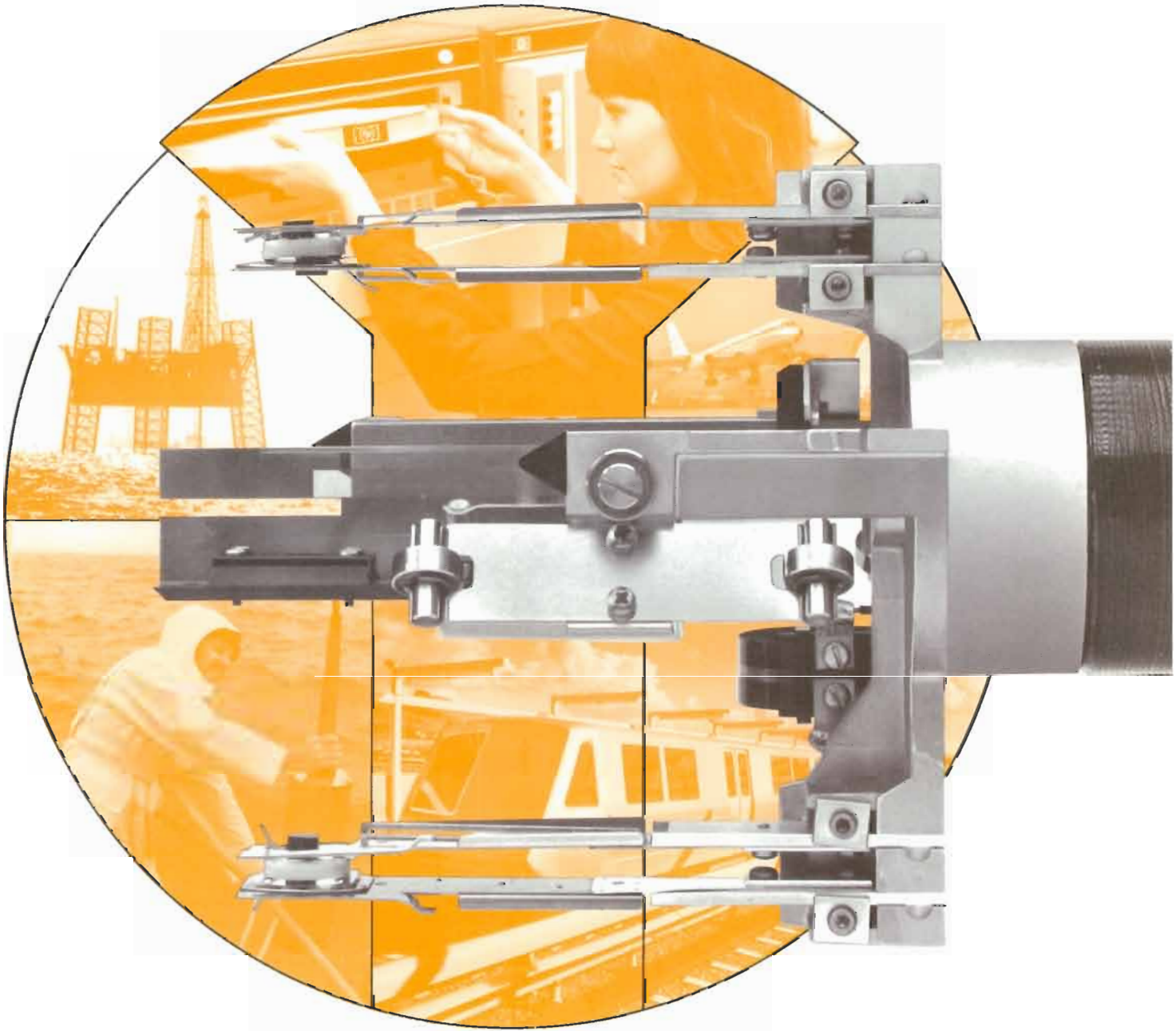
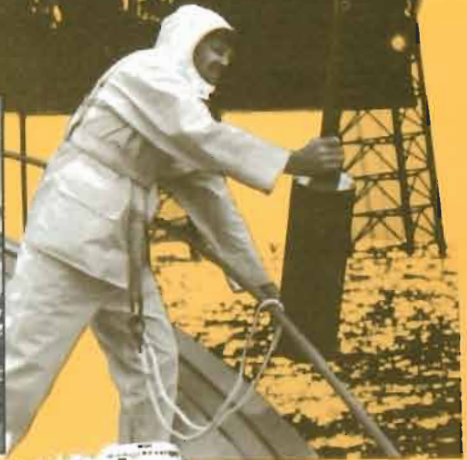


