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Hitachi Virtual Storage Platform G series and F series

SVOS 7.3

Encryption License Key User Guide

This document describes and provides instructions for Encryption License Key, a feature of the VSP G series and VSP F series storage systems.

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Contents

Preface

This document describes and provides instructions for Encryption License Key, a feature of the VSP G series or VSP F series systems.

Please read this document carefully to understand how to use these products, and maintain a copy for your reference.

Intended audience

This document is intended for system administrators, Hitachi Vantara representatives, and authorized service providers who install, configure, and operate VSP G series and VSP F series storage systems.

Readers of this document should be familiar with the following:

- Data processing and RAID storage systems and their basic functions.
- The VSP G series and VSP F series storage systems and the *Product Overview*.
- The Hitachi Device Manager - Storage Navigator software.
- The concepts and functionality of storage provisioning operations.

Product version

This document revision applies to:

- VSP G1x00 and VSP F1500 : microcode 80-05-6*x* or later
- VSP G200, G400, G600, G800, VSP F400, F600, F800 : firmware 83-04-6*x* or later
- SVOS 7.3 or later

Release notes

Read the release notes before installing and using this product. They may contain requirements or restrictions that are not fully described in this document or updates or corrections to this document. Release notes are available on Hitachi Vantara Support Connect: https://knowledge.hitachivantara.com/Documents.

Changes made in this revision

- Added procedures for enabling and disabling data encryption for V-VOLs.

Related documents

The following documents are referenced in this guide:

- *Product Overview*, MK-94HM8013
- *Hitachi Virtual Storage Platform G200 Hardware Reference Guide*, MK-94HM8020
- *Hitachi Virtual Storage Platform G400, G600 Hardware Reference Guide*, MK-94HM8022

- *Hitachi Virtual Storage Platform G800 Hardware Reference Guide*, MK-94HM8026
- *Hitachi Virtual Storage Platform F400, F600 Hardware Reference Guide*, MK-94HM8045
- *Hitachi Virtual Storage Platform F800 Hardware Reference Guide*, MK-94HM8046
- *Provisioning Guide*, MK-94HM8014
- *System Administrator Guide*, MK-94HM8016
- *Hitachi Audit Log User Guide*, MK-94HM8028
- *Hitachi Universal Replicator User Guide*, MK-94RD8023
- *Hitachi ShadowImage® User Guide*, MK-94RD8021
- *Hitachi TrueCopy® User Guide*, MK-94RD8019
- *Product Overview*, MK-92RD8051
- *Hardware Guide for Hitachi Virtual Storage Platform G1000, G1500, and F1500*, MK-92RD8007
- *Performance Guide*, MK-92RD8012
- *Provisioning Guide for Mainframe Systems*, MK-92RD8013
- *Provisioning Guide for Open Systems*, MK-92RD8014
- *System Administrator Guide*, MK-92RD8016
- *Hitachi Audit Log User Guide*, MK-94RD8008

Document conventions

This document uses the following storage system terminology conventions:

Convention	Description
VSP G series	Refers to the following storage systems: • Hitachi Virtual Storage Platform G1x00 • Hitachi Virtual Storage Platform G200 • Hitachi Virtual Storage Platform G400 • Hitachi Virtual Storage Platform G600 • Hitachi Virtual Storage Platform G800
VSP F series	Refers to the following storage systems: • Hitachi Virtual Storage Platform F1500 • Hitachi Virtual Storage Platform F400 • Hitachi Virtual Storage Platform F600 • Hitachi Virtual Storage Platform F800
VSP Gx00 models	Refers to all of the following models, unless otherwise noted. • Hitachi Virtual Storage Platform G200 • Hitachi Virtual Storage Platform G400 • Hitachi Virtual Storage Platform G600 • Hitachi Virtual Storage Platform G800
VSP Fx00 models	Refers to all of the following models, unless otherwise noted. • Hitachi Virtual Storage Platform F400 • Hitachi Virtual Storage Platform F600 • Hitachi Virtual Storage Platform F800

This document uses the following typographic conventions:

Convention	Description
Bold	• Indicates text in a window, including window titles, menus, menu options, buttons, fields, and labels. Example: Click **OK**. • Indicates emphasized words in list items.
Italic	• Indicates a document title or emphasized words in text. • Indicates a variable, which is a placeholder for actual text provided by the user or for output by the system. Example: `pairdisplay -g` *`group`* (For exceptions to this convention for variables, see the entry for angle brackets.)
`Monospace`	Indicates text that is displayed on screen or entered by the user. Example: `pairdisplay -g oradb`
< > angle brackets	Indicates variables in the following scenarios: • Variables are not clearly separated from the surrounding text or from other variables. Example: `Status-<`*`report-name`*`><`*`file-version`*`>.csv` • Variables in headings.
[ ] square brackets	Indicates optional values. Example: [a | b] indicates that you can choose a, b, or nothing.
{ } braces	Indicates required or expected values. Example: { a | b } indicates that you must choose either a or b.
| vertical bar	Indicates that you have a choice between two or more options or arguments. Examples: [a | b] indicates that you can choose a, b, or nothing. { a | b } indicates that you must choose either a or b.

This document uses the following icons to draw attention to information:

Icon	Label	Description
📄	Note	Calls attention to important or additional information.
💡	Tip	Provides helpful information, guidelines, or suggestions for performing tasks more effectively.
⚠	Caution	Warns the user of adverse conditions and/or consequences (for example, disruptive operations, data loss, or a system crash).
⚠	WARNING	Warns the user of a hazardous situation which, if not avoided, could result in death or serious injury.

Conventions for storage capacity values

Physical storage capacity values (for example, disk drive capacity) are calculated based on the following values:

Physical capacity unit	Value
1 kilobyte (KB)	1,000 (10 ^{3}) bytes
1 megabyte (MB)	1,000 KB or 1,000^2 bytes
1 gigabyte (GB)	1,000 MB or 1,000^3 bytes
1 terabyte (TB)	1,000 GB or 1,000^4 bytes
1 petabyte (PB)	1,000 TB or 1,000^5 bytes
1 exabyte (EB)	1,000 PB or 1,000^6 bytes

Logical capacity values (for example, logical device capacity, cache memory capacity) are calculated based on the following values:

Logical capacity unit	Value
1 block	512 bytes
1 cylinder	Mainframe: 870 KB Open-systems: • OPEN-V: 960 KB • Others: 720 KB
1 KB	1,024 (2^{10}) bytes
1 MB	1,024 KB or 1,024^2 bytes
1 GB	1,024 MB or 1,024^3 bytes
1 TB	1,024 GB or 1,024^4 bytes
1 PB	1,024 TB or 1,024^5 bytes
1 EB	1,024 PB or 1,024^6 bytes

Accessing product documentation

Product user documentation is available on Hitachi Vantara Support Connect: https://knowledge.hitachivantara.com/Documents. Check this site for the most current documentation, including important updates that may have been made after the release of the product.

Getting help

Hitachi Vantara Support Connect is the destination for technical support of products and solutions sold by Hitachi Vantara. To contact technical support, log on to Hitachi Vantara Support Connect for contact information: https://support.hitachivantara.com/en_us/contact-us.html.

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Thank you!

1

Encryption License Key Overview

This chapter describes the Encryption License Key features and specifications.

Encryption License Key benefits

To guarantee the security of data, use the Encryption License Key feature to encrypt the data stored on VSP G series or VSP F series storage systems. Encrypting data can prevent information loss and leaks, for example, when a drive is physically removed from the storage system due to failure or theft.

The Encryption License Key feature provides the following benefits:

- Hardware-based AES 256 encryption in XTS mode for open and mainframe systems
- Encryption can be applied to some or all internal drives.
- Encryption does not affect I/O throughput or latency.
- Encryption requires little to no disruption of existing applications and infrastructure.
- Simplified and integrated key management that does not require specialized key management infrastructure

Encryption License Key support specifications

The following table lists the support specifications for Encryption License Key.

Item		Specification
Hardware specifications	Encryption algorithm	Advanced Encryption Standard (AES) 256 bit
	Encryption mode	XTS mode
	Encryption module standard	VSP G200: Compliant to FIPS 140-2 Level 1 VSP G400, G600, G800, VSP F400, F600, F800: Compliant to FIPS 140-2 Level 2 VSP G1000, VSP G1500, and VSP F1500: Compliant to FIPS 140-2 Level 1 and Level 2*
LDEVs that you can encrypt	Volume type	Open, mainframe, multiplatform
	Emulation type	All emulation types
	Internal/external LDEVs	Internal LDEVs only
	LDEV with existing data	Supported. Requires data migration.
Managing data encryption keys	Creating data encryption keys	Use your system's storage management software to create encryption keys.
	Deleting data encryption keys	Use your system's storage management software to delete encryption keys. However, you cannot delete encryption keys that are allocated to implemented drives.
	Unit of encryption/decryption	Parity group. Data encryption key is used per HDD.
	Scope of data encryption keys	• For VSP G200:

Item		Specification
		512 encryption keys per storage system. You can create 512 Free keys or DEKs. Additionally, you can create 4 CEKs and one KEK. Therefore, the total maximum number of encryption keys will be 517 when including CEKs and KEKs. • For VSP G400, G600 and VSP F400, F600: 1,024 encryption keys per storage system. You can create 1,024 Free keys or DEKs. Additionally, you can create 4 CEKs and one KEK. Therefore, the total maximum number of encryption keys will be 1,029 when including CEKs and KEKs. • For VSP G800 and VSP F800: 2,048 encryption keys per storage system. You can create 2,048 Free keys or DEKs. Additionally, you can create 16 CEKs and one KEK. Therefore, the total maximum number of encryption keys will be 2,065 when including CEKs and KEKs. • For VSP G1x00 and VSP F1500: 4,096 encryption keys per storage system. You can create 4,096 Free keys or DEKs. Additionally, you can create 32 CEKs and one KEK. Therefore, the total maximum number of encryption keys will be 4,129 when including CEKs and KEKs.
	Attribute of encryption keys	The following attributes will be set for the encryption keys: • **Free:** The unused key before allocating the encryption key. • **DEK:** The data encryption key. The key for the encryption of the stored data. • **CEK:** The certificate encryption key. The key for the encryption of the certificate and the key for the encryption of DEK per HDD. • **KEK:** The key encryption key. The key for the encryption of the CEK.
	Backup/Restore functionality	Redundant (primary and secondary) backup/ restore copies
* To use encryption modules compliant to FIPS 140-2 Level 2, contact customer support.		

When to use encryption keys

After you set up the encryption environment, you will need encryption keys to perform the following operations:

- Adding drives

  A Free key is needed for each drive to allocate a DEK.

- Replacing drives
  A Free key is needed for each drive to change a DEK.
- Adding or replacing encrypting back-end directors (EBEDs)
  For VSP Gx00 models and VSP Fx00 models: To replace an EBED, two Free keys are used as CEKs. One Free key is used to register them.
  For VSP G1x00 and VSP F1500:
  To replace an EBED, four Free keys are used as CEKs. Two Free keys are used to register them.
- Updating CEKs
  For VSP G200, VSP G400, G600, and VSP F400, F600: Two Free keys for each EBED (four Free keys per storage system) are needed to change CEKs.
  For VSP G800 and VSP F800:
  Four Free keys for each EBED (up to 16 Free keys per storage system, regardless of the number of EBEDs) are needed to change CEKs.
  For VSP G1x00 and VSP F1500:
  Four Free keys for each EBED (32 Free keys per storage system) are needed to change CEKs.

If a problem occurs during an operation, extra keys might be needed to recover from the problem.

Primary and secondary backups of encryption keys

The storage system automatically creates and stores a primary backup of each encryption key. The Encryption License Key feature enables you to create secondary backups of the data encryption keys for the storage system. If the primary backup key is unavailable, the secondary backup is required to restore the key.

Caution: If the primary backup key becomes unavailable and no secondary backup key exists, the system cannot decrypt the encrypted data.

It is strongly recommended that you back up each encryption key or group of keys immediately after you create them and schedule regular weekly backups of all encryption keys to ensure data availability. You are responsible for storing the secondary backup keys securely.

It is also recommended that you back up each encryption key after you perform any of the following operations:

- Create encryption keys
- Add, remove, or replace drives
- Add, remove, or replace EBEDs
- Replace controllers
- Update CEKs
- Update KEKs

Important: The creation and secure storage of secondary backup encryption keys must be included as part of your corporate security policy.

Caution: (VSP Gx00 models and VSP Fx00 models) If you change time zone settings from a maintenance PC or on the SVP, you must restart the services of all storage systems in the Storage Device List window. Otherwise, regular backup is not performed as scheduled.

Related tasks

- Creating encryption keys on page 34
- Backing up keys to a file on page 35
- Backing up the keys to a key management server on page 36

Related references

- Edit Encryption Environmental Settings window on page 68

Regularly scheduled encryption key backups

An encryption key can be automatically backed up at scheduled intervals (for example, daily or weekly) at a specified time to the key management server. This operation is called a *regular backup*. You can specify the schedule for the regular backup in the **Edit Encryption Environmental Settings** window. Regular backups are performed automatically even when the user is not logged in.

Requirements for scheduling regular backups

- You must have a valid, enabled Encryption License Key license key to perform regular backups. If the Encryption License Key license expires or the license is deleted, scheduled backups will not be performed.
- Create a user dedicated to the regular backup (referred to here and in the user interface as the *regular backup user*), and then enter the user name and the password of the regular backup user in the **Edit Encryption Environmental Settings** window when configuring the key management server to include regular backups.

  For details about how to create a new user, see the *System Administrator Guide* for your storage system.

Caution: A regular backup might fail if you edit or remove the regular backup user account, including when you delete users, change the regular backup user password, or change roles. For this reason, every time you edit a regular backup user account, be sure to respecify the regular backup user's user name and password in the **Edit Encryption Environmental Settings** window.

How regular backups are queued

At the specified time for a regular backup, the backup is queued as a task. You can verify queued tasks in the **Task** window. If other tasks are already queued, the regular backup will not start until the other tasks are complete. Because of this, the time that the regular backup begins might be different from the time you specified.

Note: Like any other task, you can verify the regular backup task result in the **Task** window and in the audit log. You should verify, on a regular basis, that backups are being created. The audit log is output using the regular backup user name.

At the specified time for a regular backup, if a previous backup is not performed because another queued task is still in progress, the second backup is not queued. Only the first backup is performed. For example, if you specify 00:00 and 02:00 for regular backups, and a task started before 00:00 completes at 03:00, the 02:00 regular backup is not queued, and only the regular backup for 00:00 is performed at 03:00.

To discontinue regular backups, clear the check box for Enable Encryption Key Regular Backup to Key Management Server in the **Edit Encryption Environmental Settings** window.

A regular backup deletes old encryption keys. Because of this, the number of encryption keys to be backed up regularly is always one. Manually backed up keys are not deleted. In the same way as manually backed up keys, the status of a regular backup encryption key can be viewed, and the key itself can be restored or deleted.

When the SVP stops, regular backups are not performed. After the SVP is restarted, regularly scheduled backups will resume queueing as a task.

Caution: During a regular backup, your service representative cannot perform maintenance of storage systems and SVP operations. If a regularly scheduled backup time comes during maintenance, cancel the backup task temporarily or revise the regular backup settings.

Important: Performing a regular backup is a supplemental function. In addition to regular backups, manual backups must be performed, especially, after you complete any of the following tasks:

- Create encryption keys
- Add, remove, or replace drives
- Add, remove, or replace EBEDs
- Replace controllers
- Update CEKs
- Update KEKs

Related tasks

- Configuring the key management server on page 27
- Backing up the keys to a key management server on page 36

Related references

- Edit Encryption Environmental Settings window on page 68

KMIP key management server support

Using the Encryption License Key feature, you can create backup and restore data encryption keys on a key management server that supports Key Management Interoperability Protocol (KMIP).

There are a limited number of keys you can back up on the key management server. Therefore, it is recommended that you delete unnecessary keys when possible.

Related tasks

- Backing up the keys to a key management server on page 36

Implementing data encryption

The following steps are required to implement data encryption:

1. Install the Encryption License Key feature.
2. If you use a key management server, prepare the client certificate and configure the encryption environmental settings. For details, see Configuring the key management server on page 27.
3. Create and back up the encryption keys. For details, see Creating and backing up encryption keys on page 33 and Backing up encryption keys on page 35.
4. Enable encryption on the desired parity groups. For details, see Enabling data encryption on page 43.

How to encrypt existing data

To encrypt existing data, you must migrate the data to an encrypted parity group.

To encrypt existing data, the following steps are required:

1. Create a new parity group.
2. Enable data encryption on the parity group. For details, see Enabling data encryption on page 43.
3. Format the LDEVs in the encrypted parity group. For instructions, see the *Provisioning Guide* for your storage system.

4. Migrate the existing data to the LDEVs in the encrypted parity group. For details about data migration, contact your account team.
5. After migrating the existing data to the encrypted parity group, shred the unencrypted data (migration source volumes) to prevent the data from being leaked. For details about shredding volumes, see the *Hitachi Volume Shredder User Guide*.

Workflow for disabling encryption

Use the following process to disable encryption:

1. Back up the data in the parity group to be decrypted.
2. Disable data encryption on the parity group. For details, see Disabling data encryption on page 49.
3. Format the LDEVs in the parity group. For instructions, see the *Provisioning Guide* for your storage system.

Workflow for changing the encryption key

To change the encryption key for existing encrypted data, you must migrate the data to an encrypted parity group that has a different encryption key.

Use the following process to change the encryption key for encrypted data:

1. Create a new parity group.
2. Enable encryption with a new data encryption key. For details, see Enabling data encryption on page 43.
3. Format the LDEVs in the encrypted parity group. For instructions, see the *Provisioning Guide* for your storage system.
4. Migrate the source data to the new target LDEVs in the encrypted parity group.

When a drive is replaced, the data encryption keys that are allocated to that drive are deleted, and new data encryption keys are allocated when the new drive is added.

Audit logging of encryption events

The Audit Log feature of the VSP G series or VSP F series storage systems provides audit logging of events that happen in the system. The audit log records events related to data encryption and data encryption keys and is the only feature that records the interaction between the SVP and the KMIP key manager when configured. It can be used in checking and troubleshooting key back and generation.

For details about audit logging and audit log events, see the *Hitachi Audit Log User Guide*.

2

Encryption License Key installation

This chapter describes how to install the Encryption License Key feature.

Installing the Encryption License Key

Follow this workflow to install the Encryption License Key feature:

1. Verify that your system meets the system requirements.
   For details, see System requirements on page 22.
2. Enable the Encryption License Key feature.
   For details, see Enabling the Encryption License Key feature on page 23.
3. Assign the Security Administrator (View & Modify) role to the administrator who creates, backs up, and restores data encryption keys.
   For details, see Enabling the Encryption License Key feature on page 23.

Related tasks

- Enabling the Encryption License Key feature on page 23

Related references

- System requirements on page 22
- Interoperability requirements and considerations on page 23

System requirements

The following table lists the system requirements for the Encryption License Key feature.

Item	Requirement
VSP G1x00 and VSP F1500	Microcode 80-01-2x and later.
VSP G200, VSP G400, G600, G800 / VSP F400, F600, F800	• For VSP G200: Firmware 83-03-0x and later. • For VSP G400, G600, G800 or VSP F400, F600, F800: Firmware 83-01-0x and later.
Hitachi Device Manager - Storage Navigator	• Encryption License Key software license • Security Administrator (View & Modify) role to enable or disable data encryption and to back up or restore keys • Storage Administrator (provisioning) role to format volumes
SVP (Web server)	To connect to the key management server by specifying the host name instead of IP address, you need the DNS server settings. For SVP configuration, give your service representative the IP address of the DNS server.
Host platforms	All open-systems and mainframe host platforms are supported.
Data volumes	All volume types and emulations are supported: open-systems, mainframe, and multiplatform

Item	Requirement
	Supported volumes: Internal
Encrypting back-end director (EBED)	A special BED that provides data encryption. A BED can also be called a disk adapter (DKA). For both EBEDs and standard BEDs, spare disks must be installed. The spare disk of an EBED cannot be used as a spare disk of a standard BED, and the spare disk of a standard BED cannot be used as a spare of an EBED.

Interoperability requirements and considerations

The following table provides the interoperability requirements and considerations for Encryption License Key operations.

Functions	Interoperability requirements and considerations
ShadowImage, TrueCopy, Compatible FlashCopy® V2, and Compatible XRC	Encrypt both the P-VOL and S-VOLs (S-VOL and T-VOLs for Compatible FlashCopy® V2) of pairs to ensure data security.
Thin Image	Match the encryption states of the P-VOL and pool-VOL. If the P-VOL is encrypted, encrypt all of the pool-VOLs. If the data pool contains an unencrypted pool-VOL, the differential data of the P-VOL is not encrypted.
Universal Replicator	Match the encryption states of a P-VOL and S-VOL. If you encrypt the P-VOL only, the data copied on the S-VOL is not encrypted and therefore not protected. When you encrypt a P-VOL or S-VOL, use a journal to which only encrypted LDEVs are registered as journal volumes. If the encryption states of the P-VOL, S-VOL, and journal volumes do not match, the journal data in the P-VOL is not encrypted, and the security of the data cannot be guaranteed.
Dynamic Provisioning, Dynamic Tiering, Dynamic Provisioning for Mainframe, Dynamic Tiering for Mainframe, active flash, and active flash for mainframe	When enabling encryption for data written to a data pool through a V-VOL, use a data pool that consists of encrypted volumes. After encrypting volumes, you need to perform encryption formatting for the pool volume and the virtual volume.
Volume Migration	Encrypt the source LDEV and the target LDEV. The encryption states of the source and target LDEVs must match for the Encryption License Key feature to encrypt and guarantee the security of the data on the source and target LDEVs.
dedupe and compression	When disabling encryption, you must disable the capacity saving function settings for the virtual volume.

Enabling the Encryption License Key feature

Procedure

1. Enable the Encryption License Key license on the storage system. See the *System Administrator Guide* for your storage system.

If the Encryption License Key software license expires or is missing, you cannot delete the encryption key.

2. Assign the Security Administrator (View & Modify) role to the user who will be enabling or disabling data encryption and backing up or restoring keys.

   For details about assigning roles, see the *System Administrator Guide*.

Disabling the Encryption License Key feature

You must perform steps 1 and 2 in the following procedure before you disable the software license key.

Procedure

1. Disable data encryption on all encrypted parity groups. For instructions, see Disabling data encryption on page 49.
2. Initialize the encryption environmental settings. For instructions, see Initializing the encryption environment settings on page 60.
3. Disable the software license key. For instructions, see the *System Administrator Guide*.

3

Key Management Server Connections

You can use an optional key management server with the VSP G series or VSP F series storage systems. This chapter provides information on setting up the key management server.

Key management server requirements

The key management server must meet the following requirements:

- Protocol: Key Management Interoperability Protocol 1.0 (KMIP1.0)
- Software:
  - SafeNet KeySecure k460: 6.4.1 or 8.2.0
  - Thales keyAuthority: 4.0.2
  - Enterprise Secure Key Manager 4.1: 6.1.0
- Certificates:
  - Root certificate of the key management server (X.509)
  - Client certificate in PKCS#12 format

Setting up the root certificate

If you use SafeNet KeySecure k460 or Thales keyAuthority, or Enterprise Secure Key Manager 4.1 on the key management server, create and put the root certificate on the server. For details, see the SafeNet KeySecure k460, Thales keyAuthority, or Enterprise Secure Key Manager 4.1 documentation.

The root certificate of the key management server must be in X.509 format.

Related tasks

- Setting up the client certificate on page 26

Related references

- Key management server requirements on page 26

Setting up the client certificate

To access the key management server, the client certificate must be current and not expired. Use the following process to prepare the client certificate.

Procedure

1. Download and install `openssl.exe` from http://www.openssl.org/ to the `C:\openssl` folder.
2. Create the key file. You can create the following types of key files:
   - Private key (.key) file. For the creation of Private key, see the *System Administrator Guide*.
   - Public key (.csr) file. For the creation of Private key, see the *System Administrator Guide*.
3. Convert the client certificate to PKCS#12 format.

a. From an open command prompt, change the current directory to the folder where you want to save the client certificate in the PKCS#12 format.

b. Move the private SSL key file (.key) and the client certificate to the folder in the current directory, and run the command.

