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DATA SYSTEMS

Hitachi Freedom Storage™ Lightning 9900™

ShadowImage (HMRCF) User's Guide

Document Revision Level

Revision	Date	Description
MK-90RD012-P	May 2000	Preliminary Release
MK-90RD012-P1	June 2000	Rev. 1 of Prelim. Release, supersedes and replaces MK-90RD012-P
MK-90RD012-0	July 2000	Initial Release
MK-90RD012-1	November 2000	Revision 1, supersedes and replaces MK-90RD012-0

Source Document Revision Level

The following source documents were used to produce this 9900 user guide:

- *DKC310 Disk Subsystem, HMRCF Reference Manual*, revision 7.
- MK-90RD012-S1 (STR RAID400 document).
- MK-90RD012-S1.1 (STR RAID400 document).
- ECN DKC410I-M007-0.

Changes in this Revision

- Added the quick split option for pairsplit operations (sections 2.3.3 and 4.7).
- Added the *V-Split* status for the quick split operation (section 2.4 and Figure 4.1).
- Added the quick resync option for pairresync operations (sections 2.3.4 and 4.8).
- Added the quick restore option for pairresync operations (sections 2.3.4 and 4.8, Figure 2.6, Table 2.2, Table 2.4).
- Added notes on ShadowImage requirements (section 2.2 below Table 2.1).
- Added a note on Volume List box (section 4.1.1).
- Added a note on the license key code (section 3.2).
- Corrections: Tables 2.1, 2.3, 2.4, 4.1, 5.1, 5.2, 5.3, 5.4, 5.7, 6.2; sections 2.1.1, 2.3.1, 2.3.2, 2.3.3, 2.3.5, 2.3.6, 3.4.1, 5.5; Figures 3.1, 3.3, 3.4, 3.10, 4.6, 5.6.

Preface

The *Hitachi Lightning 9900™ ShadowImage (HMRCF) User's Guide* describes and provides instructions for performing ShadowImage operations on the 9900 subsystem using the Hitachi Multiple RAID Coupling Facility (HMRCF) remote console software. This user's guide assumes that:

- the user has a background in data processing and understands direct-access storage device (DASD) subsystems and their basic functions,
- the user is familiar with the Hitachi Lightning 9900™ array subsystem and the 9900 Remote Console PC,
- the user has read and understands both the *Hitachi Lightning 9900™ User and Reference Guide* and the *Hitachi Lightning 9900™ Remote Console PC User's Guide*, and
- the user is familiar with the Windows 98/NT operating system (e.g., opening, closing, minimizing, and restoring windows; using the keyboard and mouse to navigate on screen and select objects).

Note: The term "9900" refers to the entire Hitachi Lightning 9900™ subsystem family, unless otherwise noted. Please refer to the *Hitachi Lightning 9900™ User and Reference Guide* (MK-90RD008) for further information on the 9900 RAID subsystems. For further information on the 9900 Remote Console PC, please refer to the *Hitachi Lightning 9900™ Remote Console PC User's Guide* (MK-90RD003), or contact your Hitachi Data Systems account team.

Note: The use of ShadowImage, the HMRCF software, and all other Hitachi Data Systems products is governed by the terms of your license agreement(s) with Hitachi Data Systems.

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Chapter 1 Overview of Hitachi Copy Solutions

1.1 Hitachi ShadowImage and Open ShadowImage

The Hitachi ShadowImage and Open ShadowImage features enable you to maintain subsystem-internal copies of all user data on the Hitachi Lightning 9900™ RAID storage subsystem for purposes such as data backup or duplication. The RAID-protected duplicate volumes are created within the same 9900 subsystem as the source volume at hardware speeds. ShadowImage is used for S/390® data, and Open ShadowImage is used for UNIX®-based and PC server data. ShadowImage can provide up to three duplicates of one source volume. Hitachi ShadowImage and Open ShadowImage are key components of the Hitachi Data Systems CARE Copy suite solution (see section 1.2).

