English

FUJITSU Software

BS2000 OSD/BC V11.0

Files and Volumes Larger than 32 GB

User Guide

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Contents

1 Introduction

BS2000 OSD/BC supports files and volumes with a capacity of up to 4 terabytes. Files and volumes which exceed 32 GB are known as “large files” and “large volumes”, and together they are referred to as “large objects”.

On all BS2000 servers, large volumes can be configured on the external disk subsystems which are connected via FibreChannel.

Large files and large volumes are only supported in special pubsets, which must be assigned attributes for using these large objects. These pubsets are also called “large pubsets” and can be imported on all BS2000 versions which are currently released.

In certain data structures, including the catalog entry, the 3-byte fields that have been used for page addressing must be converted to 4-byte fields.
Converting 3-byte fields to 4-byte fields affects all components, products and applications that work directly or indirectly with these fields. The TPR interfaces have been modified accordingly, but not all of the TU user interfaces can compatibly support these large files.

1.1 Target groups

This manual is intended for programmers and systems support staff. It aims to facilitate migration to large files and large volumes.

In order to work with this manual, you need very good knowledge of DMS and the SDF command language (for systems support) or the Assembler programming language (for programmers).

1.2 Structure of the manual

The chapter “Large objects in BS2000” describes the fundamental theoretical aspects associated with the introduction of large objects (large volumes and large files). The changes that affect pubsets, volumes and files in BS2000 are outlined and general restrictions are mentioned. There is a classification for user programs which describes how the individual programs handle large files.

The chapter “Systems support” outlines the role of systems support in introducing and maintaining large objects.
Emphasis is placed on the additional tasks in the field of “Pubset Management”. But there are also various aspects of “Catalog and File Management” and “System Initialization and Parameter Service” that need to be addressed. One section outlines the changes in the command interfaces which result from the introduction of large objects.
In addition, adjustments to individual utilities that are important in the context of systems support and that have been affected by the extensions for large objects will be mentioned. The end of the chapter provides a summary of potential sources of errors and conflicts.

The chapter “Users and programmers” contains detailed descriptions of the extensions made to non-privileged command interfaces and Assembler macro interfaces to accomodate large files. In addition, there are notes on RFA and high-level programming languages that are affected by large objects. The end of the chapter provides a summary of potential sources of errors and conflicts.

The chapter “Notes on migration” contains notes on the introduction of large files. Necessary technical extensions are described in the previous chapters. Possible steps for migration and the considerations that should be included in planning will be outlined here.

Readme file

The functional changes to the current product version and revisions to this manual are described in the product-specific Readme file.

Readme files are available to you online in addition to the product manuals under the various products at *http://manuals.ts.fujitsu.com*. You will also find the Readme files on the Softbook DVD.

Information under BS2000

When a Readme file exists for a product version, you will find the following file on the BS2000 system:

```
SYSRME.<product>.<version>.<lang>
```

This file contains brief information on the Readme file in English or German (<lang>=E/D). You can view this information on screen using the `SHOW-FILE` command or an editor. The `/SHOW-INSTALLATION-PATH INSTALLATION-UNIT=<product>` command shows the user ID under which the product's files are stored.

Additional product information

Current information, version and hardware dependencies, and instructions for installing and using a product version are contained in the associated Release Notice. These Release Notices are available online at *http://manuals.ts.fujitsu.com*.

1.3 Notational conventions

References to other publications in the text are given in the form of abbreviated titles with a reference number in square brackets. The full title of each publication is given in the “Related publications” section as of page 79.

Commands mentioned in this manual are described in the “Commands” manual [10]. The macros mentioned are described in the following manuals: “Executive Macros” [11] and “DMS Macros” [3]. The metasyntax of the commands or macros can be found in the corresponding manuals.

This symbol indicates warnings that make the reader aware of possible data loss or serious conflicts.

2 Large objects in BS2000

In the following descriptions, large volumes and large files will be referred to as “large objects”.

The continual growth of disk storage capacity and of data that needs to be available online has been taken into account in BS2000 in the enlargement of previously available disk and file sizes of around 32 GB. The following maximum values apply:

– Capacity of a pubset or volume set: approx. 4 TB (2.147.483.647 PAM pages)

– Capacity of a volume: approx. 2 TB (1.073.741.824 PAM pages)

– File size: approx. 4 TB

This means that within the operating system, 4-byte block numbers and 4-byte counters must be used systematically for file sizes and disk sizes.

Block numbers and block counters become visible at different interfaces to the user in BS2000 OSD/BC. Although 4-byte fields have been used exclusively in all new versions of these interfaces, some old interface versions may still use 3-byte fields. This may lead to compatibility problems for files ≥ 32 GB (and in some rare cases also for volumes ≥ 32 GB).

The compatibility aspect has been taken into account in that new pubset types have been created as special containers for large objects. This has allowed the previous world of “small objects” to be separated off and facilitates the successive introduction of large volumes and large files.

Different conditions apply, however, when introducing large volumes and large files.

– The introduction of large volumes is designed to allow simple, low-cost expansion of capacity in the Data Center. This process is not visible to users or programs.

– Large files are necessary in order to facilitate further growth of applications, where the size of individual (and generally relatively few) files will exceed the former limit of 32 GB in the near future.
  In this context, it will be necessary in some cases to modify the programs affected, that, for instance, use old versions of particular interfaces or implicitly assume a maximum file size of 32 GB, in order to guarantee data integrity when the 32-GB limit is exceeded. Programs that are not designed to work with large files are not affected.

2.1 Pubsets

Standard pubsets cannot contain any large objects. Only LARGE_OBJECTS pubsets are able to accommodate large objects. Two types of these pubsets are available:

– LARGE_OBJECTS pubsets without large files:

  This pubset type allows large volumes, but limits the file size allowed to 32 GB. This means that the pubset may contain volumes ≥ 32 GB, but necessarily does not currently contain such volumes.

  The introduction of large volumes can only affect the PHP of the extent lists, a value which is of no interest to the application program and cannot under any circumstances be directly altered by it. Thus, this pubset type allows large volumes to be integrated into existing application programs with (almost) no problems. From the point of view of the user, these pubsets behave (almost) as conventional pubsets.

– LARGE_OBJECTS pubsets with large files:

  This pubset type allows large volumes and large files, but they do not necessarily exist.

  It allows large files to be separated from programs that use interfaces that are incompatible and supports the step-by-step introduction of large volumes and - at a second step - of large files.

Both new pubset types are only recognized as of OSD-BC V5.0 and can imported on all BS2000 versions which are currently released.

Large objects are supported by both SF and SM pubsets. To achieve this, two additional attributes exist:

LARGE_OBJECTS	Attribute for supporting volumes ≥ 32 GB
LARGE_FILES_ALLOWED	Attribute controls whether large files (files ≥ 32 GB) are also supported.

In the case of SM pubsets, the attributes LARGE_OBJECTS and LARGE_FILES_ALLOWED are also properties of the pubset, rather than of (individual) volume sets, since volume sets would otherwise be visible on different interfaces to the user and could cause incompatibilities.

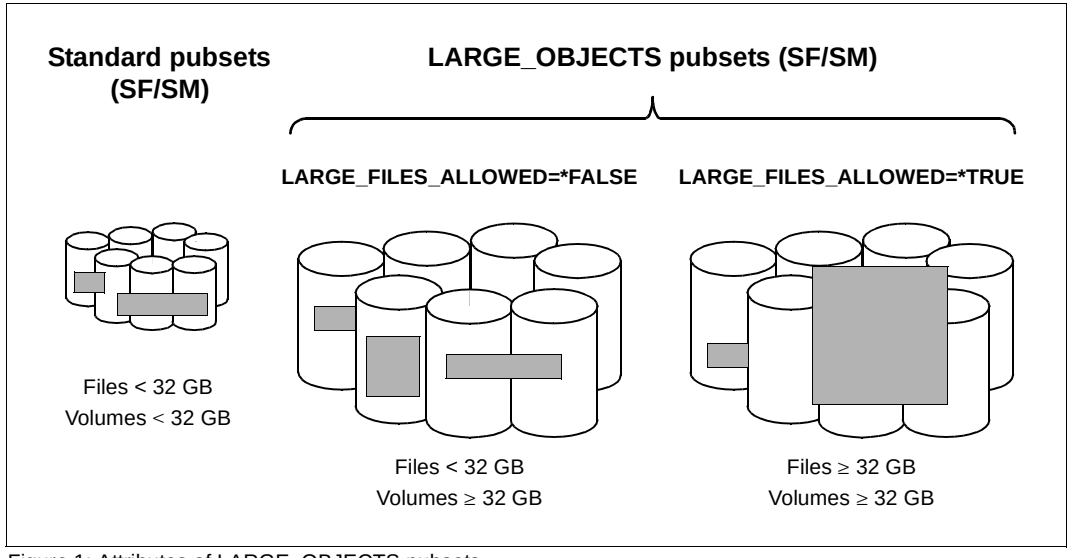
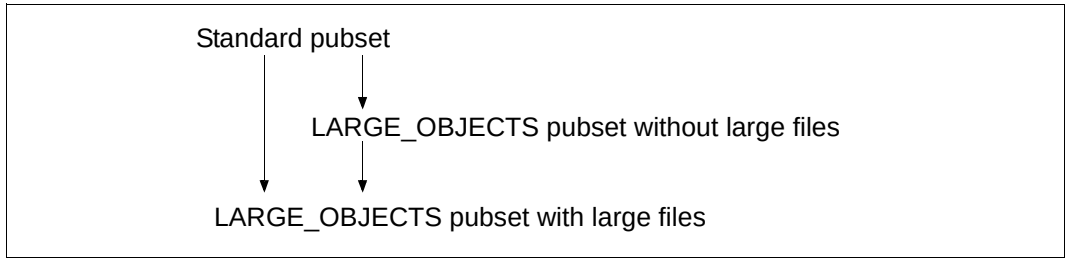


Figure 1: Attributes of LARGE_OBJECTS pubsets

Defining LARGE_OBJECTS pubsets

The properties LARGE_OBJECTS and LARGE_FILES_ALLOWED are static and can be specified when configuring the pubset with SIR (see page 25).

Using the SET-PUBSET-ATTRIBUTES command, existing standard pubsets can be upgraded to LARGE_OBJECTS pubsets with and without support for large files (see page 33). The following upgrades are possible in this context:



When the pubset is imported, the attributes are added to the MRSCAT.

Warning!

Conversion back to a standard pubset is not possible.

The existence of large files can in certain cases affect the executability of applications (see chapter “Users and programmers” as of page 39).

Summary of pubset management interfaces affected by 32 GB objects

Interface	Change
Privileged commands	
SET-PUBSET-ATTRIBUTES	Specification whether existing pubsets are to be upgraded to LARGE_OBJECTS pubsets with or without large files.
SET-PUBSET-ATTRIBUTES	Two S variables display the attributes LARGE-VOLUMES and LARGE-FILES: var(*LIST).LARGE-VOL and var(*LIST).LARGE-FILE
SHOW-MASTER-CATALOG-ENTRY	Output of LARGE_OBJECTS properties for LARGE_OBJECTS pubsets
Macros	
STAMCE	Output of MRSCAT entries related to LARGE_OBJECTS
Privileged utilities	
SIR	Installing and extending pubsets, initializing volumes in respect of LARGE_OBJECTS

Table 1: Summary of pubset management interfaces affected by 32-GB objects

2.2 Volumes

Like pubsets, large volumes have their own attribute: LARGE_VOLUME.

The LARGE_VOLUME attribute characterizes a logical volume and indicates that the volume has a gross capacity ≥ 32 GB.
The LARGE_VOLUME attribute is stored in the base record of the SVL when the volume is initialized with VOLIN.