   The following is an example for an output folder of `c:\key`, private key file (`client.key`), and a client certificate file (`client.crt:`).

```
C:\key>c:\openssl\bin\openssl pkcs12 -export -in client.crt
-inkey client.key -out client.p12
```

c. Type the client certificate password. The password can be from 0 to 128 characters in length. The valid characters for the password are:

   - Numbers (0 to 9)
   - Upper case letters (A-Z)
   - Lower case letters (a-z)
   - The following symbols: ! # $ % & ' ( ) * + , - . / : ; < = > ? @ [\ ] ^ _ ` { | } ~

4. Upload the root and client certificates to the SVP.

a. In the Device Manager - Storage Navigator main window, select **Administration** in **Explorer**, and select **Encryption Keys**.

b. In the **Encryption Keys** window, click **Edit Encryption Environmental Settings**.

c. Upload the certificates.

Related references

- Edit Encryption Environmental Settings window on page 68
- Key management server requirements on page 26

Configuring the key management server

To use a key management server, you must configure the network connection settings and back up the data encryption keys to the key management server.

Caution: Encryption keys backed up on the key management server are managed with the client certificate. If the client certificate is lost, and the SVP is replaced due to a failure, you cannot restore the encryption keys that were backed up before the SVP replacement. In addition, when the connection settings are backed up to the key management server, the system does not back up the client certificate. Make sure that you back up a copy of the connection settings to the key management server and save a copy of the client certificate separately. Refer to your corporate security policy for procedures related to backups.

Caution: To protect the key encryption key at the key management server, the key management server must be configured using two clustered servers. For this reason, you must enable the secondary server.

Note:
- If you use a V-VOL, you will need encryption/unencryption formatting for the V-VOL.
- To connect to the key management server by host name instead of IP address, send the IP address of the DNS server to your service representative and request that the service representative configure the SVP.

Before you begin

- You must have the Security Administrator (View & Modify) role.
- Verify that the client and root certificates are uploaded to the key management server. If the certificates are not uploaded, contact the key management server administrator.
- If you are configuring regularly scheduled backups, create a regular backup user. For details about how to create users, see the *System Administrator Guide* for your storage system.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Expand **Administration** in the **Explorer** pane, and select **Encryption Keys**.
3. In the **Encryption Keys** window, select the **Encryption Keys** tab.
4. Click **Edit Encryption Environmental Settings**.
5. In the **Edit Encryption Environmental Settings** window, for **Key Management Server**, select **Enable**.
6. Expand **Server Settings** and specify the **Primary Server** information.
7. For **Secondary Server**, select **Enable** and specify the settings for the secondary server.
8. For **Server Configuration Test**, click **Check** to test the connection. Error messages appear if the server configuration test fails.
9. To generate an encryption key on the key management server, select **Generate Encryption Keys on Key Management Server**.

   To store the encryption key on the key management server, select **Protect the Key Encryption Key on the Key Management Server**, then **I Agree**.

   Caution: If you have selected **Protect the Key Encryption Key on the Key Management Server** in **Generate Encryption Keys on Key Management Server**, the storage system will try to get encryption keys backed up on the key management server once the storage system is turned on. Therefore, it is recommended that you confirm that the SVP is connected to the key management server properly before turning the storage system on.

10. To schedule a regular backup, select **Enable Encryption Key Regular Backup to Key Management Server**, and then select backup times from **Regular Backup Time**.
11. Enter the user name and password for the regular backup user in **Regular Backup User**.
12. To generate an encryption key on the key management server without creating an encryption key in the storage system, select **Disable Local Key Generation**. Confirm the Warning that displays and select **I Agree**.

    Caution: When you select the **Disable local key generation** and **I Agree** check-boxes in **Generate Encryption Keys on Key Management Server** and finished the settings, you cannot undo this action.

13. Click **Next**.
14. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**, and then click **Apply**.

    If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

Result

The connection to the key management server is set up.

Important: If the key management server is unavailable after you complete this task, the settings may be incorrect. Contact the server or network administrator.

Next steps

1. Save a back up copy of the client certificate.
2. Back up the connection settings to the key management server configuration files by downloading the configuration files to a folder. You can then use the backup copies to restore one or more configuration files if it becomes necessary.

   For instructions, see the *System Administrator Guide* for your storage system.

Related concepts

- Regularly scheduled encryption key backups on page 17

Related tasks

- Setting up the client certificate on page 26

Restoring the key management server connection after SVP replacement

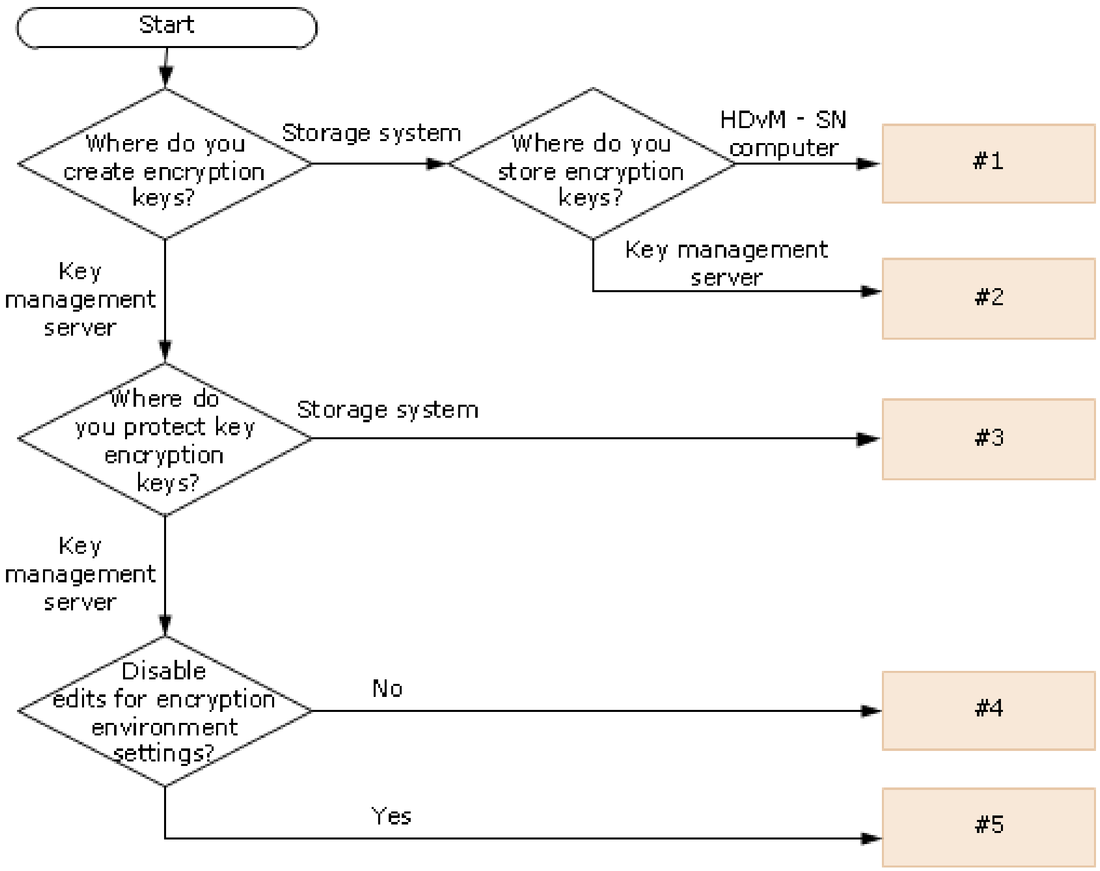
If you are restoring the key management server connection after the SVP replacement, restore the connection setting of the key management server which is already backed up. After doing so, if the setting in the **Edit Encryption Environmental Settings** window before the SVP replacement is a value other than #1 in the table in Settings in the Edit Encryption Environmental Settings window on page 30, set the client certificate and root certificate of the key management server again.

If you have not backed up the connection setting of the key management server, set the connection for the key management server again. If you have not stored the client certificate, create a new client certificate. Then, set the client certificate and root certificate of the key management server that you have just created.

If the setting in the **Edit Encryption Environmental Settings** window before the SVP replacement is #4 or #5 in the table in Settings in the Edit Encryption Environmental Settings window on page 30 and you have already created a new client certificate after the SVP replacement, update the key encryption key after you set the connection for the key management server. When you do this, the key deletion key encryption fails because you cannot delete the key encryption key before the update; however, the key encryption key is already updated.

Settings in the Edit Encryption Environmental Settings window

To manage encryption keys properly, refer to the following flow chart and table and choose settings for the Edit Encryption Environmental Settings window accordingly.


Start
Where do you create encryption keys?
Storage system
Where do you store encryption keys?
HDvM - SN computer
#1
Key management server
#2
Key management server
Where do you protect key encryption keys?
Storage system
#3
Key management server
Disable edits for encryption environment settings?
No
#4
Yes
#5

	Settings in the Edit Encryption Environmental Settings window					
	Key Management Server	Server Settings		Generate Encryption Keys on Key Management Server	Protect the Key Encryption Key at the Key Management Server	Disable local key generation
		Primary Server	Secondary Server			
#1	Disable	Do not specify	Do not specify	Clear	Clear	Clear
#2	Enable	Specify settings	Enable and specify settings	Clear	Clear	Clear
#3	Enable	Specify settings	Enable and specify settings	Select	Clear	Clear
#4	Enable	Specify settings	Enable and specify settings	Select	Select	Clear

	Settings in the Edit Encryption Environmental Settings window					
	Key Management Server	**Server Settings**		**Generate Encryption Keys on Key Management Server**	**Protect the Key Encryption Key at the Key Management Server**	**Disable local key generation**
		Primary Server	**Secondary Server**			
#5	Enable	Specify settings	Enable and specify settings	Select	Select	Select

4

Creating and backing up encryption keys

Encryption keys are commonly created in the storage system. However, when the key management server is in use, and Generate Encryption Keys on Key Management Server is checked in the **Edit Encryption Environmental Settings** window, encryption keys are created on a key management server and used in the storage system.

This topic describes the instructions for creating and backing up the data encryption keys. You can save secondary backups of encryption keys to a file or to the key management server. You can also schedule regular backups of encryption keys.

Creating encryption keys

If you need to change an encryption key, create a new encryption key. 4,048 Free keys or DEKs are created when you configure encryption environmental settings on the **Edit Encryption Environmental Settings** window for the first time (this depends on the number of EBEDs and drives setup in the configuration. 4,048 keys are created if maximum EBEDs are installed). After that, you can create 4,096 Free keys or DEKs. You can create a maximum of 4,096 encryption keys per system.

For VSP G200, when you configure encryption environmental settings on the **Edit Encryption Environmental Settings** window for the first time, 506 Free keys or DEKs are created. (This differs from the configuration. 506 keys are created if maximum EBEDs are installed). After that, you can create 512 Free keys or DEK keys.

For VSP G400, G600 and VSP F400, F600, when you configure encryption environmental settings on the **Edit Encryption Environmental Settings** window for the first time, 1,018 Free keys or DEKs are created. (This differs from the configuration. 1,018 keys are created if maximum EBEDs are installed). After that, you can create 1,024 Free keys or DEKs. You can create up to 1,024 encryption keys per storage system.

For VSP G800 and VSP F800, when you configure encryption environmental settings on the **Edit Encryption Environmental Settings** window for the first time, 2,024 Free keys or DEK keys are created. (This differs from the configuration. 2,024 keys are created if maximum EBEDs are installed). After that, you can create 2,048 Free keys or DEKs.

After creating encryption keys, it is strongly recommended that you back up all keys.

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. Select the **Encryption Keys** tab.
4. Click **Create Keys**.
5. In the **Create Keys** window, specify the number of encryption keys you want to create. The encryption keys with the attribute of **Free** will be set. The key IDs will be automatically assigned.
6. To back up encryption keys to the key management server, click **Next**. Otherwise, click **Finish**.

7. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

Result

The new encryption key is created.

Related references

- Encryption Keys window on page 66

Backing up encryption keys

Your storage system automatically creates a primary backup of the encryption keys. To ensure data availability, you should also create secondary backups of the encryption keys immediately after creating the keys, and on a regularly scheduled basis.

Caution: Securely store the secondary backup data encryption key. Include this process in your corporate security policy. If the primary data encryption license key becomes unavailable and a secondary backup data encryption key does not exist, the system cannot decrypt encrypted data.

DEKs and CEKs that you create are backed up in batch.

You can back up encryption keys to a file, or to a key management server. You can also schedule regular backups when you configure the key management server in the **Edit Encryption Environmental Settings** window.

It is recommended that you back up all keys after you perform any of the following operations:

- Create encryption keys
- Add, remove, or replace drives
- Add, remove, or replace EBEDs
- Replace controllers
- Update CEKs
- Update KEKs

Backing up keys to a file

You can create the secondary backups of the data encryption keys as a file on the computer. Back up the file and the password because the file and password are not automatically backed up.

Before you begin

- You must have the Security Administrator (View & Modify) role.

- Confirm that the storage systems are not processing other tasks. You cannot back up the keys while your storage system is processing other tasks.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Expand **Administration** in the **Explorer** pane, and then click **Encryption Keys**.
3. Click the **Encryption Keys** tab.
4. In the **Encryption Keys** table, select the key ID for the data encryption key you want to back up and click **Backup Keys > To File**.
5. In the **Backup Keys to File** window, complete the following and then click **Finish**:
   - For **Password**, type the key restoration password.

     Case sensitive: Yes
   - For **Re-enter Password**, retype the password.
6. In the **Confirm** window, confirm the settings, enter a task name in **Task Name**, and then click **Apply**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.
7. In the message that appears, click **OK**.
8. Select the location to which to save the backup file, and then type the backup file name using the extension `.ekf`.
9. Click **Save**.

Result

The secondary backup encryption key is saved.

Backing up the keys to a key management server

You can create the secondary backups of the data encryption keys on a key management server. The data encryption keys that you back up to a key management server are managed with the client certificate.

There is a limited number of keys you can back up on the key management server. Therefore, it is recommended that you delete unnecessary keys when possible.

When you back up to a key management server, the server uses another data encryption key to encrypt the original keys. Both keys reside on the server.

Before you begin

- You must have the Security Administrator (View & Modify) role
- Confirm that the storage systems are not processing other tasks. You cannot back up the keys while your storage system is processing other tasks.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Expand **Administration** in the **Explorer** pane, and select **Encryption Keys**.
3. On the **Encryption Keys** tab, click **View Backup Keys on Server** to open the **Backup Keys to Server** window.
4. (Optional) In the **Backup Keys to Server** window, for **Description**, type a description and then click **Finish**.
5. In the **Confirm** window, confirm the settings, enter a task name in **Task Name**, and then click **Apply**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

Result

The secondary backup encryption key is saved.

Changing the encryption key

If you need to change a data encryption key, create a new data encryption key. To change the encryption key for existing encrypted data, you must migrate the data to an encrypted parity group that has a different encryption key. Use the following process to change the encryption key for encrypted data:

Procedure

1. Create a new parity group.
2. Enable encryption with a new data encryption key. See Encrypting data on page 41.
3. Format the LDEVs in the encrypted parity group. For instructions, see the *Provisioning Guide* for your storage system.
4. Migrate the source data to the new target LDEVs in the encrypted parity group. When a drive is replaced, the data encryption keys that are allocated to that drive are deleted, and new data encryption keys are allocated when the new drive is added.

Changing the password requirements for the backup encryption keys

You can set the minimum number of characters required for the password for the backup encryption keys.

Before you begin

- You must have the Security Administrator (View & Modify) role

Procedure

1. Display the Device Manager - Storage Navigator main window.

2. From the **Settings** menu, select **Security > Encryption Key > Edit Password Policy (Backup Encryption Keys)**.
3. In the **Edit Password Policy (Backup Encryption Keys)** window, set the minimum number of characters.
4. Click **Finish**.
5. In the **Confirm** window, confirm the settings, enter a task name in **Task Name**, and then click **Apply**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

Related references

- Edit Password Policy (Backup Encryption Keys) window on page 75

Opening the Backup Keys to Server window using the Encryption window

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**. The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, select the key ID for the data encryption key you want to back up from the **Encryption Keys** table, and click **Backup Keys > To Server**.

Opening the Backup Keys to Server window using the View Backup Keys on Server window

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**. The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, click **View Backup Keys on Server**.
4. Click **Backup Keys to Server**.

Viewing encryption keys backed up on the key management server

You can view encryption keys that are backed up on the key management server.

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, click **View Backup Keys on Server** to view the backup keys on the key management server.

Related references

- Encryption Keys window on page 66
- View Backup Keys on Server window on page 90

5

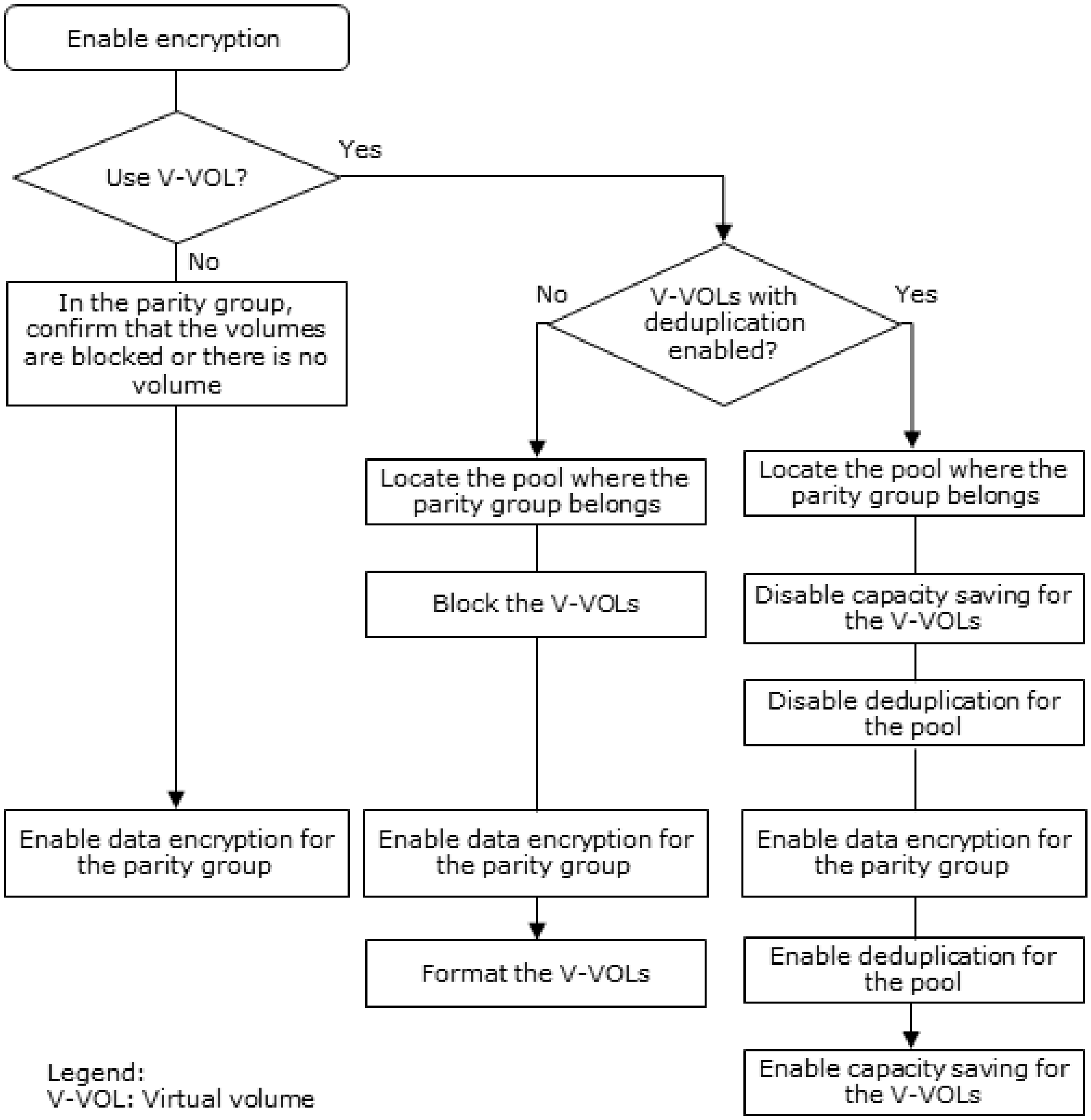
Encrypting data

The Encryption License Key feature provides data encryption at the parity-group level to protect data on LDEVs.

Enabling encryption

Encryption can be enabled only when the volumes in a parity group are blocked, or a parity group has no volume. Encryption cannot be enabled if a parity group has an unblocked volume.

As shown in the flowchart, the procedure for enabling encryption is different when you enable encryption of virtual volumes for which the deduplication function is enabled.


Enable encryption
Use V-VOL?
Yes
No
In the parity group, confirm that the volumes are blocked or there is no volume
V-VOLs with deduplication enabled?
No
Yes
Locate the pool where the parity group belongs
Block the V-VOLs
Locate the pool where the parity group belongs
Disable capacity saving for the V-VOLs
Disable deduplication for the pool
Enable data encryption for the parity group
Enable data encryption for the parity group
Enable data encryption for the parity group
Format the V-VOLs
Enable deduplication for the pool
Enable capacity saving for the V-VOLs
Legend:
V-VOL: Virtual volume

For details about operations of pools and virtual volumes, see the *Provisioning Guide* for your storage system.

Enabling data encryption

Data encryption is enabled at the parity-group level.

This procedure describes how to enable data encryption on a parity group in which the deduplication function is not enabled for the pool to which the parity group belongs.

Before you begin

- Block the volumes in the parity group to be encrypted.
- You must have the Security Administrator (View & Modify) role.
- You must have the Storage Administrator (Provisioning) role to format volumes.
- The accelerated compression feature of the parity group must be disabled. If accelerated compression is enabled on the parity group, you cannot enable encryption (an error occurs).

Procedure

1. If virtual volumes (V-VOLs) are used in the target parity group, locate and block the V-VOLs as follows:
   a. Expand **Storage Systems** in the **Explorer** pane, and then expand **Pools**.
   b. Locate and select the pool that contains the V-VOLs in the target parity group.
   c. On the **Virtual Volumes** tab, select the V-VOLs in the target parity group.
   d. Click **More Actions > Block Volumes**.

   When all volumes and V-VOLs in the target parity group are blocked, you can enable encryption.
2. In the **Explorer** pane, select **Parity Groups**.
3. In the **Parity Groups** table, select the parity group on which you want to enable encryption and then click **More Actions > Edit Encryption**.

   Note: If you do not select a specific parity group, data encryption will be enabled on all of the parity groups in the list.

4. In the **Edit Encryption** window, make the appropriate selections.
   - For **Available Parity Groups**, select the parity group for which you want to enable data encryption.
   - For **Encryption**, select **Enable** to enable data encryption for the selected parity group.
   - For **Format Type**, select the format type.

     You do not need to format volumes when there are no volumes in the selected parity group. Therefore, the format type in the **Selected**

Parity Groups list becomes a hyphen (-) regardless of the status of the format type.

5. Click **Add**.
   The parity group you selected from the **Available Parity Groups** table is added to the **Selected Parity Groups** list.

   After you click **Add**, **Format Type** becomes inactive and you cannot select the format type. If you want to change the format type, delete all parity groups in the **Selected Parity Groups** list and then select the format type again.
6. Click **Finish**.
7. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.
8. Click **Apply**.
9. In the message that appears, click **OK**.
10. If the target parity group contains V-VOLs that you blocked in step 1, format the V-VOLs.

Related tasks

- Backing up keys to a file on page 35
- Backing up the keys to a key management server on page 36

Related references

- Edit Encryption window on page 92

Enabling data encryption (for virtual volumes with deduplication function enabled)

Before you can enable data encryption on a parity group that includes virtual volumes for which the deduplication function is enabled, you must disable the deduplication function first and then enable data encryption.

Before you begin

- You must have the Security Administrator (View & Modify) role.
- You must have the Storage Administrator (Provisioning) role to format volumes.
- The accelerated compression feature of the parity group must be disabled. If accelerated compression is enabled on the parity group, you cannot enable encryption (an error occurs).

Procedure

1. Locate the pool to which the parity group you want to enable encryption belongs.

2. Locate the virtual volumes for which **Capacity Saving** is set to **Deduplication and Compression**.
3. Disable the capacity saving function for the virtual volumes in the parity group.
   a. Block the virtual volumes.
   b. Format the virtual volumes.
   c. Disable the capacity saving function of the virtual volumes by selecting **Disable** for **Capacity Saving**.
   d. Verify that the **Capacity Saving Status** shows **Disabled**.
4. Disable the deduplication function of the pool by selecting **No** for **Deduplication System Data Volume**.
5. Enable data encryption for the parity group.
   a. In the **Parity Groups** table, select the parity group on which you want to enable encryption and then click **More Actions > Edit Encryption**.