ShadowImage operations are nondisruptive and allow the source (main) volume of each volume pair to remain online to all hosts for both read and write I/O operations. Once established, ShadowImage operations continue unattended to provide asynchronous internal data backup. Usability is further enhanced through a resynchronization capability that reduces data duplication requirements and backup time, thereby increasing user productivity. Hitachi ShadowImage also supports reverse resynchronization for maximum flexibility.

This user's guide describes and provides instructions for performing ShadowImage operations using the licensed Hitachi Multiple RAID Coupling Feature (HMRCF) software for the 9900 Remote Console PC and PPRC TSO or PPRCOPY ICKDSF commands:

- For operating systems which do not support PPRC/PPRCOPY commands, ShadowImage operations are performed using the 9900 Remote Console PC. The HMRCF remote console software displays detailed ShadowImage information and allows you to perform ShadowImage operations. The Remote Console PC is attached to and communicates with the 9900 subsystems via the 9900-internal LAN. For further information on the Remote Console PC, refer to the *Hitachi Lightning 9900™ Remote Console PC User's Guide.*
- ShadowImage is functionally compatible with the industry-standard IBM Peer-to-Peer Remote Copy (PPRC) host software functions. PPRC TSO commands and/or PPRCOPY ICKDSF commands may be used to perform ShadowImage operations on the 9900 subsystem. See Chapter 5 for further information on using TSO/ICKDSF commands with the 9900 subsystem.

ShadowImage operations can be performed in conjunction with Hitachi Remote Copy (HRC) operations (see section 1.3) to provide additional remote copies of ShadowImage volumes. ShadowImage also supports the Virtual LVI (also called Custom Volume Size, CVS) and FlashAccess (also called Dynamic Cache Residency, DCR) features, ensuring that all user data on the 9900 can be duplicated by ShadowImage operations. See section 3.4 for further information on combining ShadowImage with these and other data management features.

This document does not cover Open ShadowImage operations for open-system and PC-server data. For information and instructions on performing Open ShadowImage operations, please refer to the *Hitachi Lightning 9900™ Open ShadowImage (HOMRCF) User's Guide*.

Note: The use of the 9900 HMRCF remote console software is governed by the terms of your license agreement(s) with Hitachi Data Systems.

1.2 CARE Software Solutions

Hitachi Data Systems' CARE software solutions, which include the Copy suite, Availability suite, Resource suite, and Exchange suite, deliver enterprise-wide coverage of online data duplication and relocation, data access and protection, and storage resource management. The Copy suite components are designed for data replication, protection, and sharing and include Hitachi ShadowImage, Hitachi Remote Copy, and Hitachi Online Data Migration (HODM). For further information on the CARE software solutions, please contact your Hitachi Data Systems account team, or visit Hitachi Data Systems online at http://www.hds.com/storage.

Note: Hitachi ShadowImage and the CARE Copy suite are available under a Hitachi Data Systems service agreement. The HMRCF and HRC remote console software products are available under license from Hitachi Data Systems.

1.3 Hitachi Remote Copy (HRC)

The HRC feature of the Hitachi Lightning 9900™ subsystem enables you to create and maintain remote copies of the data stored on the 9900 subsystem for data backup and disaster recovery purposes. HRC provides synchronous and asynchronous copy modes to accommodate a wide variety of user requirements and data copy/movement scenarios. HRC operations can be performed across distances of up to 43 km (27 miles) using standard ESCON® support. Long-distance solutions are provided, based on user requirements and workload characteristics, using approved channel extenders and communication lines.

HRC can be used in conjunction with Hitachi ShadowImage to provide multiple copies of volumes at both your main (primary) and remote (secondary) sites. See section 3.4.1 for further information on combining ShadowImage and HRC. This user's guide does not cover HRC operations. Please refer to the *Hitachi Lightning 9900™ Hitachi Remote Copy (HRC) User and Reference Guide* for further information on HRC.

1.4 Hitachi NanoCopy

Hitachi NanoCopy™ is the storage industry's first hardware-based solution which enables customers to make Point-in-Time (PiT) copies without quiescing the application or causing any disruption to end-user operations. NanoCopy is based on HRC Asynchronous, which is used to move large amounts of data over any distance with complete data integrity and minimal impact on performance. HRC Asynchronous can be integrated with third-party channel extender products to address the "access anywhere" goal of data availability. HRC Asynchronous enables production data to be duplicated via ESCON or communication lines from a main (primary) site to a remote (secondary) site that can be thousands of miles away.