Just as the LARGE_OBJECTS characteristic is for pubsets, the LARGE_VOLUME characteristic is permanent and is stored in the SVL.

Restrictions for large volumes

– Large volumes can only be added to LARGE_OBJECTS pubsets.

– VOLIN
VOLIN supports a maximum capacity of 2 TB for any formatting.

– Large volumes are not allowed as private disks. Any attempt to initialize a large volume as a private disk will be rejected with the following error message:

```
NVL0146   DISK CAPACITY GREATER EQUAL 32GB IS NOT PERMITTED FOR PRIVATE DISKS
```

Volume management interface affected by 32-GB objects

Interface	Change
Privileged utilities	
SIR	Installing and extending pubsets, initializing volumes in respect of LARGE_OBJECTS

Table 2: Summary of volume management interfaces affected by 32-GB objects

High-performance support of large volumes

If the load on the volume increases in accordance with the larger amount of data when large volumes are used, provisions should be made to ensure high-performance support:

– External disk storage subsystems which employ the RAID hard disk system can be employed to increase performance (and to enhance data security). When large volumes are used, RAID 5, RAID 6 or preferably RAID 1/0 is recommended. In this case the data of a logical volume is distributed over multiple physical disks (striping).

– In addition, use of the BS2000 function PAV (Parallel Access Volume) on /390 servers in order to parallelize the disk inputs/outputs. On x86 servers the corresponding function using RSC for disk I/Os is available by default.

Combining both measures results in considerable enhancements in TP and batch operation (in the case of multitask batch), in terms of both the I/O times and the throughput. Also refer to the “Performance Handbook” [12].

2.3 Files

The (theoretical) maximum file size is approx. 4 TB (2 147 483 647 PAM pages). This means that within the operating system, 4-byte block numbers and 4-byte counters must be used systematically for file sizes and disk sizes (see figure 2). (The term “block” in this context is synonymous with the terms “PAM page” and “half page”.)

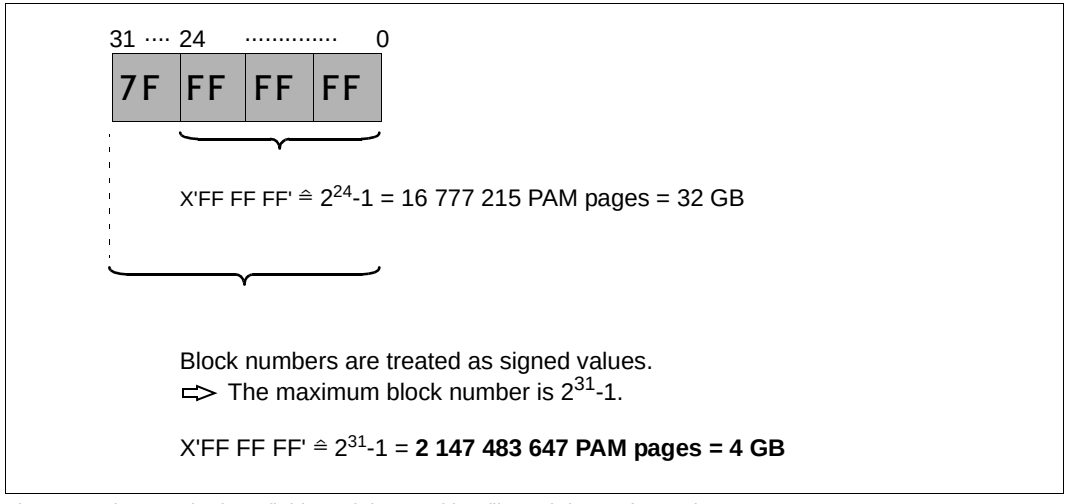


Figure 2: 3-byte and 4-byte fields and the resulting file and data volume sizes

Extending the catalog entry

The introduction of 4-byte fields for the following data stored in the catalog entry was a key aspect in the lifting of the 32-GB limit for volume and data sizes.

– FILE-SIZE, the storage space allocated for the file

– HIGHEST-USED-PAGE, the amount of storage that currently contains data

– LHP (logical halfpage number) and PHP (physical halfpage number) of the individual extents in the extent list, that allocate “physical” halfpages of volumes to the logical halfpages.

3-byte and 4-byte fields

Block numbers and block counters become visible at different interfaces to the user in BS2000. Although 4-byte fields have been used exclusively in all new versions of these interfaces, some old interface versions may still use 3-byte fields. If files ≥ 32 GB exist, you may experience compatibility problems, in a few cases also when “only” volumes ≥ 32 GB exist.

Additional format for the extent list

The introduction of 4-byte LHPs and 4-byte PHPs meant that an additional format had to be introduced for the extent list.

The correlation between the maximum size of volumes and files and the field width of LHP and PHP is depicted in figure 3:

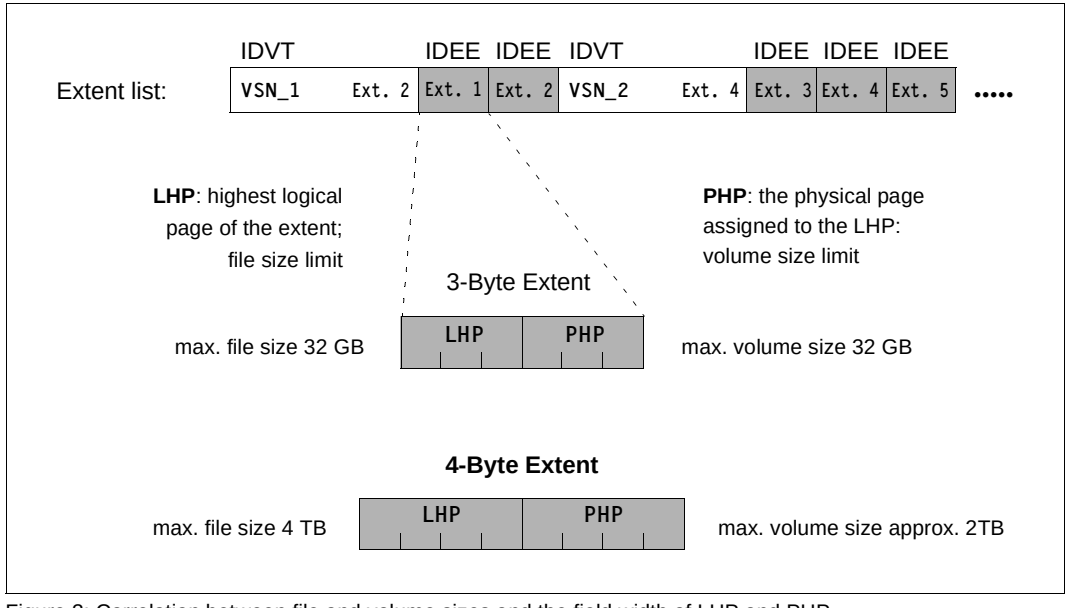


Figure 3: Correlation between file and volume sizes and the field width of LHP and PHP

Both formats of the extent list are supported:

– In general, the “old” format with 3-byte block numbers will be used.

– Only in the case of large files or of files that are wholly or partly located on large volumes, will the new format with 4-byte block numbers be used.

Extent lists therefore contain either extents with 3-byte block numbers or extents with 4-byte block numbers.

Restrictions for large files

– The paging file cannot be ≥ 2 TB.

– A SYSEAM file cannot be ≥ 32 GB.

– Files where BLKCTRL=PAMKEY are not supported, since the logical page number is stored as a 3-byte field in the system section of the PAMKEY.

Summary of file management interfaces affected by 32 GB objects

Interface	Change
Privileged commands	
SET-PUBSET-ATTRIBUTES	Specification whether existing pubsets are to be upgraded to LARGE_OBJECTS pubsets with or without large files.
SET-PUBSET-ATTRIBUTES	Two additional S variables display the attributes LARGE-VOLUMES and LARGE-FILES: var(*LIST).LARGE-VOL and var(*LIST).LARGE-FILE
SHOW-MASTER-CATALOG-ENTRY	Output of LARGE_OBJECTS properties for LARGE_OBJECTS pubsets
Non-privileged commands	
ADD-FILE-LINK	Additional operand for large files
SHOW-FILE-LINK	Output of the “File can become large” attribute
SHOW-FILE-ATTRIBUTES	The length of different output fields has been extended
Macros	
FCB	Additional operand for large files
FILE	Additional operand for large files
FSTAT	Effort involved in check and conversion if VERSION=0/1
OPEN	Address problems of semantics
RDTFT	Output of the “File can become large” attribute
DIV	Additional operand for large files; extended range of values for BLOCK and SPAN
FPAMACC	Extended range of values for BLOCK
FPAMSRV	Additional operand for large files
STAMCE	Output of MRSCAT entries related to LARGE_OBJECTS

Table 3: Summary of file management interfaces affected by 32 GB objects

2.4 POSIX file systems

The 32 gigabytes limit of the BS2000 has no significance in POSIX. But in the past only files smaller than 2 gigabytes once had been supported in POSIX. This was because the data within a file was addressed with a variable of the data type integer (signed). This could only address a maximum of 2^{31}–1 bytes, i.e. 2 gigabytes.

This limit caused problems with different applications, for instance, with print files with memory-intensive graphics. Consequently, more users called for the maximum file size to be increased. This was also supported by the standardization authorities and led to a new standard being defined for large files.

Standard for large files

The central point of this standard is that a “long long” variable is used to address data within a file. This data type consists of an integer pair, which enables an address to be 2^{63}–1 bytes long, including the sign.

This new class of files should of course be as compatible as possible with the existing ones, so that existing programs can also work with large files without any great difficulty. That is to say, it should be possible to process the large files where possible with the same interfaces as previous files, at least in terms of syntax and semantics.

2.4.1 Large POSIX file systems

The maximum size of a POSIX file is also limited by the size of the file system in which it is located, i.e by the size of the container file in BS2000.

Since internal addressing now uses a long long-type variable, a much greater range can be addressed. Consequently, container files and thus POSIX file systems as well can be a maximum of 1 terabyte.

The difference between the maximum size of BS2000 files and the maximum container size is determined by the nature of the implementation in POSIX.

The size of a container file and thus of a POSIX file system is defined when it is created with the administration tool POSINST (see the “POSIX Basics” manual [13]).

2.4.2 Large POSIX files

Large POSIX files are files of a POSIX file system which can be larger than 2 gigabytes. Large POSIX files can only be created in POSIX file systems which are based on a large container and can thus exceed the limit value of 2 gigabytes, see the previous section.

The maximum size of a POSIX file is limited by the size of the container file which contains it. You can also specify a maximum file size in POSIX, which applies to all files of the POSIX file system (command *ulimit* or parameter FILESIZE in the POSIX information file).

Program interfaces for large POSIX files

To work with POSIX files, there are a number of C-library functions, such as *open()*, *close()*, which are made available by CRTE. A subset of these functions is available in 64-bit form, so that they can process large POSIX files. These functions have the same name, with the additional suffix “64”, e.g. *open64()*. Some data structures and data types were also converted to 64-bit form.

For further information on the program interface, see the “POSIX Basics” manual [13].

Commands for large POSIX files

Most file processing commands of the POSIX shell can recognize and sometimes also process large POSIX files. They fall into two categories:

large file aware This command can process large POSIX files correctly. Some of the commands in this category can only process large files up to a certain file size, for instance *cpio* up to a maximum of 8 GB.

large file safe This command recognizes large POSIX files but rejects processing them, e.g. with an appropriate message.

For further information on the command interface, see the “POSIX Basics” manual [13].

