
**Electronic imaging — Media error
monitoring and reporting techniques for
verification of stored data on optical digital
data disks**

*Imagerie électronique — Méthodes de surveillance et d'établissement de
compte rendu d'erreurs pour la vérification des données stockées sur des
disques optiques numériques*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12142 was prepared by Technical Committee ISO/TC 171, *Document imaging applications*, Subcommittee SC 1, *Quality*.

Annexes A to D of this International Standard are for information only.

Introduction

Data and records managers in many organizations are already using optical disk-based information systems for storing and retrieving large data sets and for storing valuable information. The optical disk drives that are part of these systems are designed with powerful, but not unlimited, error correction capabilities. If the level of errors in an optical digital data disk sector exceeds the error detection and correction mechanisms implemented in the optical disk drive controller, the sector cannot be corrected (data loss might occur). System managers would like to be able to use media error monitoring and reporting techniques to verify the information stored on optical digital data disks, both initially when the data is transferred to that media and periodically to monitor the status of their data. The Media Error Levels of correction taking place in the optical disk drive controller give an indication of the status of data saved on these optical digital data disks.

This International Standard documents two approaches of media error monitoring and reporting techniques to verify stored data on optical digital data disks:

- a high-level approach with functional commands;
- an implementation of a set of Small Computer System Interface-2 (SCSI-2) commands.

The high-level interface approach is independent of the host operating system (e.g. DOS, UNIX, OS/2, etc.) and the interface that communicates between the optical disk device and the host (e.g. SCSI-2, IPI, LAN, etc.). In addition, this high-level interface is media type and size independent. That is, it can be used with systems that use Write-Once-Read-Many (WORM), rewritable, or partially read-only media; and with optical disk drives for different media sizes from 90 mm to 356 mm media. Standard information about media errors allows end users and system integrators to retrieve the same information even if their configurations consist of drives of different types, sizes, and manufacturers. This information can be retrieved using the same software, which can be integrated into the media error information utilities or device drivers.

The SCSI interface can be used instead of the high-level interface by using the selected set of SCSI-2 commands. This selected set of SCSI-2 commands allows system manufacturers to develop drive type and size independent data verification tools at the SCSI level through the use of media error monitoring and reporting techniques. The use of a selected standard set of commands and approaches for media error monitoring and reporting allows any implementor to use a common set of software tools that do not change from drive to drive.

The media error information that can be obtained using the high-level or SCSI-2 tools includes:

- a list of reallocated sectors;
- corrections above some Media Error Levels;
- warning above some Verify Media Error Levels;
- the total number of bytes in error, the number of bytes in error per sector, and the maximum number of bytes in error in any sector codeword;
- the uncorrected or corrected sector content;
- errors encountered when reading header information, such as the sector address, sector marks, and synchronization signals;
- the maximum length of contiguous defective bytes.

By acquiring optical disk-based information systems that comply with this International Standard, system managers will be able to access media error information at both a functional (higher) level and an interface level for optical

disk drives that implement ISO/IEC 9316. These tools facilitate a better understanding of the status of information stored on optical digital data disks. The tools provide for design of more efficient media error monitoring and reporting techniques, and data verification and recopying policies for transferring recorded data to similar or different media in a timely and economic manner.

These media error monitoring and reporting techniques also allow system managers to obtain media error information either in quasi-real time or during off-line operations. These techniques provide data recovery and media error monitoring tools with different levels of sophistication. Information on media errors can be obtained, which will enable the highlighting of trends on particular selected disks or in their entire data sets. Decisions on frequency of use of these tools and the level of sophistication selected are not part of this International Standard.

Electronic imaging — Media error monitoring and reporting techniques for verification of stored data on optical digital data disks

1 Scope

This International Standard specifies two techniques for media error monitoring and reporting for the verification of data stored on optical digital data disks:

- high-level, which uses a set of functional commands;
- SCSI-2 level, which uses a set of SCSI-2 commands.

It specifies two media error monitoring and reporting levels:

- system level, which uses a set of functional commands that can be used by the operating system, application software, and remote users;
- optical disk device level, which uses a set of SCSI-2 commands that can be used by the device driver or a device application programme.

Compliance to the requirements of this International Standard is specified in clause 4.

This International Standard applies to both rewritable and read only optical disk media.