For further information on Hitachi NanoCopy™, please refer to the HRC user documentation, and/or contact your Hitachi Data Systems account team.

1.5 HXRC and Concurrent Copy (CC)

The HXRC feature of the Hitachi Lightning 9900™ subsystem is functionally compatible with the industry-standard IBM Extended Remote Copy (XRC) S/390® host software function. HXRC is also compatible with the DFSMS data mover which is common to the XRC environment. HXRC operations are performed in the same manner as XRC operations, by issuing XRC TSO commands from the host system to the 9900 subsystem. HXRC can also be used in conjunction with ShadowImage to provide multiple copies of volumes at both your main (primary) and remote (secondary) sites. The HXRC feature must be enabled using the 9900 Remote Console PC.

The Hitachi Lightning 9900™ subsystem is also functionally compatible with the IBM 3990 Concurrent Copy (CC) function.

Please contact your Hitachi Data Systems account team for further information on these 9900 features, or visit Hitachi Data Systems online at http://www.hds.com/.

Note: HXRC and CC operations, as well as HRC/HORC Asynchronous, require additional cache to store the asynchronous recordsets. If you are performing HXRC and/or CC operations in addition to HRC/HORC Asynchronous on the same 9900 subsystem, you must make sure that the subsystem has adequate cache installed and available to support the asynchronous copy workloads. Please contact your Hitachi Data Systems account team to determine how much cache will be needed for your operational configuration.

Chapter 2 Overview of ShadowImage Operations

Hitachi ShadowImage is a storage-based hardware solution for duplicating logical volumes which reduces backup time and provides point-in-time backup. The ShadowImage source volumes (S-VOLs) contain the original data, and the ShadowImage target volume(s) (T-VOLs) contain the duplicate data. The user can choose to make up to three copies of each S-VOL. And since each T-VOL is paired with its S-VOL independently, each T-VOL can be maintained as an independent copy set that can be split, resynchronized, and deleted separately from the other T-VOLs assigned to the same S-VOL.

2.1 ShadowImage Components

ShadowImage operations involve the source and target volumes in the Hitachi Lightning 9900™ subsystem, the HMRCF software on the 9900 Remote Console PC, and (optionally) the IBM PPRC host software functions. Figure 2.1 shows a typical ShadowImage configuration. The ShadowImage system components are:

- ShadowImage volume pairs (S-VOLs and T-VOLs) (see section 2.1.1),
- HMRCF software on the 9900 Remote Console PC (see section 2.1.2), and
- (Optional) IBM PPRC host software functions (see section 2.1.3).