2.5 User programs for configurations with large files

As has already been mentioned, it cannot be assumed that all programs have been prepared for accessing large objects, i.e. that they can address 4-byte block numbers and block counters, although it must be borne in mind that the interfaces available to user applications only relate to accessing and processing files and their metadata. The following description is therefore confined to large files. Large disks will not be handled here, since there are no user interfaces available, as has been mentioned. Program behavior can thus be classified as follows:

Class A: A program is able to process large files without restrictions. This behavior is defined as capable of LARGE_FILES (LARGE_FILES-capable).

Class B: A program has not been explicitly prepared for processing large files and/or their metadata. It is, however, able to reject corresponding access that it regards as illegal, or alternatively, it does not access files or their metadata. This behavior is defined as compatible with LARGE_FILES (LARGE_FILES-compatible).

Class C: A program has not been prepared for processing large files and cannot perform a defined rejection of corresponding access. This behavior is defined as incompatible with LARGE_FILES (LARGE_FILES-incompatible).

The corresponding classification for products of the software configuration of BS2000/OSD-BC V8.0 can be found from page 73.

For configurations that contain large files, programs that are compatible with or capable of LARGE_FILES must be presupposed. LARGE_FILES compatibility is to be regarded as the norm. Growth over 32 GB will initially be limited to a relatively small number of files. Only programs that access these must be capable of LARGE_FILES.

3 Systems support

This chapter outlines the role of systems support in introducing and maintaining large objects.

Emphasis is placed on the additional tasks in the field of “Pubset Management”.
But there are also various aspects of “Catalog and File Management” and the “Parameter Service” that need to be addressed.

One section outlines the changes in the commands interfaces which result from the introduction of large objects.

In addition, adjustments to individual utilities that are important in the context of systems support and that have been affected by the extensions for large objects will be mentioned.

The end of the chapter provides a summary of potential sources of errors and conflicts.

3.1 Pubset Management

Systems support staff are responsible for the installation, reconfiguration and maintenance of pubsets, including LARGE_OBJECTS pubsets. Tools in the SIR utility (see page 25f) and the pubset management commands (see page 33ff) are available for this purpose.

A pubset that can accept large objects is known as a LARGE_OBJECTS pubset. Both SF and SM pubsets can possess the LARGE_OBJECTS property. In the case of SM pubsets, LARGE_OBJECTS is a property of the entire pubset, rather than of one or more volume sets.

The maximum size of a LARGE_OBJECTS pubset is 2 147 483 647 PAM pages or 4 TB. This limit is a result of the former field width for counters in the user catalog and for internally maintained counters for disk storage management.

Warning!

The existence of large files can in certain cases affect the executability of applications (see the section “Executability of utilities in environments with large objects”, on page 36, and section “Notes regarding programs created in high-level programming languages” on page 66).

Before a pubset is assigned attributes that allow it to support large files, it should be ensured that the software is configured accordingly. Appropriate measures should therefore be taken in advance to clarify such issues and make any necessary adjustments.

3.1.1 Installing and extending LARGE_OBJECTS pubsets with SIR

Volumes and files ≥ 32 GB can be allowed for SF and SM pubsets. These pubsets are then referred to as LARGE_OBJECTS pubsets.

Indicating whether large objects are permitted in a pubset

In order to allow large volumes and/or files, the SIR statement DECLARE-PUBSET provides two suboperands for creating and extending pubsets.

```
//DECLARE-PUBSET PUBSET-TYPE=...(...,ACTION=...(...,
                 LARGE-DISKS-ALLOWED=*NO/*YES(LARGE-FILES-ALLOWED=*NO/*YES)))
```

The LARGE-DISKS-ALLOWED=*NO/*YES operand determines whether or not volumes with a capacity ≥ 32 GB are allowed in a volume set of the pubset. The property “large volumes” does not depend on whether large files should be allowed or not.

The LARGE-FILES-ALLOWED=*NO/*YES operand determines whether or not files in the pubset may be ≥ 32 GB in size. Large files may only be stored in pubsets that support large volumes (LARGE-DISKS-ALLOWED=*YES).

If no explicit permission for large volumes and large files is entered in this operand, SIR creates a pubset that does not allow any large volumes/files (*NO is the default value), and thus generates a pubset format that is also compatible with earlier versions.

Warning!

Permission for large volumes and files cannot be removed from a pubset.

Changes to the LARGE_OBJECTS attributes only take effect the next time the pubset is initialized (using the IMPORT-PUBSET command).

Removing inconsistencies

If a large volume is specified when a pubset is created (ACTION=*INSTALL), but LARGE-DISKS-ALLOWED=*YES was not specified, the volume is rejected with the message SIR0308.

```
SIR0308   DISK FOR VSN '(&00)' EXCEEDS CAPACITY OF 32 GB; DISK REJECTED
```

If this large volume is to be included in this pubset, the LARGE-DISKS-ALLOWED=*YES operand must be specified afterwards.

If a large volume is specified when a pubset is extended (ACTION=*EXTEND), but LARGE-DISKS-ALLOWED=*YES was not specified, the volume is rejected with the message SIR0308 (see above).

If this large volume is to be included in this pubset, the pubset property must be changed with the SET-PUBSET-ATTRIBUTES ...,LARGE-VOLUMES=*ALLOWED command before SIR can add the volume.

3.1.2 Upgrading and extending existing pubsets

Indicating whether large objects are permitted in a pubset

Existing pubsets can be upgraded to large pubsets with and without large files using the SET-PUBSET-ATTRIBUTES command (see page 33).

Changes to the LARGE_OBJECTS attributes only take effect the next time the pubset is initialized (using the IMPORT-PUBSET command).

Adding large volumes to a pubset

Individual volumes can be added to an SF pubset or to a volume set in an SM pubset using the MODIFY-PUBSET-PROCESSING command; new volume sets can be added to an SM pubset in the same way.

If the volumes to be added are large volumes or if the (empty) volume sets that are to be added contain large volumes, the pubset being extended must be a LARGE_OBJECTS pubset. If this is not the case, the attempt to extend the pubset will be rejected with message `DMS1383` (with insert `'06'`):

```
DMS1383   VOLUME INCONSISTENT. ERROR TYPE '(&00)'. COMMAND REJECTED

          '06': A volume is larger than 32 GB, but the pubset doesn't have
                the attribute for large volumes.
```

The addition of a large volume in the context of IMPORT processing will only be successful if the pubset to be extended is a LARGE_OBJECTS pubset. If this is not the case, the attempt to extend the pubset will be aborted with message `DMS037E` (with insert `&00='04'`):

```
DMS037E   FORMAT OF VOLUME '(&02)' INCONSISTENT WITH PUBSET/VOLUMESET
          '(&00)'. IMPORT PUBSET TASK ABORTED WITH ERRORCODE '(&01)'

          '04': a volume is larger than 32 GB, but the pubset doesn't have
                the attribute for large volumes.
```

3.1.3 Generating SM pubsets with SMPGEN

The SMPGEN utility allows an SM pubset to be generated from several SF pubsets. If the SF pubsets include LARGE_OBJECTS pubsets, the resulting SM pubset will also be a LARGE_OBJECTS pubset.

If at least one of the SF pubsets that are being combined has the property LARGE_FILES_ALLOWED, then a LARGE_OBJECTS pubset with the property LARGE_FILES_ALLOWED is created.

3.1.4 Recovering SM pubsets with large objects

If an SM pubset is recovered that has a corrupt control volume set, the information determining whether the pubset is a LARGE_OBJECTS pubset must also be recovered.

The LARGE_OBJECTS attributes, therefore, are not only stored in the SVL of the VOLRES of the control volume set, but also in the SVLs of the other volume sets in the SM pubset.

The “Exclusive import of a pubset with pubset conversion” function is offered for recovery purposes.

This uses a special IMCAT to create an SF pubset from a volume set in order to enable access to data stored on a volume set, regardless of the validity of the control volume set. When it is converted, the SF pubset inherits the LARGE_OBJECTS properties of the SM pubset.
When the SF pubsets taken from the volume sets are combined to form an SM pubset using SMPGEN, the LARGE_OBJECTS properties are transferred, as described in the section “Generating SM pubsets with SMPGEN” on page 27.

3.1.5 LARGE_OBJECTS pubsets in clusters

LARGE_OBJECTS can also be operated as shared pubsets.

3.2 Catalog and file management

A new version of the catalog entry had been introduced to support large objects. In some cases, the extensions have been introduced in a source-incompatible form in order to ensure that components produced newly take into account the changes for “large objects”. Since the extension of the catalog entry and the corresponding access function for programming system exits may be of interest, a short summary of the changes is given below.

3.2.1 Consideration of large objects in the catalog entry (CE)

The following applies:

– The version identifier must be X'FF03' or higher.

– The indicator (bit) for identifying catalog entries with large objects (large extent list) identifies whether the format used is 3-byte or 4-byte.

– The description of the extent list for large objects uses 4-byte format; an extent list that does not belong to large objects remains in 3-byte format, under another name.
An additional substructure exists for the extent list (DCAEE4 or DCAEE4I), where the fields for the LHP and the PHP are each 4 bytes in length. The old substructure for the old extent list form (IDEE or DCMIDEET) with 3-byte fields has been retained.

– An additional 4-byte field exists for the file size in the main part of the catalog entry, although the old 3-byte field has been retained (under another name) in the old part.

– The maximum size for extent lists has been extended to 2496 bytes.
For large files, the maximum size for extent lists has been extended to 2496 bytes.
A large file, like a small file, can thus contain a maximum of 310 extents.

– An additional 4-byte field exists for the last halfpage pointer in the main part of the catalog entry, although the old 3-byte field has been retained (under another name) in the old part.

3.2.2 Assigning a 4-byte extent list to a file

There are various versions of the structure of the catalog entry within the LARGE_OBJECTS pubsets and in particular the extent list (3-byte and 4-byte variants). The user has no direct influence over which variant is assigned to a file. This happens implicitly via DMS, where a file is assigned a 4-byte extent list if:

– the size of the file exceeds the 32-GB limit, or

– the file is assigned an extent that is located on a volume with capacity ≥ 32 GB by the allocator.

4-byte extent lists are not converted back, even when the file becomes smaller than 32 GB or no longer has an extent on a large volume.

3.2.3 Creating SYSEAM files

The size of SYSEAM files must always be less than 32 GB.

The size of SYSEAM files is determined by specifications in the MRSCAT entry.
It is defined with the ADD-MASTER-CATALOG-ENTRY EAM=*PAR(...) command when the MRSCAT entry is created, and can be changed for an existing entry with the MODIFY-MASTER-CATALOG-ENTRY EAM=*PAR(...) command.

If no EAM specifications exist in an MRSCAT entry, the corresponding system parameters apply. Thus the maximum size specification possible (64512 units) guarantees that a SYSEAM file always remains smaller than 32 GB.
Furthermore, if a primary or secondary allocation is necessary, the appropriate parameterization within EAM ensures that a SYSEAM file cannot become larger than 32 GB.

The only way that a SYSEAM file can exceed the 32-GB limit is if it is explicitly created by systems support using FILE or CREATE-FILE and the corresponding file size.

The first EAM access to this file will however be rejected, and the message `DMS0854` will be output to the console.

```
DMS0854   FILE SIZE OF SYSEAM FILE (&00) MAY NOT EXCEED 32 GIGABYTES
```

The action associated with this message is to delete the corresponding SYSEAM file and to have systems support create the file again with a file size that is not critical.

3.2.4 Creating catalogs

A of BS2000/OSD V11.0, the catalog is always created in EXTRA-LARGE format. By this, the catalog is enlarged and therefore the capacity relating to the number of file or JV entries is increased considerably.

File catalogs of pubsets from lower OSD versions with format NORMAL or LARGE are converted automatically to the EXTRA-LARGFE format when importing them via IMPORT-PUBSET.

Catalogs are created generally in EXTRA-LARGE format when SIR with V20.0 or higher is used.