Part of the information in this International Standard may be useful for CD-ROM subsystems, but implementations for that technology are beyond the scope of this International Standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 9316:1995, *Information technology — Small Computer System Interface-2*

ISO 12651:1999, *Electronic imaging — Vocabulary*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO/IEC 9316, ISO 12651 and the following apply.

3.1

band

specified number of contiguous tracks

NOTE It is a useful notation for referencing disk regions and plotting physically descriptive media error results.

3.2

byte error rate

BER

total number of bytes in error in a given sample divided by the sample size

3.3

constant angular velocity

recording method in which the number of clock periods per revolution is constant, independent of radius

NOTE This method implies that the amount of data per track is independent of radial position.

3.4

continuous-servo media

media on which the servo information for tracking is continuously available on adjacent grooves

3.5

data field

user data, defect management pointers (DMP), cyclic redundancy check (CRC), and error correction code (ECC) bytes of a recorded sector

3.6

format

arrangement or layout of the data on the disk

3.7

initiator

SCSI device that requests an I/O process to be performed by another SCSI device (a target)

3.8

interleaving

process of allocating the physical sequence of units of data in order to render the data more immune to burst errors

3.9

native format

error correction code (ECC) data and control bytes, and stripping sync bytes

3.10

Reed-Solomon codes

error correction code particularly suited to the correction of errors that occur in bursts or are strongly correlated

3.11

sampled-servo media

media on which the servo information for focusing and tracking, along with clock information, is obtained by means of periodic sampling of information on the optical disk

3.12

target

SCSI device that performs an operation requested by the initiator

3.13

verification of data

verification of the integrity and status of data

4 Requirements

This International Standard specifies the following two levels of compliance:

- the BASIC level which uses a minimal set of functions and commands;
- the EXTENDED level which uses all of the functions and commands in the BASIC level plus a MEDIA ERROR LOG and user-set optical disk device programmable Media Error Levels and Verify Media Error Levels. The EXTENDED level also allows users to interrogate the optical disk system (using the functional commands) or the optical disk device (using a set of SCSI-2 commands) about the current setting of the optical disk device set Media Error Levels and set Verify Media Error Levels.

Statements of compliance to the requirements of this International Standard shall state the level of compliance used, BASIC or EXTENDED, at the system level interface and device level.

An optical disk-based information system is in accordance with this International Standard when it meets all the requirements specified in clause 7 (for BASIC or EXTENDED compliance).

An optical disk device that conforms to ISO/IEC 9316 is in accordance with this International Standard when it meets all the requirements specified in clause 8 (for BASIC or EXTENDED compliance).

Table 1 summarizes the BASIC and EXTENDED levels of compliance at the optical disk-based system level (system level). Table 2 summarizes the BASIC and EXTENDED levels of compliance at the optical disk device level (application of SCSI-2 commands for optical disk devices).

Table 1 — System level compliance

Functional level for optical disk-based subsystems: Function description	Level of compliance	
	BASIC	EXTENDED
Define media error recovery procedures (DMERP)	Yes	Yes
Read defect data list (RDDL)	Yes	Yes
Read media error data (RDMED)	Yes	Yes
Read log data (RLD) – Media error log and current Media Error Levels	No	Yes
Set Media Error Levels (SMEL)	No	Yes
Set Verify Media Error Levels (SVMEL)	No	Yes

Table 2 — Conformance at the optical disk device level

Application of SCSI-2 commands for optical disk devices	Level of compliance	
	BASIC	EXTENDED
The FORMAT UNIT command	Yes	Yes
The LOG SELECT command and the following pages:	No	Yes
— The media error log (MEL) page	No	Yes
— The clear MEL page	No	Yes
The LOG SENSE command and the following pages:	No	Yes
— The MEL page	No	Yes
— The clear MEL page	No	Yes
The MODE SELECT command and the following pages:	No	Yes
— The read-write error recovery page for optical disk devices	No	Yes
— The verify recovery page for optical disk devices	No	Yes
The MODE SENSE command and the following pages:	No	Yes
— The read-write error recovery page for optical disk devices	No	Yes
— The verify recovery page for optical disk devices	No	Yes
The READ DEFECT DATA command and the PDL, SDL, and WDL	Yes	Yes
The READ LONG command	Yes	Yes
The REQUEST SENSE command, the sense keys 01h or 03h, and the related ASC or ASCQs	Yes	Yes
The VERIFY command	Yes	Yes
The WRITE AND VERIFY command	Yes	Yes

5 Conventions

This International Standard follows the conventions given in 4.2 of ISO/IEC 9316:1995. For the purpose of identification, the parameters “Media Error Levels” and “Verify Media Error Levels” used in this International Standard are shown with first upper case letters. The following conventions from ISO/IEC 9316 are reproduced:

Numbers that are not immediately followed by lower-case b or h are decimal values.