# Rugged Moving-Head Disc Drives



**Hewlett-Packard Series 7900**





## The challenge of peripheral memories

### SITUATION:

You have project sites in two extreme environments. You have a truck-mounted mini-computer operating in a hot arid location. At 104°F, the truck shakes and vibrates as it travels down the dusty road.

You also have a ship-mounted data acquisition system. It operates at 50°F as the ship pitches and rolls as much as 30° in the ocean dampness.

### CHALLENGE:

You need to exchange programs and other data developed at these two extreme environments with a central office. You need two or more memory systems with removable media. They must write accurately. And they must read precisely what the other has written.

### SOLUTION:

Until recently, you'd still have a problem. We addressed this situation some time ago and found that storage capacity, access time, data transfer rate and reliability took a new perspective when applied to hostile environments.

But HP solved the problem with a tough, rugged, moving-head disc drive. It completely satisfied the ocean/desert situation. Even if you don't need such severe environmental specifications, the Hewlett-Packard disc memory system still translates into more reliability and longer life.

HP offers two disc drives. One drive has a single removable cartridge, the other a fixed disc and a removable cartridge. Both use front loading, 2200 bpi, cartridge discs. Both feature an access time and data transfer rate that's faster than any other cartridge memory. In fact, they often serve as the only peripheral memory device in real-time and time-sharing systems.

This great speed of the HP drives enables quick response to events in process control and data acquisition systems. They also save time in updating inventory control files and in executing FORTRAN programs for scientific projects. Hewlett-Packard drives are fast enough to solve not only today's problems, but tomorrow's as well.



*HP Model 7900A has a fixed disc drive plus the removable cartridge for a total storage capacity of 4.9 million bytes, an average access time of less than 30 milliseconds, and a data transfer rate of 2.5 million bits-per-second.*



*HP Model 7901A has a single removable cartridge disc with a storage capacity of 2.5 million bytes, an average access time of less than 35 milliseconds, and a data transfer rate of 2.5 million bits-per-second. It includes an integral power supply.*

# They're tougher than we thought

At the outset, we knew that our disc drives had to be tough to withstand environmental extremes and still maintain disc interchangeability. But now that they're built, tested, and installed, they're tougher than we thought. For example, our head positioning system locates to 0.010 inch between tracks. The maximum allowable error, including runout, thermal effects, hysteresis in the servo system, and external disturbances is 0.0015 inch. And the head/data alignment is within 0.0001 inch, with a worst case factor of 0.0003 inch. This, to our knowledge, has never been exceeded.

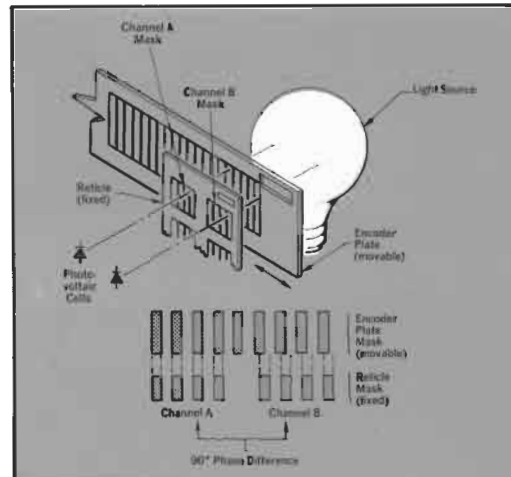
A heavy duty "voice coil" actuator rapidly moves the head-carriage assembly. With the speed of the actuator comes a servo stiffness of 10 pounds per mil. That's a big reason why our disc drives can take such physical abuse.