The current catalog format can be queried using the SHOW-PUBSET-CATALOG-ALLOCATION command.

3.3 Parameter service

3.3.1 System parameter FST32GB

(Customer) applications that do not access the critical data fields FILE-SIZE and HIGHEST-USED-PAGE could also be affected by the changes introduced for the support of large files. The system parameter FST32GB is offered to aid migration.

FST32GB only affects the following FSTAT interfaces:

– Version=0 (corresponds to Version=710) when a fully-qualified filename is specified (although not when a file generation group is specified with GEN=YES)

– Version=1 (corresponds to Version=800), where the FNAM operand was not specified

For more information regarding FSTAT, see page 49ff.

FST32GB = 0 (default setting)

If at least one of the files in the set selected by FSTAT is ≥ 32 GB, the FSTAT call is rejected with the return code `X'00000576'`.

FST32GB = 1 (ignore overflow)

If at least one of the files in the set selected by FSTAT is ≥ 32 GB, an overflow of the 3-byte fields of the PHP in the extent list is always tolerated and no error message is issued. In the event of an overflow, the value X'FFFFFF' is assigned to the data fields that cannot be displayed.

Note

The system parameter FST32GB is not evaluated if the indicator LARGE_PUBSET_ACCESS=YES is set in the FSTAT program interface (see page 52).

3.4 Affected commands

This section describes the command interface which are affected by large objects.

Command/operand	Explanation
Privileged commands	
SET-PUBSET-ATTRIBUTES LARGE-VOLUMES= *UNCHANGED/*ALLOWED(LARGE-FILES= *UNCHANGED/*ALLOWED)	Determines whether existing pubsets are to be upgraded to LARGE_OBJECTS pubsets with or without large files.
SET-PUBSET-ATTRIBUTES	The two S variables var(*LIST).LARGE-VOL and var(*LIST).LARGE-FILE show the contents of the attributes LARGE-VOLUMES and LARGE-FILES.
MODIFY-USER-PUBSET-ATTRIBUTES TOTAL-SPACE=*UNLIMITED	Operand value which permits the user's storage space quota for permanent storage space, for temporary storage space or for work files to exceed 4 TB (see PERM-, TEMP- or WORK-SPACE-LIMITS=*PARAMETERS(...)).
SHOW-PUBSET-CATALOG-ALLOCATION	Command which displays information about the catalog format, allocation and extendability of the catalogs.
Non-privileged commands	
ADD-FILE-LINK EXCEED-32GB=*BY-PROGRAM/ *FORBIDDEN/*ALLOWED	Determines whether the file size may exceed 32 GB.
SHOW-FILE-LINK	The S variable var(*LIST).EXC-32GB shows the contents of the EXCEED-32GB attribute.
SHOW-FILE-ATTRIBUTES	If the total number of reserved PAM pages exceeds 32 GB, the information is displayed in units of one thousand PAM pages. Two additional S variables contain the number in units of one thousand PAM pages if the original S variable has reached the 2147483647 PAM pages: var(*LIST).MIGRATE-S1-RESERVED-T and var(*LIST).PUBSET-RESERVED-T.
SHOW-MASTER-CATALOG-ENTRY	The LARGE_OBJECTS properties are output for LARGE_OBJECTS pubsets.

Table 4: Commands - Summary

3.4.1 SET-PUBSET-ATTRIBUTES / SHOW-PUBSET-ATTRIBUTES

Indicating whether large objects are permitted in a pubset

Existing pubsets can be upgraded to large pubsets with the SET-PUBSET-ATTRIBUTES command.

The following two operands determine whether large objects are permissible:

```
/SET-PUBSET-ATTRIBUTES ...,LARGE-VOLUMES=*UNCHANGED/*ALLOWED(
                           LARGE-FILES=*UNCHANGED/*ALLOWED)
```

The LARGE-VOLUMES operand determines whether the pubset may contain large volumes. The default setting *UNCHANGED specifies that the previous setting is retained. If *ALLOWED is specified, the pubset may contain large volumes. This setting cannot be undone.

The LARGE-FILES operand determines whether large files may also be created on these large volumes.
The default setting *UNCHANGED specifies the previous setting is retained.
If *ALLOWED is specified, large files may be stored. This setting cannot be undone.

Changes to the LARGE_OBJECTS attributes only take effect the next time the pubset is initialized (using the IMPORT-PUBSET command).

Outputting pubset attributes

Pubset attributes are output with the SHOW-PUBSET-ATTRIBUTES command.

Example of the output of /SHOW-PUBSET-ATTRIBUTES for the TST pubset

```
/sh-pub-attr tst
%
%=============================================================================
% PVSID   SYSID   SHAREABILITY   CURRENT   DESIGNATED   BACKUP    ALTERNATE
%                               MASTER      MASTER     MASTER      BACKUP
%-----------------------------------------------------------------------------
%  TST     250       *YES        126         126        124       *BY-OPER
%=============================================================================
% DEFAULT-STORAGE-TYPE   LARGE VOLUMES   LARGE FILES   SNAPSET LIMIT
%-----------------------------------------------------------------------------
% *PUBLIC-SPACE          *ALLOWED        *FORBIDDEN          0
%=============================================================================
%
```

In the S variable output of the SHOW-PUBSET-ATTRIBUTES command, these specifications are shown in the following two S variables:

- `var(*LIST).LARGE-VOL`
- `var(*LIST).LARGE-FILE`

Contents of both S variables: *NOT-ALLOW or *ALLOW.

Example of the output to the TESTOUT S variable

```
/decl-var testout(type=*struct),mult-elem=*list
/exec-cmd cmd=(show-pub-attr work),text-output=*no,struct-output=testout
/sh-var testout
TESTOUT(*LIST).PUBSET = WORK
TESTOUT(*LIST).PUBSET-TYPE = *STANDARD
TESTOUT(*LIST).CONTROL-VOLSET =
TESTOUT(*LIST).SYS-ID = 250
TESTOUT(*LIST).SHARE = *YES
TESTOUT(*LIST).LARGE-VOL = *ALLOW
TESTOUT(*LIST).LARGE-FILE = *ALLOW
TESTOUT(*LIST).CURR-MASTER = *NONE
TESTOUT(*LIST).DESIGNATED-MASTER = *NONE
TESTOUT(*LIST).BACKUP-MASTER = *NONE
TESTOUT(*LIST).ALT-BACKUP = *NONE
```

3.4.2 MODIFY-USER-PUBSET-ATTRIBUTES

As the maximum size of a volume set is 4 TB, the maximum total size of an SM pubset can be 255 * 4 TB, in other words a little over 1,000 TB. A user can occupy more than 4 TB of storage space on an SM pubset. The MODIFY-USER-PUBSET-ATTRIBUTES command permits storage space quotas > 4 TB:

```
/MODIFY-USER-PUBSET-ATTRIBUTES ...,
             PERM-SPACE-LIMIT=*PAR(TOTAL-SPACE=*UNLIMITED,...),
             TEMP-SPACE-LIMIT=*PAR(TOTAL-SPACE=*UNLIMITED,...),
             WORK-SPACE-LIMIT=*PAR(TOTAL-SPACE=*UNLIMITED,...),
```

Specifying TOTAL-SPACE=*UNLIMITED determines that the specified storage space quota may exceed the limit of 4 TB. This operand can be specified separately for the permanent storage space (PERM-SPACE-LIMIT operand), for the temporary storage space (TEMP-SPACE-LIMIT operand) or for the storage space for work files (WORK-SPACE-LIMIT operand).

Information on allocated storage space quotas is displayed by the SHOW-USER-ATTRIBUTES command with INFORMATION=*PUBSET-ATTRIBUTES or *PUBSET-SUMMARY:

– The output fields PERM-SPACE-LIMIT, TEMP-SPACE-LIMIT and WORK-SPACE-LIMIT contain *UNLIMITED if the relevant quota may exceed the limit of 4 TB.

– The S variables var(*LIST).PERM-TSL, var(*LIST).TEMP-TSL and var(*LIST).WORK-TSL show this specification with the *UNLIM value.

3.4.3 Non-privileged commands

The changes to the following non-privileged commands are described in Chapter 4 “Users and programmers” as of page 39.

ADD-FILE-LINK	Description on page 41
SHOW-FILE-ATTRIBUTES	Description on page 42
SHOW-FILE-LINK	Description on page 41
SHOW-MASTER-CATALOG-ENTRY	Description on page 41

3.5 Executability of utilities in environments with large objects

This section will refer to a few utilities that are important in the area of systems support. Once again, only the modifications for large files and volumes will be described.

A full description can be found in the following manuals: “HSMS” [8], “FDDRL” [6], “SPACEOPT” [14], “IMON” [9] and - for all the other utilities - the “Utilities” manual [2].

With regard to SIR, see page 25 and with regard to SMPGEN, see page 27.

3.5.1 HSMS / ARCHIVE

HSMS/ARCHIVE is supporting the back up and the restore of files > 32GB.

When using RESTORE with a backup set that also contains large files, the large files can only be restored only on LARGE_OBJECTS pubsets with LARGE-FILES-ALLOWED.
In all other cases - i.e. when attempting to restore to pubsets with other properties - HSMS and ARCHIVE skip all large files and output an `ARC0061` message for each file.

```
ARC0061   FILE GREATER THAN 32GB. FILE NOT PROCESSED
```

Save files on the S1 level

S1 save files are possible on large disks and/or as large files for saving and migration.

Incremental saves and partial saves

When performing incremental saves and partial saves, the situation can occur that older file versions in the backup set are small files, whereas newer versions are large files. If a backup set of this kind is restored in an environment where large files are not permitted, large files are rejected by ARCHIVE with the message `ARC0061` (see page 36).

RESTORE with K → NK conversion

When files with BLKCTRL=PAMKEY are restored to an environment with NK disks, they are automatically converted to a suitable NK format (DATA or NO) by the PAMINT subsystem. In the context of this conversion, the size of the converted file can exceed 32 GB. PAMINT supports large files. Thus a conversion can also be performed in this case, provided that a LARGE_OBJECTS pubset with LARGE-FILES-ALLOWED is specified.

3.5.2 VOLIN

It should be noted that large volumes can only be components of a LARGE_OBJECTS pubset.

Large volumes are not permitted as private disks. Any attempt to initialize a large volume as a private disk will be rejected with the message NVL0146 :

```
NVL0146   DISK CAPACITY GREATER EQUAL 32GB IS NOT PERMITTED FOR PRIVATE DISKS
```

3.5.3 SPCCNTRL

SPCCNTRL can display information about large files and volumes.

Exception

If, in the DISPLAY CATALOG,ENTRY statement, ENTRY refers to a file ≥ 32 GB, and if the user is not the system administrator (TSOS), the information cannot be returned. The request is rejected with the message SPC0030:

```
SPC0030   ERROR EXECUTING (&00)-MACRO, RETURN CODE = (&01)
```

3.6 Potential sources of errors and conflicts

3.6.1 Restrictions for system files

SYSEAM files

The size of SYSEAM files must always be less than 32 GB.

The only way that a SYSEAM file can exceed the 32-GB limit is if it is explicitly created by systems support using the FILE macro or the CREATE-FILE command and the corresponding file size.
The first EAM access to this file is, however, rejected. The file must be deleted by systems support and newly created with the permitted size (see also page 29).

Paging files

The paging file cannot be ≥ 32 GB.

3.6.2 Restrictions for large volumes

Large volumes can only be added to LARGE_OBJECTS pubsets.

Large volumes are not allowed as private disks. Any attempt to initialize a large volume as a private disk will be rejected with the following error message:

```
NVL0146   DISK CAPACITY GREATER EQUAL 32GB IS NOT PERMITTED FOR PRIVATE DISKS
```

4 Users and programmers

This chapter contains detailed descriptions of the extensions made to non-privileged command interfaces and Assembler macro interfaces in relation to large files.