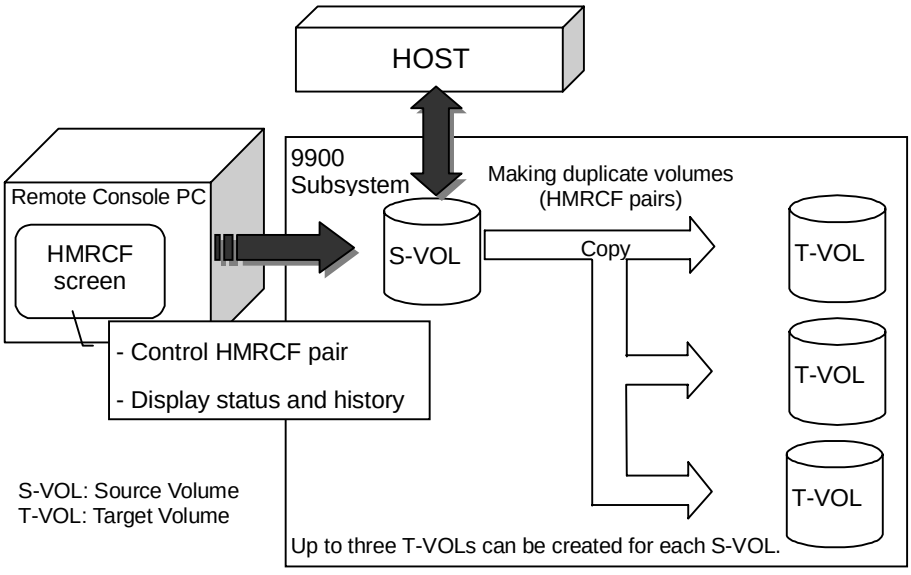

Figure 2.1 ShadowImage Components

2.1.1 ShadowImage Volume Pairs (S-VOLs and T-VOLs)

The Hitachi Lightning 9900™ subsystem contains and manages both the original and copied ShadowImage data. ShadowImage supports a maximum of 2,048 ShadowImage pairs (2,048 S-VOLs and 2,048 T-VOLs = 4,096 volumes). When ShadowImage pairs include more than one T-VOL, the maximum number of S-VOLs decreases.

ShadowImage performs internal copy operations for logical volume pairs established by the user. Each ShadowImage pair consists of one source volume (S-VOL) and up to three target volumes (T-VOLs) which are located in the same 9900 subsystem. The ShadowImage S-VOLs are the source volumes which contain the original data. The ShadowImage T-VOLs are the target or secondary (mirrored) volumes which contain the backup data. Each T-VOL must be paired with only one S-VOL. During normal ShadowImage operations, the S-VOLs remain available to all hosts at all times for read and write I/O operations. The T-VOLs become available for host access only after a split operation has been performed.

When a ShadowImage volume pair is added, the data on the S-VOL is copied to the T-VOL. During this initial copy operation and after the pair is synchronized, all write operations to the T-VOL are prohibited. If you need to access a T-VOL, you can “split” the pair to make the T-VOL accessible (the S-VOL is always accessible). While a ShadowImage pair is split, the 9900 subsystem keeps track of all changes to the S-VOL and T-VOL as a differential bitmap. When you “resync” the pair, the differential data in the S-VOL (due to S-VOL and T-VOL updates) is copied to the T-VOL so that the T-VOL is again identical to the S-VOL.

Note: ShadowImage S-VOLs or T-VOLs should not be concentrated in the same RAID group. To disperse workloads of the RAID groups, each RAID group should have both S-VOLs and T-VOLs evenly distributed. ShadowImage pairs for which a ShadowImage operation is performed simultaneously should be in different RAID groups. If ShadowImage pairs are concentrated in only a few RAID groups, the host I/O performance may be degraded.

If the 9900 subsystem is overloaded, you must increase cache, disk adapters, and/or RAID groups. It is recommended that ShadowImage T-VOLs are assigned in the newly installed RAID groups. If you continue ShadowImage operations with an overloaded 9900 subsystem, host I/O performance may be degraded.

2.1.2 HMRCF Software on the 9900 Remote Console PC

The HMRCF software for the 9900 Remote Console PC displays ShadowImage information and enables you to perform ShadowImage operations. The HMRCF remote console software runs as a component of the RMCMAIN software, and communicates with the SVP of the connected subsystem via the 9900-internal LAN. The Remote Console PC can be attached to multiple 9900 subsystems. The Remote Console PC acquires status from and issues commands to the ShadowImage S-VOLs and T-VOLs.

Note: If the 9900 Remote Console PC is not installed, please contact your Hitachi Data Systems account team for information on Hitachi ShadowImage configuration services.

2.1.3 IBM PPRC Host Software Functions

ShadowImage supports the IBM PPRC host software functions, including TSO PPRC commands and ICKDSF PPRCOPY commands. ShadowImage pairs can be added, split, resynced, and deleted using TSO PPRC or ICKDSF PPRCOPY commands. Chapter 5 describes and provides instructions for using PPRC commands to create and maintain ShadowImage volume pairs on the Hitachi Lightning 9900™ subsystem. ***Note:*** IBM PPRC does not support the ShadowImage reverse-resync operation. The reverse-resync operation can only be performed using the HMRCF remote console software.

2.2 ShadowImage Requirements

ShadowImage operations provide subsystem-internal copies of S/390® logical volume images (LVIs) on the Hitachi Lightning 9900™ subsystem. Table 2.1 lists and describes the operational requirements for ShadowImage.