## **QUALITY IS NOT ADDED AT HP... IT'S BUILT IN**

A single main base casting provides even greater ruggedness. All positioning components are stoutly fastened to its precisely milled surfaces. Hewlett-Packard innovated the use of numerically controlled machines to precisely machine all moving mechanical components. This manufacturing precision eliminates the need for shimming, parts selection and critical mechanical adjustments. It also eliminates many of the field assembly and adjustment problems.

## **FIVE YEARS OF UNLIMITED USAGE**

Besides using advanced production techniques, all Hewlett-Packard disc drives were thoroughly tested during development. These tests include shaking, rolling, dropping, heating, cooling and exposing the units to humidity extremes. Mechanical assemblies were exercised for the equivalent of five years of unlimited usage. The actuator, positioner, carriage

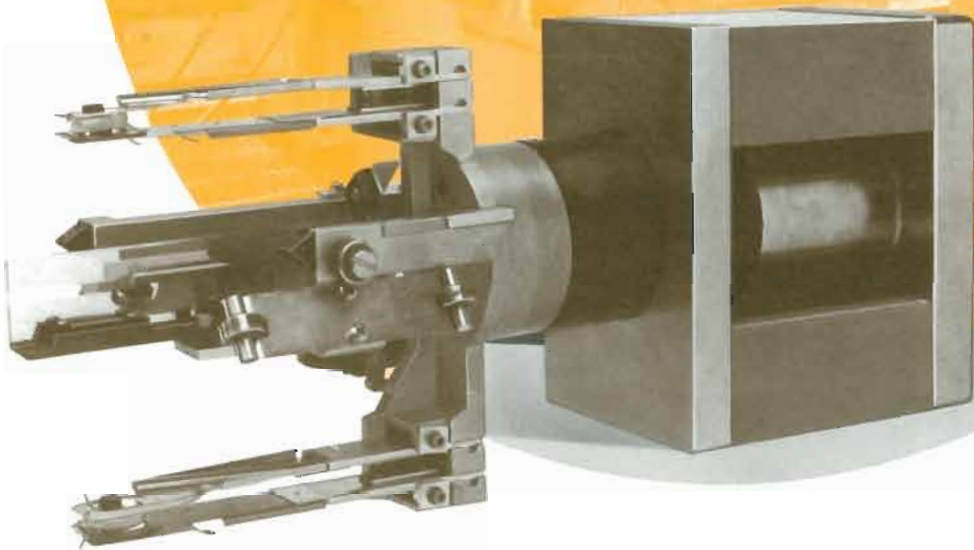


*Optical encoder senses location and direction of read/write heads. Head position and destination are both available in registers at all times.*

and rails have been tested for 300 million maximum-length seeks.

## **EXTENSIVE FINAL QUALITY ASSURANCE CHECK**

You'll receive your disc drive only after it is exercised for more than 20 hours on-line, over its full temperature range. During this time, its read/write accuracy is computer checked using disc operating system software. Programs check overall performance and data reliability with hard to recognize bit patterns, cause random seeks, and incremental seeks. Every phase of the disc and controller interface operation is thoroughly checked by this program. This test and other stringent quality control standards assure you that any discrepancy is found in our plant not yours. This is HP quality. It easily translates into "up-time," "dependability," and "reliability."



# Protecting your investment

Because some of your data is irreplaceable, we assume that it's *all* irreplaceable.

With data integrity as a primary objective, we coupled state-of-the-art technology and manufacturing innovations with a conservative, well tested, electro-mechanical design. Disc drive design features safety circuits and interlocks. It also provides for voltage protection, continuous monitoring of timing and status signals, write protection, and gentle loading of heads. Our design also includes separate circuits for monitoring seek completion and similar operating events.