This is followed by notes on RFA and high-level programming languages that are affected by large objects.

The end of the chapter summarizes potential sources of errors and conflicts.

4.1 User commands

This section describes the command interface which are affected by large objects.

Summary

Command/operand	Explanation
ADD-FILE-LINK EXCEED-32GB=*BY-PROGRAM/ *FORBIDDEN/*ALLOWED	This operand determines whether the file size may exceed 32 GB
SHOW-FILE-LINK	The S variable var(*LIST).EXC-32GB; displays the contents of the EXCEED-32GB attribute
SHOW-FILE-ATTRIBUTES	If the total number of reserved PAM pages exceeds 32 GB, the information is displayed in units of one thousand PAM pages. Two additional S variables contain the number in units of one thousand PAM pages if the original S variable has reached the 2147483647 PAM pages: var(*LIST).MIGRATE-S1-RESERVED-T and var(*LIST).PUBSET-RESERVED-T
SHOW-MASTER-CATALOG-ENTRY	The two S variables: var(*LIST).LARGE-VOL and var(*LIST).LARGE-FILE display the contents of the attributes LARGE-VOLUMES and LARGE-FILES

Table 5: User commands

4.1.1 SHOW-MASTER-CATALOG-ENTRY

The SHOW-MASTER-CATALOG-ENTRY command provides information on the contents of MRSCAT entries.

Outputting pubset attributes

If the pubset is a LARGE_OBJECTS pubset, these properties will be output by the SHOW-MASTER-CATALOG-ENTRY command.

Example of the output of /SHOW-MASTER-CATALOG-ENTRY for the TST pubset

```
/show-master-catalog-entry tst
%PUBSET TST : SINGLE-FEATURE, PUBRES-UNIT=5140, LOCAL-IMPORTED, NK2-FORMAT
%             LARGE-OBJECTS, EXTRA-LARGE-CATALOG
%             SHARED, MASTER-HOST=OWN-HOST
```

4.1.2 ADD-FILE-LINK / SHOW-FILE-LINK

Indicating whether large files are permitted

Access to large files can be controlled with the ADD-FILE-LINK command and the operand EXCEED-32GB, without intervention in the program.

```
/ADD-FILE-LINK SUPPORT=*DISK(EXCEED-32GB=*BY-PROGRAM/*FORBIDDEN/*ALLOWED,...)
```

The EXCEED-32GB operand defines whether the processing of large files is allowed (*ALLOWED) or not (*FORBIDDEN).
The specifications in the TU FCB are used for the default setting *BY-PROGRAM.
This operand is entered in the TFT (Task File Table) and is evaluated when the file is opened.

Outputting file attributes

In the S variable output of the SHOW-FILE-LINK command, the validity of large files as specified in the TFT is output in the S variable `var(*LIST).EXC-32GB` (declared using the ADD-FILE-LINK command or the FILE macro).

Contents of the S variables: '' (corresponds to BY-PROGRAM) or *FORBID or *ALLOW.

4.1.3 SHOW-FILE-ATTRIBUTES

Outputting file size

The output fields of the SHOW-FILE-ATTRIBUTES command that relate to the output of the number of PAM pages allow the output for file sizes ≥ 32 GB. 10 digits are available for the output, although leading zeros are not displayed.

This concerns the following output fields and the following output fields in the totals lines:

– File size in the header (number of PAM pages reserved for the file)
– HIGH-US-PA for the file properties (number of PAM pages occupied by the file)

The following output fields in the totals lines have also been extended to 10 digits:

– FRE (the total PAM pages that have been reserved for but are not yet occupied by the displayed output set)
– REL (the total PAM pages that can be released for the displayed output set)
– RES (the total PAM pages that are reserved for the displayed output set)
  When there are more than 2147483647 reserved PAM pages, the display uses units of one thousand PAM pages (8 digits and the right-justified identifier “T”).
– S variables `var(*LIST).MIGRATE-S1-RESERVED` and `var(*LIST).PUBSET-RESERVED`:
  When the value of 2147483647 PAM pages is reached, the corresponding S variable `var(*LIST).MIGRATE-S1-RESERVED-T` or `var(*LIST).PUBSET-RESERVED-T` is assigned the current value in units of one thousand PAM pages.

The modification have been implemented for all output destinations (OUTPUT=*SYSOUT/*SYSLST/*PRINTER/<filename>).

4.2 Assembler macros

This section describes Assembler macro interfaces which are affected by large objects.

The macros mentioned are described in the following manuals: “Executive Macros” [11] (STAMCE macro) or “DMS Macros” [3] (all other macros)

Summary of Assembler macros

Macro/operand or RC	Explanation	Page
Executive macros		
STAMCE SELECT= LARGE_OBJECTS/ LARGE_FILES_ALLOWED	 Select and display the LARGE_OBJECTS and LARGE_FILES_ALLOWED attributes	45
DMS macros		
FSTAT VERSION=0/1 X'0576'	 If FSTAT is called with these versions, you must check whether it is necessary to convert to VERSION=2/3. Extended return code for large files	49
OPEN X'0D9D' X'0D00'	Be aware of problems regarding semantics Additional return code Additional return code	53
FCB LARGE_FILE= *FORBIDDEN/*ALLOWED	 Only for disk files: LARGE_FILE specifies whether the file may become a “large” file (i.e. whether its size may increase beyond 32 GB during processing).	55
FILE EXC32GB= *FORBIDDEN/*ALLOWED	 Only for disk files; determines whether or not the file size may exceed 32 GB during processing	56
RDTFT	Information about the file property EXC32GB in the output area	57

Table 6: Assembler macros (part 1 of 2)

Macro/operand or RC	Explanation	Page
DMS macros for special access methods		
DIV		58
LARGE_FILE= *FORBIDDEN/*ALLOWED	Operand for FCT=*OPEN: LARGE_FILE specifies whether the file to be opened may become a “large” file that can exceed 32 GB in size.	
OFFSET=number	Operand for FCT=*MAP/*SAVE/*RESET: Specifies the first block of the file region to be mapped in virtual address space. The value for OFFSET is limited by the maximum size of a file, thus; – 8388606 when LARGE_FILE= *FORBIDDEN or. – 1073741823 when LARGE_FILE=*ALLOWED.	
SPAN=number	Operand for FCT=*SAVE/*RESET: Specifies the length of the file region in 4-KB blocks. The value for SPAN is limited by the maximum size of a file, thus; – 8388607 when LARGE_FILE=*FORBIDDEN or – 1073741824 when LARGE_FILE=*ALLOWED.	
X'000C' X'0030'	Return code INVALID_LARGE_FILE Return code LARGE_FILE_NOT_SPECIFIED	
FPAMSRV	Address problems of semantics	61
LARGE_FILE= *FORBIDDEN/*ALLOWED	Operand for FCT=*OPEN: LARGE_FILE specifies whether the file to be opened may become a “large” file that can exceed 32 GB in size.	
X'0015'	Return code INVALID_LARGE_FILE	
FPAMACC		63
BLOCK=number	Specifies the direct decimal numeric value for the number of the first logical block to be transferred. The value for BLOCK is limited by the maximum size of a file, thus; – 8388606 when LARGE_FILE=*FORBIDDEN or – 1073741823 when LARGE_FILE=*ALLOWED. (specified in the FPAMSRV macro)	
X'0145'	Return code LARGE_FILE_NOT_SPECIFIED	

Table 6: Assembler macros (part 2 of 2)

4.2.1 STAMCE

Outputting pubset attributes

The STAMCE macro provides information about the contents of the MRSCAT entries and also displays the LARGE_OBJECTS attributes.

Extract from the STAMCE DSECT

```
              STAMCE MF=D,PREFIX=D,XPAND=MCE,VERSION=5
:
:
:
2 *
2 DMCFDATT   DS    X        attribute
2 DMCFDLOB   EQU   X'40'    set: large_objects
2 *                             files/volumes with more than 32 GB
2 DMCFDLFA   EQU   X'20'    set: large_files_allowed
2 DMCFDRAI   EQU   X'10'    set: pubset with RAID volumes
2 DMCFDGSV   EQU   X'08'    set: gs volumes
2 DMCFDDRV   EQU   X'02'    set: high availability by DRV
2 DMCFDKEY   EQU   X'01'    set: key pubset
2 *
:
```

Example

The output of attributes addressed with DMCFDATT is laid out in such a way that in the output columns, **YES** stands for “allowed/existing” and **NO** for “not allowed/non existent”. The LARGE_OBJECTS attributes are output in the LOB and LFA columns.

```
STAMCE   START
         PRINT  NOGEN
         BALR   10,0
         USING  *,10
         USING  DSTAM3,6
         USING  DSTAM4,7
         STAMCE MF=E,PARAM=STAM3,VERSION=5
         LR     7,1
         L      6,DMCEAREA
         WROUT  HEADER,WROUTERR
SHOW     MVC    ATTRIB,=C'NO  NO  NO  NO  NO  NO  '
         MVC    CATID,DMCFSCTD
         MVC    PROCESS,DMCFSBCA
TLOB     TM     DMCFDATT,DMCFDLOB
         BZ     TLFA
         MVC    LOB,YES
TLFA     TM     DMCFDATT,DMCFDLFA
         BZ     TRAI
         MVC    LFA,YES
TRAI     TM     DMCFDATT,DMCFDRAI
         BZ     TGSV
         MVC    RAI,YES
TGSV     TM     DMCFDATT,DMCFDGSV
         BZ     TDRV
         MVC    GSV,YES
TDRV     TM     DMCFDATT,DMCFDDRV
         BZ     TKEY
         MVC    DRV,YES
TKEY     TM     DMCFDATT,DMCFDKEY
         BZ     TEND
         MVC    KEY,YES
TEND     NOP    TEND
         CLI    PROCESS,X'00'
         BNE    WROUT2
         MVC    PROCESS,=CL8' '
WROUT2   WROUT  OUTREC,WROUTERR
         LA     6,DMCF#(6)
         CLI    DMCFSCTD,' '
         BNE    SHOW
WROUTERR TERM
```

```
*** DEFINITIONS
STAM3    STAMCE CATID=' ',MF=L,VERSION=5
HEADER   DC     Y(HEADERE-HEADER)
         DC     CL2' '
         DC     CL1' '
         DC     C'CATID  PROCESSOR LOB LFA RAI GSV DRV KEY '
HEADERE  EQU    *
OUTREC   DC     Y(OUTRECE-OUTREC)
         DC     CL2' '
         DC     CL1' '
CATID    DS     CL4
         DC     CL3' '
PROCESS  DS     CL8
         DC     CL2' '
ATTRIB   DS     0CL24
LOB      DS     CL4
LFA      DS     CL4
RAI      DS     CL4
GSV      DS     CL4
DRV      DS     CL4
KEY      DS     CL4
OUTRECE  EQU    *
YES      DC     C'YES'
         LTORG
         DS     0F
OUT      DS     XL4096
DSTAM3   STAMCE MF=D,PREFIX=D,XPAND=MCE,VERSION=5
DSTAM4   STAMCE MF=D,PREFIX=D,XPAND=PL,VERSION=5
         END
```

Print-edited output

```
CATID  PROCESSOR LOB LFA RAI GSV DRV KEY
AARZ             NO  NO  NO  NO  NO  NO
BAU3   KAROBUBE  NO  NO  NO  NO  NO  NO
BLAU             NO  NO  NO  NO  NO  NO
BXT2             YES NO  NO  NO  NO  NO
 :
 :
WORK             YES YES NO  NO  NO  YES
2ATS   PIKASS    NO  NO  YES NO  NO  YES
2CVC   KAROBUBE  NO  NO  NO  NO  NO  NO
4ARB   D015ZE08  NO  NO  NO  NO  NO  YES
 :
 :
```

4.2.2 FSTAT

If the FSTAT macro accesses pubsets with large volumes that do not, however, allow large files, interface behavior is unchanged. Access of this kind is always performed without problems.
Problems can occur if pubsets that also allow large files are accessed.