   Note: If you do not select a specific parity group, data encryption will be enabled on all of the parity groups in the list.

   b. In the **Edit Encryption** window, make the appropriate selections.
   - For **Available Parity Groups**, select the parity group for which you want to enable data encryption.
   - For **Encryption**, select **Enable** to enable data encryption for the selected parity group.
   - For **Format Type**, select the format type.

     You do not need to format volumes when there are no volumes in the selected parity group. Therefore, the format type in the **Selected Parity Groups** list becomes a hyphen (-) regardless of the status of the format type.

   c. Click **Add**.
   The parity group you selected from the **Available Parity Groups** table is added to the **Selected Parity Groups** list.

   After you click **Add**, **Format Type** becomes inactive and you cannot select the format type. If you want to change the format type, delete all parity groups in the **Selected Parity Groups** list and then select the format type again.

   d. Click **Finish**.
   e. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   f. Click **Apply**.
   g. In the message that appears, click **OK**.
6. Re-enable the deduplication function of the pool by selecting **Yes** for **Assign Deduplication System Data Volume**.

7. Re-enable the capacity saving function of the virtual volumes you disabled by setting **Capacity Saving** to **Deduplication and Compression**.

Encrypting existing data

To encrypt existing data on your storage, you must migrate the data to an encrypted parity group. Use the following process to encrypt existing data.

Procedure

1. Create a new parity group.
2. Enable data encryption on the parity group. See Encrypting data on page 41.
3. Format the LDEVs in the encrypted parity group. For instructions, see the *Provisioning Guide* for your storage system.
4. Migrate the existing data to the LDEVs in the encrypted parity group. For details about data migration, contact your account team.
5. After migrating the existing data to the encrypted parity group, shred the unencrypted data (migration source volumes) to prevent the data from being leaked, using the Volume Shredder function.

6

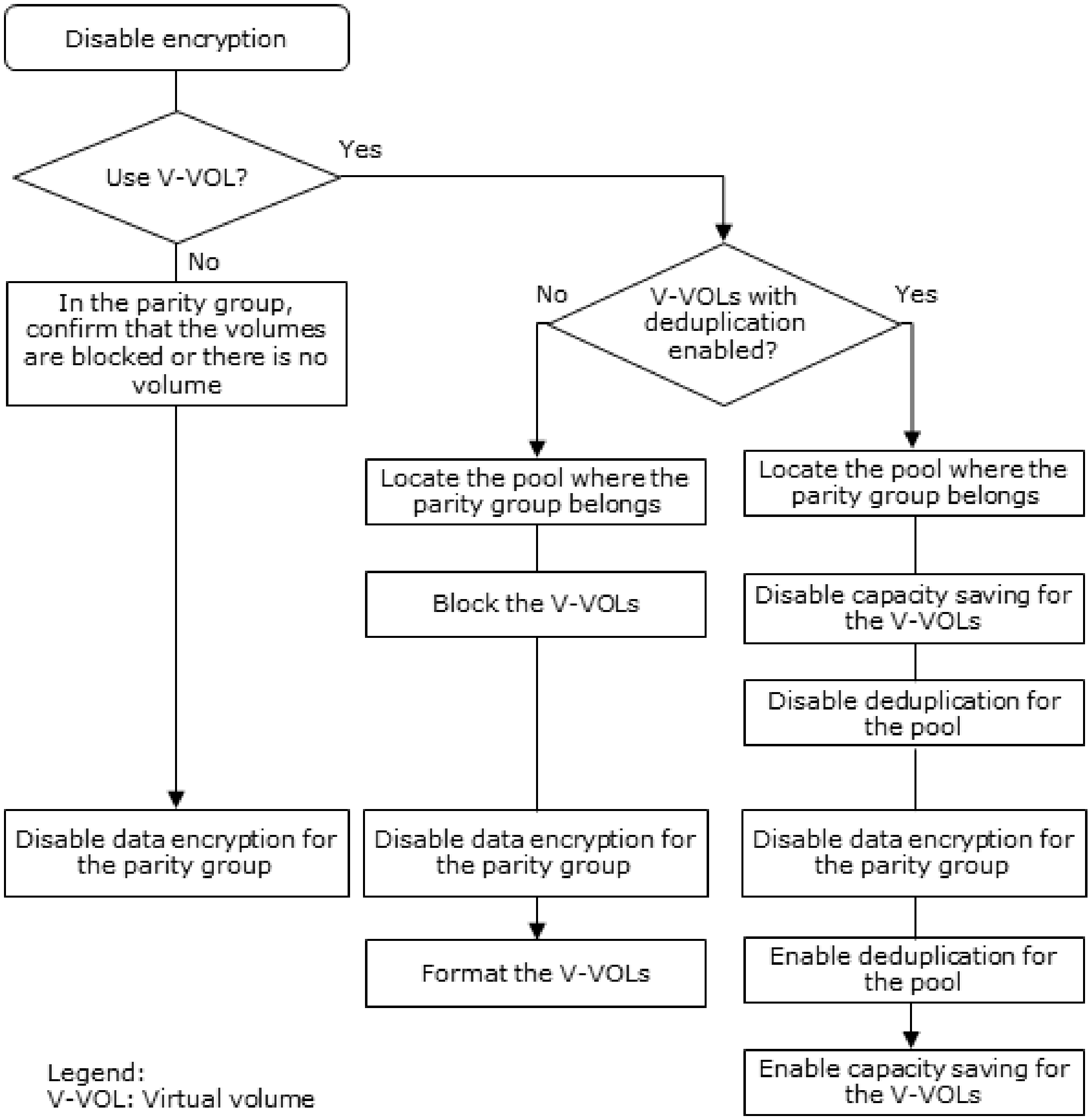
Decrypting data

Encryption is disabled at the parity-group level. You need to disable data encryption and format LDEVs in the decrypted parity group.

Disabling encryption

Encryption can be disabled only when the volumes in a parity group are blocked, or the parity group has no volume. Encryption cannot be disabled if a parity group has an unblocked volume.

As shown in the flowchart, the procedure is different if you disable encryption of virtual volumes for which the deduplication function is enabled.


Disable encryption
Use V-VOL?
Yes
No
In the parity group, confirm that the volumes are blocked or there is no volume
V-VOLs with deduplication enabled?
No
Yes
Locate the pool where the parity group belongs
Block the V-VOLs
Locate the pool where the parity group belongs
Disable capacity saving for the V-VOLs
Disable deduplication for the pool
Disable data encryption for the parity group
Disable data encryption for the parity group
Disable data encryption for the parity group
Format the V-VOLs
Enable deduplication for the pool
Enable capacity saving for the V-VOLs
Legend:
V-VOL: Virtual volume

For details about operations of pools and virtual volumes, see the *Provisioning Guide* for your storage system.

Disabling data encryption

Disable data encryption at the parity-group level to perform (normal) formatting options on encrypted data, such as writing to or overwriting an LDEV.

This procedure describes how to disable data encryption on a parity group in which virtual volumes are not used or in which the deduplication function is not enabled for the pool to which the parity group belongs.

Before you begin

- Block the LDEVs in the parity group to be decrypted.
- You must have the Security Administrator (View & Modify) role.
- You must have the Storage Administrator (Provisioning) role to format volumes.

Procedure

1. Expand **Storage Systems** in the **Explorer** pane, and select **Parity Groups**.
2. In the **Parity Groups** table, select the parity group on which you want to disable encryption and then click **More Actions > Edit Encryption**.
3. In the **Edit Encryption** window, make the appropriate selections.
   - For **Available Parity Groups**, select the parity group for which you want to disable data encryption.
   - For **Encryption**, select **Disable**.
   - For **Format Type**, select the format type.

     You do not need to format volumes when there are no volumes in the selected parity group. Therefore, the format type in the **Selected Parity Groups** list becomes a hyphen (-) regardless of the status of the format type.
4. Click **Add**.

   The parity group you selected from the **Available Parity Groups** table is added to the **Selected Parity Groups** list.

   After you click **Add**, **Format Type** becomes inactive and you cannot select the format type. If you want to change the format type, delete all parity groups in the **Selected Parity Groups** list and then select the format type again.
5. Click **Finish**.
6. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.
7. Click **Apply**.
8. In the message that appears, click **OK**.

Result

Data encryption is disabled on the parity group.

Next steps

Format the LDEVs at the parity-group level. For instructions, see Formatting LDEVS at the parity-group level on page 50.

Related tasks

- Backing up keys to a file on page 35
- Backing up the keys to a key management server on page 36

Related references

- Edit Encryption window on page 92

Formatting LDEVS at the parity-group level

The LDEV formatting operation writes zero data to the entire area of all drives in the parity group, or overwrites an LDEV. This process is also referred to as encryption formatting. If you use a V-VOL, encryption/unencryption formatting for the V-VOL is required. For details about formatting volumes, see the *Provisioning Guide* for your storage system.

Procedure

1. In the **Storage System** tree, select a resource to show one of the following tabs:
   - **LDEVs** tab when you select a parity group in **Parity Groups**
   - **LDEVs** tab when you select **Logical Devices**
   - **Virtual Volumes** tab when you select a pool in **Pools**
2. Select the LDEV, and go to **Actions > Logical Device > Format LDEVs** or select **Format LDEVs** on the bottom right-hand corner of the window.
3. In the **Format LDEVs**, select the **Normal** format type (required for V-VOLs), and click **Finish**.
4. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

7

Restoring encryption keys

Restore a data encryption key from the primary or secondary backup copy when all the LDEVs belonging to an encrypted parity group are blocked or if an existing data encryption key becomes unavailable or cannot be used (for example, due to a system failure).

Restoration is performed in a batch for the backed up encryption keys (including Free keys, DEKs, and CEKs): 516 keys for VSP G200 models, 1,028 keys for VSP G400, G600 models and VSP F400, F600 models, and 2,064 keys for VSP G800 and VSP F800 models where key information is lost or deleted.

The system automatically restores encryption keys from the primary backup. You must have the Security Administrator (View & Modify) role to restore the encryption key from a secondary backup encryption key.

⚠ **Caution:** When you restore the encryption key, always restore the latest key. If an encryption key is updated after a secondary backup is performed, and the restored key is not the latest key, drives and EBEDs will be blocked and will not be able to read data.

To restore the encryption key, the volumes belonging to the parity group for which the key is set must be blocked. In addition, after the restoration of the key, the volumes belonging to the parity group for which encryption key is set must be restored.

Restoring keys from a file

Restore the data encryption keys from a file backed up on the computer.

Before you begin

- Block the LDEVs associated to the encrypted parity group.
  For details, see the *Provisioning Guide* for your storage system.
- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, click **Restore Keys > From File**.
4. In the **Restore Keys from File** window, click **Browse** and then click **OK**.
5. In the **Open** dialog box, select the backup file and click **Open**.
6. In the **Restore Keys from File** window, complete the following item and then click **Finish**:
   - For **File Name**, shows the name of the selected file.
     View-only: Yes
   - For **Password**, type the password for the data encryption key that you typed when you backed up the selected data encryption key.
7. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

   The backup data encryption key is restored.

Related references

- Restore Keys from File window on page 83
- Encryption Keys window on page 66

Restoring keys from a key management server

Restore an encryption key from the key management server. You can restore up to 4,128 encryption keys at a time.

The client certificate is required to restore backed up encryption keys from a key management server.

Caution: If you do not have the client certificate, and the system administrator replaces the SVP due to a failure, you cannot restore the backed up data encryption keys.

Before you begin

- Block the LDEVs associated to the encrypted parity group.
- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, click **Restore Keys > From Server**.
4. In the **Restore Keys from Server** window, select the data encryption key you want to restore.
5. Click **Finish**.
6. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

   The backup data encryption key is restored.

Related references

- Restore Keys from Server window on page 85
- Encryption Keys window on page 66

8

Deleting encryption keys

You can delete an encryption key from a file on the HDvM - SN computer or from a key management server.

This topic provides instructions for deleting encryption keys from a file or from the key management server.

Deleting encryption keys from a file

Delete encryption keys from a file on the HDvM - SN computer.

You can only delete encryption keys with a Free attribute. Encryption keys with the other attributes cannot be deleted.

Before you begin

- Create the secondary backup of the encryption key. See Backing up encryption keys on page 35.
- Verify that the key is not allocated to the parity group.
- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Expand **Administration** in the **Explorer** pane, and select **Encryption Keys**.
3. On the **Encryption Keys** tab, select the key ID for the key you want to delete from the **Encryption Keys** table, and click **More Actions > Delete Keys**.
4. To back up encryption keys to the key management server, click **Next**. To back up encryption keys to the server, see Backing up the keys to a key management server on page 36.
5. In the **Delete Keys** window, click **Finish**.
6. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**, and then click **Apply**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.
7. In the message that appears asking whether to apply the setting to the storage system, click **OK**.

Result

The data encryption key is deleted.

Related references

- Delete Keys window on page 87
- Encryption Keys window on page 66

Deleting backup encryption keys from the server

Delete a backup encryption key from the key management server.

Caution: Before deleting a secondary backup encryption key from the key management server, verify that you have another backed up encryption key.

Before you begin

- Create the secondary back up of the encryption key. See Backing up encryption keys on page 35.
- Verify that the key is not allocated to the parity group.
- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Expand **Administration** in the **Explorer** pane, and select **Encryption Keys**.
3. On the **Encryption Keys** tab, click **View Backup Keys on Server**.
4. In the **View Backup Keys on Server** window, select the key ID for the backup data encryption key you want to delete and then click **Delete Backup Keys on Server**.
5. In the **Delete Backup Keys on Server** window, confirm the settings, and enter your task name in **Task Name**, and then click **Apply**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.
6. In the message that appears asking whether to apply the setting to the storage system, click **OK**.

Result

The data encryption key is deleted.

Related references

- View Backup Keys on Server window on page 90
- Delete Backup Keys on Server window on page 89
- Encryption Keys window on page 66

Exporting a list of encryption keys

You can output a list of encryption keys and their details that are shown in the Encryption Keys window. Output data includes key IDs, the dates and times the encryption keys were created on, the key attributes (CEK, DEK, KEK, or Free), the resources to which the encryption keys are assigned, the paths to which the keys were created, and the number of key backups.

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, select the key ID for the data encryption key information you want to output from the **Encryption Keys** table.
4. Click **More Actions > Export**.
5. When the **Ready to Download** message appears, click **OK**.

Rekeying key encryption keys

If you create key encryption keys on the key management server, use the following procedure to rekey key encryption keys.

After rekeying key encryption keys, it is recommended that you back up each key.

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, select the key ID for the data encryption key information you want to output from the **Encryption Keys** table.
4. Click **More Actions > Rekey Key Encryption Keys**.
5. In the **Rekey Key Encryption Key** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

Related references

- Rekey Key Encryption Key window on page 97

Rekeying certificate encryption keys

If you change certificate encryption keys, use the following procedure to rekey the keys.

After rekeying certificate encryption keys, it is recommended that you back up each key.

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, select **Rekey Certificate Encryption Keys**.
4. In the **Rekey Certificate Encryption Keys** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

Related references

- Rekey Certificate Encryption Keys window on page 96

Retrying Key Encryption Key Acquisition

If you acquire the key encryption keys from the key management server when the storage device starts, retry key encryption key acquisition.

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, select **More Actions > Retry Key Encryption Key Acquisition**.
4. In the **Retry Key Encryption Key Acquisition** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

Result

You need to restore the EBEDs and blocked drives or blocked volumes after retrying key encryption key acquisition. Contact customer support to restore the EBEDs and blocked drives or blocked volumes.

Related references

- Retry Key Encryption Key Acquisition window on page 97

Initializing the encryption environment settings

Disable data encryption at the parity-group level before initializing the encryption environment settings.

Before you begin

- You must have the Security Administrator (View & Modify) role.

Procedure

1. Display the Device Manager - Storage Navigator main window.
2. Select **Administration** in **Explorer**, and select **Encryption Keys**.
   The **Encryption Keys** window is opened.
3. On the **Encryption Keys** tab, select **Edit Encryption Environmental Settings**.
4. In the **Edit Encryption Environmental Settings** window, select **Initialize Encryption Environmental Settings**.
5. Select **Finish** to display the **Confirm** window.
6. In the **Confirm** window, confirm the settings, and enter your task name in **Task Name**.

   If you want the **Task** window to open after you click **Apply**, select **Go to tasks window for status**.

   Click **Apply**.

Related references

- Edit Encryption Environmental Settings window on page 68

9

Troubleshooting

This chapter provides troubleshooting information for Encryption License Key.

Encryption events in the audit log

The audit log records events related to Encryption License Key, including data encryption and Encryption License Key processes. You can export an audit log that contains encryption events in near real-time to an external syslog server.

For more information about the audit log and how to export log events, see the *Hitachi Audit Log User Guide*.

Troubleshooting Encryption License Key

For troubleshooting information for VSP G1x00 and VSP F1500, see the *Hardware Guide for Hitachi Virtual Storage Platform G1000, G1500, and F1500*.

For troubleshooting information for your VSP G series or VSP F series storage system, see the *Hardware Guide* for your storage system.

For troubleshooting information for Device Manager - Storage Navigator, see the *System Administrator Guide* for your storage system. For details about HDvM - SN error messages, see *Hitachi Device Manager - Storage Navigator Messages*.

The following table provides general troubleshooting information for Encryption License Key. If you need technical assistance, contact customer support.

Problem	Action
Cannot use the Encryption License Key feature to back up or restore a key.	Verify the following: • The Encryption License Key software license is valid and installed. • You have the Security Administrator (View & Modify) role. • If you backup and restore data encryption keys with a key management server, the connection to the key management server is available. • If you backup and restore data encryption keys with a key management server, the number of keys which you can back up on the key management server is not exceeded. • If you backup and restore data encryption keys with a key management server, a time-out has not occurred due to the increase in the number of keys on the key management server. • The latest key is restored (the key will not be updated after a secondary backup has been performed).
Cannot create or delete data encryption keys.	Make sure that: • The Encryption License Key software license is valid and installed. • You have the Security Administrator (View & Modify) role. • If you have backed up and restored data encryption keys with a key management server, that the connection to the key management server is available.

Problem	Action
Cannot enable encryption for a parity group.	Make sure that: • The Encryption License Key software license is valid and installed. • All LDEVs in the parity group are in the blocked status.
Cannot disable encryption for a parity group.	Make sure that all LDEVs in the parity group are in the blocked status.
Server configuration test failed.	Check the following key management server connection settings: • Host name • Port number • Client certificate file • Root certificate file If the communication failure is due to the length of time to connect to the server, try changing these settings: • Timeout • Retry interval • Number of retries
The Edit Encryption wizard operation failed, but the status of encryption (enable or disable) has changed.	The change of the status succeeds, but the format of the volume fails. Confirm the message, remove the error, and format volumes again.
The storage system failed to get encryption keys backed up on the key management server and all volumes are blocked when the storage system is turned on. The SIM code 661000 is returned.	Complete the following tasks: • Restore the connection to the key management server. • Retry key encryption key acquisition. • Contact customer support to restore the EBEDs and blocked drives or blocked volumes.
Editing encryption environmental settings has failed with the error (00002-058578).	If it is the first time you are configuring encryption environmental settings in the **Edit Encryption Environmental Settings** window and it fails (error message 00002-058578), complete the following tasks: **1.** Wait a few minutes, then click File > Refresh All to reread the configuration information. **2.** Initialize the encryption environmental settings. **3.** Configure the encryption environmental settings again. If it is *not* the first time you are configuring encryption environmental settings in the **Edit Encryption Environmental Settings** window and it fails (error message 00002-058578), complete the following tasks: **1.** Wait a few minutes, then click File > Refresh All to reread the configuration information. **2.** Configure the encryption environmental settings again.
Server configuration test has succeeded, but the following error is displayed: 10126-105022 The connected key management server does not support the required functions.	A required function for the setting of the key management server is not supported with the connected key management server. See Key management server requirements on page 26 and update the software of the key management server to the latest version.
The Edit Encryption Wizard operation failed though the Free key (Encryption key with the Free attribute) exists. The error below is displayed. 03005-108104 There are not enough Free keys.	The **Edit Encryption Environmental Settings** wizard executed prior to the **Edit Encryption** wizard might have failed because of disk board failure. Confirm in the **Task** window that the **Edit Encryption Environmental Settings wizard** failed and if so, move the cause of error. Then retry the **Edit Encryption Environmental Settings** wizard and the **Edit Encryption** wizard after initializing the **Encryption Environmental Setting**.

Contacting customer support

When contacting customer support, provide as much information about the problem as possible, including:

- The circumstances surrounding the error or failure
- The content of any error messages displayed on the host systems
- The content of any error messages displayed on Device Manager - Storage Navigator
- The Device Manager - Storage Navigator configuration information (use the FD Dump Tool)
- The service information messages (SIMs), including reference codes and severity levels, displayed by Device Manager - Storage Navigator

The customer support center is available 24 hours a day, seven days a week. If you need technical support, log on to customer support for contact information: https://support.hitachivantara.com/en_us/contact-us.html

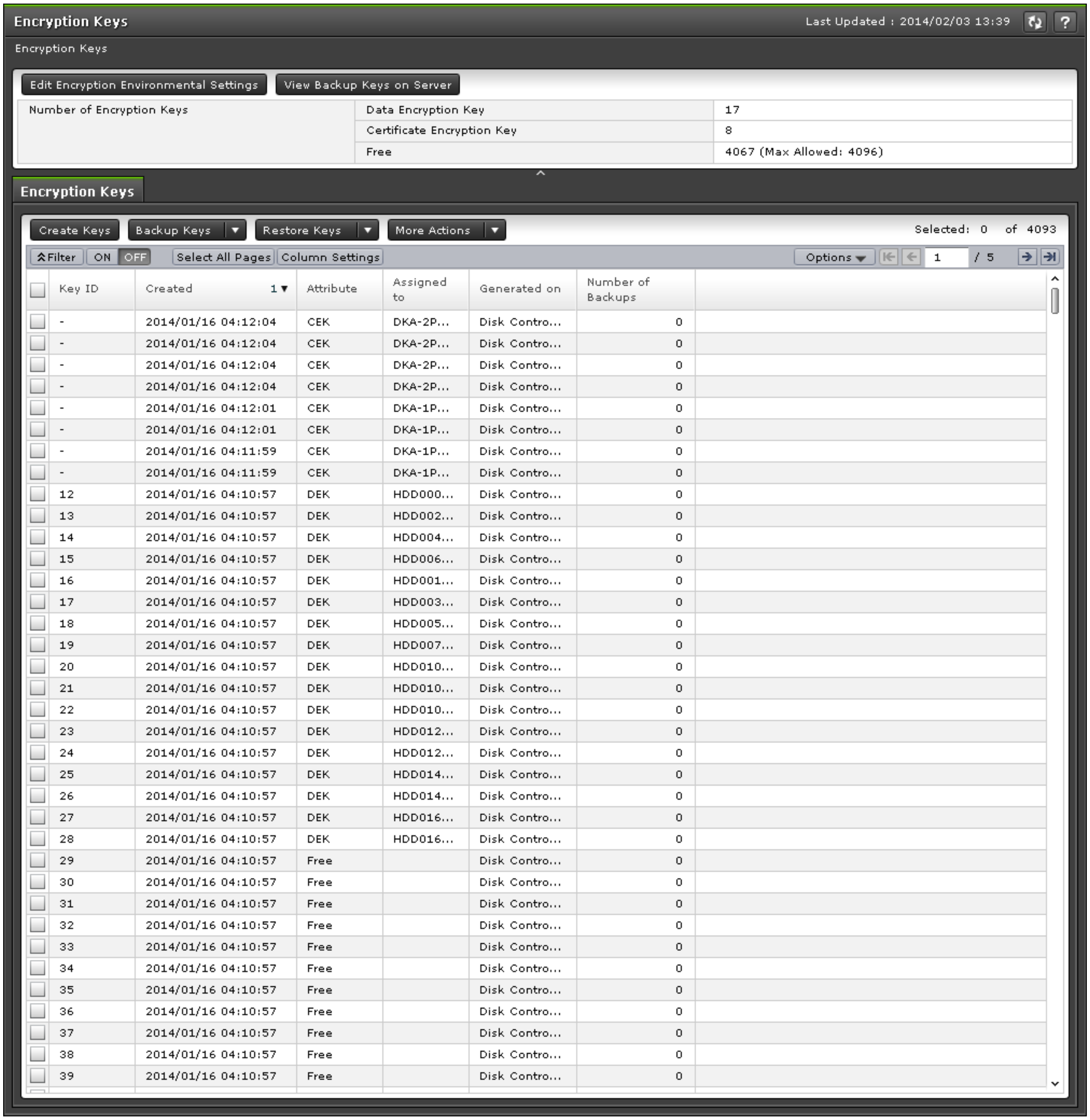
A

Encryption License Key GUI Reference

This chapter provides descriptions of the Device Manager - Storage Navigator windows and dialog boxes for the Encryption License Key feature.

