VSAM
VIRTUAL STORAGE ACCESS METHOD

November 2007

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1   INTRODUCTION

The IBM Access Methods Services (AMS) utility, which at times is referred to as, IDCAMS, is a comprehensive and efficient software tool for IBM mainframe computers that use high performance, high capacity direct-access storage devices (DASD).

This IBM access method services (IDCAMS) manages the storage of magnetic disk data access in two formats, the first is "native storage access method," and the second is "Virtual Storage Access Method" (VSAM).

VSAM is a very flexible access method and with this flexibility comes many optional features. The rules, conventions, and guidelines presented in this document must be followed to achieve the most effective results from the State's mainframe computers.

1.1   PURPOSE

The purpose for this document is to establish policies, standards, procedures, conventions and guidelines that will optimize and standardize the State's central site mainframe VSAM systems environments.

This document has the official State Executive Branch's conventions, rules, and guidelines for the effective use of VSAM at the State's central computer center.

This document will address issues related to DASD systems catalog and dataset options, features, and parameters.

It will guide information technology specialists in the most effective use of VSAM file organization, structure, and resources for application systems, programs and job streams processed at the State of Hawaii's central computer site.

There are some computer operating system (OS) multiple virtual systems (MVS) job control language (JCL) Data Definition (DD) statement options and parameter conventions that are required to efficiently support the State's VSAM environment, resources, and facilities. They are presented in this document to give computer information technology specialists a common understanding of what the Department of Accounting and General Services (DAGS) Information and Communication Services Division (ICSD) expects when application systems, programs or job streams that reference VSAM data files are submitted for processing at the State's central computer site.

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1.2 SCOPE

The scope of this document is limited to establishing policies, procedures, standards, conventions, and procedures for consultants, vendors, contractors, and information technology specialists to follow when they must set up and use VSAM datasets for application systems, programs or job streams.

This document is not a replacement for the vendor's VSAM User and/or reference manuals, or for DAGS ICSD sponsored or approved training courses developed for a basic understanding of VSAM.

Non-compliance with these established conventions, rules or procedures may result in computer systems error messages or unpredictable results.

1.3 APPLICABILITY

The intent of this document is to provide guidance for information technology specialists, contractors and consultants who must design, construct, test and/or install programs, systems, and/or job streams that use VSAM datasets in State controlled computers.

State information technology specialists and any contractor, vendor or any consultant hired by the State (who use the State's mainframe computing resources at the DAGS ICSD central site) must follow the standards, procedures, conventions, and guidelines presented in this document.

Failure to follow these procedures, standards, conventions or guidelines may result in delays and/or cancellation of the program or job stream.

1.4   COMMENTS AND SUGGESTIONS

Any State of Hawaii Information Technology (IT) Standards document, reference manual or users guide mentioned in this document are available through the departmental user agency data processing coordinator (DP Coordinator).

The State of Hawaii IT Standards are also accessible on the internet by going to the DAGS-ICSD home page at:

http://www.hawaii.gov/dags/icsd/ and clicking on **Information Technology Standards**

The Statewide ICSD Forms are accessible on the internet by going to:

http://www.hawaii.gov/dags/icsd/forms and clicking on **Statewide ICSD Forms**

Many Statewide Forms for other agencies and departments are also accessible on the internet at Forms Central by going to:

http://www.hawaii.gov/forms/ and clicking on the agency name or clicking on the

View Public Forms in the Database to view a list of all forms for all agencies.

Any comment, recommendation, proposal, or suggestion regarding the contents of this document may be sent either via email to icsd.admin.ppmo@hawaii.gov or in writing to:

>Department of Accounting and General Services
>Information and Communication Services Division
>Project Planning and Management Office
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2 VIRTUAL STORAGE ACCESS METHOD

VSAM is an IBM/MVS Operating System access method system. It is not a data base management system. VSAM supports batch users, on-line transactions, and data base applications.

VSAM is different from all other IBM access methods. Certain options and precautions must be evaluated and considered when VSAM datasets are defined and created. There are almost thirty different parameters that may be specified for data access and control options for the VSAM file.

