

UNIVAC 1900 CADE Key/Disk System

MANAGEMENT SUMMARY

UNIVAC entered the key/disk arena in 1974 with the introduction of the 1900 CADE (Computer Assisted Data Entry) System. The company enhanced this system, which is manufactured by the Pertec Corporation, by offering a data communications capability in December 1975. Further enhancements, announced in July 1976, include more powerful software and an 8.8-megabyte disk unit. Originally, only a 2.2-megabyte disk was available. Delivery of the new software and the larger disk is planned for January 1977.

The recent software enhancement, known as FIT (File Inquiry Technique), improves the data entry capabilities and provides multiple access to large data files. Users will also be able to access related files from local keystations. An overall improvement in access time is made possible by generating disk files that have an associated retrieval key for each record. FIT requires a minimum of 16K bytes of storage, depending on the number of active keyboards, record sizes, and application packages.

The new features provided by FIT include: COBOL program access to batches and files, added COBOL language capabilities, new supervisor file management facilities, and a new operator mode for file inquiry and update. File inquiries can be run concurrently with data entry, allowing multiple operators to access and update shared files. In a move toward distributed processing on the 1900, FIT will allow user departments to access related files from local keystations.

The 1900 system supports up to 32 keystations and has a modular semiconductor memory expandable from 57K to 131K bytes in 8K increments. The system can also ➤

Recent software enhancements and larger disk units have improved the data entry capabilities of this shared-processor key/disk system and permitted multiple access by user departments to data files from the local keystations. The UNIVAC 1900 CADE system can support up to 32 keystations and can communicate with other 1900 systems, with UNIVAC 1100 Series and Series 90 computers, and with IBM 360/370 computers.

CHARACTERISTICS

SUPPLIER: Sperry Univac Division, Sperry Rand Corporation, P.O. Box 500, Blue Bell, Pennsylvania 19422. Telephone (215) 542-2011.

CONFIGURATION

KEYSTATION: Consists of a video display and an electronic keyboard. It is a compact, portable, desk-top unit of the same approximate size as an office typewriter. Any keystation can be converted into a supervisory station by entering a special password.

The keyboard can have any of three standard arrangements: standard keypunch, keypunch/adding machine, or typewriter with 10-key numeric overlay. Any combination of these keyboard styles can be mixed in a given system. The controlling format program can specify that the station be automatically shifted into an alphabetic, numeric, or lower case alphabetic shift, or the operator can shift the keyboard manually. When the keystation is in the lower case alphabetic shift, the video display presents each character as a true lower case letter. A cursor in block form appears in the space to be filled next. ➤



The 1900 CADE System supports up to 32 of the CRT keystations shown here. The display is arranged in 12 lines of 40 characters each, and the keyboard is available in standard keypunch, keypunch/adding machine, or typewriter arrangements. The control processor cabinet is shown in the left background.

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handle up to four disk storage drives, providing a disk storage capacity of from 2.2 million to 35.2 million bytes. Up to four magnetic tape units (7- or 9-track), a 30-cps or 200-lpm printer, and a communications adapter can also be included.

The CADE system can support up to 32 CRT keystations, and the keyboard pattern can resemble an IBM 29 keypunch, a keypunch/adding machine combination, or a typewriter with 10-key numeric overlay. Keystations with different styles can be intermixed in a system. Each keyboard can execute three shifts—alphabetic, numeric, or lower case alphabetic. From the various keyboard styles, the user can fit one to the experience of the operator who will use it. For instance, an inexperienced operator with only a typing background would obviously be more comfortable with a typewriter-style keyboard. Because a keystation can be located up to 3,000 feet from the control processor, a station can be situated in a data source environment, away from the battery of other key operators, and a clerk can be assigned to that station. Extensive prompts permit rapid training of inexperienced operators.

The ability to transform any keystation into a supervisory console is also advantageous. If a remotely located clerk should need supervisory help, the supervisor can key in the proper password and then interrogate the system from that station without the need to walk back and forth. In addition, the system isn't knocked out when the supervisor's station goes down; a switch is made to another station and operations continue.