Encryption Keys window

Use the **Encryption Keys** window to create data encryption keys. Clicking Encryption Keys in the Administration tree opens this window.



Number of Encryption Keys	Data Encryption Key	17
	Certificate Encryption Key	8
	Free	4067 (Max Allowed: 4096)

Key ID	Created	Attribute	Assigned to	Generated on	Number of Backups
-	2014/01/16 04:12:04	CEK	DKA-2P...	Disk Contro...	0
-	2014/01/16 04:12:04	CEK	DKA-2P...	Disk Contro...	0
-	2014/01/16 04:12:04	CEK	DKA-2P...	Disk Contro...	0
-	2014/01/16 04:12:04	CEK	DKA-2P...	Disk Contro...	0
-	2014/01/16 04:12:01	CEK	DKA-1P...	Disk Contro...	0
-	2014/01/16 04:12:01	CEK	DKA-1P...	Disk Contro...	0
-	2014/01/16 04:11:59	CEK	DKA-1P...	Disk Contro...	0
-	2014/01/16 04:11:59	CEK	DKA-1P...	Disk Contro...	0
12	2014/01/16 04:10:57	DEK	HDD000...	Disk Contro...	0
13	2014/01/16 04:10:57	DEK	HDD002...	Disk Contro...	0
14	2014/01/16 04:10:57	DEK	HDD004...	Disk Contro...	0
15	2014/01/16 04:10:57	DEK	HDD006...	Disk Contro...	0
16	2014/01/16 04:10:57	DEK	HDD001...	Disk Contro...	0
17	2014/01/16 04:10:57	DEK	HDD003...	Disk Contro...	0
18	2014/01/16 04:10:57	DEK	HDD005...	Disk Contro...	0
19	2014/01/16 04:10:57	DEK	HDD007...	Disk Contro...	0
20	2014/01/16 04:10:57	DEK	HDD010...	Disk Contro...	0
21	2014/01/16 04:10:57	DEK	HDD010...	Disk Contro...	0
22	2014/01/16 04:10:57	DEK	HDD010...	Disk Contro...	0
23	2014/01/16 04:10:57	DEK	HDD012...	Disk Contro...	0
24	2014/01/16 04:10:57	DEK	HDD012...	Disk Contro...	0
25	2014/01/16 04:10:57	DEK	HDD014...	Disk Contro...	0
26	2014/01/16 04:10:57	DEK	HDD014...	Disk Contro...	0
27	2014/01/16 04:10:57	DEK	HDD016...	Disk Contro...	0
28	2014/01/16 04:10:57	DEK	HDD016...	Disk Contro...	0
29	2014/01/16 04:10:57	Free		Disk Contro...	0
30	2014/01/16 04:10:57	Free		Disk Contro...	0
31	2014/01/16 04:10:57	Free		Disk Contro...	0
32	2014/01/16 04:10:57	Free		Disk Contro...	0
33	2014/01/16 04:10:57	Free		Disk Contro...	0
34	2014/01/16 04:10:57	Free		Disk Contro...	0
35	2014/01/16 04:10:57	Free		Disk Contro...	0
36	2014/01/16 04:10:57	Free		Disk Contro...	0
37	2014/01/16 04:10:57	Free		Disk Contro...	0
38	2014/01/16 04:10:57	Free		Disk Contro...	0
39	2014/01/16 04:10:57	Free		Disk Contro...	0

Summary

Use the Summary to view details about the number of data encryption keys and to open the **View Backup Keys on Server** window.

Item	Description
Number of Encryption Keys	Shows the number of data encryption keys: • Data Encryption Key: Number of data encryption keys • Certificate Encryption Key: Number of certificate encryption keys • Free: Number of Free keys (Number of keys that can be created)The number of key encryption keys are not included.
Edit Encryption Environmental Settings	Shows the **Edit Encryption Environmental Settings** window
View Backup Keys on Server	Shows the **View Backup Keys on Server** window

Encryption Keys tab

Use the Encryption Keys tab to view a list of the data encryption key details and to select an unused data encryption key to create.

The Encryption Keys tab displays only the created encryption keys and in descending order of the Last Update Date. It also displays Perform the Edit Environmental Settings in the center of the window when the initialized settings are not performed, and displays Perform the Retry Key Encryption Key Acquisition in the center of the window when the Key Encryption Key Acquisition operation has failed.

Item	Description
Key ID	IDs of data encryption keys A hyphen (-) is displayed when the encryption key is CEK or KEK.
Created	The date and time the data encryption key was created or was last updated
Attribute	Displays the attribute (CEK, DEK, KEK or Free) of the encryption key. When KEK for the key management server is displayed, the format of “KEK (UUID)” is displayed with UUID.
Assigned to	The resource to which the encryption key is assigned is displayed. When the attribute is KEK, a hyphen (-) is displayed.
Generated on	The path in which the encryption key is created
Number of Backups	The number of times that a backup of a data encryption key is created When the attribute is KEK, a hyphen (-) is displayed.
Create Keys	Click to open the **Create Keys** window
Backup Keys	Select To File to open the **Backup Keys to File** window. Select To Server to open the **Backup Keys to Server** window.
Restore Keys	Select From File to open the **Restore Keys from File** window. Select From Server to open the **Restore Keys from Server** window.
More Actions	Select Rekey Key Encryption Keys to display the **Rekey Key Encryption Keys** window.

Item	Description
	Select Delete Keys from the list to delete a selected data encryption key. Select Retry Key Encryption Key Acquisition to display the **Retry Key Encryption Key Acquisition** window. Select Export from the list to open the window for outputting table information.

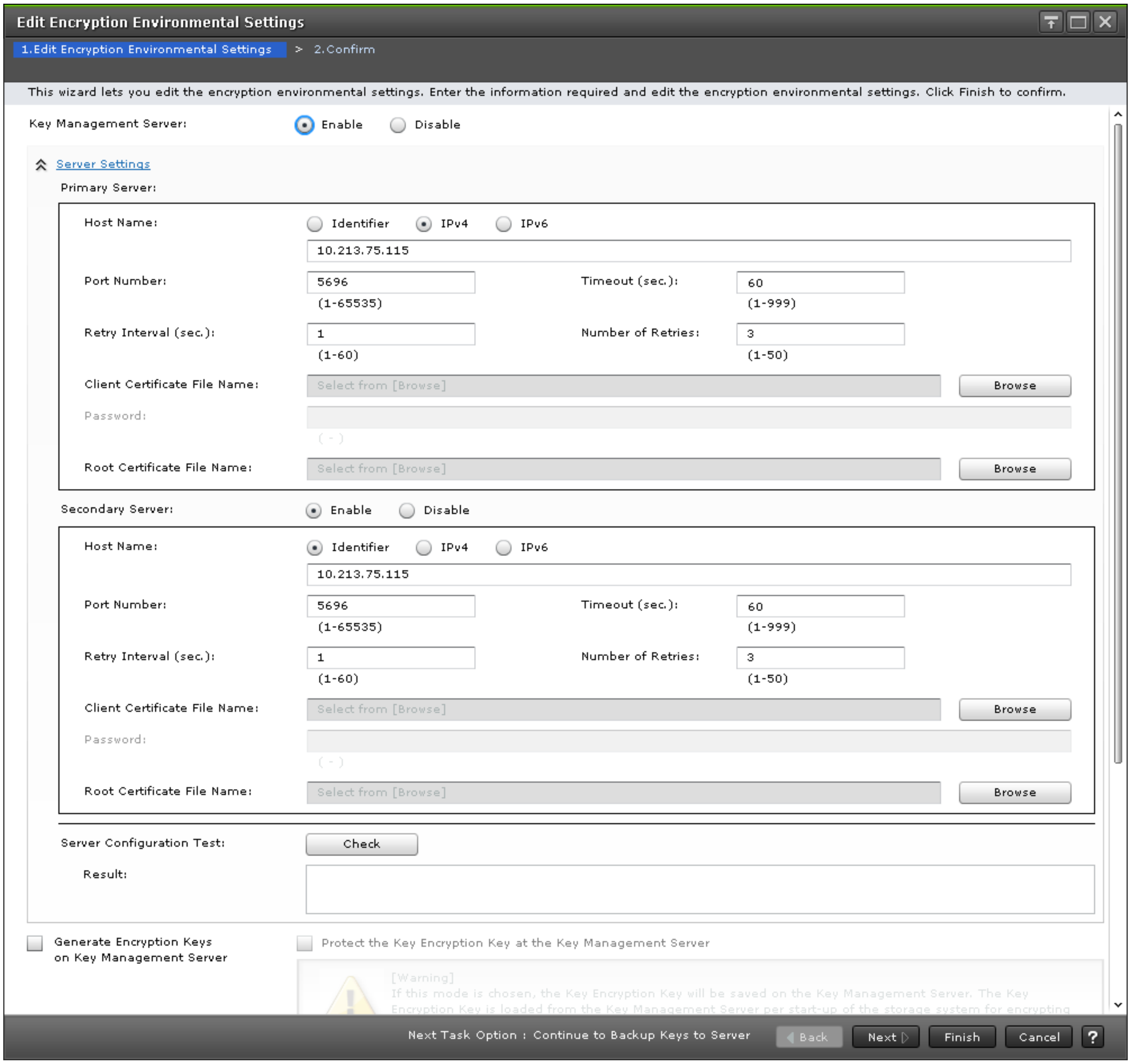
Edit Encryption Environmental Settings wizard

Use the Edit Encryption Environmental Settings wizard to edit the encryption environmental settings.

Edit Encryption Environmental Settings window

Items to be configured in the **Edit Encryption Environmental Settings** window can be changed under the following conditions:

- When the key management server is not in use
- When local key generation is disabled
- When the key encryption key for the key management server is stored on the storage system.



Edit Encryption Environmental Settings

1.Edit Encryption Environmental Settings > 2.Confirm

This wizard lets you edit the encryption environmental settings. Enter the information required and edit the encryption environmental settings. Click Finish to confirm.

Key Management Server: ● Enable ○ Disable

Server Settings

Primary Server:

Host Name: ○ Identifier ● IPv4 ○ IPv6
10.213.75.115

Port Number: 5696 (1-65535)
Timeout (sec.): 60 (1-999)

Retry Interval (sec.): 1 (1-60)
Number of Retries: 3 (1-50)

Client Certificate File Name: Select from [Browse] Browse

Password: (-)

Root Certificate File Name: Select from [Browse] Browse

Secondary Server: ● Enable ○ Disable

Host Name: ● Identifier ○ IPv4 ○ IPv6
10.213.75.115

Port Number: 5696 (1-65535)
Timeout (sec.): 60 (1-999)

Retry Interval (sec.): 1 (1-60)
Number of Retries: 3 (1-50)

Client Certificate File Name: Select from [Browse] Browse

Password: (-)

Root Certificate File Name: Select from [Browse] Browse

Server Configuration Test: Check

Result:

□ Generate Encryption Keys on Key Management Server

□ Protect the Key Encryption Key at the Key Management Server

[Warning]
If this mode is chosen, the Key Encryption Key will be saved on the Key Management Server. The Key Encryption Key is loaded from the Key Management Server per start-up of the storage system for encrypting

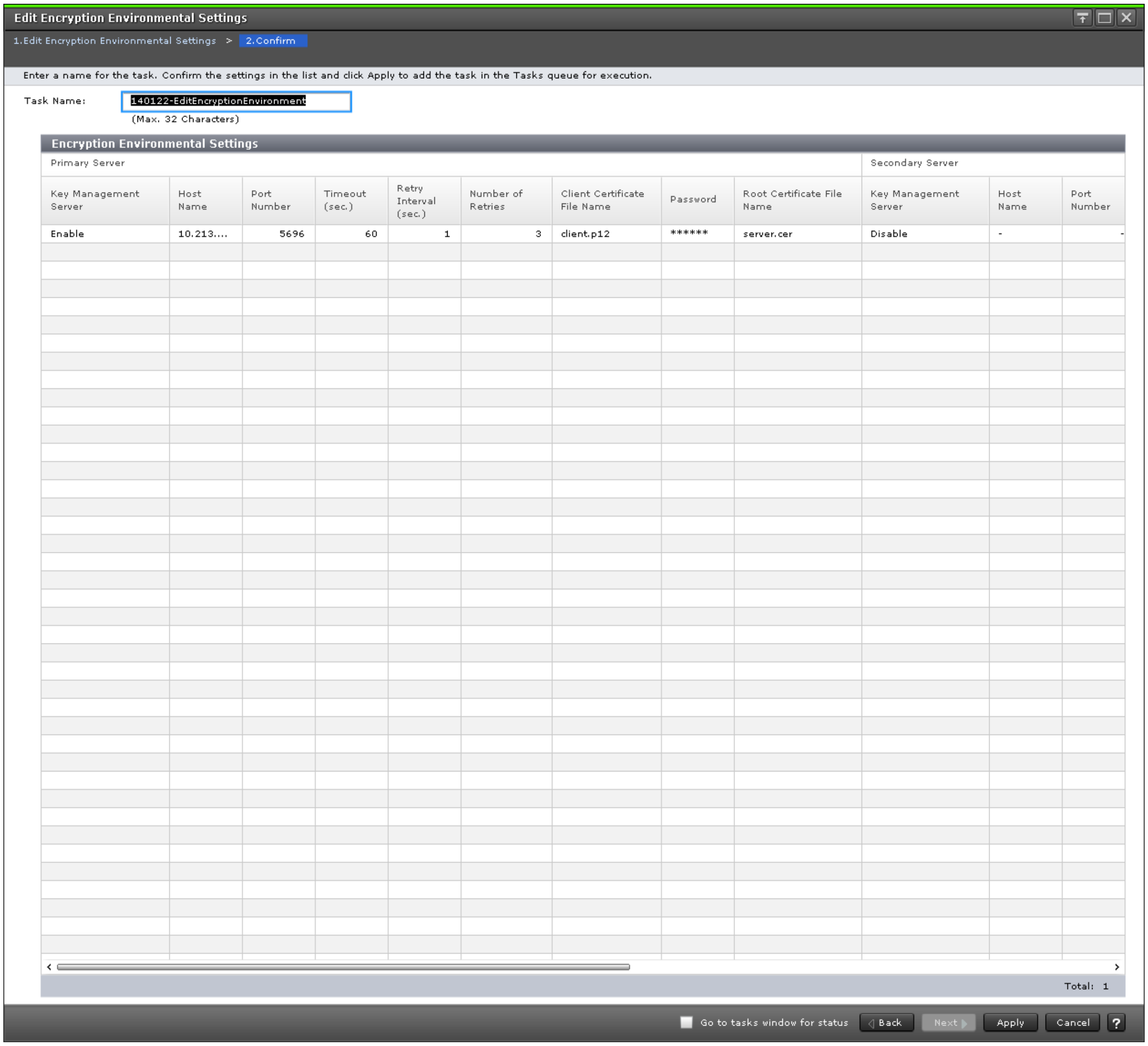
Next Task Option : Continue to Backup Keys to Server

Item	Description
Key Management Server	Select whether to use the key management server: • Enable: (default) key management server is used • Disable: key management server is not used
Server Setting	When you use the key management server, the following items display: • Primary server • Secondary server • Server Configuration test
Primary Server	Specify the primary server information. • Host Name: Enter the host name of the key management server. Identifier: Enter the host identifier. IPv4: Enter the host IPv4 address. IPv6: Enter the host IPv6 address.

Item	Description
	• Port number: Enter the port number of the key management server. Values: 1 to 65535. Default: 5696. • Timeout (sec.): Enter the time until the connection attempt to the key management server times out. Values: 1 to 999. Default: 60. • Retry Interval (sec.): Enter the interval to retry the connection to the key management server. Values: 1 to 60. Default: 1. • Number of Retries: Enter the number of times to retry the connection to the key management server. Values: 1 to 50. Default: 3. • Client Certificate File Name: Select the client certificate file for connecting to the key management server. Click Browse and select the file. • Browse: Select the client certificate file. The form of the client certificate is PKCS#12. For information about the client certificate file, contact the server or network administrator. The file name appears in the Client Certificate File Name field. • Password: Enter the password for the client certificate. Character limits: 0 to 128. Valid characters: Numbers (0 to 9) Upper case: (A-Z) Lower case: (a-z) Symbols: ! # $ % & ' ( ) * + , - . / : ; < = > ? @ [\ ] ^ _ ` { | } ~ • Root Certificate File Name: Select the root certificate file for connecting to the key management server. Click Browse and select the file. • Browse: Select the root certificate file. The form of the client certificate is X.509. If you do not know about the root certificate file, contact the server administrator or the network administrator. The name of the selected file appears in the Root Certificate File Name field.
Secondary Server	When the secondary server is set to Enable, the same settings can be specified as the primary server. **Note**: You must select Enable for Secondary Server before you can select Protect the Key Encryption Key at the Key Management Server or Disable local key generation.
Server Configuration Test	Select Check to start a server connection test for the key management server based on the specified settings.
Check	Start a server connection test for the key management server based on the specified settings
Result	Shows the result of the server connection test for the key management server
Generate Encryption Keys on Key Management Server	Checks when encryption keys are created on a key management server
Protect the Key Encryption Key at the Key Management Server	Specifies when key encryption keys are saved on key management servers. If Warning is displayed, confirm the content of the warning, and select I Agree. **Note**: This item cannot be selected if Disable is selected for Secondary Server.

Item	Description
Enable Encryption Key Regular Backup to Key Management Server	Select this option to enable regularly scheduled encryption key backups. **Note**: This item cannot be selected if Disable is selected for Secondary Server.
Regular Backup Time	Select the time, or times, you want to back up encryption keys. Check Select All to schedule hourly backups.
Regular Backup User	Defines the regular backup user. • **User Name:** Enter the user name of the regular backup user. • **Password** Enter the password of the regular backup user.
Disable local key generation	Specifies when encryption keys are created on the key management server and that encryption keys cannot be created on the storage system. If Warning is displayed, confirm the content of the warning, and select I Agree. **Caution**: If you select this option and select I Agree when prompted, you will not be able to undo this action or restore the settings. **Note**: This item cannot be selected if Disable is selected for Secondary Server.
Initialize Encryption Environmental Settings	Select to initialize the encryption environmental settings

Edit Encryption Environmental Settings confirmation window



Edit Encryption Environmental Settings

1.Edit Encryption Environmental Settings > 2.Confirm

Enter a name for the task. Confirm the settings in the list and click Apply to add the task in the Tasks queue for execution.

Task Name: 140122-EditEncryptionEnvironment

(Max. 32 Characters)

Encryption Environmental Settings

Primary Server									Secondary Server		
Key Management Server	Host Name	Port Number	Timeout (sec.)	Retry Interval (sec.)	Number of Retries	Client Certificate File Name	Password	Root Certificate File Name	Key Management Server	Host Name	Port Number
Enable	10.213....	5696	60	1	3	client.p12	******	server.cer	Disable	-	-

Total: 1

Item	Description
Primary Server	Displays the primary server information. • Key Management Server: Shows whether the key management server is used Enable: The key management server is used Disable: The key management server is not used Not Set: Initialize the encryption environmental settings • Host Name: The host name of the key management server • Port number: The port number of the key management server • Timeout (sec.): The time until the connection attempt to the key management server times out • Retry Interval (sec.): The interval to retry the connection to the key management server • Number of Retries: The number of times to retry the connection to the key management server

Item	Description
	- Client Certificate File Name: The client certificate file for connecting to the key management server - Password: The password for the client certificate is displayed as ****** (six asterisks). - Root Certificate File Name: The root certificate file for connecting to the key management server
Secondary Server	When the secondary server exists, the same items display as for the primary server.
Generate Encryption Keys on Key Management Server	Displays whether encryption keys are created on a key management server. - Yes: Encryption keys are created on a key management server. - No: Encryption keys are not created on a key management server.
Protect the Key Encryption Key at the Key Management Server	Displays whether key encryption keys are saved on key management servers. - Yes: Encryption keys are created on a key management server. - No: Encryption keys are not created on a key management server.
Enable Encryption Key Regular Backup to Key Management Server	- Yes: An encryption key is being regularly backed up. - No: An encryption key is not being regularly backed up.
Regular Backup Time	Displays the times of day an encryption key is backed up.
Regular Backup User	Displays the name of the regular backup user.
Password	Displays six asterisks (******) for the password of the regular backup user.
Disable local key generation	Displays whether encryption keys are created on key management servers and encryption keys cannot be created on the storage system - Yes: Encryption keys are created on key management servers and encryption keys cannot be created on the storage system. - No: Encryption keys are not created on key management servers. Encryption keys are created on storage systems.

Create Keys wizard

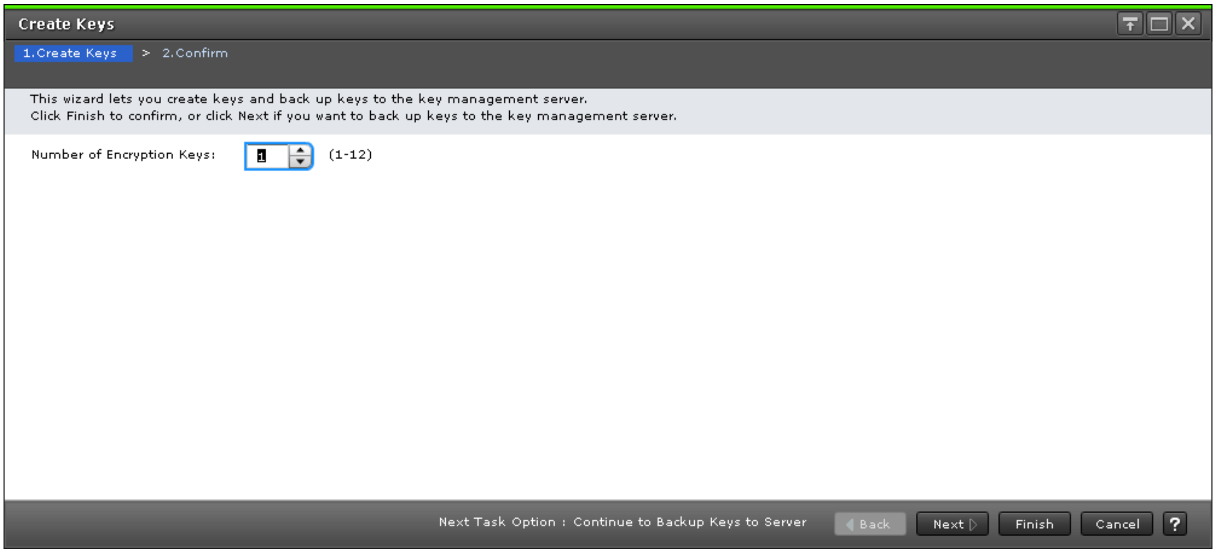
Use the Create Keys wizard to create keys and to backup keys to the key management server.

This wizard includes the following windows:

- **Create Keys** window
- **Confirm** window

Create Keys window

Use the **Create Keys** window to create a data encryption key. This window includes the Selected Keys table.



This wizard lets you create keys and back up keys to the key management server.
Click Finish to confirm, or click Next if you want to back up keys to the key management server.