2.1 VSAM ORGANIZATION TYPES

VSAM supports the following three (3) file organization types.

2.1.1 ESDS

The "entry-sequence dataset" (ESDS) is like a standard ("flat-file") sequentially accessed (SAM or QSAM) dataset.

2.1.2 RRDS

The "relative-record dataset" (RRDS) is like a directly accessible dataset file (DAM).

2.1.3 KSDS

The "key-sequenced dataset" (KSDS) is like an indexed sequentially accessible dataset, which may be processed sequentially, dynamically, or randomly based on the value of a key in a data record.

Records in a KSDS may also be accessed via an "alternate index" which specifies an order different from the file's primary (base) record key.

Although an alternate index may have an ESDS base cluster, most alternate indexes are built over a KSDS cluster.

2.2 VSAM ENVIRONMENT

In VSAM terms, a file is called a cluster. A cluster is a set of catalog entries that represent a file. A cluster has a data component that has the actual records of the file, and it may have an index component for the index keys for a KSDS file.

VSAM space is an area of a disk volume that's under the control of VSAM, so to the operating system, VSAM space is just another file. Within a VSAM space, VSAM can create sub-allocated files. If an entire space is to be allocated to a single VSAM file, it is called a "UNIQUE" file.

VSAM is used only for datasets on direct access storage devices (DASD). VSAM is very different from other dataset access methods. Certain OS MVS JCL DD statement parameters and sub-parameters are used differently for VSAM datasets.

2.3 ACCESS METHOD SERVICES (AMS) COMMANDS

AMS is a general-purpose utility that provides a variety of services for VSAM files. AMS is also called IDCAMS because IDC is IBM's prefix for VSAM.

AMS commands can be coded anywhere in columns 2 through 72. Do not use column 1 for AMS commands.

All AMS commands follow the following general format:

COMMAND parameter, parameter, ... terminator

Where:

"COMMAND" identifies the type of service requested.

"Parameter" defines particular features, attributes, or options of the service requested.

"Terminator" defines the end of the command statement.

Most of the AMS command parameters have one or more abbreviated forms. The abbreviations may be used in place of the fully spelled out form of the parameter.

2.4 CREATING A VSAM DATASET

The OS MVS JCL DD statement cannot be used to create a new VSAM dataset. The IBM Access Method Services (IDCAMS) commands must be used to create the space for a VSAM dataset.

Consult the IBM Access Method Services reference manual for information to create VSAM datasets.

The following are examples of the "DEFINE CLUSTER" command to create either a hypothetical KSDS or ESDS file.
KSDS

```
DEFINE    CLUSTER   ( NAME(PMS.PROJECT.MASTER)      -
                         INDEXED   -
                         RECORDSIZE(200 200) -
                         KEYS(6 0)  -
                         VOLUMES(PMSVOL)    -
                         UNIQUE )  -
                   DATA ( NAME(PMS.PROJECT.MASTER.DATA)      -
                         CYLINDERS(10 0) )      -
                   INDEX      ( NAME(PMS.PROJECT.MASTER.INDEX) )
ESDS

DEFINE    CLUSTER   ( NAME(PMS.PROJECT.TRANS)      -
                         NONINDEXED    -
                         RECORDSIZE(190 280) -
                         VOLUMES(PMSVOL) )   -
                   DATA ( NAME(PMS.PROJECT.TRANS.DATA) -
                         CYLINDERS(10 0))
```

2.5 RETRIEVING EXISTING VSAM DATASET

To request access to a previously created and cataloged VSAM dataset, an OS MVS JCL DD statement using one of the following formats must be in the JCL job stream:

```
//ddname      DD    DSNAME=datasetname,
//                  DISP=SHR

//ddname      DD    DSNAME=datasetname,
//                  DISP=OLD
```

A VSAM dataset cannot be passed to another step within a job stream.

The option "DISP=SHR" means that the dataset could be shared by other jobs if the share option was specified when the file was defined.

