200
523	Tapewriter & Table	22.0	50	185	8.4	3.7	0.2	0.25		685
581	Tape Station	6.2	25	900	145	36	1.1	1.3		3,750
561-2	High Speed Storage	23.6	110	1,500	127	27	3.0	4.3	2.9/1.4	10,240
	(The above items are located in the computer area)									
535	Electro-Mechanical Printer	20.4	125	1,500	73	12	4.9	6.1	5.6/.5	16,750
527	Card Transcriber	21.6	140	1,500	70	11	5.6	7.1	6.3/.8	19,800

(The printer and card equipment are located in 800 sq ft area adjacent to computer)

Assembly of Miniature Components

Photo by Air Reserve Records Center

The building type is brick construction, cement floors with asphalt tile. The ceiling is acoustical panel suspended from wooden roof trusses. The basic modifications made for the computer included a raised all metal floor with 1/8" vinyl covering (Modular 4' x 2' floor panels), an inclosure of the entire computer area with movable steel partitions (Type "CC-Accoustiwall" by E. F. Hauserman Company), and an addition of a separate air conditioner for the computer area (27 linear diffusers each 48" x 12" - 195 cfm with 4" throw.) (Unit is Carrier type 39Ull. Electro static air cleaner is Minneapolis Honeywell Model F22, No. 208 (Type C washing). Two condensing units, each with 325,000 BTU/hr at 105°F capacity (Carrier type 5H40 compressors.).

Installation of electrical circuits of data processing equipment included a new main power distribution panel-board with main feeders No. 4 350 MCM type RH and No. 1 1/0 ground wire, 3 1/2" conduit to trans. vault. Additional wiring circuits for air conditioning equipment and office lighting were also installed.

The original ceilings in the computer area were removed and installation of AMC metal pan (perforated) acoustic ceiling with metal attenuation pan was made. The suspension system was "Kemp" and the material was glass fiber sound insulating pads with minimum NRC of 0.85. The ceiling in the input-output area has the plenum above the whole area. The entire ceiling acts as a diffuser. This ceiling has no insulation and no attenuation pan. The raised floor serves as air return to air conditioner. The air conditioning equipment was placed on raised concrete floor (5000 No., 2 1/2" min over ribbed steel deck.)

Fidelity-Philadelphia Trust Company

Power, computer	26.6	Kw	34.3 KVA	0.77 pf
Power, air conditioner	42.53	Kw	49.48 KVA	0.862 pf
Volume, computer			13,016	cu ft
Volume, air conditioner			4,933	cu ft
Area, computer			1,627	sq ft
Area, air conditioner			592	sq ft
Floor loading			200	lbs/sq ft
			1,000	concen max
Capacity, air conditioner			30	Tons
Weight, computer			2,000	lbs
Weight, air conditioner			11,600	lbs
Weight, total			15,200	lbs

Plenum chambers, perforated metal ceiling, Belair flooring, storm windows, stainless steel framed viewing window, special power lines.

General Tire and Rubber Company

Volume, computing system	12,800	cu ft
Area, computing system	1,600	sq ft
Capacity, air conditioner	20	Tons

False ceiling, raised floor, wall insulation, wiring installation of two 10-Ton air conditioning units, partitioning, painting, etc.

Modular Assembly of Miniature Components

Photo by Air Reserve Records Center

State Farm Life Insurance Company

Power, computer	28.5 Kw 33.5 KVA
Area, computer	1,496 sq ft
Room size	Irregular
Weight, air conditioner	16,200 lbs
Capacity, air conditioner	Two 5 Ton units
	One 10 Ton unit

Conventional wall to "room off" area. 20 Tons of supplementary air conditioning. Cables run between floor and dropped ceiling (already there) of rooms below. Necessary ducting was added for air conditioning.

Electronic Data Processing Division, RCA

Power, computer only	7.1 Kw 10.1 KVA, max
Area, computer	220 sq ft
Room size required	2,000 sq ft
Weight, computer and all peripheral	20,110 lbs
Capacity, air conditioner	30 Tons

Air conditioning is chilled water system. False flooring is used.