Numbers immediately followed by lower-case b (xxb) are binary values.

Numbers immediately followed by lower case h (xxh) are hexadecimal values.

6 Capabilities of media error monitoring techniques

The high-level interface functions specified in clause 7 and the application of SCSI-2 commands specified in clause 8 provide two approaches for retrieving the following information about a disk:

- consumption of spare sectors (physical address of each sector reallocated and of spare sectors still available in the reallocation table, when a reallocation table exists, or a list of sector addresses of the replaced sector and its replacement);
- corrections that exceeded Media Error Levels;
- warning on Verify Media Error Levels;

- the total number of bytes in error, the number of bytes in error per sector, and the maximum number of bytes in error in any codeword;
- the uncorrected or corrected sector content;
- errors encountered when reading header information (bad IDs, sector missing marks, data syncs, and resync marks);
- maximum length of contiguous defective bytes.

Media Error Levels and Verify Media Error Levels can be set.

7 High-level techniques

7.1 Introduction

The purpose of this clause is to provide high-level (a set of functional commands) media error monitoring and reporting techniques for verifying stored data on optical digital data disks. By implementing this International Standard, the following are enabled:

- set Media Error Levels to reallocate sectors whenever one of the Media Error Levels is exceeded;
- obtain the value of the Media Error Levels;
- set Verify Media Error Levels to obtain early warning information on the status of the data when one of the Verify Media Error Levels is exceeded;
- obtain the values of the Verify Media Error Levels;
- obtain information about all the reallocated sectors and a defect list of initial media defects;
- retrieve a media error log with information about the media error activity detected by the drive;
- obtain the corrected sector content or the uncorrected sector content including user data bytes and error correction code (ECC) bytes.

The high-level interface approach is independent of the host operating system (e.g. DOS, UNIX, OS/2, etc.) and the interface between the optical disk device and the host (e.g. SCSI-2, IPI, LAN, etc.). In addition, this high-level interface is media type and size independent. That is, it can be used with systems that use WORM, rewritable or partially read-only media, and optical disk devices for different media sizes (e.g. 90 mm to 356 mm).

Standard formats for disk errors will allow the retrieval of the same information from configurations consisting of drives of different types, sizes, and manufacturers by using the same routines integrated into the media error information utilities or device drivers.

7.2 Functional commands

The following functional, or high-level (host), commands shall be used for verifying the data.

7.2.1 Generic command description

The following command syntax is used in this International Standard:

Command name [parameter 1] [parameter 2] [parameter 3] [parameter *n*]

At least one parameter shall be included with the command name. A parameter that can be set ON or OFF is indicated as:

[Parameter ON]

[OFF]

7.2.2 Define Media Error Recovery Procedures (DMERP)

The DMERP command shall be used to define to the optical disk device the following error recovery procedures:

- media error reporting;
- media error data transfer that shall be executed.

The default for an unspecified parameter shall be OFF.

DMERP [WR ON] [RE ON] [RRE ON]
 [OFF] [OFF] [OFF]

WR: Sector Reallocation on Write Error

- ON: Enables the device error recovery procedures to automatically reallocate a sector(s) to a spare sector area on the disk whenever the optical disk device encounters an error level that exceeds the set Media Error Levels during writing operations;
- OFF: Disables the optical disk device error recovery procedures from automatically reallocating a sector(s) whenever the optical disk drive encounters an error level that exceeds the set Media Error Levels during writing operations.

RE: Sector Reallocation on Read Error

- ON: Enables the optical disk device error recovery procedures to automatically reallocate a sector(s) to a spare sector area on the disk, whenever the optical disk device encounters an error level that exceeds the set Media Error Levels when reading a sector(s);
- OFF: Disables the device error recovery procedures from automatically reallocating a sector(s) whenever the optical disk device encounters an error level that exceeds the set Media Error Levels when reading a sector(s).