The option "DISP=OLD" means that the dataset would not be shared by other jobs even if the share option had been specified when the file was defined.

2.6 DD PARAMETERS TO USE WHEN PROCESSING VSAM DATASETS

Parameter	Sub-Parameter	Comments
AMP		The AMP parameter completes the information in an access method control block (ACB) for a VSAM dataset.
		The ACB is an operating system generated control block setup for entry-sequenced, key-sequenced, and relative record datasets.
		The AMP option is used only for VSAM datasets. Valid AMP sub-parameters are: AMORG, BUFND, BUFNI, BUFSP, OPTCD, TRACE, CROPS, STRNO, SYNAD, RECFM.
AMP	AMORG	When the UNIT or VOLUME parameter is coded for a VSAM file, AMORG must be specified.

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DDNAME		THE DDNAME PARAMETER functions the same as for other MVS dataset.
DISP	SHR	Indicates that the dataset can be shared and used in other jobs. This sub-parameter alone, however, does not guarantee that sharing will take place. See IBM MVS Virtual Storage Access Method (VSAM) Programmer's Guide for more information on dataset sharing.
DISP	OLD	Indicates that the accessed dataset will not be shared with other jobs.
DSNAME		The DSNAME parameter functions the same as for other MVS dataset.
DUMMY		Serves similar function as for other MVS datasets, except that the operating system will attempt to read results in an end-of-data condition, and will attempt to write results when a return code indicates the write request was successful. When the DUMMY parameter is used, the AMP=AMORG sub-parameter must be specified.
DYNAM		Works as for other MVS datasets.
FREE		Works as for other MVS datasets.
PROTECT		Works as for other MVS datasets.

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UNIT	type	Must be a device type supported by VSAM (e.g. 3380 or 3390). If not, operating system OPEN request will fail.
UNIT	group	Must be a DASD group supported by VSAM (e.g. DISKD). If not, operating system OPEN request will fail.
VOLUME	SER	The volume serial number(s) used in the IDCAMS DEFINE command for the dataset must match the volume serial number in the JCL "VOLUME=SERIAL=" specification when the dataset is defined.
		After the VSAM dataset is created, defined, and cataloged, the volume serial number(s) do not need to be specified on a JCL DD statement to retrieve or process the dataset.

2.7   DD PARAMETERS TO AVOID WHEN PROCESSING VSAM DATASETS

Parameter	Sub-Parameter	Comment
DATA		There is no way to get VSAM data elements into the job input stream. This parameter is not applicable to VSAM.
DCB	All	The access-method control block (ACB), not the data control block (DCB), describes VSAM dataset attributes. The DCB parameter is not applicable to VSAM. The DCB and AMP control parameters are mutually exclusive.
DISP	CATLG	VSAM dataset is cataloged and uncataloged via IDCAMS commands. If CATLG were coded, a message would be displayed but the dataset would not be cataloged.
DISP	DELETE	VSAM dataset is deleted as a result of an IDCAMS command. If DELETE were coded, a message would be issued, but the dataset

would not be deleted.

DISP	MOD	For VSAM datasets, MOD is treated as if OLD
DISP	KEEP	KEEP is the default disposition for VSAM datasets, it does not have to be coded.
DISP	NEW	VSAM dataset space is allocated as a result of IDCAMS commands. If NEW is specified, MVS will allocate space, but this space is never used by VSAM.
DISP	UNCATLG	VSAM dataset is cataloged/uncataloged as a result of IDCAMS commands. If UNCATLG is coded, a message is issued, but the dataset is not uncataloged.
DISP	PASS	VSAM datasets cannot be passed. The PASS parameter is not applicable to VSAM.
DSNAME	dsn(areaname)	The dataset name is used, but the "areaname" is ignored.
DSNAME	dsn(generation)	The dataset name is used, but the "generation" reference number is ignored.
DSNAME	dsn(member)	The dataset name is used, but the "member" name is ignored.
DSNAME	&&tempname	All VSAM datasets must be created via the Access Method Services which uses the dataset name provided in the IDCAMS DEFINE command. Temporary dataset names cannot be used with VSAM.
	All backward DD references using the form "*.ddname"	If the object referred to is a cluster name and the dataset and index reside on unlike devices, the results of a backward DD reference will be unpredictable.