RCA Electronic Systems Center

Power, computer	7.1 Kw 10.1 KVA 0.7 pf
Power, air conditioner	100 Kw 50 KVA
Area, computer	64 sq ft
Area, air conditioner	360 sq ft
Room size, computer	375 sq ft
Room size, air conditioner	400 sq ft
Floor loading	13 lbs/sq ft
	78 lbs concen max
Capacity, air conditioner	70 Tons
Weight, computer	5,000 lbs
Weight, air conditioner	90 lbs/sq ft

Site preparation requirements include false floor raceways for cable, carpeting, building brick - fireproof, and false ceiling plenum chamber for forced air system.

RCA Service Company - E D P Sales Dept.

Power, computer	65 Kw 85 KVA 0.77 pf
Set up for 2 system - only one now in use	
Power, air conditioner	60 Kw 78 KVA 0.77 pf
Set up for 2 system - only one now in use	
Volume, computer	2,430 cu ft
Volume, air conditioner	13,500 cu ft
Area, computer	441 sq ft
Area, air conditioner	1,350 sq ft
Room size, computer	38 ft x 100 ft
Room size, air conditioner	20 ft x 75 ft
Floor loading	13 lbs/sq ft
	900 lbs concen max
	145 lbs/sq ft max
Capacity, air conditioner	60 Tons + 30 Tons standby
Weight, computer	43,500 lbs
Weight, air conditioner	13,620 lbs

Site preparation requirements include seven (7) inch raised floor for cable distribution, acoustical tile false ceiling and complete automatic CO_2 fire extinguishing system with central control panel indication.

RCA Astro Electronics Division

Power, air conditioner	20 HP
Volume, computer	15,000 cu ft
Volume, air conditioner (with plenum)	1,350 cu ft
Area, computer	90 sq ft
Area, air conditioner	90 sq ft
Room size	1,000 sq ft
Capacity, air conditioner	20 Tons
Weight	20 Ton Worthington Unit

RCA Service Company, EDP Administration

Power, computer	7.1 Kw 10.1 KVA
Area, computer	64 sq ft
Room size	375 sq ft
Floor loading	13 lbs/sq ft

Automatically Printed Wiring

Photo by Air Reserve Records Center

Floor loading		78 lbs concen max
Weight, computer		5,000 lbs

Site preparation requirements include raised floor, increased air conditioning, ceiling to floor partitioning for classrooms, and acoustical tile false ceiling. Air conditioning is an extension of the building air conditioner.

Ordnance Weapons Command

Power, computer	31.9 Kw	40.25 KVA
230V ± 10%, 60 cycle		
Power, air conditioner	60.5 Kw	
Volume, computer	1,082	cu ft
Volume, air conditioner	5,600	cu ft
Area, computer	209	sq ft
Area, air conditioner	800	sq ft
Room size, computer	3,652	sq ft
Room size, air conditioner	1,600	sq ft
	80	x 20 x 10 ft
Floor loading	113	lbs/sq ft
	200	lbs concen max
Capacity, air conditioner	84	Tons
Weight, computer	23,500	lbs
Weight, air conditioner	12,000	lbs

Space can accommodate twice the complement now installed. Figures are for full complement, including off line equipment.

Converted loft type warehouse, reinforced concrete construction. False floor installed to permit all cabling under the floor. Concrete block interior walls except Tape Library which has semi-permanent steel walls. False ceiling, metal, sound absorbing, under concrete ceiling. Extension of bus ducts from 4th floor to 1st floor (± 65 ft). Equipment itself requires 24 tons of air-conditioning. Balance is for latent and ambient heat for a total of 24,000 sq ft area.

Atlantic City Electric Company

Power, computer	7.1 Kw	10.1 KVA
Volume, computer		320 cu ft
Area, computer		64 sq ft
Room size, computer		375 sq ft
Floor loading		13 lbs/sq ft
		78 lbs concen max
Weight, computer		5,000 lbs

Air conditioner is part of general conditioning system for entire building.

Computer installed in new buildings whose design included necessary structural considerations.

Ordnance Ammunition Command

Power, computer	74.1 Kw	90.5 KVA
Power, air conditioner	71.9 Kw	
Volume, computer		8,160 cu ft
Volume, air conditioner		907 cu ft
(includ condensers, cooling tower & air filter)		
Area, computer		280.20 sq ft
Area, air conditioner		120 sq ft
Room size, computer		1,600 sq ft
Room size, air conditioner		343 sq ft
Floor loading		513.60 lbs/sq ft
		3,112.20 lbs concen max
Capacity, air conditioner		50 Tons
Weight, computer		17,600 lbs
Weight, air conditioner		12,162 lbs

Required installation of pedestal type floor - painted combustible walls with fire retardant paint-modified air conditioner ducts to channel return air thru electro dust filter.