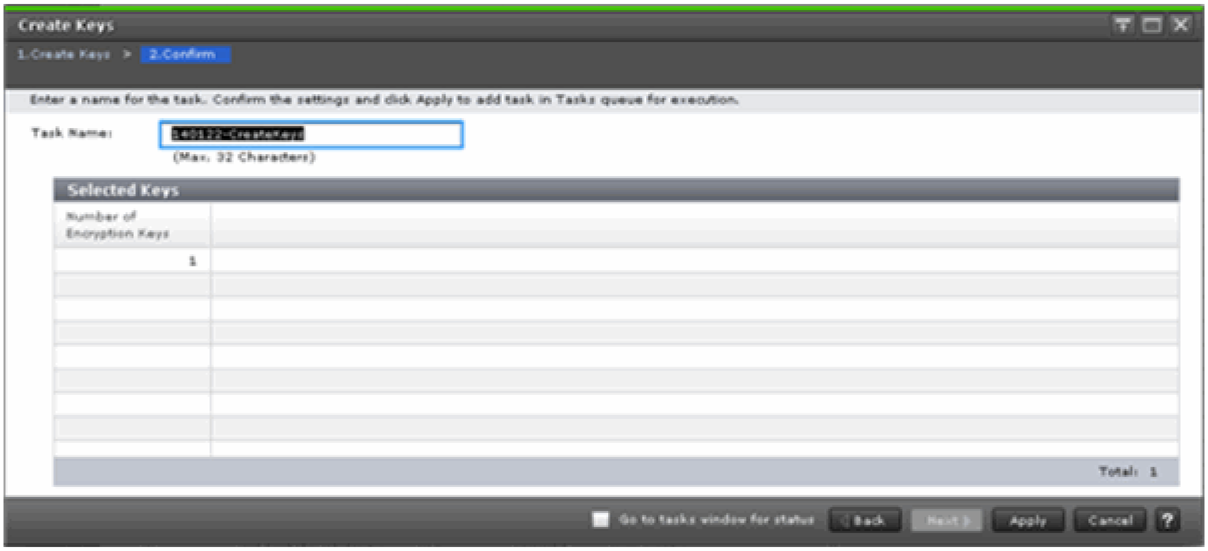
Number of Encryption Keys: 1 (1-12)

Next Task Option : Continue to Backup Keys to Server

Item	Description
Number of Encryption Keys	• For VSP G200, this specifies the number of encryption keys (1-512). The maximum number of encryption keys is 512. This window shows the value obtained by subtracting the number of created DEK and Free keys from 512. • For VSP G400, G600 or VSP F400, F600, this specifies the number of encryption keys (1-1,024). 1,024 is the maximum number of encryption keys. This window shows the value that subtracted the number of created DEK and Free keys from 1,024. • For VSP G800 and VSP F800, this specifies the number of encryption keys (1-2,048). The maximum number of encryption keys is 2,048. This window shows the value obtained by subtracting the number of created DEK and Free keys from 2,048. • For VSP G1x00 and VSP F1500, this specifies the number of encryption keys (1-4,096). 4,096 is the maximum number of encryption keys. This window shows the value obtained by subtracting the number of created DEK and Free keys from 4,096.

Create Keys confirmation window

The following is the **Confirm** window in the Create Keys wizard.



Enter a name for the task. Confirm the settings and click Apply to add task in Tasks queue for execution.

Task Name: 140122-CreateKeys

(Max. 32 Characters)

Selected Keys

Number of Encryption Keys
1

Total: 1

Item	Description
Number of Encryption Keys	Displays the number of encryption keys

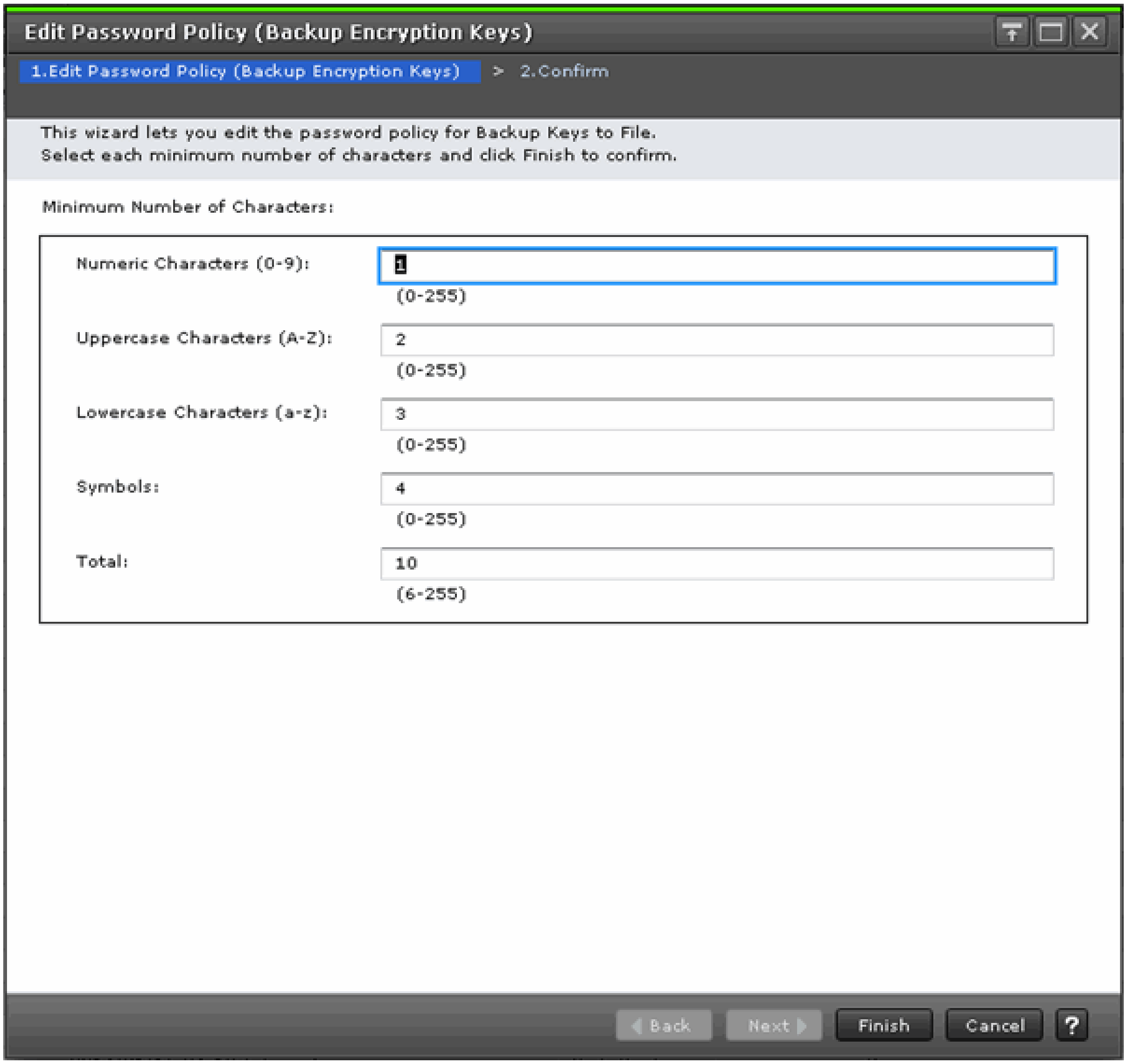
Edit Password Policy (Backup Encryption Keys) wizard

Use the Edit Password Policy (Backup Encryption Keys) wizard to edit the password policy for backup keys.

This wizard includes the following windows:

- **Edit Password Policy (Backup Encryption Keys)** window
- **Confirm** window

Edit Password Policy (Backup Encryption Keys) window



Edit Password Policy (Backup Encryption Keys)
1.Edit Password Policy (Backup Encryption Keys)
> 2.Confirm

This wizard lets you edit the password policy for Backup Keys to File.
Select each minimum number of characters and click Finish to confirm.

Minimum Number of Characters:

Numeric Characters (0-9): 1 (0-255)

Uppercase Characters (A-Z): 2 (0-255)

Lowercase Characters (a-z): 3 (0-255)

Symbols: 4 (0-255)

Total: 10 (6-255)

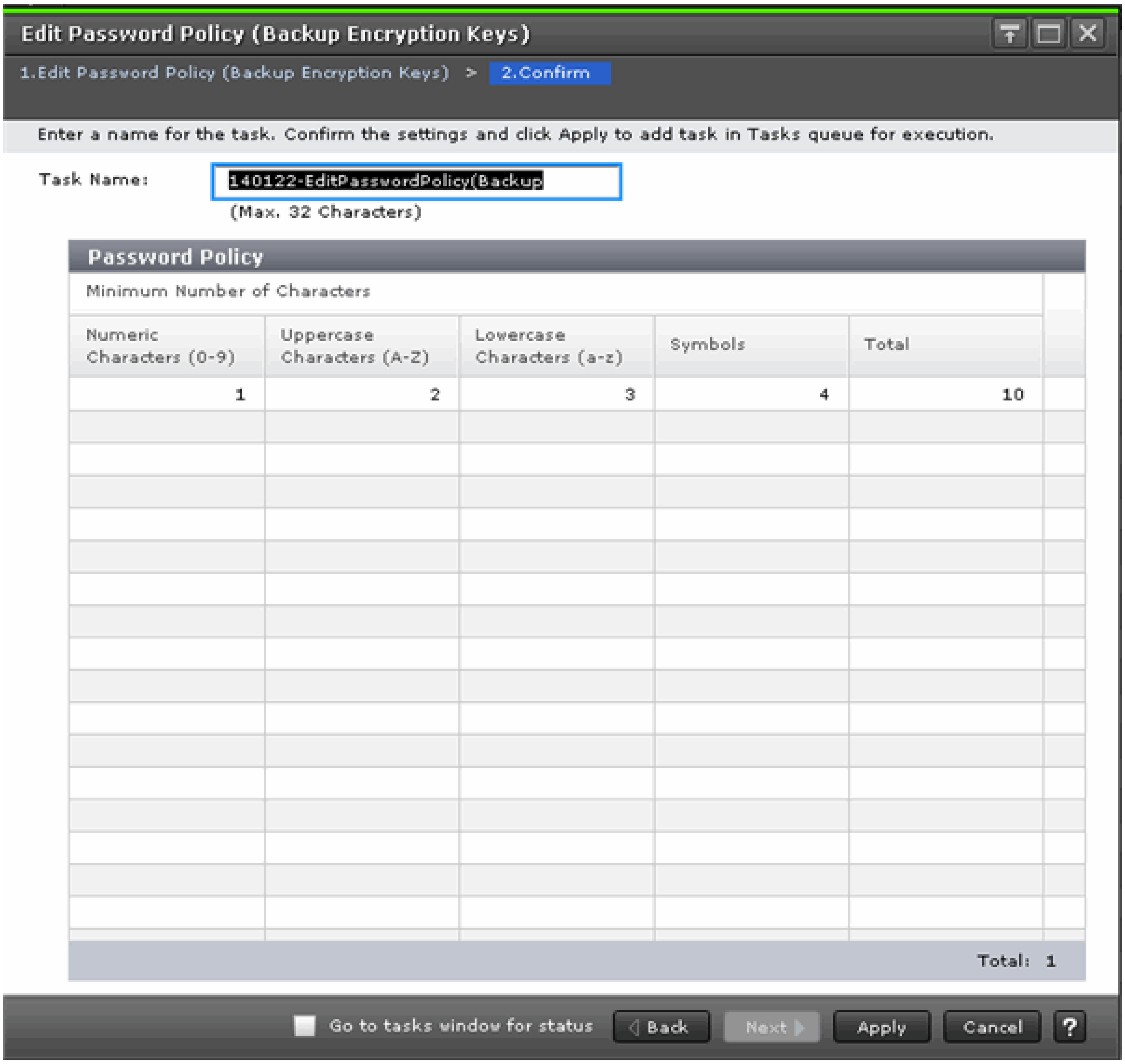
Back
Next
Finish
Cancel
?

Item	Description
Numeric Characters (0-9)	The minimum number of numeric characters that should be used for this password Values: 0 to 255 Default: 0
Uppercase Characters (A-Z)	The minimum number of alphabetical upper case characters that should be used for this password Values: 0 to 255 Default: 0
Lowercase Characters (a-z)	The minimum number of alphabetical lower case characters that should be used for this password

Item	Description
	Values: 0 to 255 Default: 0
Symbols	The minimum number of symbols that should be used for this password Values: 0 to 255 Default: 0
Total	The minimum number of characters for this password Values: 6 to 255 Default: 6

Edit Password Policy (Backup Encryption Keys) confirmation window

Use the **Confirm** window in the Edit Password Policy (Backup Encryption Keys) wizard to confirm the changes to the password policy.



Edit Password Policy (Backup Encryption Keys)
1.Edit Password Policy (Backup Encryption Keys) > 2.Confirm

Enter a name for the task. Confirm the settings and click Apply to add task in Tasks queue for execution.

Task Name: 140122-EditPasswordPolicy(Backup
(Max. 32 Characters)

Password Policy

Minimum Number of Characters

Numeric Characters (0-9)	Uppercase Characters (A-Z)	Lowercase Characters (a-z)	Symbols	Total
1	2	3	4	10

Total: 1

□ Go to tasks window for status
Back
Next
Apply
Cancel
?

Item	Description
Numeric Characters (0-9)	Displays the minimum number of numeric characters that should be used for this password
Uppercase Characters (A-Z)	Displays the minimum number of alphabetical upper case characters that should be used for this password
Lowercase Characters (a-z)	Displays the minimum number of alphabetical lower case characters that should be used for this password
Symbols	Displays the minimum number of symbols that should be used for this password
Total	Displays the minimum number of characters for this password

Backup Keys to File wizard

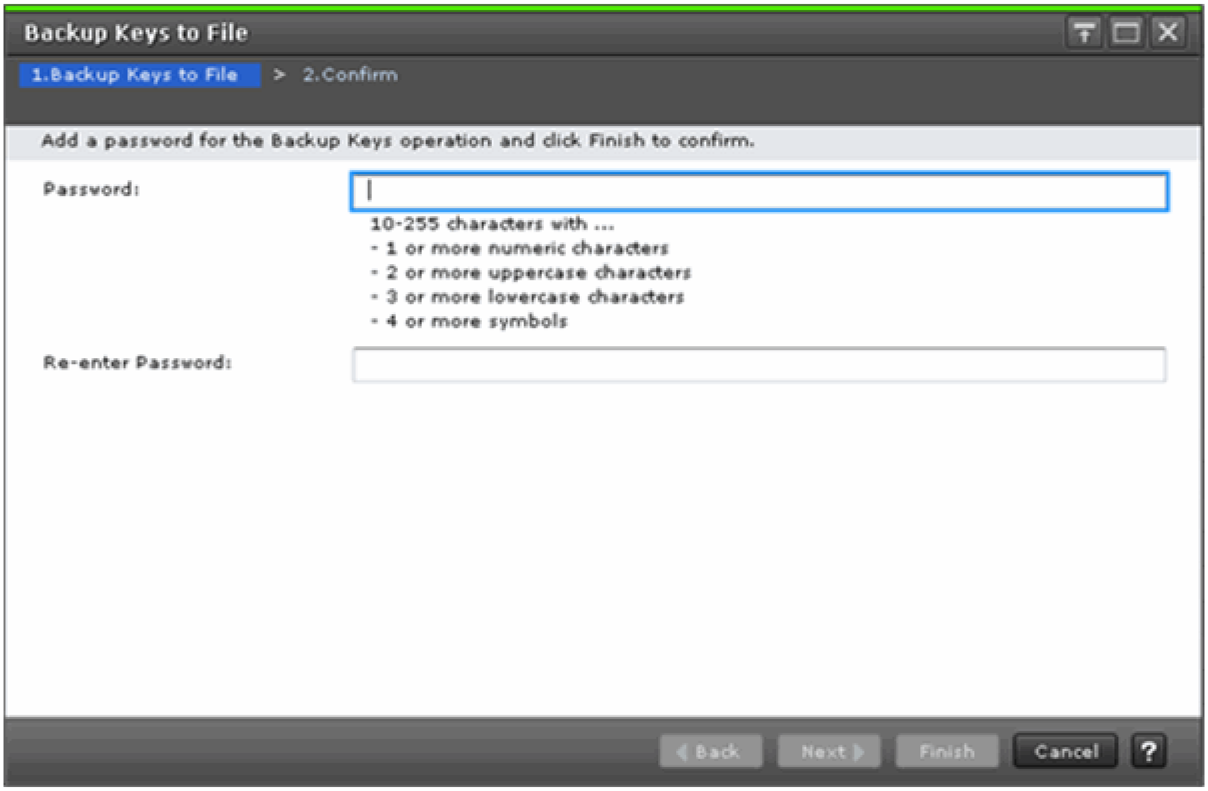
Use the Backup Keys to File wizard to create backup data encryption keys as files on the HDvM - SN computer.

This wizard includes the following windows:

- **Backup Keys to File** window
- **Confirm** window

Backup Keys to File window

When the password policy is edited in the **Edit Password Policy (Backup Encryption Keys)** window, the screen appears as follows:



Backup Keys to File

1.Backup Keys to File > 2.Confirm

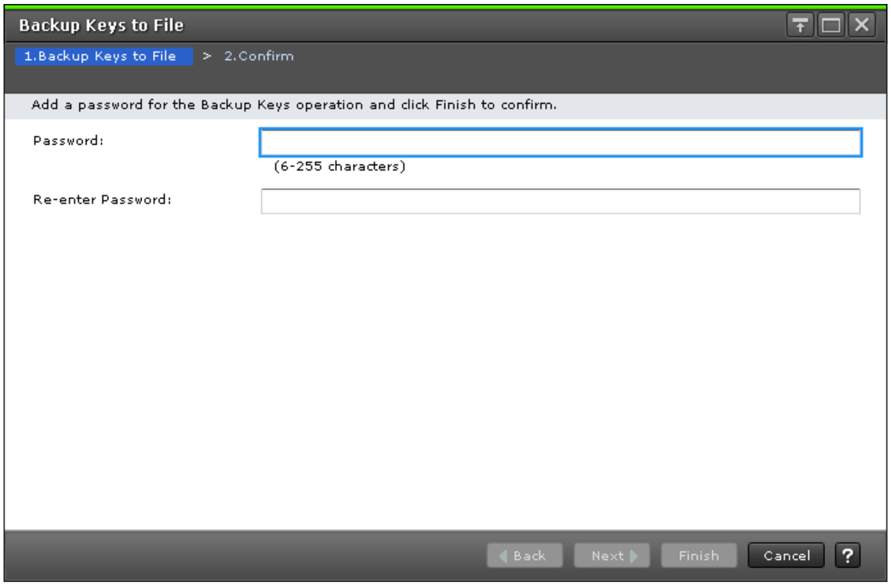
Add a password for the Backup Keys operation and click Finish to confirm.

Password:

10-255 characters with ...
- 1 or more numeric characters
- 2 or more uppercase characters
- 3 or more lowercase characters
- 4 or more symbols

Re-enter Password:

When the password policy is not edited in the **Edit Password Policy (Backup Encryption Keys)** window, the screen appears as follows:

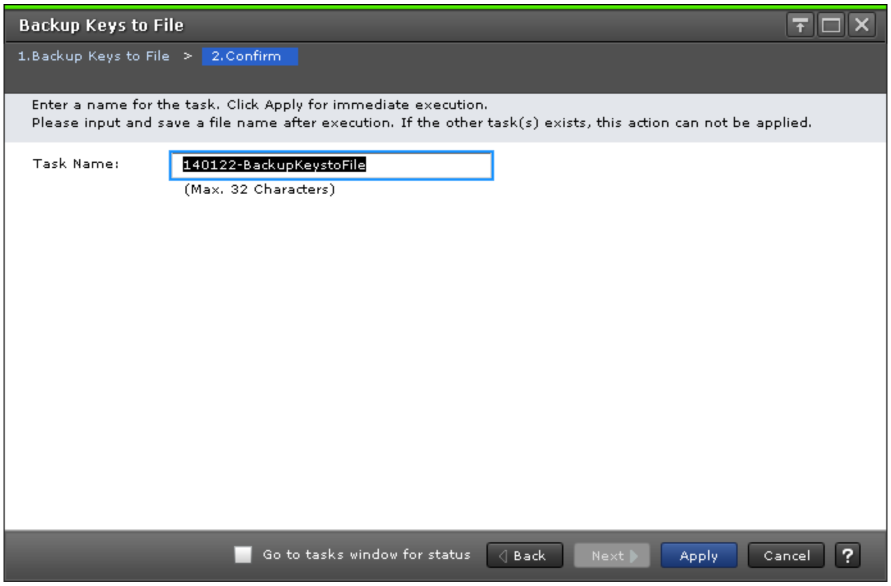


Backup Keys to File

Add a password for the Backup Keys operation and click Finish to confirm.

Item	Description
Password	The password for the backup data encryption key Character limits: 6 to 255 Valid characters: • Numbers (0 to 9) • Upper case (A-Z) • Lower case (a-z) • Symbols: ! " # $ % & ' ( ) * + , - . / : ; < = > ? @ [\ ] ^ _ ` { | } ~
Re-enter Password	Type the password again for confirmation.

Backup Keys to File confirmation window


Backup Keys to File
1.Backup Keys to File > 2.Confirm

Enter a name for the task. Click Apply for immediate execution.
Please input and save a file name after execution. If the other task(s) exists, this action can not be applied.

Task Name: 140122-BackupKeystoFile
(Max. 32 Characters)

□ Go to tasks window for status
Back
Next
Apply
Cancel
?

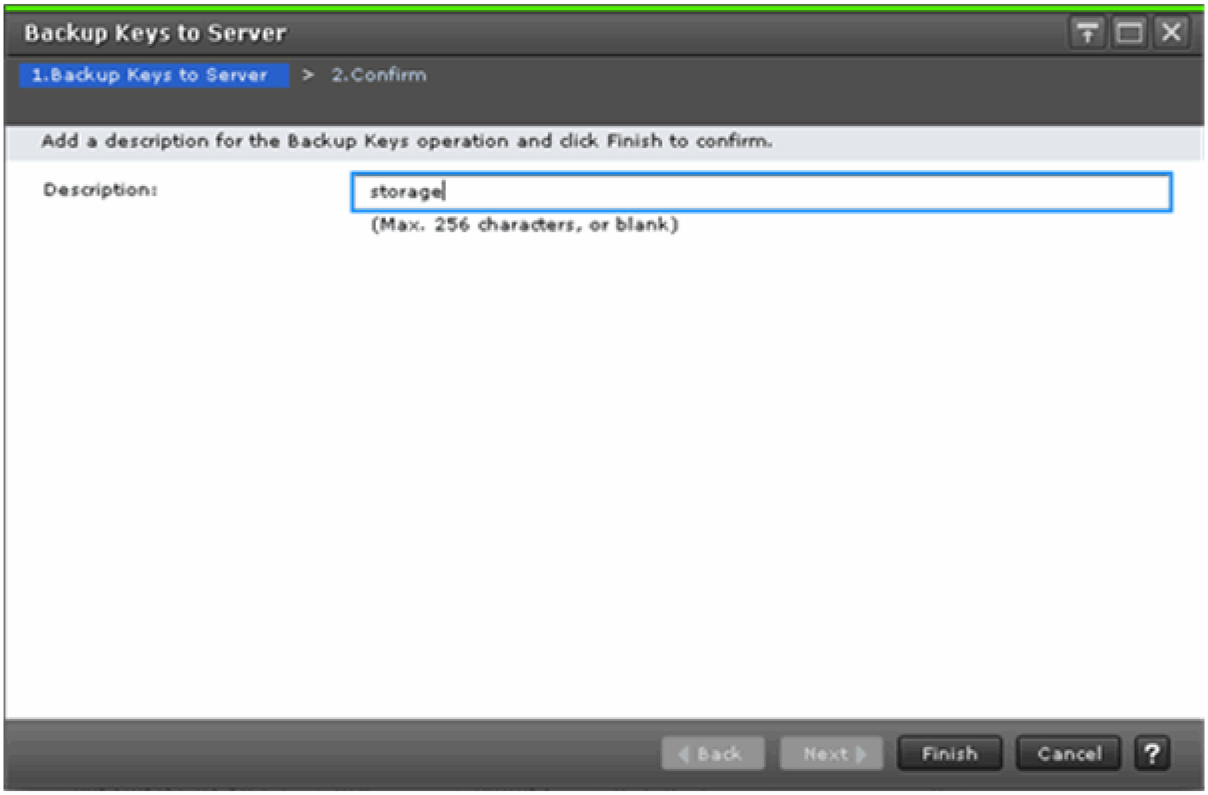
When you click Apply in the **Confirm** window, a confirmation message will appear. After you click OK, a window for saving the file for encryption keys will appear. Enter the backup file name with the extension of ".ekf" and save the file.

Backup Keys to Server wizard

Use the Backup Keys to Server wizard to backup data encryption keys on the key management server.

This wizard includes the following windows:
- **Backup Keys to Server** window
- **Confirm** window

Backup Keys to Server window



Backup Keys to Server

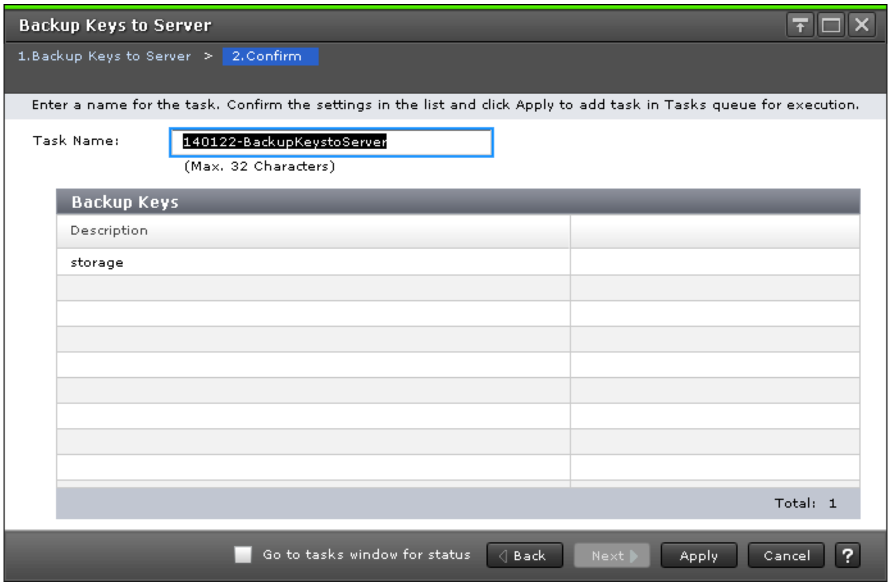
Add a description for the Backup Keys operation and click Finish to confirm.