Each keystation features three different methods of formatting the screen. In the first method, field names and corresponding keyed data both appear in the body of the display. These field prompts assist in job training or in expediting an unfamiliar job. In the second method, field names are displayed one by one on the top line of the display, and each one remains until the operator is ready to key the next field; only data appears in the body of the display. In the third method, the keyed data does not build up on the screen, and instead only the last character keyed is shown on the top line.

Each format can consist of up to 32 levels, and each keystation has access to an unlimited number of formats stored on disk. Any or all of these control formats are available to as many keystations at the same time as desired. After the operator has finished keying a format level, another program can automatically succeed the previous one (format level chaining). This sequence of execution can be modified manually by the operator or by the onset of conditions specified in the format programs.

The main editing and validation procedures are as follows: alpha-only entry, numeric-only entry, must enter, must complete, boundary checking, range checking, ascendancy checking, sign checking, comparison logic (greater than, less than, equal to), check digit verification (modulo 7, 10, or 11, or user-specified), crossfooting, record sub-totalling, and batch totalling and balancing. The conditions for comparison tests, such as those of range checking, are specified in the format program by means of COBOL verb statements and designations of the fields to be affected. By means of these elementary COBOL state- ➤

➤ The video display is composed of 12 lines of 40 characters each. The first two lines normally present job status information (job name, current field name, current record number, current character position in the record and in the field, current program level, and current status of automatic functions). System messages appear in the third line. Data keyed by the operator, with or without format headers, is exhibited in the remaining nine lines.

CONTROL PROCESSOR: This specially designed Pertec minicomputer has a 1.25-microsecond cycle time, a 16-bit word structure (plus 2 parity bits), a basic memory of 57,344 bytes, which can be expanded to 131,072 bytes in 8K-byte increments, 1 selector channel, and a real-time clock. All words are directly addressable.

MAGNETIC TAPE DRIVES: Six models, all intermixable, are available: 7 tracks, 556/800 bits/inch, at 18.75 or 37.5 inches/second forward speed; 9 tracks, 800 bits/inch, at 18.75 or 37.5 inches/second; and 9 tracks, 1600 bits/inch, at 18.75 or 37.5 inches/second. Operation of one tape drive in the system is standard, but a maximum of four is possible. Reel capacity is 600 feet or 2400 feet, depending on the model selected. These units are manufactured by Pertec.

DISK STORAGE: The standard Pertec magnetic disk drive employed in the system has a capacity of either 2.2 million bytes on a single removable platter; 4.4 million bytes on two platters, one removable and one fixed; or 8.8 million bytes on two platters, one removable and one fixed. Additional drives can be added to the system for a total of up to 35.2 million bytes of storage. The track-to-track head positioning time is 9 milliseconds, the average positioning time is 35 milliseconds, and the maximum is 60 milliseconds. The average rotational delay is 20 milliseconds.

PRINTERS: There are two printers available for use with the system, a 30-character/second incremental printer and a 200-line/minute matrix printer.

The incremental printer is from the UNIVAC DCT 500 terminal. It uses a helical print-wheel with single print-hammer actuator and ink roller to print 63 symbols and up to 132 columns per line. Horizontal pitch is 10 char/inch; vertical spacing is 6 lines/inch.

The incremental printer accommodates six-part continuous forms (or three-part carbonless forms) from 3-7/8 inches to 14-7/8 inches wide. Forms are fed at 30 lines/second; skipping speed is 12 inches or 72 lines per second. Black ink is standard; and red, green, or violet inks are available. Forms control, available as an option, features horizontal and vertical tabulation and accommodates forms of varying lengths.

The matrix printer is manufactured by Tally Corporation and has maximum print speed of 200 lines/minute. When printing lines containing lower case alphabetic characters that have descenders (i.e., g, j, p, q, y), however, the print speed is 165 lines/minute for those lines. This printer uses a 64- or 96-character set and prints up to 132 columns per line. Horizontal pitch is 10 char/inch and vertical spacing is selectable at 6 or 8 lines/inch.

