Basic Description of the TENEX Disk Structures
(Revised version)

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Technical Memo

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Introduction:

This memo describes the organization of the TENEX disk drive structures. (One should beware that the terminology used by TENEX is not that normally used by most systems, e.g., what most systems consider a cylinder, TENEX calls a track. And, of course, a track is usually understood to be that surface readable by one head in a given revolution of the disk.)

In TENEX we have two kinds of systems, referred to respectively as the large and small KI systems. These two systems are different only in the disk capacities available to users. (As you will see from Figure 2 and 3, in the large system we have 1544 tracks for the users, and in the small system 529 usable tracks.)

Organization of the TENEX Disk

From Figure 1 we obtain the basic disk organization. For each disk drive (≡ pack) we have 2Ø surfaces and NTKUN tracks (remember: a TENEX track is what we normally call a cylinder).

An important construct in all the disk management is the disk sector. There are two uses of the word sector:

1) Physical Sector

2) Logical Sector

A surface is divided into three equivalent pie-shaped areas. Each of these areas is a physical sector. Thus we partition each of the 2Ø surfaces into three parts, giving us 6Ø parts altogether. Each of these parts contains NTKUN TENEX pages (512 words) and is known as a logical sector. The logical sectors are numbered in the following manner.

Starting with the top surface of the top plate, we have logical sectors Ø, 1, and 2. The bottom surface of the top plate has logical sectors 3, 4, and 5. At the end, the bottom surface of the bottom plate has sectors 57, 58, and 59.

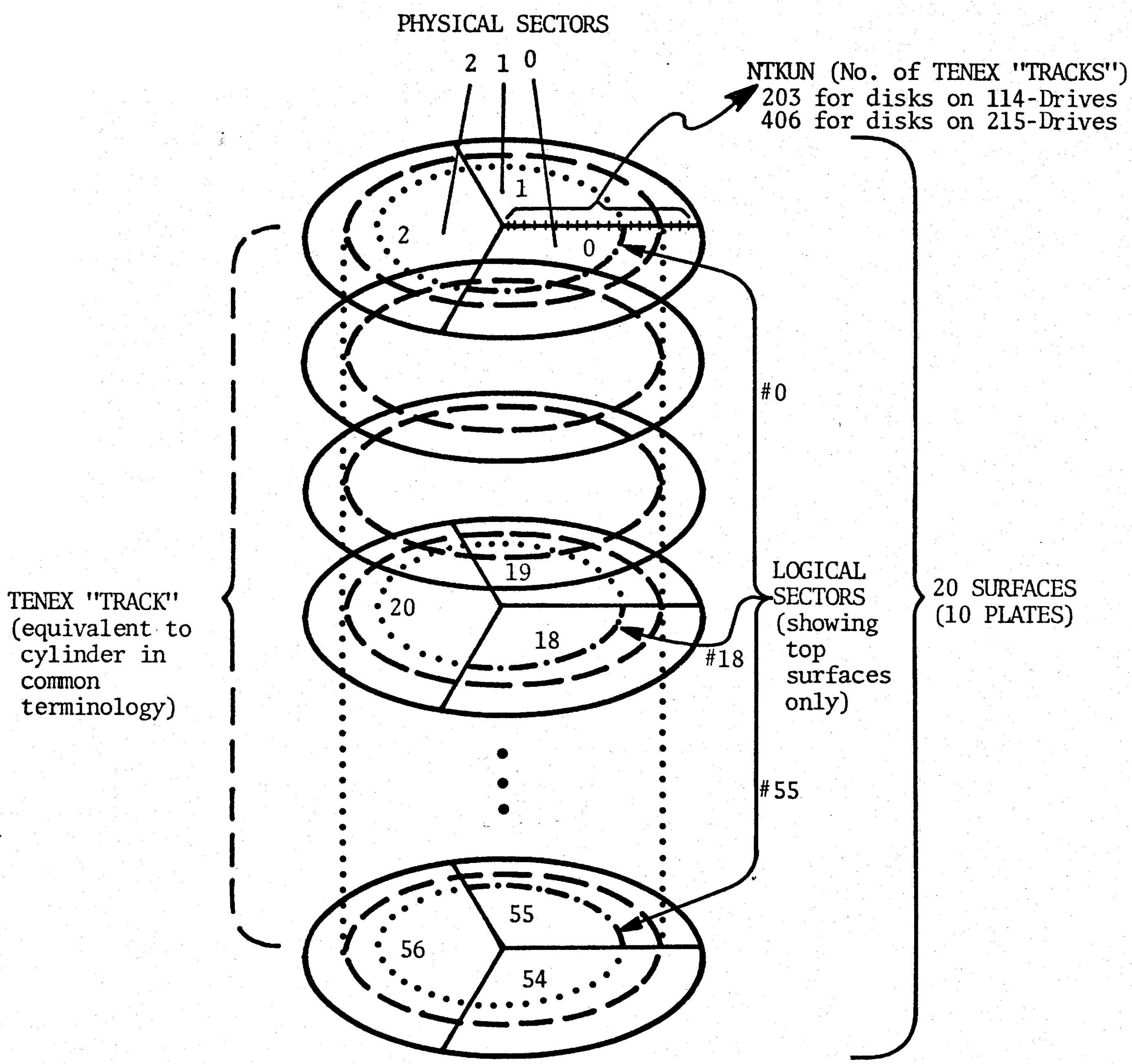
There are two kinds of disk drive:

1) For 114-Drive:

- 203 tracks per pack
- Total three drives, i.e., total 609 tracks.

2) For 215-Drive:

- 406 tracks per pack
- Total four drives, i.e., total 1624 tracks.



There are two kinds of disk drives used for TENEX:

(1) With 114-Drives, pack sizes are: NTKUN = NTKUN4 = 203 (CYLINDERS≡TRACKS)

(2) With 215-Drives, pack sizes are: NTKUN = NTKUN5 = 406 (CYLINDERS≡TRACKS)

Figure 1: TENEX DISK DRIVE (OR PACK)

<u>Address Representation</u>

We have three kinds of addresses to describe the location of a page on the disk.

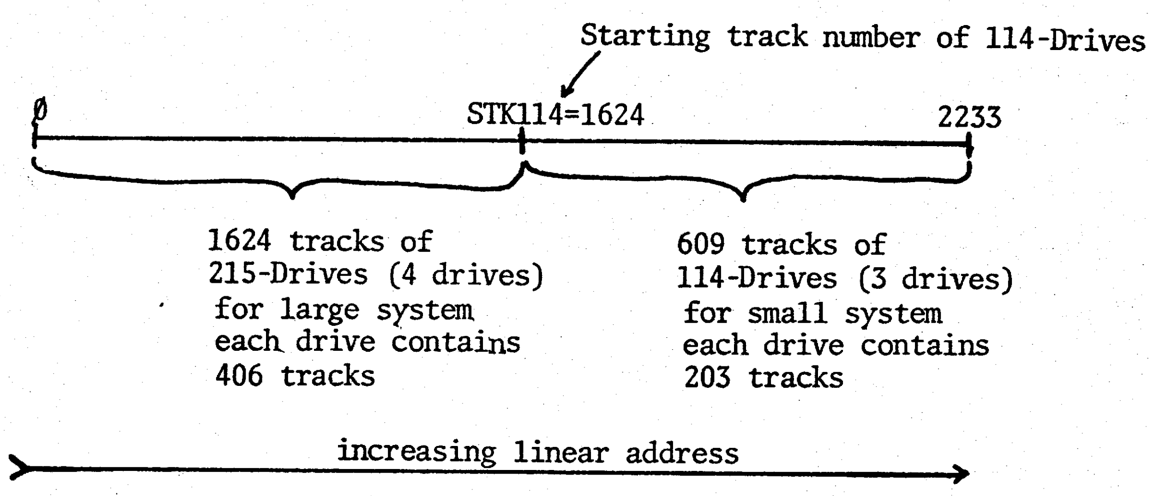
A) linear addresses, which run from Ø to the total number of disk pages (minus 1)

B) Disk pack oriented addresses: AKA hardware form addresses.