RRE: Report Recovered Errors

- ON: The optical disk device shall report recovered errors to the host computer;
- OFF: The optical disk device shall not report recovered errors to the host computer.

7.2.3 Read Defect Data List (RDDL)

The RDDL command shall be used to read the defect data list from the optical disk device. The defect data list is shown in Table 3.

Table 3 — Defect data list

Byte	Description
1	Number of entries in the list (MSB)
2	Number of entries in the list (LSB)
3	Defective sector track number (MSB)
4	Defective sector track number
5	Defective sector track number (LSB)
6	Defective sector number
$n - 3$	Defective sector track number (MSB)
$n - 2$	Defective sector track number
$n - 1$	Defective sector track number (LSB)
n	Defective sector number

RDDL [List Size]

List Size specifies, in hexadecimal, the number of bytes to be transferred. The defect list data shall be returned to the host in the format shown in Table 3. If List Size is set to zero, no data shall be transferred. Bytes shall be transferred in hexadecimal values.

7.2.4 Read Media Error Data (RDMED)

The RDMED command shall be used to request the optical disk device to transfer the content of a sector to the host computer. The data transferred to the host shall include the following:

- the user data bytes;
- the ECC bytes;
- the defect management pointers (DMP) bytes;
- any other bytes that are part of the sector data field and can be corrected by the ECC.

These bytes shall be sent to the host in the same order as they occur on the medium, according to any existing related medium International Standard (e.g. for ISO/IEC 10089, format A media, the type of bytes shall be Data, DMP, CRC, and ECC. See ISO/IEC 10089:1991, annex G). The bytes shall be expressed in hexadecimal values. The most recent data written to the addressed sector shall be read from the medium and returned.

RDMED [ADDR BXFER [CORR ON]]
 [[OFF]]

where

ADDR is the logical or physical address of the sector that shall be transferred expressed as track and sector number (expressed in hexadecimal values);

BXFER is the number of bytes that shall be read by the optical disk device and transferred to the host computer (expressed in hexadecimal values);

CORR is the data corrected by the ECC. The default shall be to turn ECC correction ON.

- ON: Causes data to be corrected by the ECC before being transferred to the host computer.
- OFF: Causes uncorrected data to be transferred to the host computer.

7.2.5 Read Log Data (RLD)

The RLD command shall be used to request that the optical disk device report log data to the host. Each parameter included with the command identifies a different log.

The logs shall be returned to the host in the order that the log parameters are passed to the optical disk device.

RLD	[MEL	[CLRMEL	ON]]	[CMELL]	[VCMELL]
			OFF		

MEL is the Media Error Log; it provides detailed information about different media error indicators. The data in the MEL shall be sent to the host in the sequence defined in clause 8 and Table 22. That is, number of read retries shall be sent first, followed by number of write retries, etc. Each parameter shall have a length of 6 bytes. This is the same parameter length specified for the same parameters in 8.12.3.2 and Table 21. The parameters shall be transferred as hexadecimal values.

CLRMEL specifies that the MEL shall be cleared when read. The default shall be OFF.

- ON: The MEL shall be cleared when it is read.
- OFF: The MEL shall not be cleared when it is read.

CMELL is the Current Media Error Levels Log; it reports the current set media error level values. These values shall be used by the optical disk device to reallocate a sector(s). Table 4 shows the four specified media error level parameters.

The media error level values shall be sent to the host in the sequence shown in Table 4. Each parameter shall have a length of 6 bytes. This is the same parameter length specified for the same parameters in 8.12.2.1 and Table 18. The parameters shall be transferred as hexadecimal values.

Table 4 — Media Error Levels

Maximum number of bytes in error per codeword per sector
Number of bytes in error per sector
Number of bad IDs
Number missing resync ^a
^a If the medium does not use resyncs, this level is N/A and the parameter shall be FFh.

If either the WR or the RE parameters from the DMERP command is ON, the optical disk device shall reallocate sector(s) that have an error recovery level exceeding one or more of the set Media Error Levels as specified in Table 4.

VCMELL is the Verify Current Media Error Levels Log; it reports the current set verify level values. These levels shall be used by the optical disk device to provide an early warning to the host computer that the correction level exceeded the value for the related set level as defined in Table 5.