SPACE		VSAM dataset space is designated or allocated as a result of IDCAMS commands. If SPACE is specified, an extent is allocated that is never used by VSAM.
UNIT	AFF	Use this sub-parameter with extreme care. If the cluster components, the data, and its index reside on unlike devices, the results of UNIT=AFF will not be predictable.
VOLUME	REF	Use this sub-parameter with extreme care. If the referenced volumes are not a subset of those contained in the catalog record for the dataset, the results are unpredictable.

2.8   CLOSING A VSAM DATASET

Under normal termination situations, the CLOSE macro does the following:

a.   Disconnects the application program from the dataset.

b.   Causes VSAM to update information in the VSAM catalog if data had been brought into virtual storage after the dataset was opened.

c.   Writes records in the operating system's SMF dataset.

d.   Writes out buffers of data or index records when their contents were changed by the job but which were not already written out.

If an application program had entered an abnormal termination routine, all datasets that were open at the time of the ABEND would be closed.

The VSAM CLOSE invoked by an ABEND will not update the dataset's catalog information. It does not complete outstanding I/O requests, and buffers are not flushed. This means that the catalog might not properly reflect the cluster's status, and the index might not accurately reference some of the data records.

If a VSAM dataset is closed as a result of an ABEND, the information technology specialist should execute an IDCAMS VERIFY command to restore the dataset's end-of-file values before the dataset is accessed again.

The VERIFY command does not work for KSDS or RRDS files that were improperly closed when they had been open for a load operation.

If a load does ABEND, the information technology specialist must delete the cluster, redefine it, and start the load operation over from the beginning.

3   VSAM OPTIONS

Many options, features, and situations either influence or, in some cases, determine VSAM's performance as well as the performance of the computer's operating system.

For information on these options and features see the vendor's Access Method Services manual.
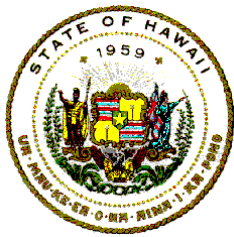
3.1   SPEED OR RECOVERY (LOADING OPTION)

The SPEED or RECOVERY option is coded at the CLUSTER or DATA level of a DEFINE CLUSTER command. SPEED or RECOVERY applies only to the initial loading of data. This option influences how VSAM loads data into a new file.

a.   If RECOVERY is specified (or allowed as default), VSAM pre-formats each control area that it allocates with binary zeros before it writes any control intervals to it.

b.   If SPEED is specified, VSAM does not pre-format the control areas. Therefore, the data load processing is much faster when SPEED is in effect because the additional I/O required to pre-format the control intervals is eliminated.

Since dataset load is probably not a significant part of the total job processing time, the SPEED option should be used instead of the RECOVERY option.

The overhead involved with the RECOVERY option is normally not worth the potential savings. If a system failure does occur, the dataset can be deleted, redefined, and loaded again from the beginning.

3.2 FILE STATUS CLAUSE (COBOL)

The FILE STATUS clause in a COBOL program specifies a field that is updated by VSAM when an I/O operation for that VSAM file has been executed.

The FILE STATUS field must be defined in the program's Working-Storage Section as a two-character alphanumeric item.

When a COBOL I/O operation is successful, VSAM will put "00" in the FILE STATUS field. But when an error condition occurs, VSAM will put a non-zero two-digit error code in the FILE STATUS field.

Therefore, COBOL program's logic should examine the FILE STATUS field after each VSAM I/O operation to determine whether an error occurred and, if so, what action should be taken (See Chapter 5, VSAM FOR COBOL for more detailed information).

The available COBOL VSAM I/O operation verbs are:

    OPEN,
    CLOSE,
    READ,
    WRITE,
    DELETE,
    REWRITE, and
    START.