C) DC1Ø hardware form addresses.

The algorithm for the conversion of a linear address to a hardware form address is described below:

(In the linear ordering of disk pages, those pages on the 215-Drives are numbered ahead of those on the 114-Drives.)



1) Get the track # and logical sector # by dividing the linear address by the number of logical sectors per track. (The track # is the integral part and the logical sector # is the remainder of the division.)

(Note that a linear address is represented in a full-word using only bits 16-35.)

2) If the track is on a 114-Drive [track # $\geq$ STK114] then compute the drive # and track # within the 114-Drive.

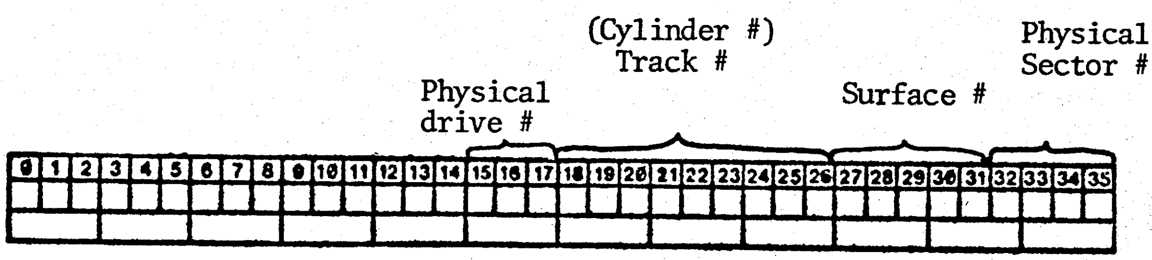
Otherwise, compute the drive number and the track number within the 215-Drive.

For the 215-Drive there are 406 tracks/drive, while for the 114-Drive there are 203 tracks/drive. Thus, for the 215-Drives, one divides the track number by the number of tracks per 215-Drive (406). The integral part is the drive number, with the remainder being the track number within that drive. We do similarly for the 114-Drive, except that the number of tracks per 114-Drive is 203, and also take into account the fact that the 114-Drives come after the 215-Drives. These are done separately, of course, because the two kinds of drives have different number of tracks per drive;

3) Compute the surface number and physical sector number by dividing the logical sector number of step 1 by the number of physical sectors per surface (=3). The surface number is the integral amount and the physical sector number is the remainder of the division.

Note: The drive number computed in step two is known as an internal drive number which is converted to a physical drive number by a one to one mapping (using a table.) Right now, the internal drive number is identical to the physical drive number. But it can be changed by modifying the table map.

After doing some shifting and packing we obtain the following hardware form address:

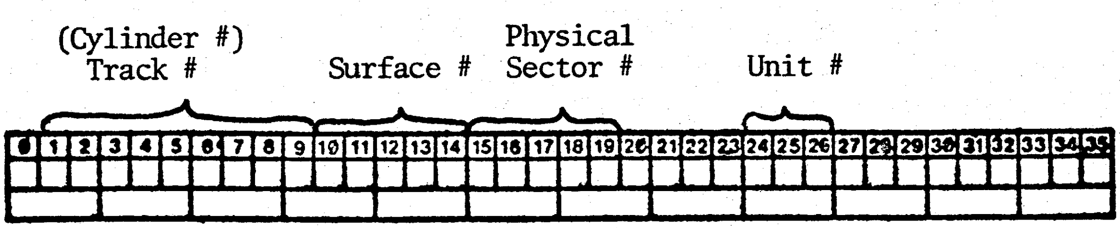


Hardware Form Address

Note: The physical drive number starts with the first drive of 215-Drives and runs to the last drive of 114-Drives. (Maximum number for drive number is 6)

An example of converting an actual linear address to hardware form is given in the appendix.