The sector(s) that provoke the early warning can be found through the MEL. Table 5 shows the four specified verify media error level parameters. The data in the VCMELL shall be sent to the host in the sequence shown in Table 3. Each parameter shall have a length of 6 bytes. This is the same parameter length specified for the same parameters in 8.12.2.2 and Table 19. The parameters shall be transferred as hexadecimal values.

Table 5 — Verify Media Error Levels

Verify maximum number of bytes in error per codeword per sector
Verify number of bytes in error per sector
Verify number of bad IDs
Verify number missing resync ^a
^a If the medium does not use resyncs, this level is N/A and the parameter shall be FFh.

7.2.6 Set Media Error Levels (SMEL)

The SMEL command shall be used to set Media Error Levels that the optical disk device shall use for error recovery. The four Media Error Levels that can be set with this command are specified in Table 4. The Media Error Levels are the same as those that are reported by CMELL using the RLD command.

The Media Error Levels shall be used for reallocating sectors. If the ECC level of correction exceeds one or more of the set levels and the parameters WR or RE in the DMERP command are ON, the sector shall be reallocated to a spare sector. If the parameters WR or RE in the DMERP command are OFF, the optical disk device shall not reallocate the sector. In either case, the optical disk device shall report that a set level was exceeded, identify the level, and indicate whether the data were recovered or unrecovered.

SMEL [LBECW = n1] [LBES = n2] [LID = n3] [LMRS = n4]

where n1 to n4 are the level values (expressed in hexadecimal) specified below:

- LBECW: level for maximum number of bytes in error per codeword per sector;
- LBES: level for number of bytes in error per sector;
- LID: level for number of bad IDs;
- LMRS: level for missing resync.

7.2.7 Set Verify Media Error Levels (SVMEL)

The SVMEL command shall be used to set Verify Media Error Levels that the optical disk device shall use for error recovery. The four Verify Media Error Levels that can be set with this command are specified in Table 5. The Verify Media Error Levels are the same as those that are reported by VCMELL using the RLD command.

These levels shall be used for obtaining an early warning of media errors that exceeded any level set by this command. The optical disk device shall report that a set level was exceeded, identify the level, and indicate whether the data were recovered or unrecovered.

SVMEL [VLBECW = n1] [VLBES = n2] [VLID = n3] [VLMRS = n4]

where n1 to n4 are the level values (expressed in hexadecimal) specified below:

- VLBE CW: verify level for maximum number of bytes in error per codeword per sector;
- VLBE S: verify level for number of bytes in error per sector;
- VLID: verify level for number of bad IDs;
- VLMRS: verify level for missing resync.

8 SCSI-2 level techniques

8.1 Introduction

The purpose of this clause is to provide an application of a selected set of SCSI-2 commands.

Selected commands from the SCSI-2 command set can be used to tailor the retrieval of media error information according to system requirements. The application of a selected set of SCSI-2 commands from the SCSI-2 command set in this International Standard is related to media error information only and is to be used in conjunction with ISO/IEC 9316. Some of the SCSI-2 commands that are specified in ISO/IEC 9316 are included here. However, to use the SCSI-2 commands for applications other than media error monitoring and reporting refer to ISO/IEC 9316.

In 8.2 to 8.11, requirements for media error monitoring and reporting are described. These requirements define information about methods for implementing better media error monitoring and reporting approaches, and provide users with more information on how to satisfy the system requirements through the use of this International Standard. Requirements for media error monitoring and reporting described in each command implementation supersede the implementation requirements given in ISO/IEC 9316. Any command, option, or implementation not covered in this International Standard will remain as specified in ISO/IEC 9316. It is the responsibility of the user to request from the target any information provided by the commands as specified in this clause.

The FORMAT UNIT command shall be used to format the media. This command allows users, as an option, to certify the media and create a certification list, which is retrievable as part of the information available through the READ DEFECT DATA command (see 8.2 and 8.7).

The LOG SELECT command shall be used to clear the MEL page specified in this International Standard, which provides information about different media error indicators (see 8.3 and 8.12.3.3).

The LOG SENSE command shall be used to retrieve the MEL (see 8.4 and 8.12.3.3).

The read-write error recovery page for optical disk devices and the verify error recovery page for optical disk devices, as specified in this International Standard, shall be implemented by a device/subsystem manufacturer or implementor claiming EXTENDED compliance to this International Standard (see 8.12.2).