Standardized Modules

Photo by Air Reserve Records Center

Raytheon Company - Missile Systems Division

Power, computer	30.25 Kw 38.9 KVA (Complete System)
Power, air conditioner	23 Kw
Volume, computer	21,600 cu ft
Volume, air conditioner	12,480 cu ft
Area, computer	2,160 sq ft
Area, air conditioner	1,060 sq ft
Room size, computer	40 ft x 54 ft
Room size, air conditioner	(47 ft 4 in) x (22 ft 4 in)
Floor loading	100 lbs/sq ft
	100,000 lbs concen max
Capacity, air conditioner	20 Tons
	450 cfm per ton
Weight, computer	16,200 lbs
Weight, air conditioner	5,000 lbs

Exterior walls are filled concrete blocks, plastered and covered with "Kalistron".

Interior partition is floor to ceiling metal and glass partitions.

Windows are existing metal frame windows removed and space filled with glass blocks.

Ceilings are hung metal pan type with glass wool insulation. Also included flush type fluorescent lighting, supply and return air diffusers.

Floors are aluminum and tile raised floor as manufactured by "Lisky".

Protection of tape library is accomplished by an automatic CO_2 flooding system. Remainder of area is protected by a combustion sensitive "pyralarm" which opens power circuit to computer equipment and air conditioning system and signals alarm adjacent to the room and in Main Guard House.

Power distribution is by main feed panel in computer room through cables under raised floor to each piece of equipment.

The air conditioning equipment is housed in a room built into a monitor centered over the main floor, outside and to the north of the computer area. Exterior walls and flooring are made up of metal partitions as manufactured by "Mahon". Interior flooring is made up of 2" x 6" matched boards. All construction is for a four hour fire protection as requested by F. I. A.

PRODUCTION RECORD

Number produced to date	24
Number in current operation	16
Time required for delivery	12 months

COST, PRICE AND RENTAL RATES

		Basic System	Sales Price
1	503	Computer	$ 257,000
1	561-1	Hi-Speed Storage (16,384 char)	120,000
6	581	Tape Stations (33,333 char/sec)	29,700 ea
1	523	Tapewriter	3,300 ea
1	525	Tapewriter-Verifier	4,500 ea
1	533	On-Line Printer	60,000 ea
1	580	Tape Station (22,222 char/sec)	$ 25,190
1	582	Tape Station (66,666 char/sec)	
1	535	Off-Line Printer (600 lines/sec)	
1	561-2	High-Speed Storage (32,768 char)	
1	561-3	High-Speed Storage (49,152 char)	
1	561-4	High-Speed Storage (65,536 char)	
1	543	Tape Selecting Unit (additional 8 sta)	
1	595	Tape Selecting Unit (additional 16 sta)	
1	527	Card Transcriber (400 cards/min)	
1	528	Card Reader (400 cards/min)	
1	537	Transcribing Card Punch (150 cards/min)	
1	538	Card Punch (150 cards/min)	
1	567	Random Access File (1,500,000 char)	
1	560/597	File Control & Power Units	$ 110,000
1	512-5/7	On-Line Paper Tape Punch (100 char/sec)	17,200
1	513-5/7	On-Line Paper Tape Punch (300 char/sec)	38,700
1	551	On-Line Card Buffer	
1	523	Tapewriter	
1	525	Tapewriter-Verifier	
	547-6	Tape Switching Unit	11,800