The third form of disk addressing DC1Ø hardware form is shown below. This form is easily derived from the normal hardware form by an obvious repackaging; the unit # is equal to the physical drive # + 1.



DC1Ø hardware form address

Track Allocation

In the ideal case, we have 3 114-Drives for the KI small system, and 4 215-Drives for the KI large system, and every drive is in perfect condition; if this is in fact the case, then the tracks will be allocated as shown in Figure 2 and Figure 3. But in real life, nothing is perfect, so some of the drives may be down. This means all the drives must be reallocable.
The algorithm for the calculation of this reallocation is described below:

1) look at the table map (mentioned in Address Representation) for each logical drive. If the physical drive for that logical drive is down, then rearrange the logical drive in the table map, so that the drives in the beginning positions of the map are up.
2) The 40 tracks used for the resident monitor image are assigned as the first 40 tracks of the first up drive, same as Figure 2 and Figure 3.
   The 40 tracks for check point and swapping are assigned in the last 40 tracks of the last up drive.

Note: This algorithm is for both the KI large and small systems.

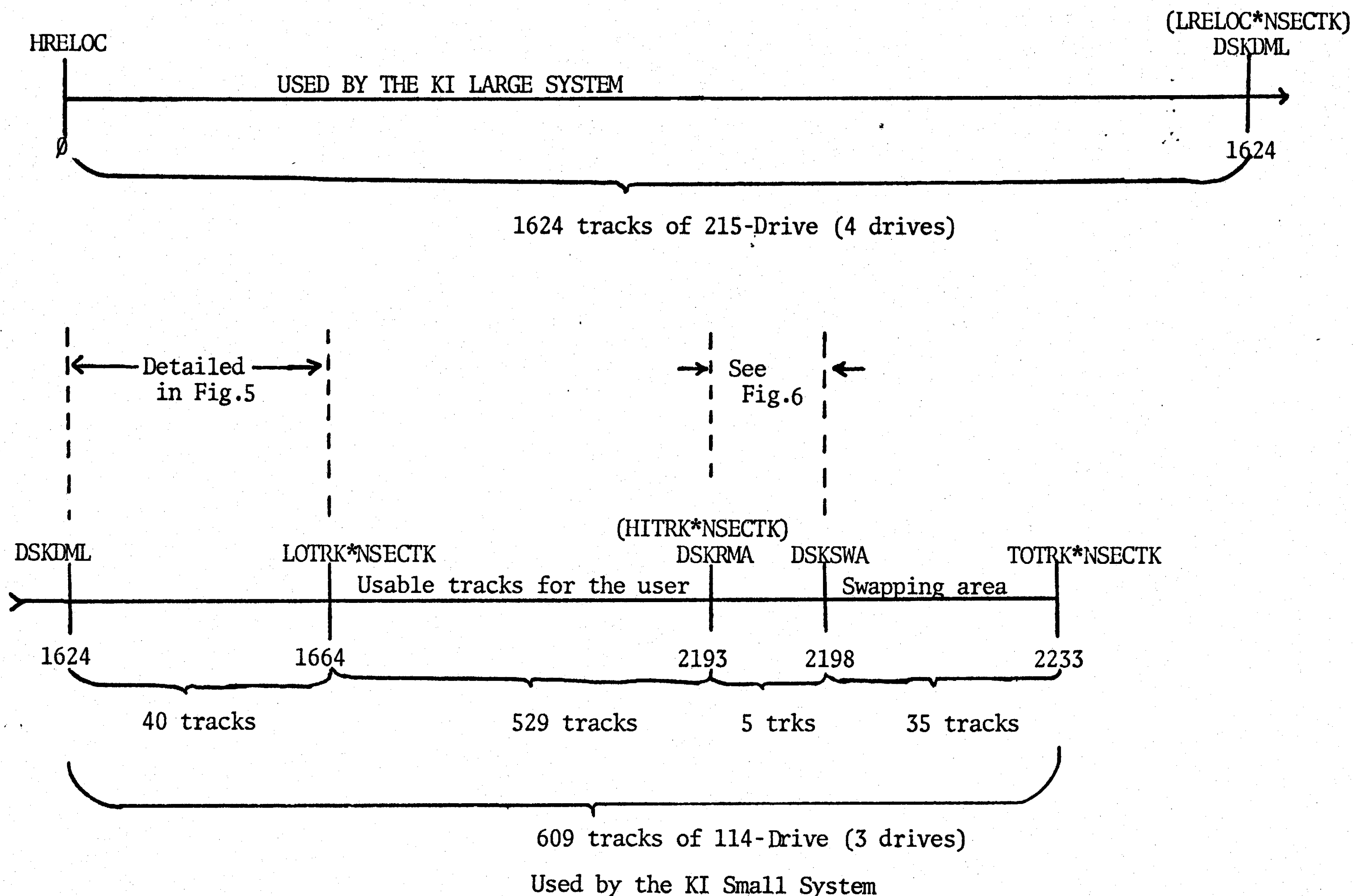


Figure 2: Track Allocation of TENEX Disk for KI Small System

(LRELOC = total # of tracks of 215-Drive
HRELOC = Ø)