Description: storage

(Max. 256 characters, or blank)

Item	Description
Description	Optionally, enter a description for the backup data encryption key. Character limits: 256

Backup Keys to Server confirmation window



Backup Keys to Server

1.Backup Keys to Server > 2.Confirm

Enter a name for the task. Confirm the settings in the list and click Apply to add task in Tasks queue for execution.

Task Name: 140122-BackupKeystoServer

(Max. 32 Characters)

Backup Keys

Description	
storage	

Total: 1

Item	Description
Description	Shows the description for the backup data encryption key

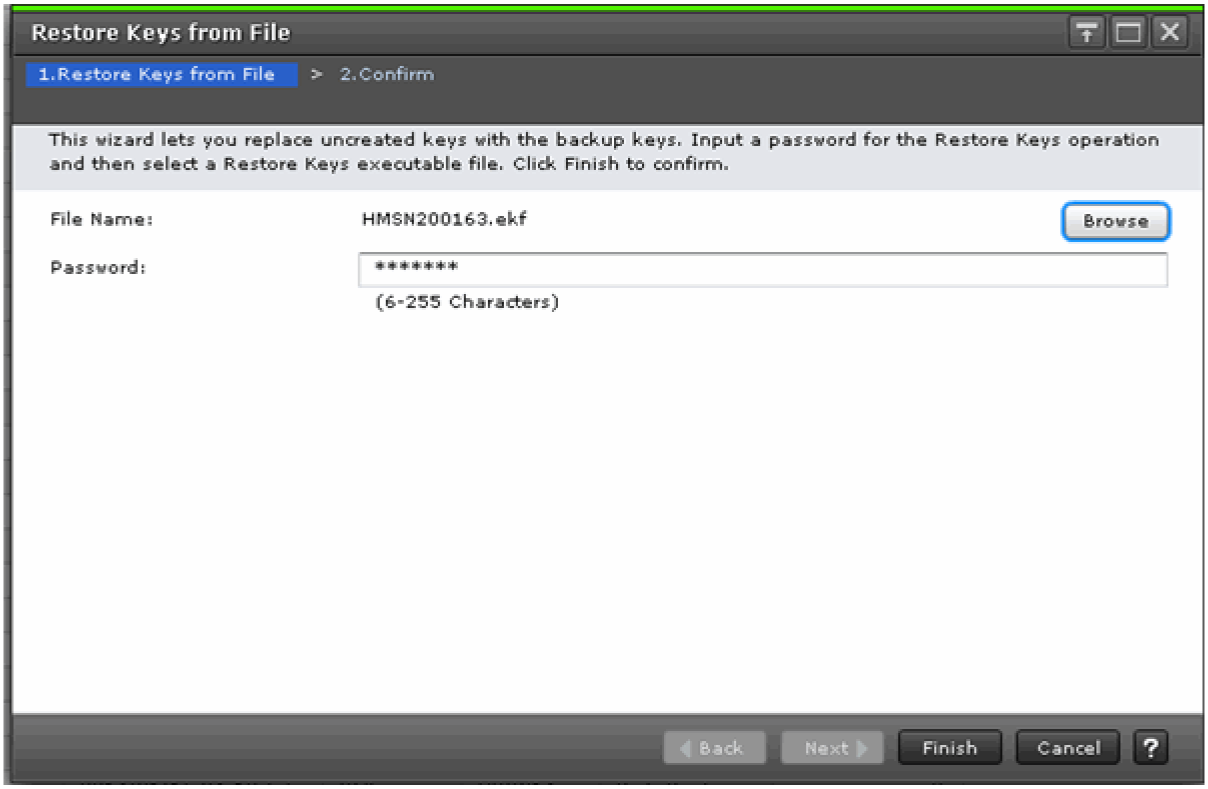
Restore Keys from File wizard

Use the Restore Keys wizard to restore data encryption keys from a file you backed up on the HDvM - SN computer.

This wizard includes the following windows:

- **Restore Keys from File** window
- **Confirm** window

Restore Keys from File window



This wizard lets you replace uncreated keys with the backup keys. Input a password for the Restore Keys operation and then select a Restore Keys executable file. Click Finish to confirm.

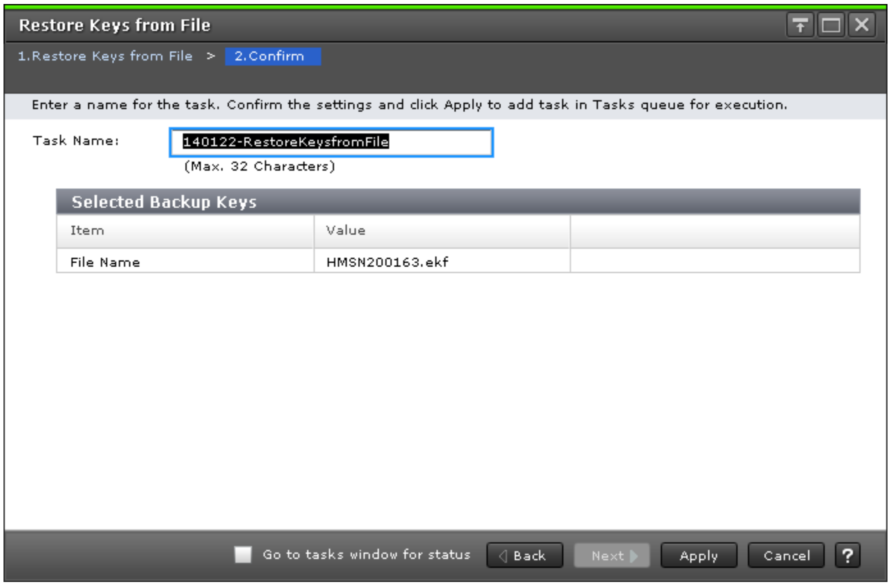
File Name: HMSN200163.ekf

Password: *******

(6-255 Characters)

Item	Description
File Name	File name of the selected backup file
Browse	Select the backup file (.ekf). The name of the selected file is shown for File Name.
Password	The password that you typed when you created the backup data encryption key

Restore Keys confirmation window


Restore Keys from File
1.Restore Keys from File > 2.Confirm

Enter a name for the task. Confirm the settings and click Apply to add task in Tasks queue for execution.

Task Name: 140122-RestoreKeysfromFile
(Max. 32 Characters)

Selected Backup Keys

Item	Value
File Name	HMSN200163.ekf

□ Go to tasks window for status
Back
Next
Apply
Cancel
?

Item	Description
Item	Item of the data encryption key to restore.
Value	Value of the data encryption key to restore.

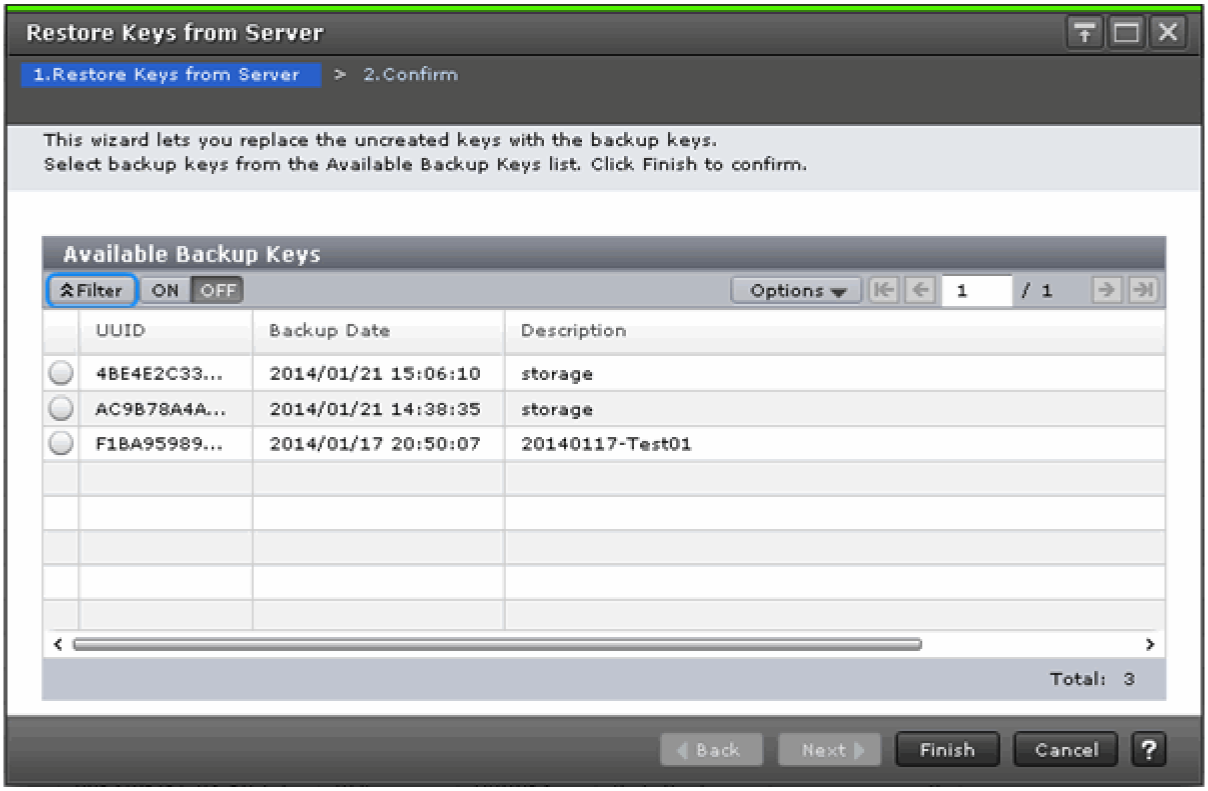
Restore Keys from Server wizard

Use the Restore Keys from Server wizard to restore data encryption keys from the key management server.

This wizard includes the following windows:

- **Restore Keys from Server** window
- **Confirm** window

Restore Keys from Server window



This wizard lets you replace the uncreated keys with the backup keys.
Select backup keys from the Available Backup Keys list. Click Finish to confirm.

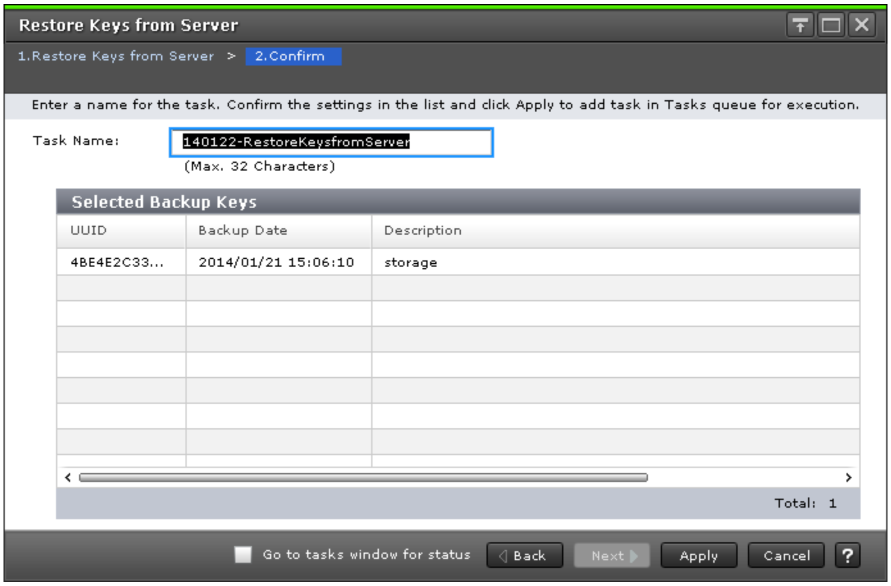
Available Backup Keys

	UUID	Backup Date	Description
○	4BE4E2C33...	2014/01/21 15:06:10	storage
○	AC9B78A4A...	2014/01/21 14:38:35	storage
○	F1BA95989...	2014/01/17 20:50:07	20140117-Test01

Total: 3

Item	Description
UUID	Shows the UUID of the encryption key that you backed up on the key management server
Backup Date	Shows the time you backed up the encryption key on the key management server
Description	Shows the description you defined when you backed up the encryption key on the key management server The encryption key for a regular backup is displayed in the following format: `RegularBackup_`*[backed-up-year-month-date_backed-up-time]*

Restore Keys from Server confirmation window



Restore Keys from Server

1.Restore Keys from Server > 2.Confirm

Enter a name for the task. Confirm the settings in the list and click Apply to add task in Tasks queue for execution.

Task Name: 140122-RestoreKeysfromServer

(Max. 32 Characters)

Selected Backup Keys

UUID	Backup Date	Description
4BE4E2C33...	2014/01/21 15:06:10	storage

Total: 1

Item	Description
UUID	Shows the UUID of the encryption key you backed up on the key management server
Backup Date	Shows the time when you backed up the encryption key on the key management server
Description	Shows the description you defined when you backed up the encryption key on the key management server The encryption key for a regular backup is displayed in the following format: `RegularBackup_`*`[backed-up-year-month-date_backed-up-time]`*

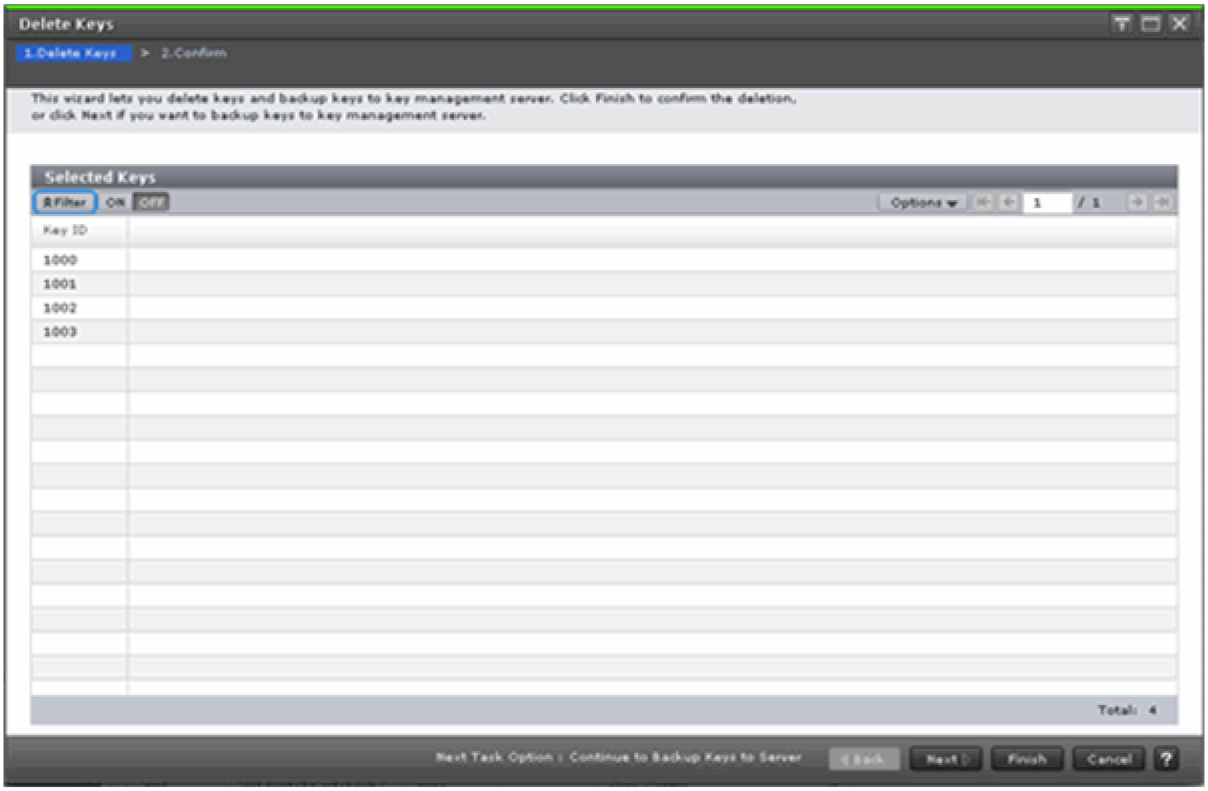
Delete Keys wizard

Use the Delete Keys wizard to delete keys and backup data encryption keys.

This wizard includes the following windows:

- **Delete Keys** window
- **Confirm** window

Delete Keys window



This wizard lets you delete keys and backup keys to key management server. Click Finish to confirm the deletion, or click Next if you want to backup keys to key management server.

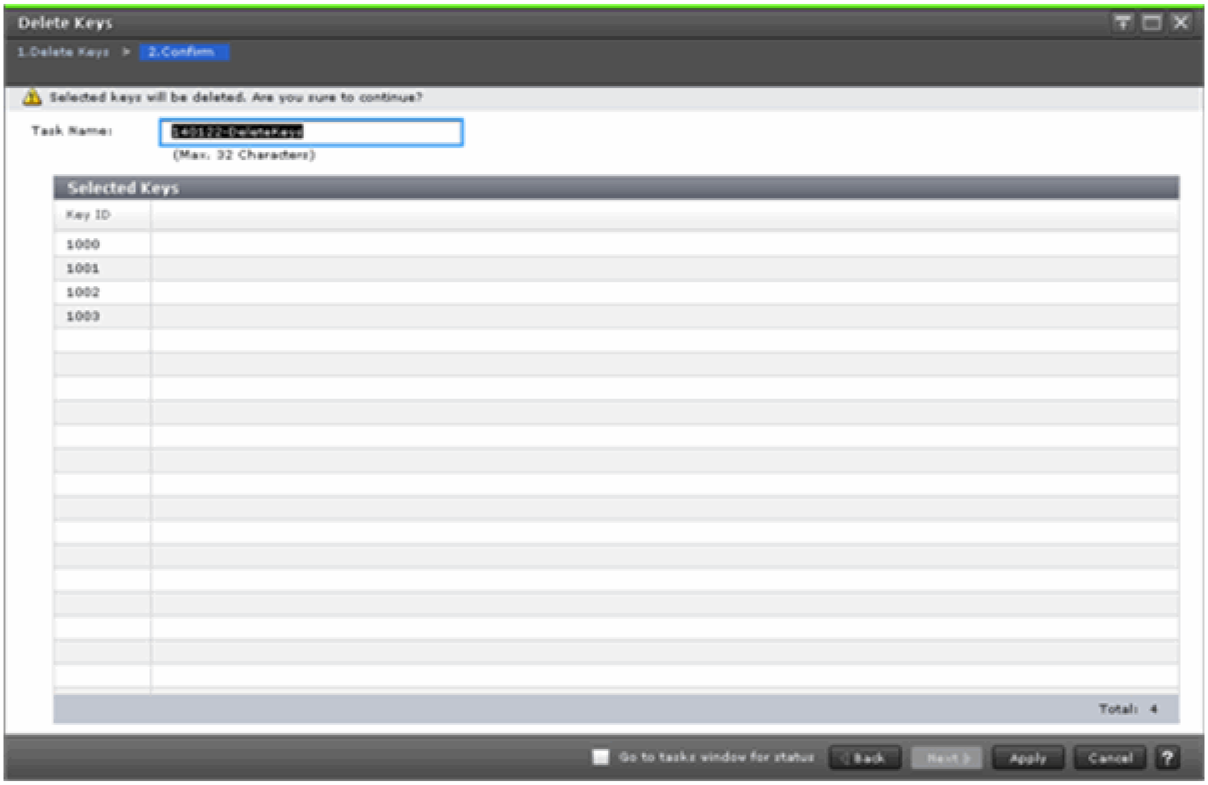
Key ID
1000
1001
1002
1003

Total: 4

Next Task Option : Continue to Backup Keys to Server

Item	Description
Key ID	IDs of data encryption keys

Delete Keys confirmation window



Selected keys will be deleted. Are you sure to continue?

Task Name: 140122-DeleteKeys
(Max. 32 Characters)

Selected Keys

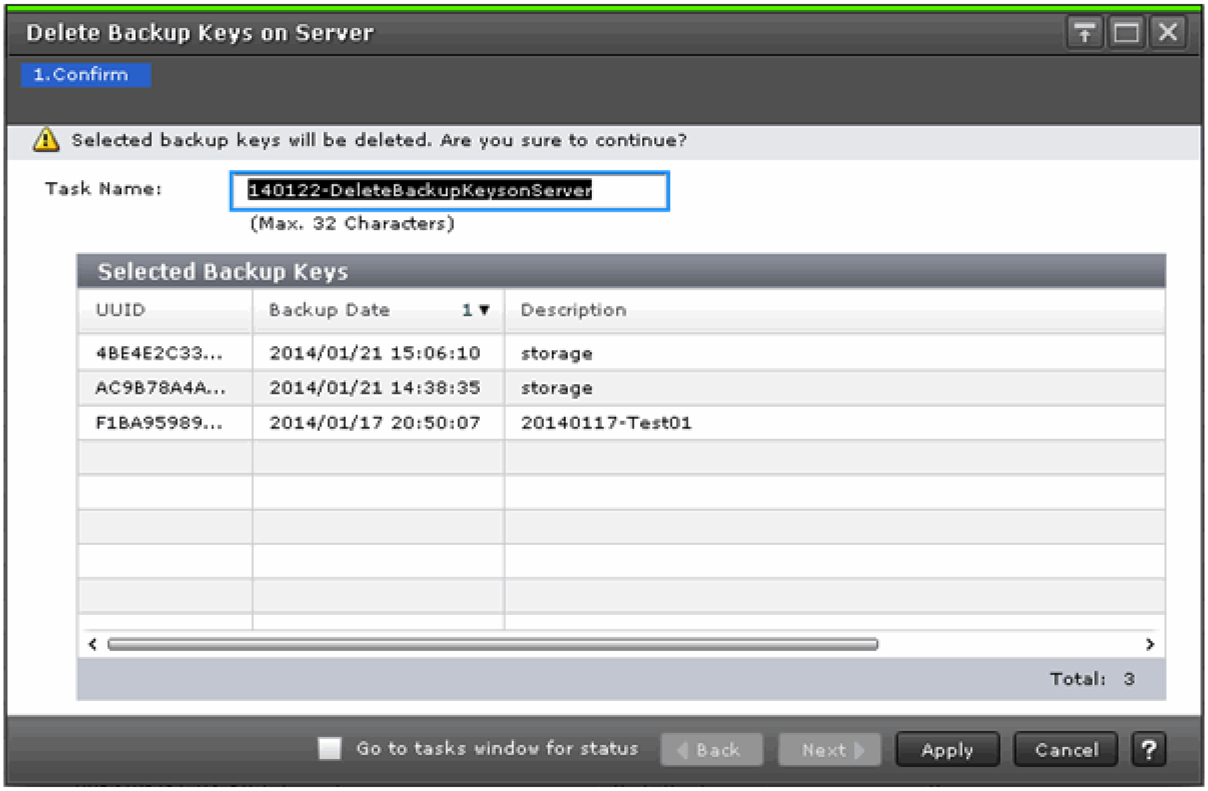
Key ID
1000
1001
1002
1003

Item	Description
Key ID	The identifiers for the data encryption keys

Delete Backup Keys on Server window

Use the **Delete Backup Keys on Server** window to confirm the deletion of a backup key.

This window includes the Selected Backup Keys table.



Selected backup keys will be deleted. Are you sure to continue?