The MODE SELECT command and the read-write error recovery page for optical disk devices shall be used to set Media Error Levels different from the drive default values (see 8.5 and 8.12.2). When automatic reallocation is set, the set media error level values shall be used by the optical disk device to reallocate sectors that have exceeded the reallocation criteria defined in Table 4.

The MODE SELECT command and the verify error recovery page for optical disk devices shall be used to set new verify media error level values (see 8.5 and 8.12.2). The set verify media error level values shall be used by the optical disk device to warn users that the disk has exceeded one or more of the Verify Media Error Levels defined in Table 5.

The MODE SENSE command shall be used to retrieve from the device the Media Error Levels in the read-write error recovery page for optical disk devices and the Verify Media Error Levels in the verify error recovery page for optical disk devices, both specified in this International Standard (see 8.6 and 8.12.2).

The READ DEFECT DATA command shall be used to retrieve information about bad sectors and sectors that have been reallocated (see 8.7).

The READ LONG command shall be used to retrieve the corrected content of a sector or the uncorrected content of a sector including user data, ECC, and other sector bytes (see 8.8). This command can also be used to determine the length of media defects (see 8.8.2.2).

The REQUEST SENSE command shall be used to transfer sense data to the initiator (see 8.9).

The list of the selected set of SCSI-2 commands included in this International Standard is shown in Table 6.

Table 6 — Selected set of SCSI-2 commands

SCSI-2 Command	Rewritable media	WORM/ read-only
FORMAT UNIT	✓	—
LOG SELECT	✓	✓
LOG SENSE	✓	✓
MODE SELECT	✓	✓
MODE SENSE	✓	✓
READ DEFECT DATA	✓	✓
READ LONG	✓	✓
REQUEST SENSE	✓	✓
VERIFY	✓	✓
WRITE AND VERIFY	✓	✓

8.2 The FORMAT UNIT command

8.2.1 Introduction

In 9.2.1 of ISO/IEC 9316:1995, the use of the FORMAT UNIT command is documented. That information shall be considered part of this International Standard.

8.2.2 Requirements for media error monitoring and reporting

Before using the FORMAT UNIT command, disks shall be inspected, and reasonable precautions taken to ensure that the disk is clean and free of contamination. If the disk is not clean or free of contamination, it shall be cleaned using procedures recommended by the media vendor. Formatting a disk with an unclean surface forces sectors that could be used to be reallocated. The original manufacturer of the device or media might not certify the media. If the media is not certified, the disk should be formatted with certification ON before implementing media error monitoring and reporting techniques. Formatting with certification ON will create a defect list and baseline information useful for media error monitoring.

Table 7 provides the results of executing the READ DEFECT DATA command. The acronym PDL stands for primary defect list; SDL is the acronym for secondary defect list. PDL and SDL, as well as the Plist and Glist bits are defined in ISO/IEC 9316 under the READ DEFECT DATA command (see 9.2.8 of ISO/IEC 9316:1995).

Table 7 — Result of using the READ DEFECT DATA command

Plist bit	Glist bit	Result transmitted	Qualifier
ON	OFF	PDL	If it exists
OFF	ON	SDL	
ON	ON	PDL first followed by SDL ^a	
^a For WORM media and devices, a working defect list (WDL) might exist. See both 8.7 (which describes the READ DEFECT DATA Command) and Table 10, Defect descriptor 2 format (WDL).			

It is recommended that the READ DEFECT DATA command should be executed with the Glist and the Plist bits ON, immediately after certifying the media. When the SDL and the PDL exist on the media, they are part of the disk definition structure (DDS). This structure is defined in the media standards listed in the Bibliography.

In the case of alternative structures (such as other defect management pointers or sector maps) when using the READ DEFECT DATA command with the Glist bit ON, the data transferred to the initiator shall be the list of reallocated sectors and replaced sectors sent to the host computer in the format of a SDL (see 8.7 and Table 9).

It is recommended that MODE SELECT parameters be set before executing the FORMAT UNIT command. Otherwise, the values recorded on the media will be used, if available. If these values are not on the media, the default values of the optical disk device will be used (to set the MODE SELECT parameters, see the manufacturer's SCSI-2 programming manual for the appropriate optical disk device).