3.3 CONTROL INTERVAL SIZE (KSDS DATASETS)

One of the most important aspects of insuring good VSAM file performance is selecting an appropriate control interval (CI) size.

To specify a control interval size, code the CONTROLINTERVALSIZE parameter (abbreviated CISZ) in the DEFINE command.

Although the CISZ parameter can be coded at the CLUSTER level, that's not a good idea because VSAM would assign the same CI size to both the DATA component and INDEX component.

The VSAM should calculate the INDEX CI size.
The following should be considered when calculating the DATA level CISZ .

a.   Initially for most datasets, CISZ(4096) is an appropriate assignment.

Smaller CI size (4096 or less) is recommended when a file will be mostly used for random retrieval.

Larger CI size is recommended when the file will be processed sequentially.

CI size up to 8192 bytes must be a multiple of 512.

CI size larger than 8192 must be a multiple of 2048.

b.   When VSAM tries to insert a record into a control interval that does not have enough free space, VSAM looks for a free control interval in the same control area so that it can do a "CI split".

If there are no free control intervals in that control area, VSAM splits the entire control area and may even extend the dataset.

If the control interval size (CI size) parameter is not explicitly specified in the "DEFINE" COMMAND, VSAM will select the CI size for both the data component and index component.

However, VSAM usually makes a poor choice for the data component CI size, but for the index component, VSAM's CI size value is usually best.

3.4   FREESPACE

Free space is allocated in terms of bytes, and not in terms of logical records. The parameters for defining free space are percentages of the defined data component.

For the FREESPACE parameter, the first value defines the percentage of free space to be reserved within each control interval, and the second defines the number of control intervals within each control area that should be reserved as free space.

3.5   IMBED AND REPLICATE (KSDS INDEX)

The DEFINE CLUSTER parameters IMBED and REPLICATE affect the way that the index component of a keyed sequence dataset (KSDS) is stored.

The index component has two parts, the index dataset records, and the sequencial dataset records.

The IMBED and REPLICATE options may be coded in either the CLUSTER or the INDEX level.

a.   The IMBED option places the index component's sequence set records in the space with the data component and causes the sequence set records to be duplicated as many times as possible on its track. This means that the first track of each control area will not be available for user data.

b.   The REPLICATE option places both index set and sequence set records on a separate track, duplicated as many times as possible.

The REPLICATE option may be used with the IMBED option, however, the IMBED option without the REPLICATE option, and also with sufficient buffering for the index is effective for most situations.

The easiest way to specify (and adjust) buffer space for the data and index is to specify BUFND and BUFNI in the AMP parameter of the file's JCL DD statement.

3.6   UNIQUE OR SUBALLOCATION PARAMETER

The UNIQUE or SUBALLOCATION parameter specifies whether a file should be sub-allocated within existing VSAM space, or created in its own space.

a.   A sub-allocated VSAM file shares the VSAM space with other sub-allocated files, and the VSAM space must be pre-defined through the use of the DEFINE SPACE command.

b.   A unique file resides in a space by itself and there is no need to pre-define the VSAM space. In this case, the space is allocated at the time when the file is defined, so there must be enough non-VSAM space on the volume to contain the file.

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The default attribute is SUBALLOCATION. Some computer centers may use SUBALLOCATION for easier management and control of VSAM spaces.

However at DAGS ICSD, the UNIQUE parameter must be specified when defining files.

3.7   VERIFY (DATA RECOVERY)

The VERIFY command is used to verify, and if necessary, to update, the end-of-file information in the VSAM catalog in order to make the catalog information consistent with the data file.

The VERIFY command cannot be used for an empty VSAM file where the high-used RBA (Relative Byte Address) in its catalog record is 0 (zero).

The creation of a low-value record in an empty VSAM file is normally the first step VSAM performs after a file is defined.

When a VSAM dataset is closed in an update program, VSAM will update the end-of-file information in both the VSAM catalog and the data file.

If an update program fails or the operating system fails, VSAM may not close the file properly. When this happens, VSAM is unable to update important information in the file's catalog record.