The matrix printer accommodates up to six-part continuous forms from 4 to 14-7/8 inches wide. Forms are controlled by industry-standard 8-channel tape, and the paper advance speed is 4 inches/second.

COMMUNICATIONS

The communications adapter provides an RS-232/CCITT interface for synchronous data transmission in half-duplex mode at a speed of up to 9600 bps with the appropriate lines and modems. A 1900 CADE system can communicate with another 1900 system, with UNIVAC 1100 Series and Series 90 computer systems, or with IBM 360/370 systems. The user selects the line procedure to be used with the communications adapter.

Selection of the Uniscope 100 Display Terminal communications protocol allows the communications adapter to emulate the communications line procedures of the ➤

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➤ ments, virtually any kind of conditional test that the user may require can be programmed into the system. COBOL statements can also be used to enter constants into registers and to mandate their insertion into records, either at the time of keying or at the time of writing to tape, according to specified conditions. Tables can be stored for look-up operations, and the allowable detail of the tables is limited only by the available processor and disk storage space. User effort can be negligible if simple tests are specified and more substantial if complex test routines are introduced; the system can perform tests and checks up to the degree of complexity that the user cares to install.

The data file in disk storage can be searched for a particular record number in a batch, for the next record in a batch carrying an error flag, for the next record having certain field contents specified by the operator, or for the next record within a particular program format having a specified field content. A record can be inserted or deleted from the batch in the Verify, Search/Modify, or Update mode. If you insert or delete a record, the system then renumbers the batch from this point forward; if duplications or calculations have been specified, the system automatically performs these operations with respect to the appropriate record.

The ability to perform all four arithmetic operations is an extremely valuable system property. If fast turnaround on certain types of documents is needed, such as invoices, purchase requisitions, trial balances, customer account statements, etc., the system can compute data for such forms and print formatted output from keyed data even as data for other jobs is being keyed.

Initially introduced without communications capability, the 1900 now offers a communications adapter as an integral feature. The adapter provides an RS-232/CCITT interface for synchronous data transmission in half-duplex mode at speeds up to 9600 bps. Selection features are available which enable the system to communicate with another 1900 system, with UNIVAC Series 90 or 1100 computer systems, or with an IBM 360/370 computer system.

USER REACTION

In Datapro's 1976 survey of key entry equipment users, responses were received from 10 users who reported on their experiences with 11 UNIVAC CADE systems. These 11 systems had a total of 109 keystations for an average of almost 10 keystations per system. The largest system had 17 keystations, while the smallest had only 6. Most of these users had installed 9-track, 800-bpi magnetic tape drives. Also, the majority of the users were employing most of the available data editing and validation features. These features included zero batch balancing, range checking and reformatting, table lookup, total and compare batch balancing, value checking, and prompting. These 10 users rated the CADE system as follows.

➤ UNIVAC Uniscope 100. This enables the 1900 system to communicate with any of the UNIVAC computer systems in the 90, 9000, or 1100 Series. The emulation is for a polled environment, irrespective of whether communicating over a multipoint or point-to-point network. The system will handle a single data line. Some features of Uniscope 100 display terminal communications protocol are not supported under the 1900 system Uniscope 100 terminal emulation. These are: imbedded messages, asynchronous interfaces, terminal multiplexer interfaces, direct synchronous with clock interfaces, screen control, and report address.

The Binary Synchronous communications selection enables the communications adapter to emulate the IBM 2770 Data Communication System and the IBM 2780 and 3780 Data Transmission Terminals. This allows the 1900 system to communicate with another 1900 system and the following IBM systems/terminals:

- 360 under DOS with BTAM
- 360/370 under OS with BTAM, QTAM, or TCAM
- 360/370 under HASP, HASP II, or ASP
- System 3 with RPG II Telecommunications
- 2770
- 2780
- 3780

The 1900 system can receive or transmit data from any of the above systems/terminals, under control of the 1900 system supervisor.