Task Name: 140122-DeleteBackupKeysonServer

(Max. 32 Characters)

Selected Backup Keys

UUID	Backup Date	Description
4BE4E2C33...	2014/01/21 15:06:10	storage
AC9B78A4A...	2014/01/21 14:38:35	storage
F1BA95989...	2014/01/17 20:50:07	20140117-Test01

Total: 3

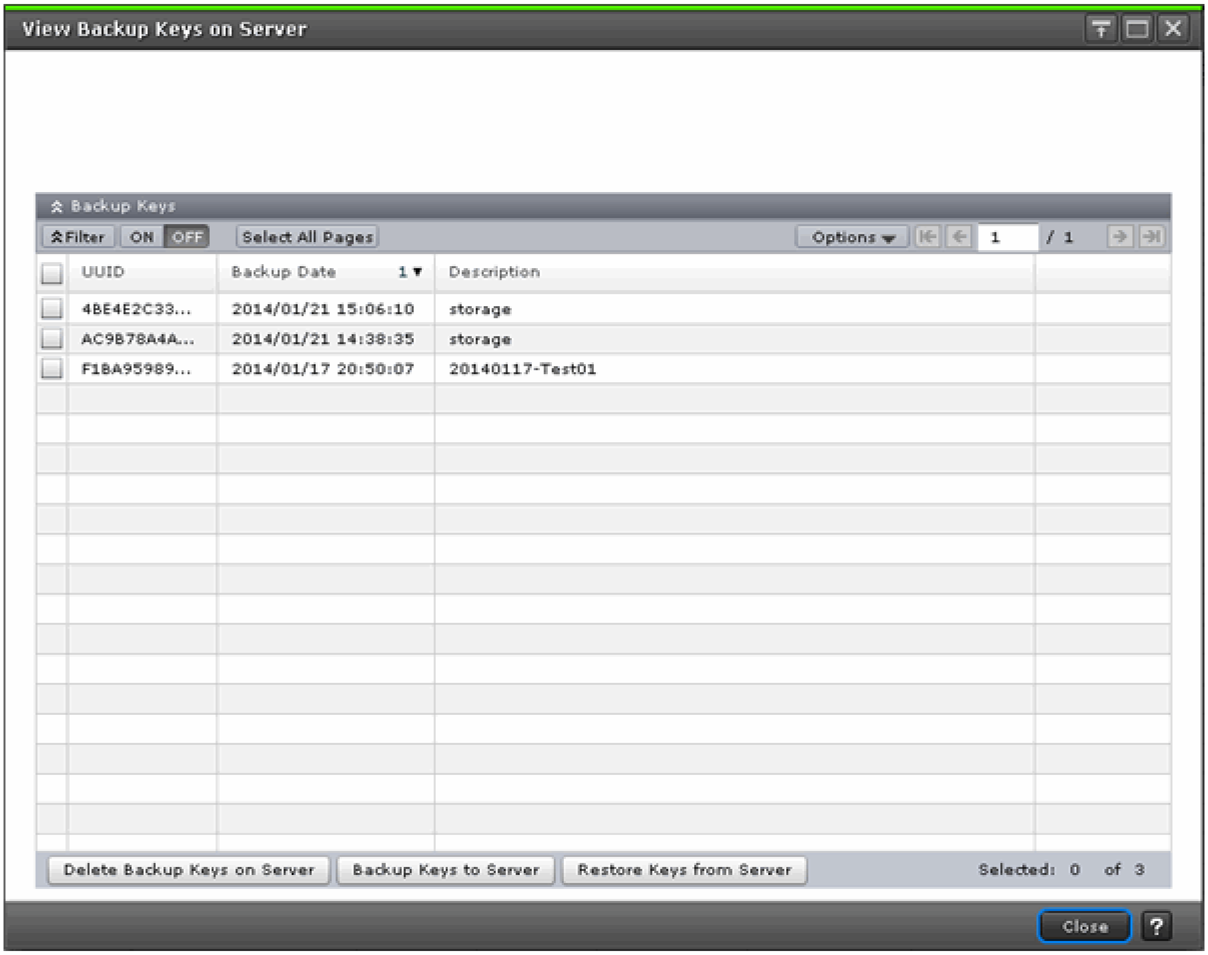
□ Go to tasks window for status

Item	Description
UUID	Shows the UUID of the encryption key you backed up on the key management server
Backup Date	Shows the time when you backed up the encryption key on the key management server
Description	Shows the description you defined when you backed up the encryption key on the key management server The encryption key for a regular backup is displayed in the following format: `RegularBackup_`*`[backed-up-year-month-date_backed-up-time]`*

View Backup Keys on Server window

Use the **View Backup Keys on Server** window to view a list of the backup encryption keys on the server.

This window includes the Backup Keys table.



☐	UUID	Backup Date 1▼	Description
☐	4BE4E2C33...	2014/01/21 15:06:10	storage
☐	AC9B78A4A...	2014/01/21 14:38:35	storage
☐	F1BA95989...	2014/01/17 20:50:07	20140117-Test01

Selected: 0 of 3

Backup Keys table

The Backup Keys table is shown on the **View Backup Keys on Server** window. This table lists the backup encryption keys.

Item	Description
UUID	Shows the UUID of the backup encryption key on the key management server.
Backup Date	Shows the time you backed up the encryption key on the key management server.
Description	Shows the description you defined when you backed up the encryption key on the key management server. The encryption key for a regular backup is displayed in the following format: `RegularBackup_`*`[backed-up-year-month-date_backed-up-time]`*
Delete Backup Keys on Server button	Opens the **Delete Backup Keys on Server** window
Backup Keys to Server button	Open the **Backup Keys to Server** window

Item	Description
Restore Keys from Server button	Opens the **Restore Keys from Server** window

Edit Encryption wizard

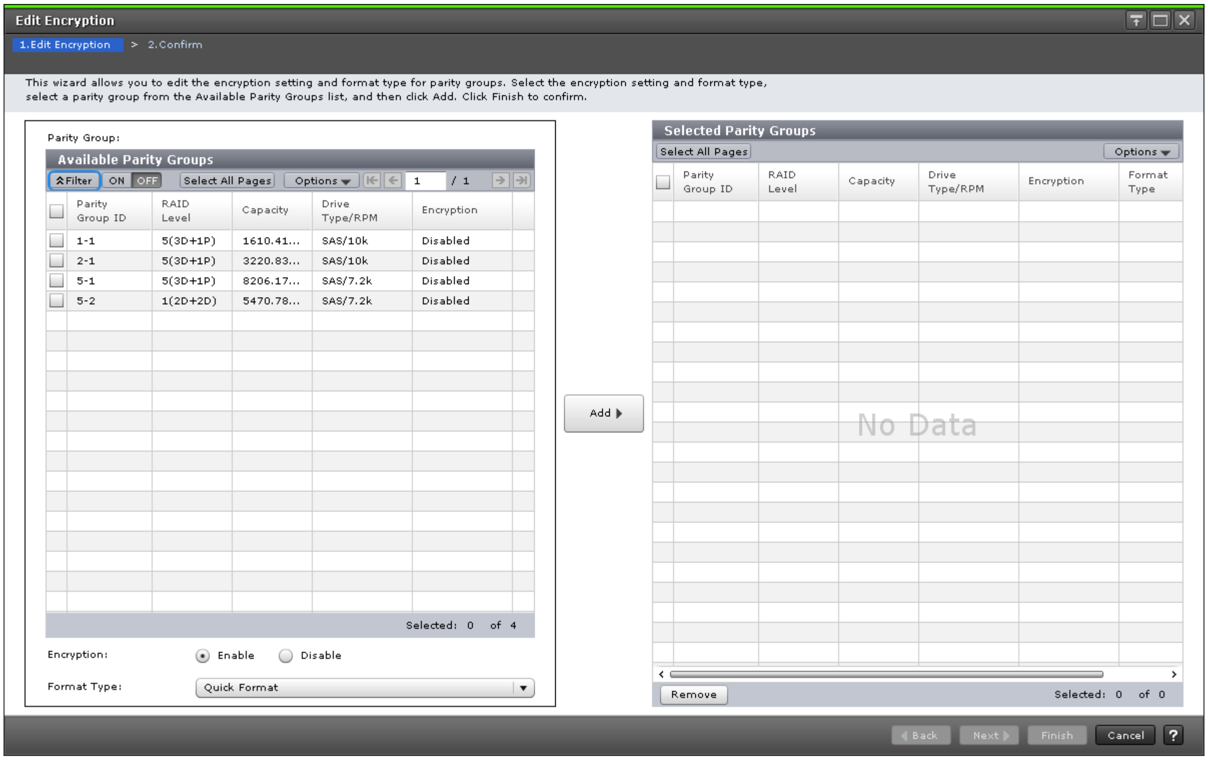
Use the Edit Encryption wizard to do the following:

- Enable data encryption on a parity group
- Edit or associate the data encryption key to the LDEV
- Edit the format type for the parity group

This wizard includes the following windows:

- **Edit Encryption** window
- **Confirm** window

Edit Encryption window



This wizard allows you to edit the encryption setting and format type for parity groups. Select the encryption setting and format type, select a parity group from the Available Parity Groups list, and then click Add. Click Finish to confirm.

Parity Group:

Available Parity Groups

□	Parity Group ID	RAID Level	Capacity	Drive Type/RPM	Encryption
□	1-1	5(3D+1P)	1610.41...	SAS/10k	Disabled
□	2-1	5(3D+1P)	3220.83...	SAS/10k	Disabled
□	5-1	5(3D+1P)	8206.17...	SAS/7.2k	Disabled
□	5-2	1(2D+2D)	5470.78...	SAS/7.2k	Disabled

Selected: 0 of 4

Encryption: ● Enable ○ Disable

Format Type: Quick Format

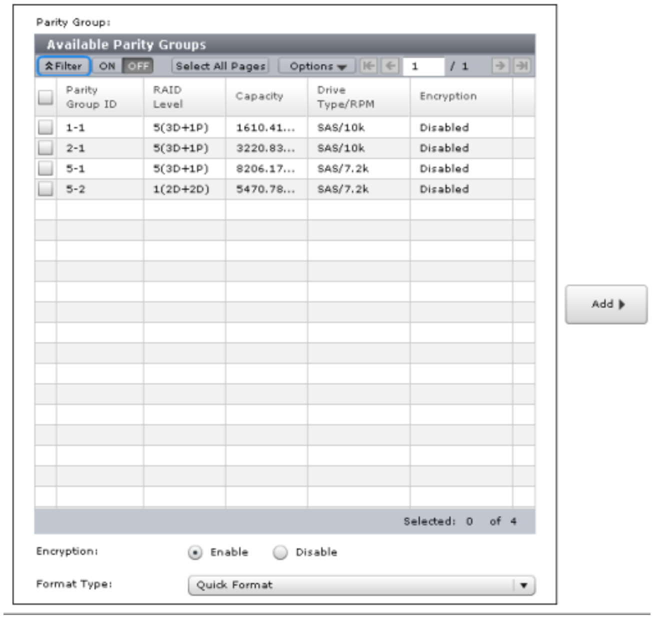
Selected Parity Groups

□	Parity Group ID	RAID Level	Capacity	Drive Type/RPM	Encryption	Format Type

Selected: 0 of 0

Available Parity Groups table

Use the Available Parity Groups table on the **Edit Encryption** window to view a list of the available parity groups.



Parity Group:

Available Parity Groups

□	Parity Group ID	RAID Level	Capacity	Drive Type/RPM	Encryption
□	1-1	5(3D+1P)	1610.41...	SAS/10k	Disabled
□	2-1	5(3D+1P)	3220.83...	SAS/10k	Disabled
□	5-1	5(3D+1P)	8206.17...	SAS/7.2k	Disabled
□	5-2	1(2D+2D)	5470.78...	SAS/7.2k	Disabled

Selected: 0 of 4

Encryption: ● Enable ○ Disable

Format Type: Quick Format ▾

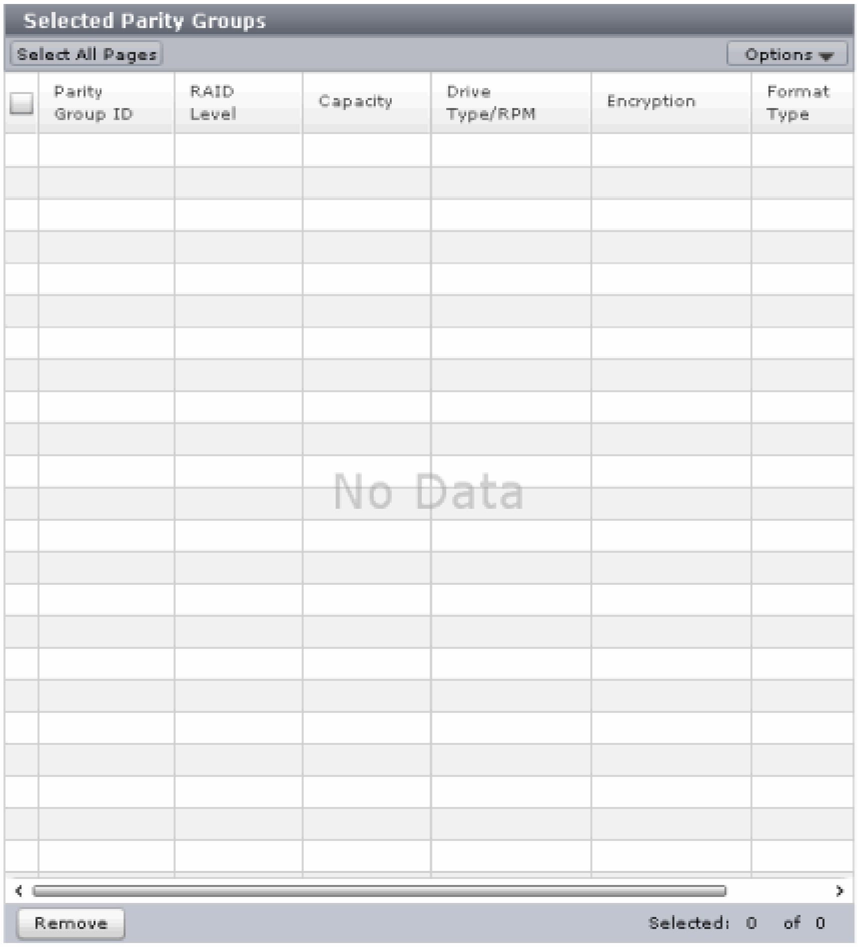
Item	Description
Parity Group ID	Shows the parity group IDs
RAID Level	Shows the RAID level of the parity group For an interleaved parity group, the interleaved number appears after the RAID level. Example: 1(2D+2D)*2
Capacity	Shows the total capacity (unit) of the parity group
Drive Type/RPM	Shows the drive types and RPM (rotation per minute) of the LDEV in the parity group
Encryption	Shows the encryption setting for the parity group. • Enabled: Encryption is enabled. • Disabled: Encryption is disabled. If accelerated compression of the parity group is enabled, do not select Enable for Encryption. If you select Enable for Encryption, an error occurs when performing the task.
Format Type	Select the format types of the parity group. You do not need to format volumes when there are none in the selected parity group. Therefore, the format type in the Selected Parity Groups list becomes a hyphen (-) regardless of the status of the format type.

Add

Use this button to move a selected parity group in the Available Parity Groups table to the Selected Parity Groups table.

Selected Parity Groups table

Use the Selected Parity Groups table to remove the parity group from the list.

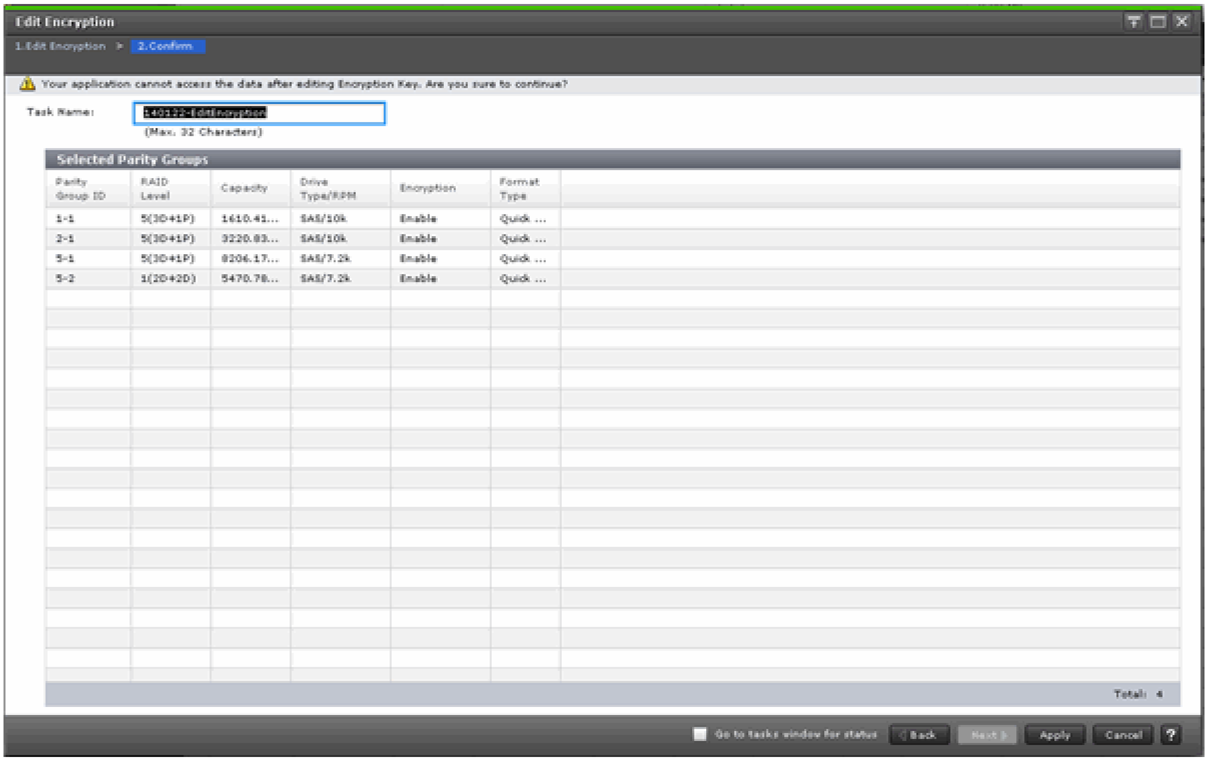


Item	Description
Parity Group ID	Shows parity group IDs
RAID Level	Shows the RAID level of the parity group For an interleaved parity group, the interleaved number appears after the RAID level. Example: 1(2D+2D)*2
Capacity	Shows the total capacity (unit) of the parity group
Drive Type/RPM	Shows the drive types and RPM (rotation per minute) of the LDEV in the parity group
Encryption	Shows the encryption setting for the parity group: • Enable: Encryption is enabled. • Disable: Encryption is disabled
Format Type	Shows the format types of the parity group

Item	Description
	You do not need to format volumes when there are none in the selected parity group. Therefore, the format type in the Selected Parity Groups list becomes a hyphen (-) regardless of the status of the format type.
Remove	Removes parity groups from the Selected Parity Groups table

Edit Encryption confirmation window

Use the **Confirm** window to confirm the changes to the data encryption key and to view a list of the selected parity groups related to the data encryption key.



Your application cannot access the data after editing Encryption Key. Are you sure to continue?

Task Name: 140122-EditEncryption
(Max. 32 Characters)

Selected Parity Groups

Parity Group ID	RAID Level	Capacity	Drive Type/RPM	Encryption	Format Type
1-1	5(3D+1P)	1610.41...	SAS/10k	Enable	Quick ...
2-1	5(3D+1P)	3220.83...	SAS/10k	Enable	Quick ...
5-1	5(3D+1P)	8206.17...	SAS/7.2k	Enable	Quick ...
5-2	1(2D+2D)	5470.78...	SAS/7.2k	Enable	Quick ...

Total: 4

Selected Parity Groups table

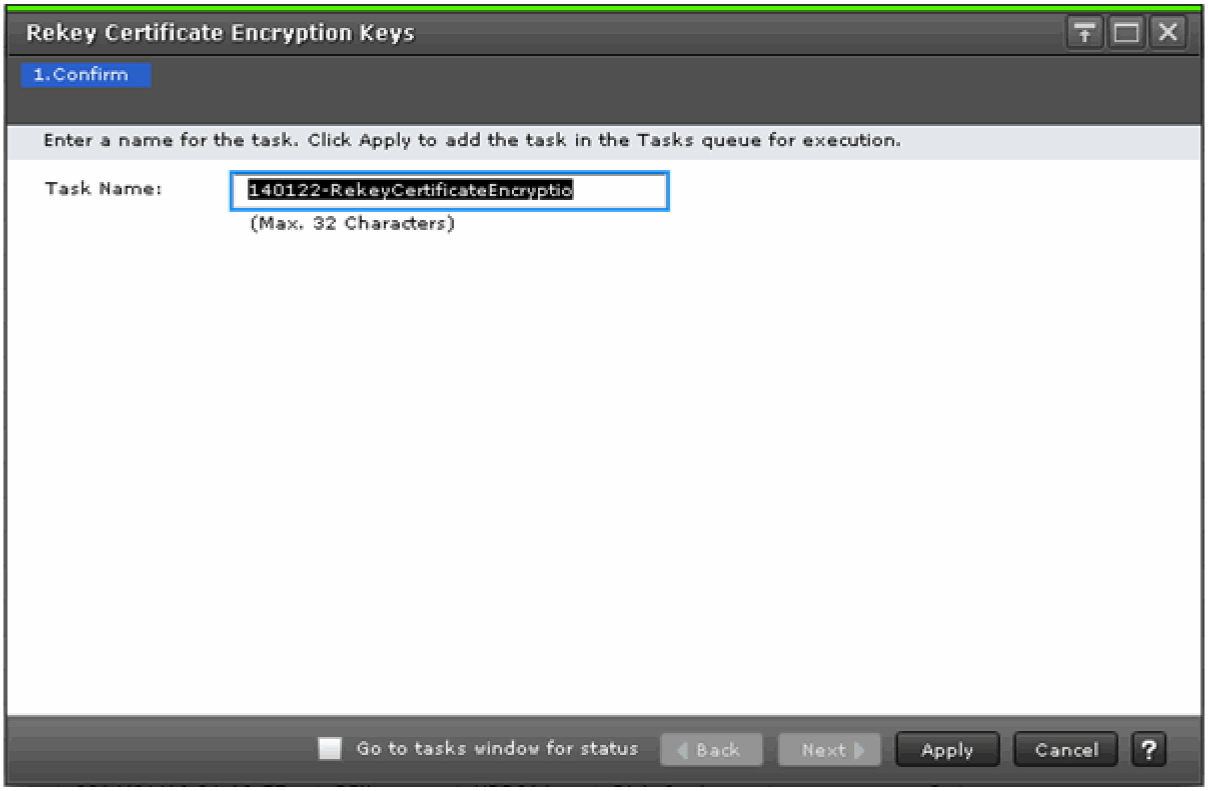
Use the Selected Parity Groups table to view a list of the selected parity groups related to the data encryption key.

Item	Description
Parity Group ID	Shows parity group identifier
RAID Level	Shows the RAID level of the parity group

Item	Description
	For an interleaved parity group, the interleaved number appears after the RAID level. Example: 1(2D+2D)*2
Capacity	Shows the total capacity of the parity group
Drive Type/RPM	Shows the drive types and RPM (rotation per minute) of the LDEV in the parity group
Encryption	Encryption setting for the parity group: • Enable - encryption enabled • Disable - no encryption
Format Type	Shows the format types of the parity group You do not need to format volumes when there are no volumes in the selected parity group. Therefore, the format type in the Selected Parity Groups list becomes "-" (a hyphen) regardless of the status of Format Type.

Rekey Certificate Encryption Keys window

If you change certificate encryption keys, you can use the **Rekey Certificate Encryption Keys** window to rekey certificate encryption keys.



Rekey Certificate Encryption Keys

1.Confirm

Enter a name for the task. Click Apply to add the task in the Tasks queue for execution.

Task Name: 140122-RekeyCertificateEncryptio

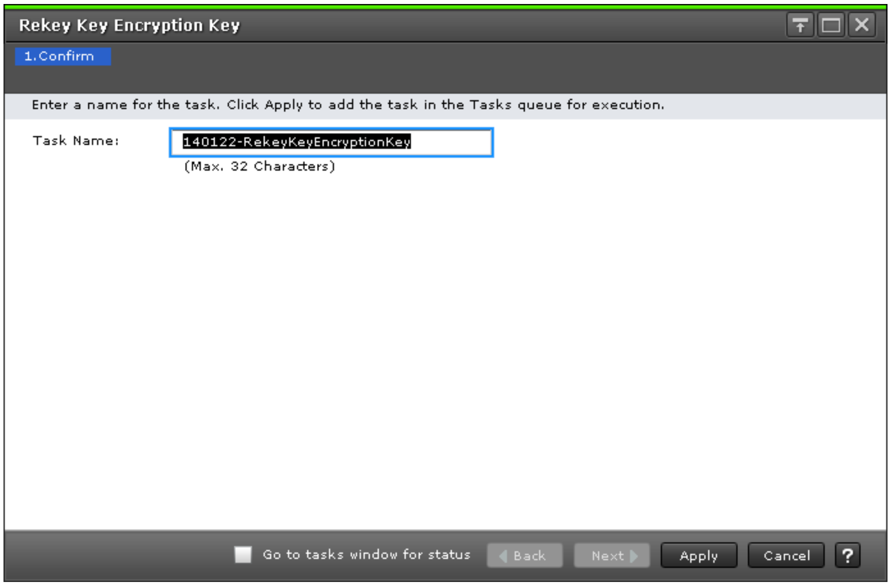
(Max. 32 Characters)

□ Go to tasks window for status

Item	Description
Task Name	You can enter up to 32 ASCII characters (letters,numerals, and symbols) in Task Name. Task names are case-sensitive.