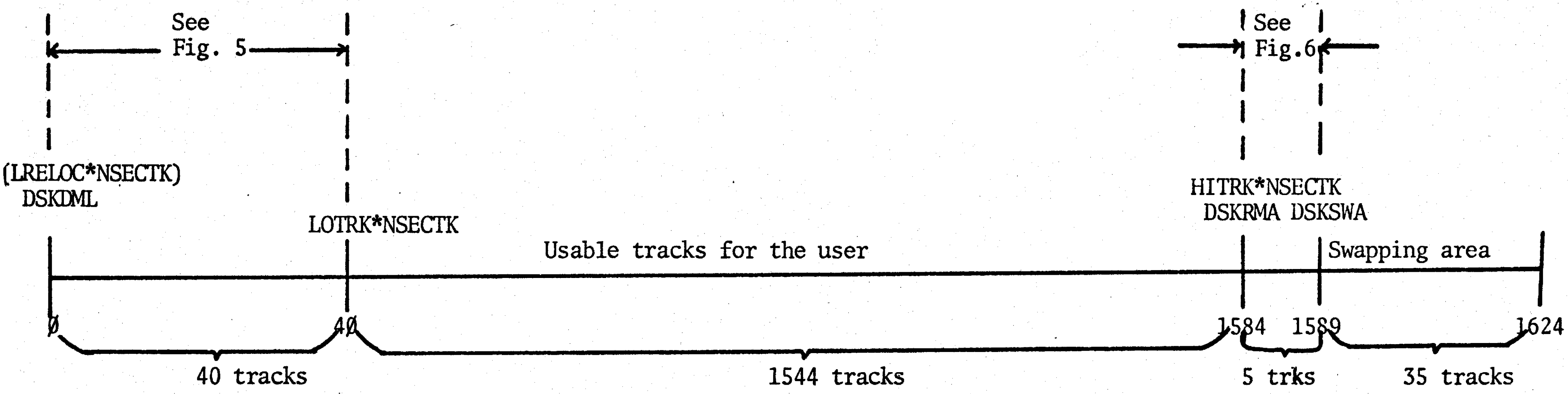


Figure 3: For KI Large System

LRELOC = Ø
HRELOC = total # of tracks of 114-Drive

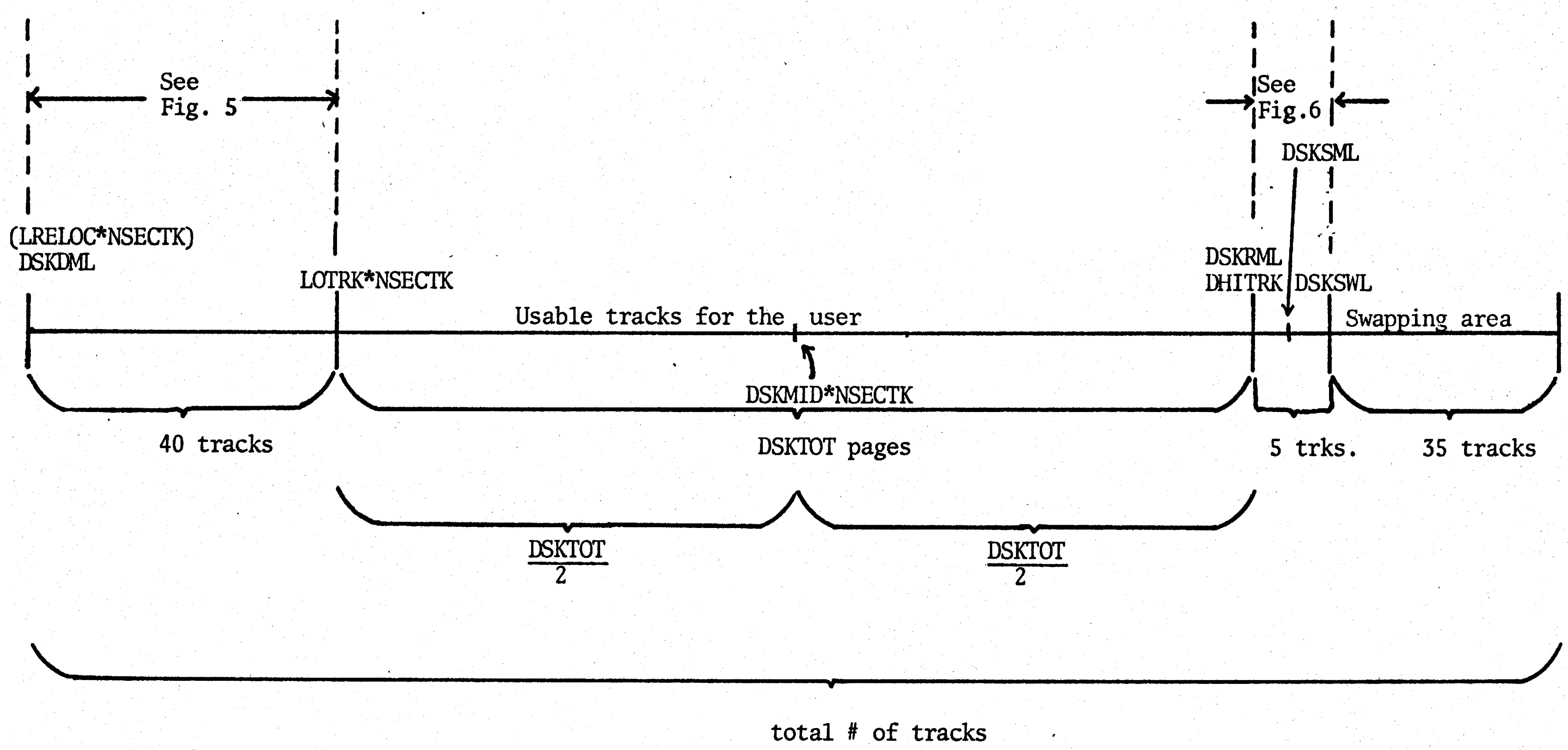


Figure 4: For Dynamic Reallocable Track Allocation

(DHITRK = total # of tracks + LRELOC - 5 - NUMTSW
NUMTSW is # of tracks for swapping)