Another selection provides for the emulation of IBM 2780 point-to-point communications procedures and also allows 1900-to-1900 system point-to-point communications. Data transmission can take place, dependent on lines and/or modems, at rates up to 9600 bps in either a dedicated or switched environment. IBM binary synchronous communication (BSC) conventions are observed and data transfer is performed in half-duplex mode using EBCDIC, ASCII, or 6-bit Transcode. EBCDIC may be used in transparency mode for sending any one of 256 characters. The following features are supported: trailing blank truncation, blank compression, horizontal tabling, multi-record formatting, EBCDIC transparency, multiple record transmission, extended inquiry retry, internal clock, and automatic answer/automatic hang-up. The IBM 2780 dual interface capability is not supported.

The communications adapter can operate at data rates ranging from 2000 bps to 9600 bps, depending on the lines and modems used. The lines can be either privately leased or dial-up lines and can use either 2- or 4-wire circuits.

The following table reflects the modems recommended for use with the 1900 system and their characteristics:

Modem	Speed (bps)	Line Type
Sperry UNIVAC 201	2400	Switched or private
Bell 201A	2000	Switched
Bell 201B	2400	Private 2- or 4-wire
Bell 201C	2400	Switched or private
Bell 208A	4800	Private 2- or 4-wire
Bell 208B	4800	Switched
Sperry UNIVAC DCM (type 8543)	2400, 3600, 4800, 7200, or 9600	Privately owned

Other equivalent modems to 9600 bps may be used assuming that unusual timing or interface constraints are not encountered.

SYSTEM OPERATION

Three display modes are available to the operator. In the *Formatted* mode, field names are written on the screen in their appropriate places within the record, and the operator keys data into the respective blanks. This mode is helpful in training novice operators or in expediting an unfamiliar job. In the *Unformatted* mode, a field name displayed on the first status line when the operator is ready to key the corresponding field; this name yields to the next one upon completion of the field. As the data is keyed, it is presented

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	Excellent	Good	Fair	Poor	WA*
Overall performance	6	3	1	0	3.5
Ease of operation	6	4	0	0	3.6
Hardware reliability	2	7	1	0	3.1
Maintenance service:					
Promptness	4	5	1	0	3.3
Quality	3	6	0	1	3.1
Software	2	6	2	0	3.0
Technical support	2	3	4	1	2.6

*Weighted Average on a scale of 4.0 for Excellent.

The CADE users' ratings made it clear that they were generally well pleased with their systems. Only 2 of the 10 users assigned any poor ratings. One, located in a small town in the southwest, rated the quality of maintenance poor. The other user, who was operating a single CADE processor with 12 keystations, gave a poor rating to the UNIVAC technical support but assigned ratings of good or excellent to all the other categories.

One user who had assigned fair ratings to the hardware reliability, promptness of maintenance service, and quality of maintenance in Datapro's 1975 key entry survey assigned good or excellent ratings to the same categories in the 1976 survey. This user had identified tape alignment problems as the reason for the initial low ratings, but he stated that these problems were resolved shortly before the 1975 survey. As evidenced by the high ratings he assigned in the latest survey, this user is now well satisfied with his CADE system and says the tape problems have been totally resolved. □

► in the bottom nine lines in the usual way unless the format program orders that it not be displayed. Each data field is separated by a single space or by a field separator. In the *Blind* mode, only the last character keyed is displayed, and it appears on the top status line of the screen. Transition from this mode to either of the other two is easily accomplished from the keyboard.

Activity at the key entry installation is essentially like that of other key-to-disk systems. The supervisor maintains tight control over all system personnel and operations. She enters job and batch numbers, assigns the keystation operators, designs new program formats and enters them into the program library (or assigns the entry task to an operator), releases completed and reformatted batches on the disk file to tape, deletes outdated records or programs from the disk, requests system information and status messages, and causes printouts of various kinds of information. Operator statistics, which consist of the operator's identity, the time elapsed in keying a batch, the number of keystrokes, the keystrokes per hour, and the number of inserts, deletions, and corrections, represent a particularly useful system printout that the supervisor can specify. The operator and supervisor are assisted by nearly 100 prompts and nearly 100 messages describing system conditions.