The FSTAT macro offers the following interface variants:

(a)	Version=0	(corresponds to Version 710, default)	
(b)	Version=1	(corresponds to Version 800)	as of BS2000 version V8.0
(c)	Version=2		as of OSD-BC version V1.0
(d)	Version=3		as of OSD-BC version V3.0
(e)	Version=4		as of OSD-BC version V9.0
(f)	Version=5		as of OSD/BC version V11.0

Interface variants that do not need to be converted

If FSTAT calls with version 2 or higher are used exclusively, no incompatibilities occur.

The variants as of (c) return the relevant data (extent lists and data fields for File-Size and Last-Page-Pointer) as 4-byte fields. These interfaces do not need to be converted when large files are used, and they are not affected by the comments below.
The semantics problem discussed in section “OPEN” on page 54, however, must be considered. Each user of this interface must check whether this problem applies to their implementation.

The following variants are not affected either:

– `FSTAT ...,VERSION=0,<partially-qualified filename>`
  `FSTAT ...,VERSION=0,<file generation group with GEN=YES>`

– `FSTAT ...,VERSION=1,FNAM`

Interface variants that need to be checked/converted

In the following section, the remaining variants of (a) and (b) will be examined more closely:

`FSTAT ...,VERSION=0/1,SHORT/LONG`

These variants return the catalog information in BS2000 V10.0 format.
The extent lists and data fields for File-Size and Last-Page-Pointer are output with only 3 bytes. For reasons of compatibility, it is not possible to change the layout of these interfaces.

Calls that refer to large objects cause an overflow in the 3-byte fields.

Two different cases must be distinguished. These depend on the contents of the result list from the FSTAT call:

a) No file ≥ 32 GB exists in the result list (set of selected files).

In this instance, FSTAT tolerates the overflow of the 3-byte data field of the PHP in the extent list. The value X'FFFFFF' is assigned to the PHPs that cannot be displayed. It is assumed that the PHPs are never or very rarely evaluated at the interfaces. If this is occasionally not the case, the interface must be converted to version 2 or 3.

This achieves the following:

– The introduction of large volumes can be carried out in a compatible manner, user programs do not need to be changed.

– FSTAT calls with fully-qualified pathnames can be supported compatibly (except for the PHP overflow in the extent list).

► No conversion is necessary.

b) At least one file ≥ 32 GB exists in the result list (FSTAT is called with a partially-qualified filename or with wildcards).

Calls of this kind are rejected with the following return code:

X'cc'	**X'bb'**	**X'aaaa'**	**Explanation**
X'00'	X'01'	X'0576'	The selection contains large files.

The following types of FSTAT interfaces are affected:

Type		**Comment**
I	FSTAT ...	VERSION=0 is set as default
II	FSTAT ...,VERSION=0	
III	FSTAT ...,VERSION=1,SHORT	
IV	FSTAT ...,VERSION=1,LONG	
V	FSTAT ...,VERSION=1	The SHORT operand is set as default

► These calls must be converted to VERSION ≥ 2.

It is generally recommended to use the newest FSTAT versions. This especially applies to the case when Net-Storage files (FTSTAT as of VERSION=4) or SAM node files (FTSTAT as of VERSION=5) are to be considered.

Summary of FSTAT calls

```
FSTAT <fully-qualified pathname>,VERSION=0/1
```

1. Access only to small files (less than 32 GB):
   No action necessary [1)]
2. Large files are also accessed (≥ 32 GB):
   If the call is made with one of the types I to V, conversion to VERSION=2/3 is necessary, with the exception of types I and II where the file generation group and GEN=YES are specified.

```
FSTAT <partially-qualified pathname or pathname with wildcards>,VERSION=0/1
```

1. The result list contains only small files (less than 32 GB):
   No action necessary [1)]

   Warning!

   You must ensure that the requirements are always fulfilled.
   This is probably only possible for pathnames that contain wildcards in the catalog ID and otherwise contain fully-qualified components.
2. The result list can also contain large files (≥ 32 GB):
   If the call is made with one of the types III to V, conversion to VERSION=2/3 is necessary.

Conclusion

When using the FSTAT interface with VERSION < 2 and FORM=LONG or FORM=SHORT, it is necessary to convert to the most recent interface version under the following circumstances:

a) Large files should be accessible with the FSTAT call in the affected program.

b) The pathname in the FSTAT call is partially-qualified or contains wildcards and it cannot be assumed that the result list contains no large files. Calls with wildcards in the catalog ID are particularly critical here.

It may be necessary to convert the data structures in the program as well as the interface.

[1] "No action necessary" applies here if the result list contains only small files and the overflow of the 3-byte data field of the PHP in the extent list does not present a problem. If this is not the case, conversion to VERSION>2 is necessary.

Control using the system parameter FST32GB

FST32GB only affects the following FSTAT interfaces:

– Version=0 (corresponds to Version=710) when a fully-qualified filename is specified (although not when a file generation group is specified with GEN=YES)

– Version=1 (corresponds to Version=800), where the FNAM operand was not specified

Whether the existence of a file ≥ 32 GB in the list of selected files leads to the FSTAT call being rejected with the `X'00000576'` return code (FST32GB=0, default setting) or whether an overflow of the 3-byte fields is always tolerated (FST32GB=1) is set globally on the system by systems support staff. In the latter case, the value X'FFFFFF' is assigned to the data fields that cannot be displayed.

Note

The system parameter FST32GB is not evaluated if the FSTAT indicator (see below) is set.

Control using the FSTAT indicator

Behavior equivalent to FST32GB=1, i.e. ignoring the overflow, can be activated for specific interfaces for FSTAT types `I` to `V` using an indicator.

Note

The FSTAT indicator has a higher priority than the system parameter FST32GB. If the FSTAT indicator is set, FST32GB is not evaluated.
The indicator must be set directly in the parameter list; no support is provided in the FSTAT macro.

Description of the bits in the corresponding DSECT:

```
         FSTAT MF=D,PARMOD=31,VERSION=710
IDBFLAG2 DS    X                                FLAGS 2
IDBLOPYE EQU   X'04'                            2-2 S LARGE PUBSET ACCESS=YES


         FSTAT MF=D,PARMOD=31,VERSION=800
IFLAG0   DC    B'10001100'
ILOPY    EQU   X'04'                            2-2 S LARGE PUBSET ACCESS=YES
```

4.2.3 OPEN

The OPEN macro and the access methods are only affected by the introduction of large files, not by the introduction of large volumes.

The OPEN interface checks whether files are permitted to extend beyond 32 GB and whether the creation of files ≥ 32 GB and access to such files are permitted.

There are two aspects associated with this:

a) Rejection of access to or the creation of large files for access methods that do not allow processing of large files.

b) Indication that a program can create or open files ≥ 32 GB.

Incompatible interface variants

Interfaces where 3-byte block numbers are used are never able to work with files ≥ 32 GB. This affects the following cases:

– All files in key format (BLKCTRL=PAMKEY):
  The logical block numbers in the PAMKEY are only 3 bytes wide.

– 24-bit interface of UPAM
  The field for logical block numbers in the UPAM parameter lists and in the TU FCB is only 3 bytes wide.

– 24-bit interface of SAM
  The logical block numbers are affected as part of the retrieval address.

– 24-bit interface of ISAM

In all the cases described above, the following applies:

– Access to files ≥ 32 GB is rejected with the return code `X'00000D9D'` or `X'00000D00'`, depending on the size of the storage space allocated to the file (FILE_SIZE).

– Exceeding a file size of 32 GB as a result of secondary allocation is prohibited (LARGE_FILE).

Semantic incompatibilities

It is possible that applications use interfaces that employ 4-byte fields for the data fields described above, but that these 4-byte fields are implicitly or explicitly subject to the former limitation to values less than X'00FFFFFF'. Detailed information relating to this can be found in the Appendix, in the section “Semantic incompatibilities” on page 74.

The following return codes display information about execution of the macro with regard to large files:

X'cc'	X'bb'	X'aaaa'	Explanation
X'00'	X'00'	X'0D9D'	Error when opening a disk file
X'00'	X'00'	X'0D00'	System error when opening a file

4.2.4 FCB

The FCB macro defines the file control block, which is the central source of information for the BTAM, ISAM, SAM and UPAM access methods.

Indicating whether large files are permitted

At program level, the LARGE_FILE operand controls whether large files are permitted.

Operation	Operands
FCB	: : [,LARGE_FILE={ *FORBIDDEN / *ALLOWED }] :

LARGE_FILE
Only for disk files (ISAM, SAM and UPAM access methods):
The LARGE-FILE operand defines whether or not the logical file size may exceed 32 GB.

= *FORBIDDEN
Default setting: The logical file size may not exceed 32 GB.

= *ALLOWED
Only for files with BLKCTRL ≠ PAMKEY:
The logical file size may exceed 32 GB.

4.2.5 FILE

Allocation behavior

Support for files ≥ 32 GB is only possible for non-PAMKEY files on pubsets where LARGE_OBJECTS=TRUE and LARGE_FILES_ALLOWED=TRUE.

Thus, PAMKEY files on these pubsets may not exceed previous allocation limits for reasons of compatibility. The PAMKEY property of a file is not binding at the point at which FILE is executed; it only becomes definitive when the file is accessed using OPEN.

The behavior for files on all other pubsets (LARGE_OBJECTS=FALSE or TRUE, LARGE_FILES_ALLOWED=FALSE) does not change, i.e. the FILE interface rejects an allocation that exceeds the 32 GB limit.

Indicating whether large files are permitted

At program level, the EXC32GB operand controls whether large files are permitted. The operand does not affect the allocation behavior of the FILE interface.

Operation	Operands
FILE	: : ,EXC32GB=FORBIDDEN/ALLOWED :

EXC32GB
Only for disk files; only for non-PAMKEY files:
The EXC32GB operand determines whether or not the file size may exceed 32 GB when the file is processed. The operand is entered in the TFT (Task File Table) and is only evaluated when the file is opened using OPEN.
During processing, EXC32GB does not affect the space assignment of the FILE call.

= FORBIDDEN
The file size may not exceed 32 GB.

= ALLOWED
The file size may exceed 32 GB.

4.2.6 RDTFT

Outputting file attributes

The RDTFT macro allows information to be output from the TFT.

```
RDTFT ...,LINK=...,VERSION=2/3
```

Using the VERSION=2/3 and PARMOD=31 operands, an output list is created that also outputs information about the file property EXC32GB (see FILE macro, page 56).

Extract from the RDTFT DSECT

```
             RDTFT MF=D,PLIST=OUTPUT,VERSION=3
:
:
:
1 ***************** FCB AND DEVICE TYPE INFORMATION
1 IDRFINFO DS    OHL2
:
:
1 IDRIND15 DS    C                 INDICATOR 15
1 IDRDESCS EQU   X'80'               7-7 S DESTOC SPECIFIED
1 IDRDESCY EQU   X'40'               6-6 S DESTOC = YES
1 IDRCMSGS EQU   X'20'               5-5 S CLOSMSG SPECIFIED
1 IDRCMSGY EQU   X'10'               4-4 S CLOSMSG = YES
1 IDRTAPWS EQU   X'08'               3-3 S TAPEWR  SPECIFIED
1 IDRTAPWY EQU   X'04'               2-2 S TAPEWR  = DEVICE-BUFFER
1 IDRX32GS EQU   X'02'               1-1 S EXC32GB SPECIFIED
1 IDRX32GA EQU   X'01'               0-0 S EXC32GB = ALLOWED
:
```

4.2.7 DIV

The DIV access method (like FASTPAM) uses its own parameter list, rather than the TU FCB for passing parameters.
This DIV(I) parameter list includes - among others - the LARGE_FILE operand for the “Open files” function. The default value *FORBIDDEN prevents uncontrolled access to large files. This function is represented in the parameter list in a bit field that is preset with B'0' (≙ *FORBIDDEN).
The presetting with the default value *FORBIDDEN is therefore guaranteed for programs that were compiled in versions earlier than OSD-BC V5.0.