Quan	Model	Basic System	Monthly Rental
1	503	Computer	$ 5,400
1	561-1	Hi-Speed Storage (16,384 char)	2,400
6	581	Tape Stations (33,333 char/sec)	550 ea
1	523	Tapewriter	110 ea
1	525	Tapewriter-Verifier	150 ea
1	533	On-Line Printer	1,300 ea
1	580	Tape Station (22,222 char/sec)	$ 465
1	582	Tape Station (66,666 char/sec)	
1	535	Off-Line Printer (600 lines/min)	
1	561-2	High-Speed Storage (32,768 char)	
1	561-3	High-Speed Storage (49,152 char)	
1	561-4	High-Speed Storage (65,536 char)	
1	543	Tape Selecting Unit (additional 8 stations)	
1	545	Tape Selecting Unit (additional 16 stations)	
1	527	Card Transcriber (400 cards/min)	
1	528	Card Reader (400 cards/min)	
1	537	Transcribing Card Punch (150 cards/min)	
1	538	Card Punch (150 cards/min)	
1	567	Random Access File (1,500,000 char)	
1	560/597	File Control & Power Units	1,525
1	512-5/7	On-Line Paper Tape Punch (100 char/sec)	400
1	513-5/7	On-Line Paper Tape Punch (300 char/sec)	900
1	551	On-Line Card Buffer	
1	523	Tapewriter	
1	525	Tapewriter-Verifier	
1	547-6	Tape Switching Unit	300

Maintenance and service contracting benefits:
Industrial Specialists
Debugging Time Allowed
Standard Programs
General Backup
Executive Orientation

U.S. Naval Propellant Plant

			Price	Monthly Rental
One	503	Computer	$257,000	$ 5,400
One	561-2	High Speed Storage	177,000	3,400
Five	581	Magnetic Tape Stations	148,500	2,750
One		Tapewriter Verifier	4,500	150
		Total	$587,000	$11,700

Scott Air Force Base

One 503 Computer, one 561-1 High speed storage, five 581 Tape stations, one 533 On-line printer, and one 538 Card punch rents for a total of $13,850 per month. A 5 to 7 channel tape to tape converter and a PCAM card to 7 channel tape converter caused a one-time cost of $6,790. Maintenance and service is included in rental.

Mitchel Air Force Base

The Air Reserve Records Center system consists of

	Model	Description
1	503	Computer, less High Speed Storage Unit (Includes Program Control, Console, Paper Tape Reader, Monitor Printer, Tape Selecting and Buffer Unit - A (eight trunks and Power Supply).
1	561-2	High Speed Storage (32,768 characters)
10	581	Tape Station, 33,333 char/sec
1	535	Electro-Mechanical Printer (Off line 600 lines/min)
1	527	Card Transcriber

For sales and rental prices, see page 16 of GSA Contract No. GS-00S-23296.

Fidelity-Philadelphia Trust Company

System rents at $16,150 per month, including maintenance.

General Tire and Rubber Company

Computer, console, 8 tape stations, paper tape reader, on-line printer and 2 tapewriters rent at approx $16,000.

State Farm Life Insurance Company

503 Computer, 561-3 High Speed Storage, eight 581 tape stations, 533 High speed printer, six 523 Tapewriters, twenty-four 525 Tapewriter-Verifier, rents at $19,760 per month. Two 527 Card Transcribers and a 5971 Tapewriter Reader, temporary for conversion period, rent at $4,550 and $160 per month. Rental includes maintenance.

Electronic Data Processing Division, RCA

System configuration is as follows:

503	Computer
561-4	High Speed Memory
	Paper Tape Reader
	Monitor Printer
581 (8)	Tape Stations
547-6 (6)	Tape Switching Unit
537	Transcribing Card Punch
527	Card Transcriber

RCA Electronic Systems Center

Cost of basic system $586,000
Cost of additional equipment $1,359,800
Rental rate for basic system $11,850 per month
Rental rate for additional equipment $26,570 per month
Maintenance and service contracting is included in rental.

RCA Service Company - E D P Sales Dept.

System includes one 503 Computer, one 543 Tape Selector, one 561-4 High Speed Storage, twelve 581 Tape Stations, one 533 E. M. Printer, one 547-6 Tape Switching Panel, one 513-7 Hi Speed Paper Tape Punch and at a total rental of $21,100 per month.

System includes three 581 Tape Stations, one 535 EM Printer, one 527 Card Transcriber, one 537 Transcribing Card Punch, two 523 Tape Writers, and two 525 Tape Writer-Verifiers at a total rental of $10,700 per month.
Maintenance is performed by our technicians, who are a combination of operators and maintenance technicians.