The basic processor permits simultaneous operation of up to eight keystations, one of which can be controlling a disk-to-tape batch output operation. The expanded versions permit up to 32 keystations to be active simultaneously, together with write-to-tape and output-to-printer operations. In an emergency, such as when one of two system processors goes down, up to 62 keystations can be connected to the active processor.

Any keystation can be converted to a supervisory station by keying in a special password. Other passwords limit access to batches, records, or fields to authorized persons.

ERROR CONTROL: Parity generation and checking is performed on data transferred between the computer and disk and between disk and tape or other output devices. Odd parity is written on 9-track tape, and either odd or even parity on 7-track tape. Longitudinal and cyclic

redundancy characters are created and written on disk and tape. A read-after-write check is performed on both tape and disk. Data written on a disk is read during the next revolution and compared with the original data in core; erroneous data is immediately rewritten. A read check is performed when reading from the disk. Validation and other errors cause electronic blocking of the keyboard and sounding of a tone. If desired, the operator can override errors and flag the record for later action.

OPERATING MODES

- **Entry**—Operator keys data from source documents under control of the format program; she can correct errors in any character position before releasing the record to the disk.
- **Verify**—An operator rekeys those fields specified for verification by the format program plus other fields that are either contributing to an out-of-balance condition or are designated by the system as containing invalid data.
- **Search/Modify**—Records stored in the data file can be searched and accessed by the operator according to a particular record number in a batch, by requesting the next record in a batch with an error flag, by calling for the next record having a specific data content entered by the operator, or by requesting the next record within a particular program level having a specific data content. Changes to the record can then be made in the normal way, as described for the Entry mode. Records can also be inserted or deleted from the batch; the batch is then renumbered from this point forward, and any specified duplication or calculation that affects subsequent records is automatically performed.
- **Update**—The operator can key additional data into each of the records of an existing batch; the display cursor is automatically positioned to the beginning of the field(s) designated for Update by the controlling format program. The purpose of this mode is to enable the operator to update files where most of the information remains constant. Essentially, the Update mode is a form of the Entry mode.
- **Supervisor**—This mode can be invoked only at a supervisory station for the purpose of supervisor/system conversation or for the performance of supervisory functions such as requesting system hard-copy print-out, writing a completed batch to tape, deleting odd records from the data file, etc.
- **Format Entry**—The specifications for a format program and all automatic operations related to it are entered into the format program library by the operator from any keystation.
- **File Inquiry**—The FIT software adds COBOL indexed I/O (with minor variations), permitting multiple operators to share indexed files. Operations with indexed files can proceed simultaneously with regular data entry. All operations are under control of format programs prepared by the user. Although data in the indexed files can be accessed by format programs in the Enter, Verify, Update, and Search/Modify modes of operation, the new File Inquiry Update mode is recommended for use in inquiry-response applications and whenever data in indexed files is to be changed. This mode is a special case of the Enter mode in which certain functions, such as the record backspace key and replay, have been deleted. These functions are not applicable, or would have caused problems, when applied to indexed files. The data validation features of the Enter mode are retained to help assure that only error-free data is entered.

The format program can inhibit a particular field from being displayed and require the operator in the Entry mode to rekey that field for immediate verification. If the two field entries agree, the system permits the operator to continue. This entry/verification feature can save time when only one or a few fields in each record require

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► verification. Another system feature is concurrent verification, which takes place when an operator keying in the Entry mode is almost immediately followed by a second operator keying the same material.

SYSTEM PROFILE

Since the basic 2.2-million-byte disk drive can be augmented with additional storage of up to 35.2 million bytes and the minicomputer memory can be expanded to 131,072 bytes, ample storage can be added to the CADE system for implementing any desired complement of features and storing any practical quantity of data records. Therefore, the file capacities appearing below represent a typical division of the basic 2.2-million-byte disk and should not be regarded as fixed.