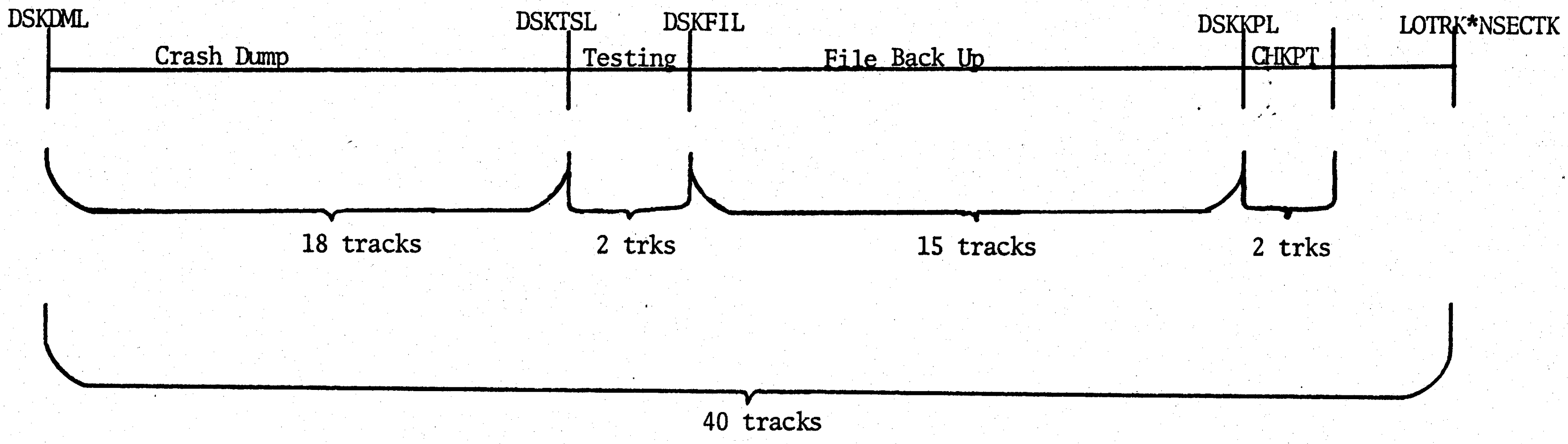


Figure 5:

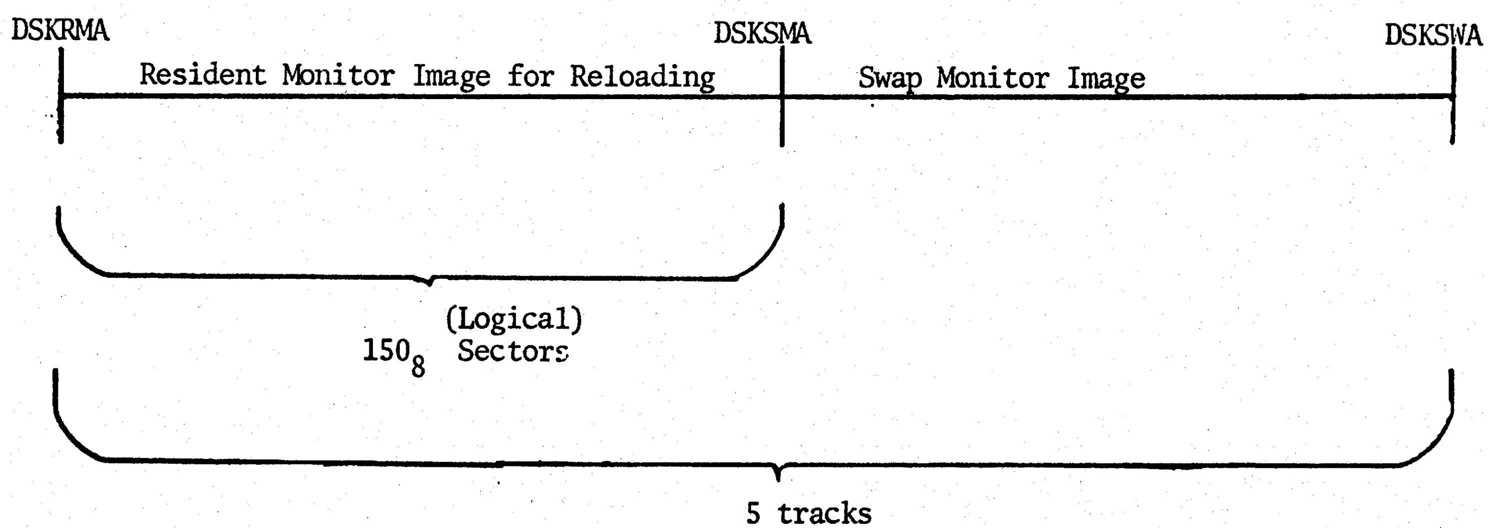
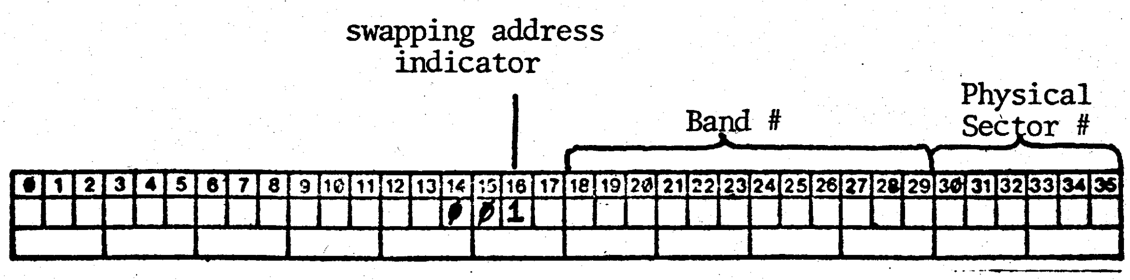