EDPD - New York Electronics System Center - System Configuration

Model No.	Quantity	Description	Sales Price	Monthly Rental
503	2	Computer	$ 257,000	$ 5,400
561-4	2	High Speed Storage	291,000	5,400
543	2	Tape Sel. B-1	56,700	1,200
581	27	Tape Stations	29,700	550
533	2	Electro Mechanical Printer (On Line)	60,500	1,300
535	2	Electro Mechanical Printer (Off Line)	170,000	3,400
527	2	Card Transcriber	103,000	2,275
537	2	Transcriber Card Punch	148,300	2,965
523	2	Tape Writer	3,300	110
525	2	Tape Writer Verifier	4,500	150
547-6	2	Tape Switching Unit	11,800	300
513-5	2	Paper Tape Punch	38,700	900
513-7	2	Paper Tape Punch	38,700	900

All sales and monthly rentals are for a quantity of one.

RCA Astro Electronics Division

Rental contracting and rates for system

Model	Description	Monthly Rental
503	Computer, less High Speed Storage Unit	$5,400
561-1	High Speed Storage (16,384 char)	2,400
581	Tape Stations, 33 KC (4)	2,200
533	On Line Printer (600 lines/min)	1,300
567	Random Access File	500
568	File Control Unit	1,375
597	Power Supply	150
538	Card Punch	1,700
591	Card Reader Punch	1,500
525	Tapewriter Verifier	150

RCA Service Company, EDP Administration

System, composed of Tape Stations (12), Computer, High Speed Storage, Tape Selector B-1, Card Transcriber, Transcribing Card Punch, Printer Off-line, and Tapewriter-Verifier, sells at a total sales price of $1,215,900.

Rental for above equipment on an 8 hour shift, 5 days per week for 1 month is $24,390.

Ordnance Weapons Command

5 Tape Stations, On-Line Printer, Computer, Paper Tape Reader, Monitor Printer, and one Module Memory, rents at $11,800 per month.

5 Tape Stations, 3 Modules Memory, Off-Line Card Transcriber, Transcribing Card Punch & Electro- Mechanical Printer rents at $16,510.

Maintenance is included in basic rental.

Atlantic City Electric Company

Main frame rents at $7,800 per month.

7 Tape Stations, Off-line Printer, computer punch, 4 tapewriters, 4 tapewriter-verifiers, and 4 add-punches rents at $9,285 per month.

Ordnance Ammunition Command

Total rental is $17,585 per month.

Raytheon Company - Missile Systems Division

8 tape stations, 1 503 computer, 2 Modules (Hi-speed memory), 1 On-line Hi-speed printer, and rents at $14,500 per month.

7 tapewriters, 6 tapewriter verifiers, 1 card transcriber, 1 card punch, and 1 tape switching unit rents at $5,945 per month.

PERSONNEL REQUIREMENTS

Manufacturer's recommendation for a "typical" system

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	1	2	3
Analysts	*	*	*
Programmers	*	*	*
Coders	*	*	*
Clerks	*	*	*
Librarians	1	2	3
Operators	3	5	7
Technicians	2	4	5
In-Output Oper	1	2	3
Tape Handlers	1	2	3

*Variable depending on problem.

Training made available by Manufacturer to Users as required. Analyst Training, Technical Training, Automatic Programming Training, Pre-Installation Training of Operators, Coders, clerks, etc, and Operator Training are made available. The figures on personnel requirements are approximate and depend on the size of the system.

U.S. Naval Propellant Plant

	One 8-Hour Shift	
	Used	Recommended
Supervisors	1	1
Analysts	2*	2
Programmers	1	4
Coders	0	1
Clerks	1	1
Librarians	1	1
Operators	2	2
Engineers	**	**
Technicians	**	**

Operation tends toward closed shop.

RCA-supplied training course. Accelerated course given mathematicians at NPP.

*Analysts do programming and coding because of present personnel shortage. Because of a lack of operators for the machine being utilized, they also have acquired the ability to operate the machine.

** Engineers and Technicians are RCA personnel.

Scott Air Force Base

	One 8-Hour Shift		Two 8-Hour Shifts		Three 8-Hour Shifts
	Used	Recom	Used	Recom	Recommended
Supervisors	2	2	2	2	2
Analysts	4	4	4	4	4
Programmers	10	10	10	10	10
Clerks	1	1	1	1	1
Operators	1	1	3	3	8
Tape Handlers	1	1	3	3	8

Operation tends toward open shop (USAF).