## AUTOMATIC PROTECTION

Hewlett-Packard disc design anticipates and prevents malfunctions which may be caused by the operator, environment, controller, or internal sources. However, if a malfunction should occur, your HP disc drive will automatically remedy the situation. In any event, your data is always protected.

## RETRACTABLE HEADS

A head/disc malfunction, controller error or hardware failure will retract the heads, thus protecting data.

## AUXILIARY POWER

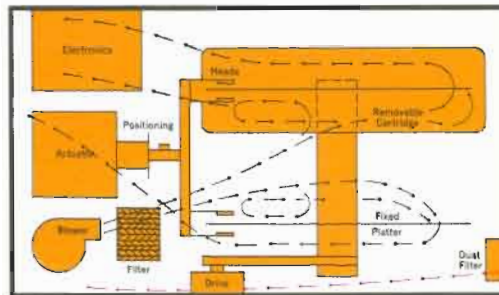
A primary power failure retracts all heads and activates the auxiliary battery preventing head damage and data loss. Restoration of primary power automatically cycles the drive through its power-on sequence. This returns the drive to full operational status without operator intervention.

## SAFETY CIRCUITS

Safety circuits include overvoltage and over-current protection and sequence timing control. The operator cannot damage the drive with external inputs. There are no duty-cycle

restrictions on accessing. Zero-crossing detectors for a.c. power control prevent line transients. Write protection is switch-selectable from the front panel.

## POSITIVE PRESSURE AIR FILTRATION



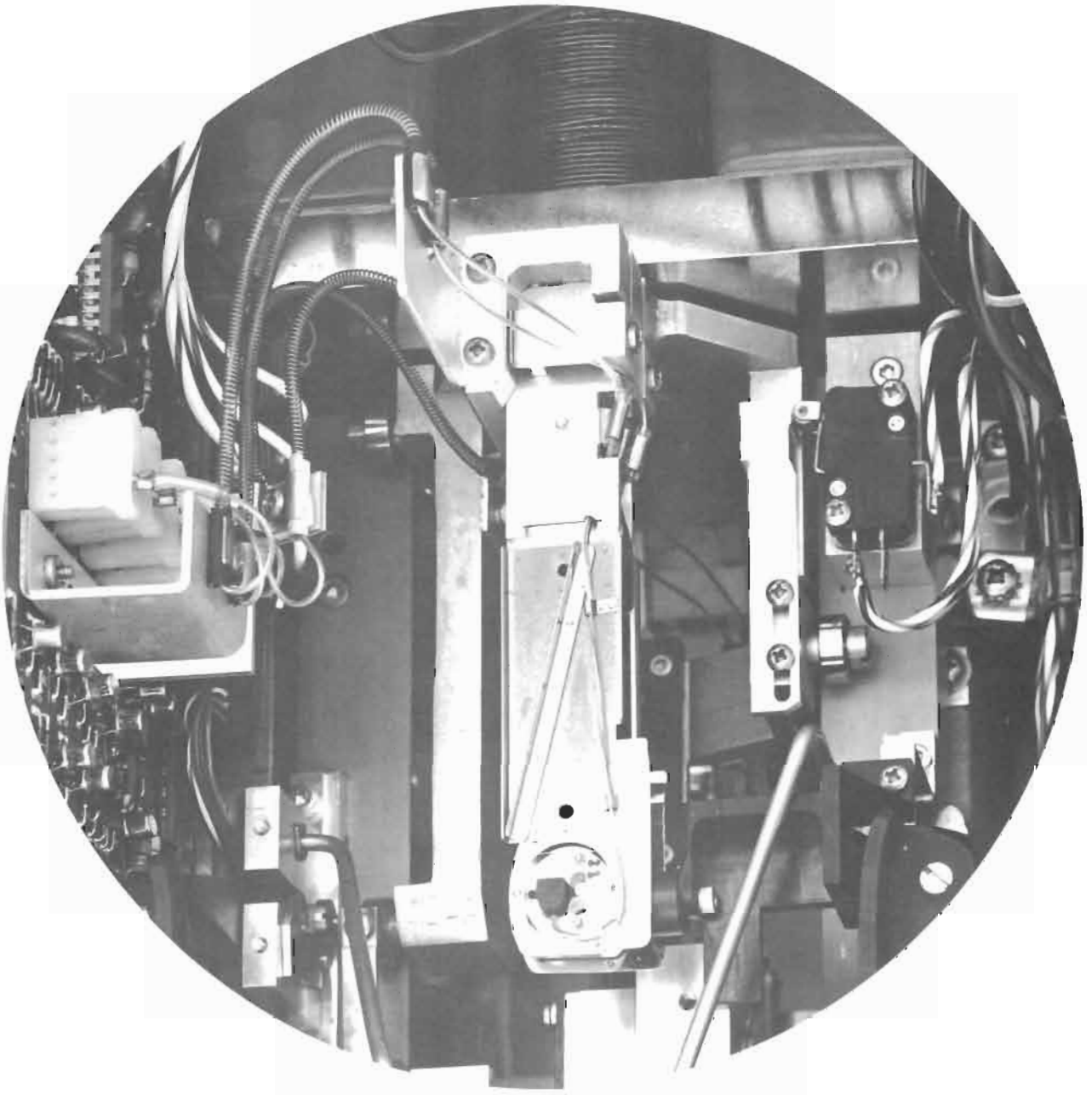
The recording heads actually fly on an air bearing at 65 to 90 microinches from the disc surface. That's only one-thirtieth the diameter of a human hair. With this clearance even dust particles have the potential to cause damage or data loss.