Indicating whether large files are permitted

The DIV macro with the OPEN function indicates whether large files are permitted. At program level, the LARGE_FILE operand controls whether large files are permitted.

The operand is entered in the TFT (Task File Table) and is evaluated when the file is opened using OPEN.

Operation	Operands
DIV	[,FCT={*OPEN / adr / (r)}] : : [,LARGE_FILE={*FORBIDDEN / *ALLOWED / adr / (r)}] :

LARGE_FILE
The LARGE_FILE operand determines whether or not the file size may exceed 32 GB during processing. The operand is entered in the TFT (Task File Table) and is only evaluated when the file is opened using OPEN.

With the form MF=L, only direct specification is permitted.

= *FORBIDDEN
Default setting: The file size may not exceed 32 GB.

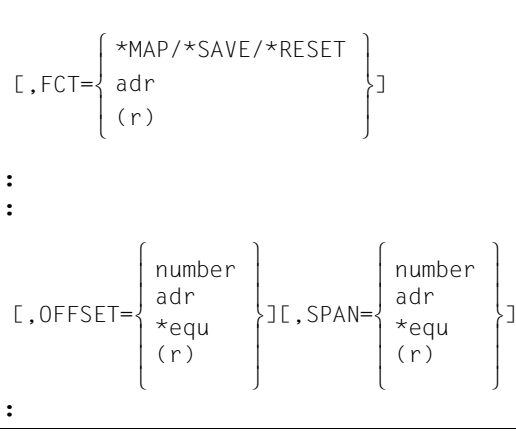
= *ALLOWED
The file size may exceed 32 GB.

= adr / (r)
The address of a field that is 1 byte in length and contains the value for LARGE_FILE or the register that contains the value.

Specifying the first block of the data area and the file length

The first block of the file area to be mapped to the virtual address space is specified using the OFFSET operand and the MAP, SAVE, or RESET function. This value is limited depending on the maximum size of a file.

The length of the file area is specified in 4-KB blocks using the SPAN operand and the SAVE or RESET function. This value is limited depending on the maximum size of a file.

Operation	Operands
DIV	

OFFSET
Together with SPAN, OFFSET defines the file region for which the window is created. The OFFSET operand can be specified with the MAP, SAVE or RESET functions.

Default setting: OFFSET = 0

With the form MF=L, only direct specification is permitted.

= number
Specifies the first block of the file region to be mapped in virtual address space. The value for OFFSET is limited to the maximum size of a file in 4 KB pages minus 1:

$0 \leq$ number $\leq$ 8388606 for LARGE_FILE=*FORBIDDEN

$0 \leq$ number $\leq$ 1073741823 for LARGE_FILE=*ALLOWED

= adr
Symbolic address of a 4-byte field containing the numeric value (binary) of the specification for the first block of the file region to be mapped in virtual address space.

= *equ
Equate representing the numeric value of the specification for the first block of the file region to be mapped in virtual address space.
The “*” character must precede the name of the equate.

= (r)
Register containing the numeric value of the specification for the first block of the file region to be mapped in virtual address space.

SPAN
Together with OFFSET, SPAN defines the data area which is referred to in SAVE.
The SPAN operand can be specified with the SAVE or RESET functions.

Default setting: SPAN = 0

With the form MF=L, only direct specification is permitted.

= number
Specifies the length of the file region in 4-KB blocks. The value for SPAN is limited by the maximum size of a file in 4 KB pages minus 1:

$0 \leq$ number $\leq$ 8388607 for LARGE_FILE=*FORBIDDEN

$0 \leq$ number $\leq$ 1073741824 for LARGE_FILE=*ALLOWED

= adr
Symbolic address of a 4-byte field which specifies the length of the file region in 4-KB blocks (binary).

= *equ
Equate which specifies the length of the file area in 4-KB blocks (binary).
The “*” character must precede the name of the equate.

= (r)
Register containing the length of the file region in 4-KB blocks (binary).

Additional return codes display information about the execution of the macro with regard to large files:

X'cc'	**X'bb'**	**X'aaaa'**	**Explanation**
X'00'	X'01'	X'000C'	The value for LARGE_FILE (OPEN) is neither *ALLOWED nor *FORBIDDEN.
X'00'	X'40'	X'0030'	When a file was accessed in the mode SHARUPD=YES, it was determined that the file size exceeded 32 GB; exceeding 32 GB was not permitted for this file in OPEN.

4.2.8 FPAMSRV

The FASTPAM access method (like DIV) uses its own parameter list, rather than the TU FCB for passing parameters.
This FPAMSRV(I) parameter list includes - among others - the LARGE_FILE=*FORBIDDEN/*ALLOWED operands for the “Open files” function.

The operand controls whether the processing of large files is permitted.
The default value *FORBIDDEN prevents uncontrolled access to large files. This function is represented in the parameter list in a bit field which is preset with B'0' (≙ *FORBIDDEN). The presetting with the default value *FORBIDDEN is therefore guaranteed for programs that were compiled in versions earlier than OSD-BC V5.0.

Indicating whether large files are permitted

The FPAMSRV macro, with the OPEN function and the LARGE-FILE operand, indicates whether large files are permitted.

Operation	Operands
FPAMSRV	[,FCT={*OPEN / adr / (r)}] : : [,LARGE_FILE={*FORBIDDEN / *ALLOWED / adr / (r)}] :

LARGE_FILE
specifies whether the file to be opened may become a “large” file that can exceed 32 GB in size.

Default setting: LARGE_FILE = *FORBIDDEN

With the form MF=L, only direct specification is permitted.

= *FORBIDDEN
Default setting: The file may not become a “large file”.

= *ALLOWED
The file may become a “large file”.

= adr / (r)
The address of a field that is 1 byte in length and contains the value for LARGE_FILE or the register that contains the value.

An additional return code displays information about the execution of the macro with regard to large files:

X'cc'	X'bb'	X'aaaa'	Explanation
X'00'	X'01'	X'0015'	The function was not performed. Invalid specification for LARGE_FILE

4.2.9 FPAMACC

The direct decimal numeric value for the number of the first logical block to be transferred can be specified in the BLOCK operand of the FPAMACC macro.
This value is limited depending on the maximum size of a file (specified in the FPAMSRV macro).

Operation	Operands
FPAMACC	: : [,BLOCK={number / adr / (r)}] :

BLOCK
Specifies the number of the first logical FASTPAM block within the file to be transferred. The block size is determined with the BLKSIZE operand in the the OPEN function of the FPAMSRV macro. Only integer values are permitted.

With the form MF=L, only direct specification is permitted.

= number
Direct entry of a decimal numeric value for the number of the first logical block to be transferred. The value is limited to the maximum size of a file in 4 KB pages minus 1:

$1 \leq$ number $\leq$ 8388606 for LARGE_FILE=*FORBIDDEN (see FPAMSRV macro)

$1 \leq$ number $\leq$ 1073741823 for LARGE_FILE=*ALLOWED (see FPAMSRV macro)

= adr / (r)
Symbolic address of a 4-byte field containing the numeric value (binary) or the register which contains this address.

An additional return code displays information about the execution of the macro with regard to large files:

X'cc'	X'bb'	X'aaaa'	Explanation
X'00'	X'40'	X'0145'	When a file was accessed in the mode SHARUPD=YES, it was determined that the file size exceeded 32 GB; exceeding 32 GB was not permitted for this file in OPEN.

4.2.10 Special issues when SHARUPD=YES

When files are accessed in the mode SHARUPD=YES, it is possible that a file with a file size of less than 32 GB could become ≥ 32 GB during processing.

There are two different cases here:

– Callers that are prepared for this situation:
  – by specifying LARGE_FILE=*ALLOWED in the FCB macro
  – by specifying EXCEED-32GB=*ALLOWED in the ADD-FILE-LINK command
– Unprepared callers:
  – by specifying LARGE_FILE=*FORBIDDEN in the FCB macro
  – by specifying EXCEED-32GB=*FORBIDDEN in the ADD-FILE-LINK command

UPAM, FASTPAM and DIV access methods

When a file is accessed with the UPAM, FASTPAM and DIV access methods, the size of the file is checked after each allocator call.
If this check reveals a file size ≥ 32 GB and the LARGE_FILE=*FORBIDDEN attribute or the EXCEED-32GB=*FORBIDDEN attribute is set in the corresponding TFT, processing is aborted.

– UPAM then issues the following return code

  `X'000009AD'` FILE SIZE GREATER 32 GIGABYTES IS NOT ALLOWED

  or the corresponding DMS message

  `DMS09AD` `FILE SIZE GREATER 32 GIGABYTES IS NOT ALLOWED`

– In this instance, FASTPAM issues the following return code in its own parameter list FPAMACC(I)

  `X'00400145'` `LARGE_FILE_NOT_SPECIFIED`
  When a file was accessed in the mode SHARUPD=YES, it was determined that the file size exceeded 32 GB; exceeding 32 GB was not permitted for this file in OPEN.

– In this instance, DIV issues the following return code in its own parameter list DIV(I)

  `X'00400030'` `LARGE_FILE_NOT_SPECIFIED`
  When a file was accessed in the mode SHARUPD=YES, it was determined that the file size exceeded 32 GB; exceeding 32 GB was not permitted for this file in OPEN.

NK-ISAM access method

Under the NK-ISAM access method, the size of the NK-ISAM file is checked on the basis of the extent list located in the file table entry at every SVC entry point. If this check reveals a file size ≥ 32 GB and if the caller set the LARGE_FILE=*FORBIDDEN attribute in the FCB or the EXCEED-32GB=*FORBIDDEN attribute in the TFT, processing is aborted.

– NK-ISAM then issues the following return code

  `X'00000A23'` FILE SIZE GREATER 32 GIGABYTES IS NOT ALLOWED

  or the corresponding DMS message

  `DMS0A23` `FILE SIZE GREATER 32 GIGABYTES IS NOT ALLOWED`

The **K-ISAM** access method is not affected by this problem.

4.3 Notes regarding programs created in high-level programming languages

In the context of high-level programming languages / programming systems, there are two different aspects of file processing:

– File processing in the framework of program creation using compilers

– File processing when running objects created under a compiler/programming system

File processing by compilers

Support for source programs ≥ 32 GB is neither necessary nor desirable - it is unlikely that input objects of this size will be manageable. The same applies to output objects created by compilers such as object modules, listings and debugging output.
As long as the corresponding objects are managed in libraries, the size of the library, but not the size of the library elements, may exceed 32 GB.

File processing by runtime systems

Please refer to the documentation of the corresponding run time system for details of the compatibility of individual runtime systems with large files.

COBOL

In COBOL programs that were compiled with COBOL85, any attempt to work with large files will be rejected with the file status '9x'.

Avoiding this limitation by explicitly specifying the
ADD-FILE-LINK ...,EXCEED-32GB=*ALLOWED command is not permitted and will cause undefined behavior, in particular the omission of necessary checks.

For programs that were compiled with COBOL2000, it is possible to access files ≥ 32 GB via the SEQUENTIAL, LINE SEQUENTIAL and INDEXED file organization methods in COBOL.