Rekey Key Encryption Key window

If you change key encryption keys, you can use the **Rekey key Encryption Keys** window to rekey key encryption keys.



Enter a name for the task. Click Apply to add the task in the Tasks queue for execution.

Task Name: 140122-RekeyKeyEncryptionKey

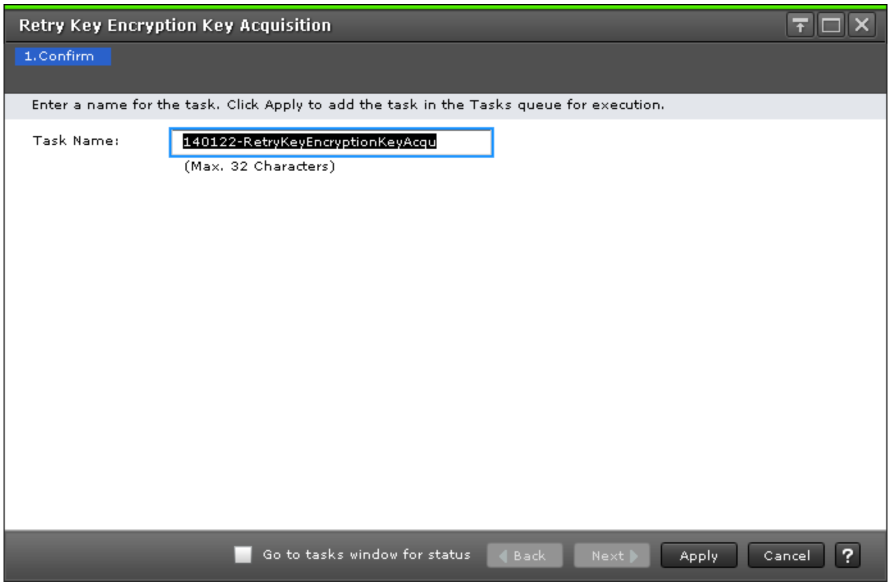
(Max. 32 Characters)

□ Go to tasks window for status

Item	Description
Task Name	You can enter up to 32 ASCII characters (letters, numerals, and symbols) in Task Name. Task names are case sensitive.

Retry Key Encryption Key Acquisition window

If you acquire the key encryption keys from the external key management server when the storage device starts, retry key encryption key acquisition unless you can acquire them by some other means.



Retry Key Encryption Key Acquisition

1.Confirm

Enter a name for the task. Click Apply to add the task in the Tasks queue for execution.

Task Name: 140122-RetryKeyEncryptionKeyAcqu

(Max. 32 Characters)

Item	Description
Task Name	You can enter up to 32 ASCII characters (letters, numerals, and symbols) in Task Name. Task names are case-sensitive.

Glossary

#

2DC

two-data-center. Refers to the local and remote sites, or data centers, in which TrueCopy (TC) and Universal Replicator (UR) combine to form a remote replication configuration.

In a 2DC configuration, data is copied from a TC primary volume at the local site to the UR master journal volume at an intermediate site, then replicated to the UR secondary volume at the remote site. Since this configuration side-steps the TC secondary volume at the intermediate site, the intermediate site is not considered a data center.

3DC

three-data-center. Refers to the local, intermediate, and remote sites, or data centers, in which TrueCopy and Universal Replicator combine to form a remote replication configuration.

In a 3DC configuration, data is copied from a local site to an intermediate site and then to a remote site (3DC cascade configuration), or from a local site to two separate remote sites (3DC multi-target configuration).

A

administrative logical unit (ALU)

An LU used for the conglomerate LUN structure, a SCSI architecture model. In the conglomerate LUN structure, all host access is through the ALU, which functions as a gateway to sort the I/Os for the subsidiary logical units (SLUs) grouped under the ALU.

The host requests I/Os by using SCSI commands to specify the ALU and the SLUs grouped under the ALU. An ALU is called a Protocol Endpoint (PE) in vSphere. See also *subsidiary logical unit (SLU)*.

ALU

See *administrative logical unit (ALU)*.

ALUA

See *asymmetric logical unit access*.

array

See disk array

asymmetric access

A method of defining a preferred path for sending and receiving data when multiple alternate paths are used between a server and storage systems, such as a cross-path configuration for global-active device. To use, ALUA must be enabled.

asymmetric logical unit access (ALUA)

Asymmetric logical unit access functionality of SCSI. When multiple alternate paths are used to connect storage systems, or a server and one or more storage systems, you can define a preferred path in a storage system, and issue I/O requests from the server to storage systems. If a failure occurs in a preferred path, an alternate path is used. See also *asymmetric access*.

audit log

Files that store a history of the operations performed from Device Manager - Storage Navigator and the commands that the storage system received from hosts, and data encryption operations.

B

back end module (EBEM)

The hardware component that controls the transfer of data between the drives and cache. A BEM consists of a pair of boards. A BEM is also referred to as a *disk adapter* (DKA).

back-end director (BED)

The hardware component that controls the transfer of data between the drives and cache. A BED feature consists of a pair of boards. A BED is also referred to as a disk adapter (DKA) or disk board (DKB).

BED

See *back-end director*.

BEM

See *back end module (BEM)*.

bind mode

In bind mode the Cache Residency Manager extents are used to hold read and write data for specific extent(s) on volume(s). Data written to the Cache Residency Manager bind area is not destaged to the drives. For bind mode, all targeted read and write data is transferred at host data transfer speed.

blade

A computer module, generally a single circuit board, used mostly in servers.

C

cache logical partition (CLPR)

Consists of virtual cache memory that is set up to be allocated to different hosts in contention for cache memory.

capacity

The amount of data storage space available on a physical storage device, usually measured in bytes (MB, GB, TB, and so on).

CCI

Command Control Interface

channel board box (CHBB)

See *host port expansion chassis*.

CHAP

challenge handshake authentication protocol

CHBB

channel board box. See *host port expansion chassis*.

CLPR

See *cache logical partition (CLPR)*.

cluster

Multiple-storage servers working together to respond to multiple read and write requests.

command device

A dedicated logical volume used only by Command Control Interface and Business Continuity Manager to interface with the storage system. Can be shared by several hosts.

controller

The component in a storage system that manages all storage functions. It is analogous to a computer and contains a processors, I/O devices, RAM, power supplies, cooling fans, and other sub-components as needed to support the operation of the storage system.

copy pair

A pair of volumes in which one volume contains original data and the other volume contains the copy of the original. Copy operations can be synchronous or asynchronous, and the volumes of the copy pair can be located in the same storage system (local copy) or in different storage systems (remote copy).

A copy pair can also be called a volume pair, or just pair. A pair created by Compatible FlashCopy® is called a relationship.

copy-on-write (COW)

Point-in-time snapshot copy of any data volume within a storage system. Copy-on-write snapshots only store changed data blocks, therefore the amount of storage capacity required for each copy is substantially smaller than the source volume.

COW

See *copy-on-write (COW)*.

COW Snapshot

Hitachi Copy-on-Write Snapshot

custom volume (CV)

A custom-size volume whose size is defined by the user using Virtual LVI/ Virtual LUN.

CV

See *custom volume*.

CVS

custom volume size

CXFS

clustered version of XFS file system

D

data drive

A physical data storage device that can be either a hard disk drive (HDD) or a flash drive (also called a solid-state device).

DBV

Hitachi Database Validator

DC

data center

delta resync

A disaster recovery solution in which TrueCopy and Universal Replicator systems are configured to provide a quick recovery using only differential data stored at an intermediate site.

device

A physical or logical unit with a specific function.

device emulation

Indicates the type of logical volume. Mainframe device emulation types provide logical volumes of fixed size, called logical volume images (LVIs), which contain EBCDIC data in CKD format. Typical mainframe device emulation types include 3390-9 and 3390-M. Open-systems device emulation types provide logical volumes of variable size, called logical units (LUs), that contain ASCII data in FBA format. The typical open-systems device emulation type is OPEN-V.

disaster recovery

A set of procedures to recover critical application data and processing after a disaster or other failure.

disk adapter (DKA)

The hardware component that controls the transfer of data between the drives and cache. A DKA feature consists of a pair of boards.

disk array

Disk array, or just array, is a complete storage system, including the control and logic devices, storage devices (HDD, SSD), connecting cables, and racks

disk controller (DKC)

The hardware component that manages front-end and back-end storage operations. The term DKC can refer to the entire storage system or to the controller components.

DKC

See *disk controller (DKC)*.

DKCMAIN

disk controller main. Refers to the microcode or software for the storage system.

DKU

disk unit. Refers to the cabinet (floor model) or rack-mounted hardware component that contains data drives and no controller components.

dump

A collection of data that is saved to a file when an error or crash occurs. The data is used by support personnel to determine the cause of the error or crash.

Dump tool

Downloads Device Manager - Storage Navigator configuration information onto recording media for backup and troubleshooting purposes.

Dynamic Provisioning (HDP)

An approach to managing storage. Instead of "reserving" a fixed amount of storage, it removes capacity from the available pool when data is actually written to disk.

E

EBED

See *encrypting back end director (EBED)*.

EBEM

See *encrypting back end module (EBEM)*.

emulation

The operation of a storage system to emulate the characteristics of a different storage system. For device emulation, the mainframe host recognizes the logical devices on the storage system as 3390-x devices. For controller emulation, the mainframe host recognizes the control units (CUs) on the storage system as 2105 or 2107 controllers.

The storage system operates the same as the storage system being emulated.

emulation group

A set of device emulation types that can be intermixed within a RAID group and treated as a group.

encrypting back end module (EBEM)

A special back end module (BEM) that provides data encryption.

encrypting back-end director (EBED)

A special back-end director (BED) that provides data encryption.

external application

A software module that is used by a storage system but runs on a separate platform.

external volume

A logical volume whose data resides on drives that are physically located outside the Hitachi storage system.

F

FC

Fibre Channel; FlashCopy

FC-AL

fibre-channel arbitrated loop

FCP

fibre-channel protocol

FCSP

fibre-channel security protocol

FED

See front-end director.

FICON

Fibre Connectivity

flash drive

A data drive that uses a solid-state memory device instead of a rotating hard disk.

flash module

A high speed data storage device that includes a custom flash controller and several flash memory sub-modules on a single PCB.

FMD

See flash module

front-end director (FED)

The hardware component that processes channel commands from hosts and manages host access to cache.

H

HBA

host bus adapter

HCS

Hitachi Command Suite - a set of software applications included in the system firmware. Via the GUI, they are used to configure, control, and monitor the storage system.

HDD

hard disk drive

HDT

Hitachi Dynamic Tiering

HDU

hard disk unit

head LDEV

See *top LDEV*.

host group

A group of hosts of the same operating system platform.

host mode

Operational modes that provide enhanced compatibility with supported host platforms. Used with fibre-channel ports on RAID storage systems.

host mode option

Additional options for fibre-channel ports on RAID storage systems. Provide enhanced functionality for host software and middleware.

host port expansion chassis

A chassis that increases the number of front-end directors connected to the disk controller of a VSP G800 or VSP F800. This chassis is also referred to as a *channel board box (CHBB)*.

I

in-system replication

The original data volume and its copy are located in the same storage system. ShadowImage in-system replication provides duplication of logical volumes; Thin Image in-system replication provides "snapshots" of logical volumes that are stored and managed as virtual volumes (V-VOLs).

See also *remote replication*.

internal volume

A logical volume whose data resides on drives that are physically located within the storage system. See also *external volume*.

J

JNL

journal

journal volume

A volume that records and stores a log of all events that take place in another volume. In the event of a system crash, the journal volume logs are used to restore lost data and maintain data integrity.

In Universal Replicator, differential data is held in journal volumes on until it is copied to the S-VOL.

JRE

Java Runtime Environment

K

key management server

A server that manages encryption keys. Encryption keys can be backed up to, and restored from, a key management server that complies with the Key Management Interoperability Protocol (KMIP).

keypair

Two mathematically-related cryptographic keys: a private key and its associated public key.

L

LBA

logical block address

LCP

local control port; link control processor

LD

local directory; logical device

LDAP

lightweight directory access protocol

LDEV

logical device

LDKC

See *logical disk controller (LDKC)*.

LDM

Logical Disk Manager

license key

A specific set of characters that unlocks an application and allows it to be used.

local control port (LCP)

A serial-channel (ESCON) port configured to receive I/Os from a host or remote I/Os from a TrueCopy main control unit (MCU).

local copy

See *in-system replication*.

logical device (LDEV)

An individual logical data volume (on multiple drives in a RAID configuration) in the storage system. An LDEV may or may not contain any data and may or may not be defined to any hosts. Each LDEV has a unique identifier or "address" within the storage system composed of the logical disk controller (LDKC) number, control unit (CU) number, and LDEV number. The LDEV IDs within a storage system do not change.An LDEV formatted for use by mainframe hosts is called a logical volume image (LVI). An LDEV formatted for use by open-system hosts is called a logical unit (LU).

logical disk controller (LDKC)

A group of 255 control unit (CU) images in the RAID storage system that is controlled by a virtual (logical) storage system within the single physical storage system. For example, the Hitachi Universal Storage Platform V storage system supports two LDKCs, LDKC 00 and LDKC 01.

logical partition (LPAR)

A subset of a system's hardware resources that is virtualized as a separate system. For a storage system, logical partitioning can be applied to cache memory and/or storage capacity.

logical unit (LU)

A logical volume that is configured for use by open-systems hosts (for example, OPEN-V).

logical unit (LU) path

The path between an open-systems host and a logical unit.

logical volume (LV)

See *volume*.

logical volume image (LVI)

A logical volume that is configured for use by mainframe hosts (for example, 3390-9).

LU

See *logical unit (LU)*.

LUN

See logical unit number

LV

logical volume

LVI

See *logical volume image*.

M

MF, M/F

mainframe

modify mode

The mode of operation of Device Manager - Storage Navigator that allows changes to the storage system configuration. See also *view mode*.

O

OPEN-V

A logical unit (LU) of user-defined size that is formatted for use by open-systems hosts.

OPEN-x

A logical unit (LU) of fixed size (for example, OPEN-3 or OPEN-9) that is used primarily for sharing data between mainframe and open-systems hosts using Hitachi Cross-OS File Exchange.

P

P-VOL

This term is used only in the earlier version of the Device Manager - Storage Navigator GUI (still in use) for the primary volume. See *primary volume*.

pair

Two logical volumes in a replication relationship in which one volume contains original data to be copied and the other volume contains the copy of the original data. The copy operations can be synchronous or asynchronous, and the pair volumes can be located in the same storage system (in-system replication) or in different storage systems (remote replication).

parity group

See *RAID group*.

PAV

Hitachi Compatible PAV

PCB

printed circuit board

PCIe channel board

See *PCIe module*.

PCIe module

A module that connects a host port expansion chassis to the disk controller of a VSP G800 or VSP F800. This module is also referred to as a *PCIe channel board*.

PDEV

physical device

PG

parity group. See *RAID group*.

physical device

See *device*.

pool

A set of volumes that are reserved for storing pool volumes (pool-VOL), and used by Thin Image, Dynamic Provisioning, Dynamic Provisioning for Mainframe, Dynamic Tiering, Dynamic Tiering for Mainframe, active flash, or active flash for mainframe data.

A set of volumes that are reserved for storing pool volumes (pool-VOL), and used by Thin Image, Dynamic Provisioning, Dynamic Tiering, or active flash data.

pool volume (pool-VOL)

A logical volume that is reserved for storing snapshot data for Thin Image operations or write data for Dynamic Provisioning, Dynamic Provisioning for Mainframe, Dynamic Tiering, Dynamic Tiering for Mainframe, active flash, or active flash for mainframe.

A logical volume that is reserved for storing snapshot data for Thin Image operations or write data for Dynamic Provisioning, Dynamic Tiering, or active flash.

port attribute

Indicates the type of fibre-channel port: target, RCU target, or initiator.

primary volume (P-VOL)

The volume in a copy pair that contains the original data to be replicated. The data on the P-VOL is duplicated synchronously or asynchronously on the secondary volume (S-VOL).

The following Hitachi products use the term P-VOL: Thin Image, Copy-on-Write Snapshot, ShadowImage, TrueCopy, Universal Replicator, Universal Replicator for Mainframe, and High Availability Manager.

See also *secondary volume*.

prio

priority mode. Used in Cache Residency Manager.

Q

quick format

The quick format feature in Virtual LVI/Virtual LUN in which the formatting of the internal volumes is done in the background. This allows system configuration (such as defining a path or creating a TrueCopy pair) before the formatting is completed. To execute quick formatting, the volumes must be in blocked status.

quick restore

A reverse resynchronization in which no data is actually copied: the primary and secondary volumes are swapped.

quorum disk

Used to determine the volume in the global-active device pair on which server I/O should continue when a failure occurs in a path or a storage system. Quorum disks reside in an external storage system.

R

RAID

redundant array of inexpensive disks

RAID group

A set of RAID disks that have the same capacity and are treated as one group for data storage and recovery. A RAID group contains both user data and parity information. This allows user data to be accessed in the event that one or more of the drives within the RAID group are not available. The RAID level of a RAID group determines the number of data drives and parity drives and how the data is "striped" across the drives. For RAID1, user data is duplicated within the RAID group, so there is no parity data for RAID1 RAID groups.

A RAID group can also be called an array group or a parity group.

RAID level

The type of RAID implementation. RAID levels include RAID0, RAID1, RAID2, RAID3, RAID4, RAID5 and RAID6.

RCU

See *remote control unit*.

RCU target port

A fibre-channel port that is configured to receive remote I/Os from an initiator port on another storage system.

remote control unit (RCU)

A storage system at a secondary or remote site that is configured to receive remote I/Os from one or more storage systems at the primary or main site.

remote copy

See *remote replication*.

resync

resynchronize.

RMI

Remote Method Invocation

S

S-VOL

See *secondary volume* or *source volume*. When used for "secondary volume", "S-VOL" is only seen in the earlier version of the Device Manager - Storage Navigator GUI (still in use).

SAS

serial-attached SCSI

secondary volume (S-VOL)

The volume in a copy pair that is the copy of the original data on the primary volume (P-VOL). The following Hitachi products use the term "secondary volume": Thin Image, Copy-on-Write Snapshot, ShadowImage, TrueCopy, Universal Replicator, Universal Replicator for Mainframe, and High Availability Manager.

See also *primary volume*.

service information message (SIM)

Messages generated by a RAID storage system when it detects an error or service requirement. SIMs are reported to hosts and displayed on Device Manager - Storage Navigator.

service processor

The computer in a storage system that hosts the Device Manager - Storage Navigator software and is used to configure and maintain the storage system.

severity level

Applies to service information messages (SIMs) and Device Manager - Storage Navigator error codes.

SFP

small form-factor pluggable

shared memory

Memory that exists logically in the cache. It stores common information about the storage system and the cache management information (directory). The storage system uses this information to control exclusions and differential table information. Shared memory is managed in two segments and is used when copy pairs are created.

In the event of a power failure, the shared memory is kept alive by the cache memory batteries while the data is copied to the cache flash memory (SSDs).

shredding

See *volume shredding*.

SI

Hitachi ShadowImage

SIM

See *service information message*.

SIz

ShadowImage for Mainframe

size

Generally refers to the storage capacity of a memory module or cache. Not usually used for storage of data on disk or flash drives.

SLU

See *subsidiary logical unit*.

SM

shared memory

SMTP

simple mail transfer protocol

SN

Device Manager - Storage Navigator

snapshot

A point-in-time virtual copy of a Hitachi Thin Image primary volume (P-VOL). The snapshot is maintained when the P-VOL is updated by storing pre-updated data (snapshot data) in a data pool.

SNMP

See *Simple Network Management Protocol*.

SOM

See *system option mode*.

source volume (S-VOL)

Used only in the earlier version of the Device Manager - Storage Navigator GUI (still in use). This is the volume in a mainframe copy pair containing the original data that is duplicated on the target volume (T-VOL). The following Hitachi products use the term source volume: ShadowImage for Mainframe, Dataset Replication, and Compatible FlashCopy®.

In the current version of the GUI, "target volume" and "T-VOL" are replaced with "primary volume".

See also *source volume*.

space

Generally refers to the data storage capacity of a disk drive or flash drive.

SRM

Storage Replication Manager

SSD

solid-state drive. Also called flash drive.

SSID

See *storage subsystem identifier*.

SSL

secure socket layer

storage cluster

See *cluster*.

storage tiers

See *tiered storage*.

subsidiary logical unit (SLU)

An LU used for the conglomerate LUN structure, a SCSI architecture model. An SLU is an LU that stores actual data. You can use a DP-VOL or snapshot data (or a V-VOL allocated to snapshot data) as an SLU. All host access to SLUs is through the administrative logical unit (ALU). An SLU is called a virtual volume (VVol) in vSphere. See *administrative logical unit*.

SVP

See *service processor*.

SVS

Storage Virtualization System

SW, sw

short wavelength, software

syslog

The file on the SVP that includes both syslog and audit log information, such as the date and time.

system disk

The volume from which an open-systems host boots.

system option mode (SOM)

Additional operational parameters for the RAID storage systems that enable the storage system to be tailored to unique customer operating requirements. SOMs are set on the service processor.

T

T-VOL

See *target volume*.

target port

A fibre-channel port that is configured to receive and process host I/Os.

target volume (T-VOL)

The volume in a mainframe copy pair that is the copy of the original data on the source volume (S-VOL). The term is used only in the earlier version of the Device Manager - Storage Navigator GUI (still in use), for the following Hitachi products: ShadowImage for Mainframe, Dataset Replication, and Compatible FlashCopy® V2.

See also *source volume*.

TC

Hitachi TrueCopy

TCz

Hitachi TrueCopy for mainframe

TI

See Thin Image.

tiered storage

A layered structure of performance levels, or tiers, that matches data access requirements with the appropriate performance tiers. The tiers are:

Tier 1: Static content. Tier 1 is fully supported computing expected to be production quality.

Tier 2: Application logic. Tier 2 platforms are not supported by the security officer and release engineering teams. Tier 2 systems are targeted for Tier 1 support, but are still under development.

Tier 3: Database. Tier 3 platforms are architectures for which hardware is not or will not be available or that are considered legacy systems unlikely to see broad future use.

Tier 4 systems are not supported.

total capacity

The aggregate amount of storage space in a data storage system.

TPF

Transaction Processing Facility

U

UR

Hitachi Universal Replicator

URz

Hitachi Universal Replicator software for Mainframe

V

V-VOL

virtual volume

VDEV

See *virtual device*.

view mode

The mode of operation of Device Manager - Storage Navigator that allows viewing only of the storage system configuration. The two Device Manager - Storage Navigator modes are view mode and modify mode.

virtual device (VDEV)

A group of logical devices (LDEVs) in a RAID group. A VDEV typically consists of some fixed volumes (FVs) and some free space. The number of fixed volumes is determined by the RAID level and device emulation type.

Virtual LVI/LUN

A custom-size volume whose size is defined by the user using Virtual LVI/LUN. Also called a custom volume (CV).

virtual volume (V-VOL)

A logical volume in a storage system. A V-VOL has no physical storage space.

Thin Image uses V-VOLs as secondary volumes of copy pairs.

In Dynamic Provisioning, Dynamic Provisioning for Mainframe, Dynamic Tiering, Dynamic Tiering for Mainframe, active flash, and active flash for mainframe, V-VOLs are called DP-VOLs.

In Dynamic Provisioning, Dynamic Tiering, and active flash, V-VOLs are called DP-VOLs.

VLUN

Hitachi Virtual LUN

VLVI

Hitachi Virtual LVI

VM

volume migration; volume manager

volume (VOL or vol)

A logical device (LDEV), or a set of concatenated LDEVs in the case of LUSE, that has been defined to one or more hosts as a single data storage unit. An open-systems volume is called a logical unit (LU), and a mainframe volume is called a logical volume image (LVI).

volume shredding

Deleting the user data on a volume by overwriting all data in the volume with dummy data.

W

WWN

worldwide name

X

XRC

IBM® Extended Remote Copy

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