This was solved in HP disc drives by using absolute air filtration which eliminates particles down to a fraction of a micron. To maintain cleanliness, the cartridge is purged of contaminants by forced air which constantly travels across the disc surface. This positive air pressure is maintained during cartridge changes.

## INTERLOCK CIRCUITS

Interlock circuitry turns off the drive motor or prevents it from starting if certain improper conditions occur. For example, interlocks assure that no printed circuit boards are missing, that the power supplies and the encoder lamp are operating, that the removable disc cartridge is properly seated on the spindle, and that the door is properly closed and locked.







# The Inside Story

**Access Time:** Fast access time to data is achieved by the HP-developed linear-motor actuator. Total access time of a moving-head disc drive is the sum of seek time and latency or rotational delay. Average seek time is 30 milliseconds. This is the average time to position the heads over the desired track. Average rotational delay is 12.5 milliseconds. At 2400 rpm, this is the average time required for the disc to place desired data under the heads. As far as it can be determined, this is the fastest access time of any cartridge disc drive.

**Data Capacity:** The removable disc cartridge feature of HP disc drives allows virtually unlimited off-line storage of data. Each removable cartridge contains a disc platter with two recording surfaces. Each recording surface has 200 tracks plus three spare tracks. And each track is organized into twenty-four 256-byte sectors. Thus each surface contains 1.25 million 8-bit bytes or 2.5 million bytes per cartridge. Because the recording element used in the cartridge is also used for the fixed disc, the 7900A provides a total of 5-million bytes. Operating up to four drives on the same controller provides you with the capability of storing nearly 20-million bytes on-line.

**Transfer Rate:** Maximum data transfer is 312,000 8-bit bytes, or 2.5 million bits per second. And is realized when reading or writing within any single sector. This high transfer rate allows you to minimize the amount of computer's core memory that has to be used as an I/O buffer.

**Data Electronics:** Your data is written serially on each track, one bit at a time. Data electronics and read/write heads accurately encode the data, put it on the disc and retrieve it when needed. During operation, electronic circuits compensate for changes in disc speed caused by variations in line voltage and frequency.