- Record length—can be any length up to 999 characters; there can be 333 separate fields. If the record size is greater than can be displayed on a keystation CRT screen, the system automatically starts a new page when necessary, beginning with a reprinting of the last line of the previous page.
- Record blocking—records written to tape can be blocked up to 4096 characters.
- Record formats—for 999-character records or smaller, a 200-program library is representative of most application environments.
- Data record storage—25,000 80-character records or 18,000 120-character records are normal limits for the data record file.

Exact figures for the number of edit routines and system management programs that can be stored will not be stated, since additional storage capacity can be added as needed to accommodate new routines.

SOFTWARE

All of the conventional keypunch operations, such as skipping, duplication, left-zero fill, alpha-only entry, numeric-only entry, etc., are performed in conjunction with operator keying. In addition, the CADE system imposes such editing constraints as must enter, must skip, and must complete. Check digit verification using modulo 7, 10, 11 or any customer-specified check digit is also performed. Any violations detected by these procedures disable the keyboard, and the condition must be immediately corrected by the operator. Another useful feature is auxiliary duplication, which consists of emitting constants up to 999 characters long at positions within the record specified by the format program.

An advanced feature is "COBOL-procedure programming." Almost 40 COBOL and other procedural-language verbs are available, including Alarm, Call, Compute, Connect, Display, Dup, Field Backspace, Find, If, Move, and Tab. Use of the verbs Allow and Disallow can effect a broad range of character and field validity checking that is limited only by the available processor memory and disk space on the file. The user can also program arithmetic comparison conditions. For example, the operator must enter a certain field if the entry in a prior field exceeds a certain quantity. Or, the quantity entered within a certain field must fall within a specified range (range checking) if the quantity entered in a prior field is less than a certain quantity. Program statements are used to enter the limits of range checks, and to enter a set of table look-up values. If simple range-checking or table look-ups are to be performed, programming with the COBOL statements is not much different from the straightforward entry of parameters common to other systems.

The new FIT (File Inquiry Technique) software adds COBOL indexed I/O to the CADE system. Operations with these indexed files can occur concurrently with data entry. Multiple operators can share indexed files which are accessed by user-prepared format programs in the enter, verify, update, or search/modify modes of operation. The key characteristics of the FIT software can be summarized as follows:

- Multiple operators can simultaneously share a common indexed file.
- Operators can access multiple indexed files in a single format program.
- Primary and alternate keys are supported for all indexed files.
- Alternate index keys are automatically updated, as required, in real time.
- When records are added to an indexed file, index keys are automatically added (in sorted order) to existing indices.
- Sharing of files is under program control. The following rules are available for sharing a file. The Input Only option limits a file to an inquiry-response function. No change in the data base is permitted. This is the primary method of sharing indexed files for regular data entry operations. The Output Only option limits an indexed file to a collection of records that could be used as an indexed transaction file. The Input/Output option is the real-time transaction capability. Records can be inserted, deleted, read, modified, and rewritten to the file. If multiple operators are sharing such a file, programmable record lock capabilities are provided to restrict access by other operators to a record which is being modified until the record is rewritten to file.

The format program can also close and lock files so that a temporary file can be deleted to release memory and disk space used by that file while the job continues. It is also used to prevent undesired re-entry into a designated file as work progresses.

New verbs are added to the COBOL compiler to permit a full set of operator prompts to be displayed and retained on the CRT screen and to prohibit these prompt records from being written to disk.

An interesting property conferred by COBOL programming is the ability to alter format level sequencing in accordance with specified conditions. Hence, a particular sequence can be automatically instituted under one condition, and a different sequence can be implemented under another condition, all program-specified.

Extensive crossfooting within each record can be carried out. These totals can be added to those accumulated in previous records.