Defect descriptors shall be returned in either the block format or the physical format. The parameter shall be expressed in hexadecimal values. The bytes from index format in Tables 112 and 114 of ISO/IEC 9316:1995 do not apply to this International Standard.

For implementations of this International Standard, bytes 0 to 2 in Table 115 of ISO/IEC 9316:1995 shall contain the parameter "Track number of defect" (the track where the defect occurred) instead of "Cylinder number of defect" parameter specified in ISO/IEC 9316.

Parameters shall be expressed in hexadecimal values.

8.3 The LOG SELECT command

8.3.1 Introduction

In 8.2.6 of ISO/IEC 9316:1995, the use of the LOG SELECT command is documented. That information shall be considered part of this International Standard.

8.3.2 Requirements for media error monitoring and reporting

The LOG SELECT command shall be used to clear the MEL page (see 8.12.3 and 8.12.3.2). The MEL page provides information about different media error indicators. Three approaches are defined to clear the MEL page.

- The first alternative is to use the LOG SELECT command with the clear MEL page (see Table 23). When a target receives this page, it shall clear the MEL page. The page code for the clear MEL page shall be 3Ah for SCSI-2 compliant devices and 0Ah for SCSI-3 compliant devices as shown in Table 20.
- The second alternative is to use the LOG SELECT command with the parameter code reset (PCR) bit set to one and the parameter list length set to zero (see 8.2.6 of ISO/IEC 9316:1995). No page shall be sent to the target. All implemented parameters of the target are set to their default values.
- The third alternative is to use the LOG SELECT command with the page code (PC) set to 11b and the parameter list length set to zero (see 8.2.6 of ISO/IEC 9316:1995). No page shall be sent to the target. All the cumulative parameters are set to their default values.

8.4 The LOG SENSE command

8.4.1 Introduction

In 8.2.7 of ISO/IEC 9316:1995, the use of the LOG SENSE command is documented. That information shall be considered part of this International Standard.

8.4.2 Requirements for media error monitoring and reporting

The LOG SENSE command shall be used to retrieve the MEL page (see 8.12.3 and 8.12.3.2). The MEL page provides information about different media error indicators. The MEL page is retrieved through the use of a log page specified by the page code field.

The page code for the MEL page shall be 39h for SCSI-2 compliant devices and 09h for SCSI-3 compliant devices (see Table 20, 8.12.3.2 and Table 21).

8.5 The MODE SELECT command

8.5.1 Introduction

In 8.2.8 and 8.2.9 of ISO/IEC 9316:1995, the use of the MODE SELECT command is documented. That information shall be considered part of this International Standard.

8.5.2 Requirements for media error monitoring and reporting

Some applications are more critical than others and systems implemented in more critical applications might want to adjust the sector retirement or early warning thresholds according to their applications. For instance, an application might want highly reliable media error reporting. Other applications need recoverable data but cannot afford to perform frequent recopy operations because of the large size of the data sets and consequent high cost. For these applications, obtaining the maximum useful lifetime from their media may be important.

The target shall provide user-modifiable Media Error Levels to decide when to reallocate defective sectors, and Verify Media Error Levels to warn that the disk has exceeded a certain level of errors. The following media error conditions are specified:

- number of bytes in error per sector;
- maximum number of bytes in error per codeword per sector;
- number of bad IDs;
- number of missing resyncs.

The levels shall be set for the optical disk device through the read-write error recovery page for optical disk devices and the verify error recovery page for optical disk devices specified in this International Standard (see 8.12). These specified pages are extensions of the original read-write and verify recovery pages specified in ISO/IEC 9316 (see 9.3.3.6 and 9.3.3.8 of ISO/IEC 9316:1995).

The MODE SELECT command shall be used to set the new Media Error Levels through the read-write error recovery page for optical disk devices, and to set the new Verify Media Error Levels through the verify error recovery page for optical disk devices.

If a media error level is exceeded during reading or writing operations, the optical disk device shall return a CHECK CONDITION status with a sense key of 01h (RECOVERED ERROR) if the PER bit was set to ONE, or 03h (MEDIUM ERROR). Additional sense codes (ASCs) and additional sense code qualifiers (ASCQs) can be retrieved with the REQUEST SENSE command (see Tables 11, 12 and 13).