The VSAM file's catalog record has the high-used RBA that specifies the end of the file address. If this field is not updated, the information stored in the catalog record does not agree with the actual contents of the related file.

After the abnormal termination of a VSAM file, the VERIFY command must be executed to correct the catalog record information to reflect the actual status of the dataset before the file is used again.

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4 VSAM FEATURES

Certain features, facilities, functions, structures, or environments affect the efficiency and effectiveness of VSAM's operations and the performance of the computer's operating system.

4.1 VSAM SECURITY FACILITIES

The security facilities provided by VSAM generally are not sufficient for an installation that is serious about data security. For one thing, too many passwords are involved. With VSAM, it is possible to assign as many as twelve (12) different passwords to each VSAM KSDS (four each for the cluster, the data component, and the index component). As a result, a shop can easily end up managing thousands of different passwords.

Because of the inherent weaknesses of VSAM security, most installations use other security managers that provide a more comprehensive, system-wide approach to security.

At DAGS ICSD on the OS MVS systems, the IBM product RACF is used for data security.

RACF, which stands for Resource Access Control Facility, is just that: "a facility to control access to MVS system resources". RACF identifies both the users and the resources of the computer system. Then, RACF controls "which user" has "what access" to which particular MVS system resource.

One final point about the RACF product is that RACF completely replaces the password protection feature under VSAM. As a result, when a dataset is RACF protected, any VSAM password specification coded is ignored.

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4.2   VSAM BACKUP

Most installations routinely back up entire DASD volumes. Strictly speaking, volume-level backup and restoration is not a VSAM consideration; it is not performed by AMS.

DAGS ICSD has the FDR utility program that can dump disk volumes to magnetic tapes and can restore disk volumes from backup magnetic tapes. FDR can be used to back up disk volumes that contain VSAM data.

Application project managers must arrange to have their critical VSAM files backed up routinely. There are three (3) ways to back up VSAM files:

a.   A batch processing application designed to backup the data.

b.   The EXPORT and IMPORT commands to produce a backup copy of a dataset and later restore that copy.

c.   The REPRO command to copy a VSAM dataset along with DEFINE (and possibly DELETE) commands to backup and restore the file.

At DAGS ICSD, the recommended way to backup datasets is to use the AMS command REPRO to save a backup copy, and to restore a VSAM file.

Information technology specialists should REPRO to magnetic tape cartridge(s) (that are under the control of TLMS, the Tape Library Management System) for their dataset backups.

Before using the REPRO to restore the data files from the magnetic tape cartridge(s), use the DELETE command to erase and purge the VSAM area, and use the DEFINE command to again define the VSAM dataset attributes.

The output file specified in a REPRO command must exist. The output file must be created with a DEFINE CLUSTER command.

When the output file is empty, VSAM processes the file in load mode, and records are copied one by one from the input file to the output file.

When output files are not empty, VSAM merges the input file with the output file.
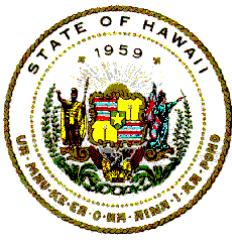
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4.2.1 Backup to TLMS Media

The following is an example that uses the REPRO command to backup a hypothetical file to a TLMS controlled GDG on tape cartridges:

```
//JOB2      JOB   (1234,PMS,2,5),' ITS-NAME',
//          MSGLEVEL=(1,1),
//          MSGCLASS=E,
//          CLASS=J
//STEPB     EXEC PGM=IDCAMS
//SYSPRINT DD    SYSOUT=*
//DATAIN    DD    DSN=PMS.MASTER,
//          DISP=OLD
//DATAOUT  DD    DSN=TMS.PMS.MASTER(+1),
//          DISP=(NEW,CATLG,DELETE),
//          UNIT=(ACS,,DEFER),
//      DCB=(X.SHRMODD,RECFM=FB,LRECL=080,BLKSIZE=32720)
//SYSIN     DD    *
     REPRO     INFILE    (DATAIN)    -
               OUTFILE   (DATAOUT)
/*
//
```