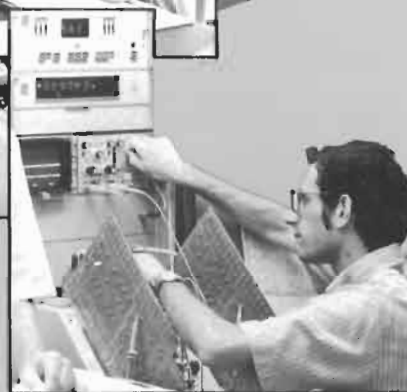
These circuits also compensate for drive-to-drive differences in head positioning, disc-to-disc variations in magnetic characteristics, and internal variations caused by environmental changes.

**Fault Circuits:** Hewlett-Packard data electronics also incorporate fault circuits that test for seven possible combinations of latches and status conditions. Any one of these conditions will terminate any operation in progress. Termination of an operation retracts and unloads the heads and lights the drive fault indicator on the front panel.

**Noise Immunity:** Maximum noise immunity is provided in the data path from the read/write heads to the controller. This further ensures accuracy of the data recorded or retrieved.

**Unique Grounding Method:** Hewlett-Packard disc drives are designed to operate in areas which have a large amount of electromagnetic interference. A line filter in the power supply removes severe line transients. Provision for electrically isolating the disc drive from the cabinet rack is incorporated in the chassis slides. This is accomplished without sacrificing grounding of all operator-accessible controls. The front-end frame assembly is separately grounded to the rack, rather than the main casting (which serves as disc system ground). Thus the disc can be isolated for added protection from noise, such as that from static charges produced by personnel walking on carpeted floors.

**Read/Write Heads:** Besides data electronics, recording heads comprise the most critical elements in the read/write process. To achieve complete control of head characteristics, HP manufactures all disc drive heads. With a ceramic shoe and a ferrite core, they read and write at 2200 bits-per-inch.



# To enhance your own capabilities

## **INTERNATIONAL SUPPORT:**

You can rely on a full spectrum of Hewlett-Packard support from 170 computer-linked field offices in 65 countries. Service centers are located in major metropolitan areas. This assures that wherever you are, you'll always have an expert HP problem solving team available. No service situation is too complicated for our technicians. Field personnel are backed by factory service engineers, who have direct access to design and production information. HP support is with you all the way.

## **INTERFACING ASSISTANCE:**

Hewlett-Packard system analysts are available to help interface disc drives to various processors, and to integrate disc units into your product line or system.

HP support is compatible.

## **CUSTOMER TRAINING:**

A broad range of training courses and materials covering both software and hardware have been specially developed for our customers. Complementing instructor training is HP's unique video tape library. Video tapes convey more information in less time and with high retention.

HP support is understanding.

## **IN-DEPTH DOCUMENTATION:**

Comprehensive documentation is available from Hewlett-Packard to help your development manufacturing and service personnel. This documentation helps to integrate HP disc drives into your product line or system, and to support it throughout its useful life. Typical publications are: *Operating and Service Manual*, *Service Training Manual*, *Interface Guide*, and product information sheets.

HP support is knowledge.

## **TEST & SERVICE EQUIPMENT:**

Each Hewlett-Packard service facility maintains an extensive inventory of the latest instruments, including equipment developed specifically for servicing and repairing HP disc drives.

HP support is innovative.

## **REPLACEMENT PARTS:**

Nearly \$10 million worth of parts are stocked by our worldwide facilities. Each field office maintains an inventory that is supplemented by U.S. and European regional service centers. Orders for parts not stocked locally are normally filled and shipped in one day, using our computerized data communications system. HP support is attention to little things that count.

## **FOR MORE INFORMATION:**

Call your local HP Sales Office, or, East (201) 265-500, Midwest (312) 677-0400, South (404) 436-6181, West (213) 877-1282. Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Post Office Box 85, CH-1217 Meyrin 2 Geneva, Switzerland. In Japan, Yokogawa-Hewlett-Packard 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.



For more information: Call your local HP Sales Office, or, East (201) 265-500, Midwest (312) 677-0400, South (404) 436-6181, West (213) 877-1282.  
Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Post Office Box 85, CH-1217 Meyrin 2 Geneva, Switzerland.  
In Japan, Yokogawa-Hewlett-Packard 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151