The COBOL file organization method RELATIVE is only supported with large files if mapped to BS2000-ISAM.

There are no restrictions to files smaller than 32 GB caused by the COBOL product for BS2000 files and POSIX files using the SEQUENTIAL and RELATIVE organization methods. Files using the INDEXED organization method are still restricted in terms of size in the POSIX file system.

C

The full functionality of the open64 interface family is available for correct processing of BS2000 files ≥ 32 GB. Please refer to the “C Library functions for POSIX applications” manual [1] for a description of these interfaces.

C++

The IOSTREAM interface supplied with CRTE does not support large files. Using IOSTREAM to open large files will fail. By default, no further information other than the return code zero will be issued (in particular, no error message).
The “errno” variable returns the value 3 (`DMS ERROR`).

If C++ programs need interfaces to large files, they must work with the C API (open64) (see “C” section, above).

5 Notes on migration

This chapter contains notes on the introduction of large files. Necessary interfaces are described in the previous chapters. Possible steps for migration and the considerations that should be included in planning will be outlined here.

5.1 Preliminary considerations

Due to the continual growth of the volume of data stored, the size of individual files can exceed 32 GB. In order to be able to make modifications when and where appropriate, these developments must be carefully monitored and extrapolated.
Generally the option exists for introducing an environment in which files ≥ 32 GB can be processed.

If large files are to be introduced, it is necessary to clarify the following points in advance:

– Which files will or should exceed 32 GB?

– Which programs/applications should run in an “environment with large files”?

– Which programs/applications operate on these files?

Programs/applications that are identified in this way must be checked to ensure that they will be executable in the future, i.e. that they will be able to process large files. Modifications may be necessary. The following sections will examine this.

5.2 Environment

An appropriate environment must be made available by systems support in order to support large files. It is advisable initially to install this environment for test purposes only, on a test application or a guest system under VM2000.

System requirements

As described in Chapter 2 “Large objects in BS2000”, large files can only be created in special pubsets, known as LARGE_OBJECTS pubsets, with the LARGE_FILES_ALLOWED attribute.
At least one of these pubsets must therefore be made available. This can be achieved by generation with SIR or by subsequent assignment of attributes using the SET-PUBSET-ATTRIBUTES command. The latter approach has the advantage that existing files can be included and updated.

Software configuration

The software configuration of the current OSD/BC version supports the operation with large files.

5.3 Program Conversion

5.3.1 Assembler programs

Assembler programs are directly based on the TU interfaces of BS2000 OSD/BC.

1. Modifications may be necessary for programs that should be executable for large files in the future (LARGE-FILES-compatible programs)
2. In general, modification measures will be necessary for programs that should process large files.

In the first case, the way in which the FSTAT program interface is used, and whether it is used, must be checked. As described in detail in Chapter 4, in the “FSTAT” section as of page 49, interface variants earlier than VERSION=2 only support 3-byte block numbers. When large files are accessed, these interfaces issue the return code x'0576'.
This behavior is only undesirable and incorrect if the return code appears “randomly”, because the result list of the FSTAT call also contains large files, although these do not need to be processed. This can occur for FSTAT calls with partially-qualified filenames or filenames with wildcards. Calls with wildcards in the catalog ID are particularly critical. In this instance, the call is not restricted to the file catalog of a pubset, but among other things includes several or all of the pubsets imported in the system.
When critical FSTAT calls are converted to an interface variant equal to or greater than VERSION=2, it is not only modification of access to output area fields that is necessary. Further use of the counters or block numbers taken from here must also be checked and adapted where appropriate.

In the second case, it is necessary to perform modifications in the context of file processing in addition to the modification of FSTAT calls that may be required. For this purpose, the indication LARGE_FILES=*ALLOWED for OPEN in the FCB (or in the parameter list for FASTPAM and DIV) must then be set. This determines that large files can be processed. A check and possible modification of the program logic may also be necessary in order to ensure that large files can be processed without errors. If you are working with block-oriented access methods (UPAM, FASTPAM) or block numbers (retrieval address in SAM), it is also necessary to ensure that the block numbers can universally be handled as 4-byte fields.
In addition to this direct dependence, there may also be an implicit assumption within the program logic that a block number or file cannot be larger than 2^{24}-1. No exhaustive set of rules can be given for identifying “semantic incompatibilities” of this kind. A list of examples in the form of a checklist is given in the Appendix (“Semantic incompatibilities” section, page 74).

For test purposes, or if no modifications are necessary, it is possible to set whether large files are permitted via the ADD-FILE-LINK command interface (see page 41).

5.3.2 Programs in high-level programming languages

The current compiler versions and run time systems support large files. If want to you use older programs for the operation with large files a new compilation using the current compiler may be necessary, see the following sections.

COBOL

New compilation is necessary if the program had been compiled with a COBOL2000 < V1.1A before.

For further information, see the “COBOL” section on page 66.

C, C++

The program has to be adapted, compiled and linked again if the program had been created and linked using a program environment with CRTE < V2.3C before.

For further information, see the “C” section on page 67.

6 Appendix

The appendix contains the following tables and overviews:

- Semantic incompatibilities (page 74)
- Messages referring to large objects (page 75)
  New or changed messages for processing large volumes and files, organized according to message codes

6.1 Semantic incompatibilities

In Chapter 5, it was mentioned that for the modifications in Assembler code for files ≥ 32 GB in addition to the conversion to 4-byte block numbers and counters, it is necessary to check whether the program logic implicitly assumes that files may not be larger than 32 GB.

The following lists a number of examples of potential problems.

– The highest 3-byte block number X'FFFFFF' has a special meaning.

– “Block numbers” greater than X'00FFFFFF' represent objects other than blocks.

– For calculations with block numbers or counters greater than X'00FFFFFF', overflow can occur.

– The number of digits in input or output fields is not sufficient for displaying such large block numbers or counters.

– When converting hexadecimal numbers to decimal numbers, the field length is too small for the decimal number.

– It is assumed that data structures whose size depends on a file size always find space in virtual memory. This assumption can apply to files less than 32 GB, but not if this size is exceeded.

6.2 Messages referring to large objects

The following displays the messages that are mentioned in this manual with reference to large objects. They are sorted alphabetically according to message code.

```
ARC0061   FILE GREATER THAN 32GB. FILE NOT PROCESSED

          ? Files with a file size greater than 32GB can not be processed
            with this ARCHIVE Version or in this environment

          ! Processing of this file is possible in an environment with
            following features:
            - >= BS2000 OSD V5.0A
            - >= ARCHIVE V6.0A
            - In case of a restoration the destination pubset must allow
              files larger than 32GB


DMS037E   FORMAT OF VOLUME '(&02)' INCONSISTENT WITH PUBSET/VOLUMESET
          '(&00)'. IMPORT PUBSET TASK ABORTED WITH ERRORCODE '(&01)'

          ? (&00): id of SF pubset or volumeset
            (&01): format error
             '01': PAM key volumes and NON-PAM key volumes exists. SF pubsets
                   or volumesets may only consist of volumes with the same
                   PAM key type.
             '02': volumes with different minimal I/O-transfer units exist.
                   SF pubsets or volumesets may only consist of volumes with
                   the same minimal I/O unit.
             '03': volumes with different minimal allocation units exist.
                   SF pubsets or volumesets may only consists of volumes with
                   the same minimal allocation unit.
             '04': a volume is larger than 32 GB, but the pubset doesn't have
                   the attribute for large volumes.
            (&02): vsn of current volume

          ! Check volume identity, maybe initialize some volumes and try
            import again.
```

```
DMS0501   REQUESTED CATALOG NOT AVAILABLE OR WILDCARDS IN USER IDENTIFICATION

          ? Possible reasons:
            Case 1: The class 2 option BMTNUM=0 is set for private disks.
            Case 2: When accessing files with the aid of a MSCF connection,
                    wildcards were used in the user identification.
            Case 3: The required catalog is not imported.
            Case 4: The identification of a volume set from a pubset was
                    specified in the pathname.
            Case 5: The required volume set is not available.

          ! Case 1: Request the system administrator to make the catalog
                    available. Reset the class 2 option BMTNUM to a value
                    other than zero.
            Case 2: Repeat the call without wildcards.
            Case 3: Request the system administrator to import the required
                    catalog.
            Case 4: Specify the identification of the relevant pubset.
            Case 5: Ask the system administrator to make the required volume
                    set available.


DMS0854   FILE SIZE OF SYSEAM FILE (&00) MAY NOT EXCEED 32 GIGABYTES

          ? SYSEAM file (&00) has been created with unallowed file size
            higher than 32 gigabytes (by CREATE-FILE).

          ! Delete SYSEAM-file (&00) and create it again with allowed file
            size below 32 gigabytes.


DMS09AD   FILE SIZE GREATER 32 GIGABYTES IS NOT ALLOWED

          ? In FCB or ADD-FILE-LINK LARGE_FILE=*FORBIDDEN has been set, but
            concerned file exceeeds 32 gigabytes.

          ! Correct program. If the error persists, contact system
            administrator.


DMS0A23   FILE SIZE GREATER 32 GIGABYTES IS NOT ALLOWED

          ? In FCB or ADD-FILE-LINK LARGE_FILE=*FORBIDDEN has been set, but
            concerned file exceeeds 32 gigabytes.

          ! Correct program. If the error persists, contact system
            administrator.
```

```
DMS1383   VOLUME INCONSISTENT. ERROR TYPE '(&00)'. COMMAND REJECTED

          ? (&00): error type
             '01': The raid mode of the volume does not match the
                   pubset/volumeset.
             '02': The GS mode of the volume does not match the
                   pubset/volumeset.
             '03': Returncode "bad volume" from the allocator.
             '04': The dual recording mode of the volume does not match the
                   pubset/volumeset.
             '05': The timestamp of the volume reserved by the slave does not
                   match the master.
             '06': A volume is larger than 32 GB, but the pubset doesn't have
                   the attribute for large volumes.

          ! Dependent on cause.


NVL0146   DISK CAPACITY GREATER EQUAL 32GB IS NOT PERMITTED FOR PRIVATE DISKS

          ? no further information

          ! none


SIR0308   DISK FOR VSN '(&00)' EXCEEDS CAPACITY OF 32 GB; DISK REJECTED

          ? In a SIR run with ACTION=*INSTALL is the operand LARGE-DISKS-
            ALLOWED=*NO specified in the //DECLARE-PUBSET assignment or for
            ACTION=*EXTEND the coresponding pubset attribute is set.

          ! - for ACTION=*INSTALL you have to set the operand LARGE-DISKS-
              ALLOWED to *YES
            - for ACTION=*EXTEND you have to set the coresponding attribute
              of the pubset using the command /SET-PUBSET-ATTRIBUTES ...,
              LARGE-VOLUMES=*ALLOWED before you restart the SIR run.


SIR0728   COPYING OF FILE '(&00)' ABNORMALLY TERMINATED. FILE SIZE EXCEEDS
          THE LIMIT OF 32GB

          ? no further information

          ! none


SPC0030   ERROR EXECUTING (&00)-MACRO, RETURN CODE = (&01)

          ? no further information

          ! none
```

Related publications

You will find the manuals on the internet at *http://manuals.ts.fujitsu.com*. You can order printed copies of those manuals which are displayed with an order number.

[1] **CRTE** (BS2000)
C Library Functions for POSIX Applications
Reference Manual

[2] **BS2000 OSD/BC**
Utility Routines
User Guide

[3] **BS2000 OSD/BC**
DMS Macros
User Guide

[4] **BS2000 OSD/BC**
Introductory Guide to DMS
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[5] **BS2000 OSD/BC**
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[6] **FDDRL** (BS2000)
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[7] **HIPLEX MSCF** (BS2000)
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