If a verify media error level is exceeded during a VERIFY command or the verify operation of a WRITE AND VERIFY command, the optical disk device shall return a CHECK CONDITION status with a sense key of 03h (MEDIUM ERROR). Additional sense codes (ASCs) and additional sense code qualifiers (ASCQs) can be retrieved with the REQUEST SENSE command (see Table 14).

8.6 The MODE SENSE command

8.6.1 Introduction

In 8.2.10 and 8.2.11 of ISO/IEC 9316:1995, the use of the MODE SENSE command is documented. That information shall be considered part of this International Standard.

8.6.2 Requirements for media error monitoring and reporting

The requirements for media error monitoring and reporting are specified in 8.5.2. The MODE SENSE command shall be used to retrieve the values of the current Media Error Levels defined in the read-write error recovery page for optical disk devices, and the values of the current Verify Media Error Levels specified in the verify error recovery page for optical disk devices.

8.7 The READ DEFECT DATA command

8.7.1 Introduction

In 9.2.8 of ISO/IEC 9316:1995, the use of the READ DEFECT DATA command is documented. That information shall be considered part of this International Standard.

8.7.2 Requirements for media error monitoring and reporting

See Table 7 for the result of using the READ DEFECT DATA command. A primary defect list (PDL) might or might not exist on the media. If the PDL exists, it shall be sent through the READ DEFECT DATA command using defect descriptor 0 (see Table 8 for reading the PDL.) The bytes of the defect descriptor 0 format (PDL) shall be expressed in hexadecimal values.

If a secondary defect list (SDL) exists on the media (empty or not), it shall be sent through the READ DEFECT DATA command using defect descriptor 1 for reading the Glist (see Table 9.) The bytes of the defect descriptor 1 format (SDL) shall be expressed in hexadecimal form.

Table 8 — Defect descriptor 0 format (PDL)

Byte	Description
0	(00h)
1	(01h) (Defect list identifier)
2	Number of entries MSB (each entry is 4 bytes long)
3	Number of entries LSB
4	Address of the first defective sector (track number MSB)
5	Address of the first defective sector (track number)
6	Address of the first defective sector (track number LSB)
7	Address of the first defective sector (sector number)
$4n-3$	Address of the n th defective sector (track number MSB)
$4n-2$	Address of the n th defective sector (track number)
$4n-1$	Address of the n th defective sector (track number LSB)
$4n$	Address of the n th defective sector (sector number)

Table 9 — Defect descriptor 1 format (SDL)

Byte	Description
0	(00h)
1	(02h) (Defect list identifier)
2	(00h)
3	(01h)
4	MSB of the list length specified in number of bytes from byte 6 to byte x-1
5	LSB of the list length
6	(02h) (SDL)
7	(01h)
8	MSB of the list length specified in number of bytes from byte 10 to byte x-1
9	LSB of the list length
10	Address of the first defective sector (track number MSB)
11	Address of the first defective sector (track number)
12	Address of the first defective sector (track number LSB)
13	Address of the first defective sector (sector number)
14	Address of the first replacement sector (track number MSB)
15	Address of the first replacement sector (track number)
16	Address of the first replacement sector (track number LSB)
17	Address of the first replacement sector (sector number)
x-8	Address of the last defective sector (track number MSB)
x-7	Address of the last defective sector (track number)
x-6	Address of the last defective sector (track number LSB)
x-5	Address of the last defective sector (sector number)
x-4	Address of the last replacement sector (track number MSB)
x-3	Address of the last replacement sector (track number)
x-2	Address of the last replacement sector (track number LSB)
x-1	Address of the last replacement sector (sector number)

For WORM media, a third list might exist — the working defect list (WDL). The WDL shall be sent through the READ DEFECT DATA command using defect descriptor 2 with the Glist bit ON (see Table 10.) The bytes of the defect descriptor 2 format (WDL) shall be expressed in hexadecimal values (See the WORM media interchange standards for the definition of the WDL.) Note that the WDL might not exist on the media, or if it exists, it might be empty. The format of defect descriptors 0 (PDL), 1 (SDL), and 2 (WDL) shall be as shown in Tables 8, 9, and 10.

For optical digital data disks that do not specify defect lists (such as PDL, SDL and WDL) but use spare areas and defect management pointers (DMP) only or other types of defect management, such as sector maps, the information on defective sectors shall be provided to the host computer as defined in Table 5.