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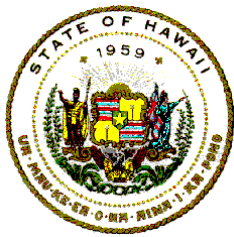**Information Technology Standards**

4.2.2 Reorganize KSDS

The following is an example that uses the REPRO command to
reorganize a hypothetical KSDS file:

```
//STEPC     EXEC PGM=IDCAMS
//SYSPRINT DD    SYSOUT=*
//DATAIN    DD    DSN=PMS.MASTER,
//          DISP=OLD
//DATAOUT  DD    DSN=TMS.PMS.MASTER(+1),
//          DISP=(NEW,CATLG,DELETE),
//          UNIT=(ACS,,DEFER),
//          VOL=(,RETAIN)
//      DCB=(X.SHRMODD,RECFM=FB,LRECL=080,BLKSIZE=32720)
//SYSIN     DD    *
  REPRO    INFILE     (DATAIN)     -
           OUTFILE    (DATAOUT)
/*
//STEPD     EXEC PGM=IDCAMS,COND=(7,LT)
//SYSPRINT DD    SYSOUT=*
//DATAIN    DD    DSN=TMS.PMS.MASTER(+1),
//          DISP=(OLD,KEEP),
//          UNIT=(ACS,,DEFER)
//SYSIN     DD    *
  DELETE   PMS.MASTER      CLUSTER
  DEFINE   CLUSTER   ( NAME(PMS.MASTER)   -
           INDEXED   -
           RECORDSIZE(200 200)   -
           KEYS(6 0)   -
           VOLUMES(PMSVOL)      -
           UNIQUE )   -
           DATA      ( NAME(PMS.MASTER.DATA)   -
           CYLINDERS(10 0) )      -
           INDEX     ( NAME(PMS.MASTER.INDEX) )
  REPRO    INFILE(DATAIN)     -
           OUTDATASET(PMS.MASTER)
/*
//
```

4.3   CICS DYNAMIC TRANSACTION BACKOUT

DAGS ICSD does not support CICS Dynamic Transaction. The application must be designed and developed to have its own recovery procedure that can perform an automatic backout of changes made to CICS protected resources by transactions that subsequently fail.

5   VSAM FOR COBOL

Input/Output statements common COBOL processing facilities are:

      o   status key field
      o   invalid key condition
      o   INTO/FROM identifier option
      o   current record pointer

Only the first three facilities are discussed in the following sections.

I.   STATUS KEY

If the FILE STATUS clause is specified in the FILE-CONTROL entry, a value is placed in the specified STATUS KEY (in the two (2) character data item that is named in the FILE STATUS clause) during the execution of any request on that file.

The value indicates the status of the I/O request. It is placed in the STATUS KEY before the execution of any EXCEPTION/ERROR Declaratives, or the INVALID KEY/AT END option associated with the request.

The first character of the STATUS KEY is known as the HIGH-ORDER DIGIT.

The second character of the STATUS KEY is known as the LOW-ORDER DIGIT.
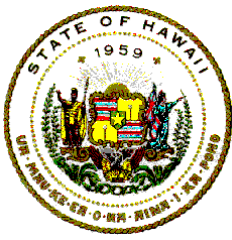
For VSAM files, the combination of possible STATUS KEY values, and their meanings are shown in the next table. Note: This is a partial table compared to all the possible status codes that are listed on the next page.