Personnel were selected within this command for computer training on the basis of computer aptitude and speciality background. We attempted to select personnel with background training in each of the applications scheduled for the computer, e.g., based upon our expected requirement for analysts and programmers for the personnel application, we selected personnel with high computer aptitude and previous personnel experience.

Mitchel Air Force Base

	One 8-Hour Shift		Two 8-Hour Shifts	
	Used	Recommended	Used	Recommended
Supervisors	2	11	11	12
Analysts	4	6	-	-
Programmers		15	17	17
Coders		0	0	0
Clerks		3	3	4
Librarians		1	1	2
Operators		1	6	3
Engineers		3	10	10
Technicians		0	0	0
In-Output Oper		0	0	0
Tape Handlers		2	0	3

Methods of training used
Programmers - Five weeks formal classroom and on-the-job training - total 12 months
Operators - Two weeks classroom and 5 1/2 months on-the-job training - total 6 months

Organization consists of Data Development Division (Programming and Operations) and System Analysis Division. One position in System Analysis Division is concerned with ADP equipment and use in our system.

"Used" personnel are in Systems Analysis Division. "Recommended" is combination of both Divisions.

Programmers at this installation are analyst trained. Analysts in Systems Analysis Division are former programmers.

This installation operates 20 hours per day and 9 hours on Saturday. Overtime is not normally required in the operating area.

Engineers are furnished by the contractor.

Operators presently perform all operating functions, i.e., peripheral equipment operation, tape handling, and console operation.

Fidelity-Philadelphia Trust Company

	One 8-Hour Shift	Two 8-Hour Shifts	Three 8-Hour Shifts
Supervisors	2		
Programmers	6		
Librarians	1		
Operators	1		
Engineers	2	1	1
Technicians		2	2
In-Output Oper	1		
Tape Handlers	1		

Operation tends toward open shop.

Methods of training used include RCA Schools plus on-the-job training.

General Tire and Rubber Company

	One 8-Hour Shift
Supervisors	1
Programmers	1
Clerks	1/2
Librarians	1/2
Operators	2
Engineers	2
Technicians	1

Operation tends toward closed shop.

Methods of training used are RCA personnel-conducted courses.

State Farm Life Insurance Company

	One 8-Hour Shift
Supervisors	3
Analysts	3
Programmers	10
Clerks	6
Librarians	1
Operators	4
In-Output Oper	29

Not in production as yet. These are anticipated figures.

Operation tends toward open shop.

RCA for programmer and operator training.

Electronic Data Processing Division, RCA

Operation tends toward closed shop.

Methods of training used are RCA training schools, plus on-the-job training.

RCA Electronic Systems Center

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

Operation tends toward open shop.

Methods of training used includes 5 weeks program training and on-the-job training in operations.

The shift supervisor, operator, and tape handler rotate between jobs - actually use three men per shift on all equipments. Programmers, analysts, etc. are not part of Operations group. Support in this area comes from another group.

RCA Service Company - E D P Sales Dept.

	One 8-Hour Shift
Supervisors	5
Analysts	5
Programmers & Coders	7
Clerks	10
Operators*	*8
Technicians*	
Tape Handlers*	
Salesman	5

Personnel shown are for one shift operation on one system with maintenance on a 24-hour 7-day basis. Approximately 12 additional operator technicians and programmers will be required upon installation of 2nd system. Operators, technicians and tape handlers also perform demand and preventive maintenance.

Supervisors consist of Center Manager, Sales Manager, Systems and Programming Manager, Operations Manager and Office Manager. Clerical personnel include Office Administrative, Sales and Accounting functions in addition to data preparation operations.

Operation tends toward closed shop.

Operator technicians trained for 6 months at school and thereafter on the job.

Experienced Systems Analysts and Programmers attend 4 week programming ccurse and untrained employees receive an 8 week basic training course plus on-the-job training.

EDPD - New York Electronics System Center

Operation tends toward closed shop.

Programmers given formal school training and on-the-job training.

RCA Astro Electronics Division

	One 8-Hour Shift
Supervisors	1
Analysts	2
Operators	2

Operation tends toward open shop.

We use our own training program for computer center personnel and personnel who submit problems to the Computer Center.

A three tier approach is used for personnel requirements for the Computer Center.