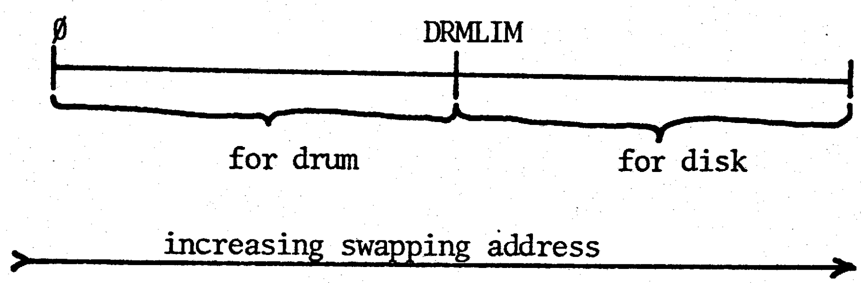
Figure 6:

Swapping Address

The swapping address has the format:



These addresses are linearly ordered:



If the swapping address is less than DRMLIM then the swapping is done to the drum. Otherwise it is done to the disk. We have a routine called DSKIS in DSK11 for converting the swapping address to disk linear address. The algorithm for the conversion is described below:

1) If the swapping address is greater than or equal to DRMLIM then form a new swapping address calculated as the difference of the given address minus DRMLIM.

2) Multiply the band # by # of sectors per band (DRMSEC = 20_8), and add the physical sector #.

3) The linear disk address is the sum of the result from 2) and the address of the beginning of the swapping area, DSKSWL.

Appendix: Converting Linear Address to Hardware Form Address, an example

For example, assume the linear address is 119313, the conversion is performed according to the steps described under the topic of address representation

1) The linear address is divided by number of sector/track:

$\frac{119313}{60} = 1988$ Track number — Remainder: 33 Logical Sector #

2) 1988 is greater than STK114 (=1624). Hence it is on a 114-Drive.

$\frac{1988 - 1624}{203} = 1$ — Remainder: 161 Track Number

Total # of 215-Drives

$1 + 4 = 5$

Internal drive #

3) Dividing the logical sector # by number of physical sector per surface (= 3):

$\frac{33}{3} = 11$ Surface Number — Remainder: Ø Physical sector #