To implement batch balancing, a predetermined batch total is entered into the system. After the entire batch has been keyed, the aggregate of these entries must equal the predetermined entry. If an imbalance occurs, the batch is flagged to signify that it requires supervisory attention. The records of this batch need be verified only until correction of an error or errors produces a batch balance.

REGISTERS: The following allocation of registers is available to every batch stored in the system:

- Up to 99 character registers are available for storing characters or fields to facilitate their manipulation.
- Up to 99 auxiliary duplication registers are available for storing and emitting constants.
- Up to 99 balance registers are available for accumulating crossfooting totals and batch totals.
- Up to 99 arithmetic registers are available for COBOL arithmetic operations.

Any register can be displayed on the message line of a keystation CRT screen. Arithmetic registers, in conjunction with COBOL verbs specifying each of the four arithmetic operations, enable elementary data processing to be performed on entered data prior to its release to the output ►

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► tapes. If the user wishes, he can program various basic operations that are ordinarily performed by the mainframe.

REFORMATTING: In the standard form of the system, fields within a record can be rearranged before writing the record to tape. The records, which must all be of the same length, can be blocked up to a limit of 4096 characters. Constants can be emitted into appropriate field locations at this time as well as during the keying operations. Headers or accumulations can also be emitted into the reformatted record. If more complicated reformatting is desired, such as composing entirely new records by abstracting designated fields from stored records, appropriate COBOL statements can be entered into the system.

PRICING

The UNIVAC 1900 CADE system is available for rental on a one-year or five-year lease or for purchase. Monthly rental costs under a five-year lease are approximately 20 percent less than under a one-year lease. Maintenance contracts are available for either arrangement. Lease costs based on a one-year contract, purchase prices, and prime-shift maintenance charges are presented below. The monthly rental costs below include prime-shift maintenance.

	Monthly Rental*	Purchase	Monthly Maint.
1900 CADE Processor (includes 57K-byte memory, controllers for up to 4 disk drives and 4 tape drives, and space for two 7-inch tape drives and one disk drive or one 7-inch tape drive and two disk drives)	\$606	\$25,200	\$81
Storage expansion—8K-byte module (first module)	138	6,096	11
Storage expansion—each succeeding 8K-byte module	96	4,080	11
Power Supply Expansion (required for memory over 65K)	42	1,824	4

	Monthly Rental*	Purchase	Monthly Maint.
Drive/Single Disk (2.2M-byte cartridge)	270	10,176	58
Drive/Double Disk (2.2M-byte cartridge and 2.2M-byte fixed disk)	400	15,024	87
Drive/Double Disk (4.4M-byte cartridge and 4.4M-byte fixed disk):			
First drive	487	19,200	87
Second drive	377	13,920	87
Third drive	345	12,960	75
Fourth drive	315	12,000	65
Disk Control Expansion (provides second disk controller for dual access to two or more drives)	63	2,784	5
18.75 ips tape drives; 7-inch reels (fit into Processor or Tape/Disk Cabinet):			
7-track, 556/800 bpi, NRZI	135	5,088	29
9-track, 800 bpi, NRZI	135	5,088	29
9-track, 1600 bpi, PE	179	6,624	41
37.5 ips tape drives; 10.5-inch reels (free-standing):			
7-track, 556/800 bpi, NRZI	222	8,400	47
9-track, 800 bpi, NRZI	222	8,400	47
9-track, 1600 bpi, PE	259	9,936	52
NRZI Formatter**	53	2,304	5
Phase Formatter (for PE drives)**	106	4,560	11
Tape/Disk Cabinet (houses two 7-inch tape drives and two disk drives, or four 7-inch tape drives)	106	4,560	11
Keystation (any keyboard style)	76	3,168	10
Table—one drawer	5	240	—
Table—two drawers	7	336	—
Character Printer (30 cps)	109	4,080	24
Line Printer (200 lpm)	397	14,976	85
Communications Adapter	70	2,640	15

*Includes prime-shift maintenance.

**One Formatter is required for a group of NRZI and PE tape drives.■