1. Professional programmers are attached to the Computer Center. (2 + a supervisor)

2. Project programmers, who are considered professional programmers, are attached to the Engineering Sections that are developing projects. They work in concert with competent line engineers in developing programs.

3. Open Shop Engineer Personnel. These are engineers who are trained by us to develop and program the less complicated problems.

RCA Service Company, EDP Administration

This system is used for training of service personnel to support EDP Operations in the Field.

Ordnance Weapons Command

	Two 8-Hour Shifts	
	Used	Recommended
Supervisors	6	10
Analysts	21	21
Programmers	21	26
Clerks	6	7
Librarians	1	2
Operators	4	4
In-Output Oper	6	6

Personnel were selected from within the installation with emphasis on obtaining some from each of the application areas (subject matter specialists). Others had specific backgrounds desirable, i.e. Management Analysts, Accountants, Mathematicians/Statisticians and Tab Equipment Planners. There is no job as Coder, per se. When using object or machine coding, each programmer codes his own. On large program, he may have assistance. There are no tape handlers. Equipment operators perform the function when set-ups are required. Input-Output operators include 4 tapewriter and tapewriter verifier operators. Initially operation is on a closed shop basis, but as each application becomes operational, analysts are placed in "customer" organization.

United States Civil Service Commission training agreement calls for six month program; a 1 week orientation -classroom, 4 weeks programmer training by RCA - classroom, 4 weeks applied problems - half classroom, half on-the-job training, 1 week advanced analysis - classroom, and on-the-job training.

Atlantic City Electric Company

	One 8-Hour Shift
	Recommended
Supervisors	4
Analysts	1
Programmers	2
Clerks	3
Librarians	1
Operators	3
In-Output Oper	12

Operation tends toward open shop.

Training is performed on site and at manufacturer's schools.

Computer is in process of being shaken down during system testing and parallel production runs. Recommended organization shown above is the anticipated requirement. The manufacturer will have a maintenance staff of 8 employees on site.

Ordnance Ammunition Command

	One 8-Hour Shift
Supervisors	6
Analysts	7
Programmers	15
Clerks	2
Librarians	2
Operators	4
In-Output Oper	3
Tape Handlers	2

Operation tends toward open shop.

Methods of training used includes manufacturer's training courses, specialized OMETA courses, guided applications and on-the-job training.

Raytheon Company - Missile Systems Division

	One 8-Hour Shift	
	Used	Recommended
Supervisors	2	Depends on projects
Analysts	9	Depends on projects
Programmers	15	Depends on projects
Librarians	1	1
Operators	1	1
Engineers	2	3
Technicians	1	1
In-Output Oper	1	1
Tape Handlers	1	1

Operation tends toward closed shop.

Methods of training used include programming and technical training given on-site by RCA instructors. RCA maintains several full time on-site representatives for methods assistance. Classes, case problems and on-job training is also given.

RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

Reliability is obtained by dual recording on tape, simultaneous operation, automatic accuracy checks, lockout features of the Input-Output equipment, and tape flow sensing.

U.S. Naval Propellant Plant

Installation date for NPP equipment was 1 June 1960. At present, Bureau of Weapons equipment is being utilized.

Scott Air Force Base

Good time 145 hrs 45 min Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 95%
Above figures based on period 1 Apr 60 to 30 Apr 60
Date system passed 9 Mar 60
Time is available for rent to outside organizations.

We are currently preparing programs for the support of Hqs Air Weather Service. We expect to utilize approximately 30 hours of computer time for these applications.

Mitchel Air Force Base

Good time 78 Hours/Week (Average)
Attempted to run time 98 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.795
Above figures based on period 1 Jan 60 to 1 May 60
Date this system passed 9 Nov 59
Time is not available for rent to outside organizations.

Fidelity-Philadelphia Trust Company

Good time 15 Hours/Week (Average)
Attempted to run time 15-16 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.984
Above figures based on period 2 Jun 60 to 18 Jun 60

Date this system passed 11 Jan 60
Time is available for rent to outside organizations.
Have had no down time 9 Jun 60 to 18 Jun 60, inclusive.
Rent 8 hours per day to R.C.A.

General Tire and Rubber Company
Good time 39 Hours/Week (Average)
Attempted to run time 35 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.90
Above figures based on period 11 Apr 60 to 6 May 60
Date this system passed 11 Apr 60
Time is available for rent to outside organizations.