High-Order Digit	MEANING	Low-Order Digit	MEANING
0	Successful completion	0	No further information
		2	Duplicate key, and DUPLICATES specified
1	AT END (no next logical record; or OPTIONAL file not available at OPEN time)	0	No further information
		4	Sequential READ issued but relative record number exceeded largest number allowed
2	Invalid Key Condition	1	Prime Key changed between a READ and REWRITE statement
		2	Duplicate Key during READ, REWRITE or WRITE
		3	Record not found during START or READ
		4	Out of space during WRITE, or record number exceeded largest relative record number allowed
3	Permanent Error (data check, parity check, transmission error)	0	No further information
		4	Boundary violation (sequential file)
9	Other errors	0	No further information
		1	Password failure
		2	Logic error (file already open; file not OPEN; no previous READ; end-of-file reached; incorrect key for EXTEND file)
		3	Resource not available; not enough virtual storage for VSAM task
		4	No current record pointer for sequential request
		5	Invalid or incomplete file information; conflicting file attributes
		6	No file identification; no DD statement
		7	OPEN statement execution successful; file integrity is verified; file not closed by previous job

To summarize, after each VSAM file operation is carried out, the VSAM status code should be checked. To use the status code, there must be a working storage field that will contain the file status. Use the clause "FILE STATUS IS status-field" in the SELECT statement. The list below has valid VSAM return codes and their meanings.

CODE	STATUS CODE MEANING
00	Operation completed successfully
02	Duplicate key was found
04	Invalid fixed length record
05	The file was created when OPENed - Successful Completion
07	CLOSE with REEL or NO REWIND executed for non-tape dataset
10	End-of-File encountered
14	Attempted to READ a relative record outside file boundary
21	Invalid Key - Sequence error
22	Invalid Key - Duplicate Key found
23	Invalid Key - No record found
24	Invalid Key - Key outside boundary of file
30	Permanent I/O Error
34	Permanent I/O error - Record outside file boundary
35	OPEN executed but file not found
37	OPEN executed with wrong mode
38	Tried to OPEN a LOCKed file
39	OPEN failed, conflicting file attributes
41	Tried to OPEN a file that is already OPEN
42	Tried to CLOSE a file that is not OPEN
43	Tried to REWRITE without READing a record first
44	Tried to REWRITE a record of a different length
46	Tried to READ beyond End-of-File
47	Tried to READ from a file that was not OPENed I-O or INPUT
48	Tried to WRITE to a file that was not OPENed I-O or OUTPUT
49	Tried to DELETE or REWRITE to a file that was not OPENed I-O
91	Password or Authorization failed
92	Logic error
93	Resource not available, may be allocated to CICS or another user
94	Sequential record not available, or concurrent OPEN error
95	File Information invalid or not complete
96	No DD statement for the file
97	OPEN successful and file integrity was verified
98	File is Locked - OPEN failed
99	Record is Locked - record access failed

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II.   INVALID KEY CONDITION

The INVALID KEY condition can occur during the execution of a START, READ, WRITE, REWRITE, or DELETE statement.

For details of the causes for the condition, see the discussions of those statements.

When the INVALID KEY condition is recognized, the following actions are taken in the following order:

1.   If the FILE-STATUS clause is specified in the FILE-CONTROL entry, a value is placed into the STATUS KEY to indicate an INVALID KEY condition.

2.   If the INVALID KEY option is specified in the statement causing the condition, control is transferred to the INVALID KEY imperative-statement.

     Any EXCEPTION/ERROR declarative procedure specified for this file is not executed.

3.   If the INVALID KEY option is not specified, but the EXCEPTION/ERROR declarative procedure is specified for the file, the EXCEPTION/ERROR procedure is executed.

When an INVALID KEY condition occurs, the Input/Output statement that caused the condition is not successful.

If the INVALID KEY option is not specified for the file, an EXCEPTION/ERROR procedure must be specified.

(HOWEVER (as an IBM Extension), this implementation allows both the INVALID KEY option, and the EXCEPTION/ERROR procedure to be omitted.)

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III.   INTO/FROM IDENTIFIER OPTION

This option is valid for READ, REWRITE, and WRITE statements.

The specified identifier must be the name of an Entry in the WORKING-STORAGE SECTION, the LINKAGE SECTION, or of a record description for another previously opened file.

RECORD-NAME/FILE-NAME and the IDENTIFIER must not refer to the same Storage Area.

The input-output statements take the following form:

```
READ file-name RECORD        INTO identifier
WRITE record-name            FROM identifier
REWRITE record-name          FROM identifier
```