State Farm Life Insurance Company
Date this system passed 1 Mar 60 to 28 Mar 60
Time is available for rent to qualified outside organizations.
Experience to date limited to system and program testing. Progress is satisfactory and improving.

Electronic Data Processing Division, RCA
Good time 110 Hours/Week (Average)
Attempted to run time 112 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.98
Above figures based on period Jan 59 to 16 Jun 60
Time is not available for rent to outside organizations.

RCA Electronic Systems Center
Good time 118.3 Hours/Week (Average)
Attempted to run time 120 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.985
Above figures based on period Dec 59 to May 60
Date this system passed 15 May 59
Time is available for rent to outside organizations.

RCA Service Company- E D P Sales Dept.
Date this system passed 16 May 60
Time is available for rent to outside organizations.

RCA Astro Electronics Division
Operating ratio (Good/Attempted to run time) 100
Above figure based on period from 6 weeks to date
Date this system passed Initial system 1 Jan 60
Time is available for rent to outside qualified organizations.
Due to short length of time since installation we cannot make a definitive statement as to our running time. However our experience has been good. After acceptance test we started at 80% running time and have improved to 100% for the past six weeks.

RCA Service Company, EDP Administration
Time is not available for rent to outside organizations.

Ordnance Weapons Command
Average error-free running period 48 Hours
Good time 82.7 Hours/Week (Average)
Attempted to run time 83.5 Hours/Week (Average)
Operating ratio (Good/Attempted to run time) 0.99
Above figures based on period 1 Jul 60 to 30 Jul 60
Time is available for rent to outside organizations on a limited basis.
RCA Maintenance requires minimum of 90 minutes daily. Time is available from midnight until 0530. Computer good time is over 99% over a six month period. Down time accumulated is primarily due to tape station malfunction and secondarily due to the paper tape reader. (Electro-Mechanical devices).

Raytheon Company - Missile Systems Division
System passed Customer Acceptance Test 26 Jul 60

ADDITIONAL FEATURES AND REMARKS

Manufacturer
The RCA 501 System can be tailored to fit the needs of the user. It takes advantage of the latest programming techniques and can be expanded to suit future needs. The design concept, using completely transistorized circuit modules, saves power and space. Reliability and savings in maintenance costs have been realized by actual field operational data. Records (word) lengths are completely variable both on tape and in memory. Unique symbology on tape tells the computer where messages and items begin and end. Thus, artificial fixed word or fixed maximum word lengths do not have to be resorted to i.e., each item and message occupies on tape only the exact space that it requires. Blocks of several messages may also be variable in length. The system handles all of this automatically.

U.S. Naval Propellant Plant
Outstanding features: Completely variable recording of data; building block or modular expansion principle; transistorized; fast speed (microsecond access); simultaneous tape read-compute, write-compute, read-write operations.
Unique system advantages: Ability to perform real-time operations with modification; fast tape speeds; ability to perform binay operations through its special binary instruction codes.
The RCA 501 Computer System is the only one in its price class and currently available which satisfies the on-line, real-time requirements of the NPP workload. The tape speeds can accommodate 15,000 data points per second for NPP's real-time applications.

Scott Air Force Base
Adopted procedures for magnetic tape labelling, storage, shipping, and protection from humidity, temperature and physical, electrical, fire, or other damage. All magnetic tapes are assigned an inventory number and are labeled with its content. A current inventory card is maintained reflecting current and previous content, reuseable date and labeling information. Each program is so designed to check the label of each tape used to insure that proper tapes are mounted for use. Tapes are stored in a separate room, under the same temperature and humidity controls as the computer.

Mitchel Air Force Base
Outstanding features include transistor design, plug-in assemblies, printed wiring, modularized components, building-block construction, simplified automatic control, complete variable data recording, and tape reading/writing is possible in both forward and reverse directions.
Unique system advantages include four-character parallel transfer, increased data transfer rates, and addressable registers. Built-in and programmed accuracy controls, checking correct transfer of data in peripheral devices, into and out of the computer, and within the computer proper; additional controls ascertain correct arithmetic operations. Time-shared electronics, permitting simultaneous operation of input-output devices with computer functions. Complete range of computer instructions; 47 basic, wired-in, two-address instructions for input-output (12) data - handling (13), arithmetic (11), and decision and control (11).