Table 2.1 ShadowImage Requirements

Parameter	Specification
Pair objects	Logical devices (LDEVs): 3390-x and 3380-x, including custom-size devices (Virtual LVI). Devices must be installed and formatted. The S-VOL and T-VOL must be the same type and same size (e.g., 3390-3R to 3390-3R allowed, 3380-K to 3390-9 not allowed). A custom-size S-VOL must be paired with T-VOLs of the same type and the same capacity. ShadowImage does not support multiplatform devices (e.g., 3390-3A, -3B, -3C).
Number of copies	Maximum three copies (T-VOLs) per source volume (S-VOL).
Maximum number of ShadowImage pairs	2048 pairs per 9900 subsystem (2048 S-VOLs and 2048 T-VOLs). When pairs include more than one T-VOL, the maximum number of S-VOLs decreases (e.g., if there are three T-VOLs per S-VOL: 4096 ÷ 4 = 1024 S-VOLs max).
Maximum number of reserved volumes	2048 reserved volumes per 9900 subsystem.
Combinations of RAID levels	All combinations supported: RAID1-RAID1, RAID5-RAID5, RAID1-RAID5, RAID5-RAID1.
Dynamic sparing and auto correction copy	If a failure occurs that requires use of dynamic sparing or automatic correction copy, the status of the paired volumes associated with the failed physical device will not be affected.
Physical device (PDEV) maintenance	If a PDEV requires maintenance, the status of the logical volumes associated with that PDEV will not be affected. However, if PDEV maintenance requires access to a ShadowImage pair volume, the pair must be deleted, and the **Reserve** attribute must be reset (unreserved).
Logical device maintenance	LDEV maintenance cannot be performed on LDEVs which are assigned to ShadowImage pairs. If LDEV maintenance requires access to a ShadowImage LDEV, the pair must be deleted, and the **Reserve** attribute must be reset (unreserved).
Cache maintenance	If 9900 cache maintenance is performed during a period of high I/O usage, one or more ShadowImage pairs may be suspended. Reduce the I/O load before cache maintenance.
Point-in-time backup	For duplex pairs, host I/Os are copied to the T-VOL asynchronously. If you want to synchronize a pair and then access the T-VOL as soon as possible, vary the S-VOL offline and then split the pair before using the T-VOL.
Failures	When a failure of any kind prevents a ShadowImage copy operation from completing, the pair is suspended. If an LDEV failure occurs, the pair is suspended. If a PDEV failure occurs, ShadowImage pair status is not affected because of the RAID architecture.

2.3 ShadowImage Operations

ShadowImage operations can be performed from the Remote Console PC using HMRCF, or from the S/390® host using TSO and/or ICKDSF commands. For further information on using TSO and/or ICKDSF commands to set up and maintain ShadowImage volume pairs, please see Chapter 5. Your Hitachi Data Systems representative can also perform ShadowImage operations for you using the 9900 service processor (SVP). For information on ShadowImage configuration services, please contact your Hitachi Data Systems account team.

2.3.1 Setting/Resetting Reserve Attribute Operation

The ShadowImage set reserve attribute operation reserves a volume so that it can be used as a ShadowImage T-VOL. Reserved volumes can only be used as ShadowImage T-VOLs. The 9900 subsystem rejects all write operations to reserved volumes (unless in split status). You can reserve up to 2048 volumes in one 9900 subsystem. The Set Reserve Attribute panel (see section 4.2) allows you to reserve volumes for use as T-VOLs.

The ShadowImage reset reserve attribute operation unreserves a volume so that it can be varied online and accessed by hosts. After you reset the reserve attribute, the 9900 will accept all subsequent read and write I/O operations to the volume. The Reset Reserve Attribute panel (see section 4.3) allows you to unreserve volumes.

Note: When TSO or ICKDSF commands are used to establish ShadowImage pairs, the T-VOLs do not need to be reserved. The CESTPAIR and PPRCOPY ESTPAIR commands require that potential T-VOLs be offline to the host.

2.3.2 Add Pair Operation

The ShadowImage add pair operation establishes the new specified ShadowImage pair(s). The volume which will be the S-VOL must be in the simplex state, and the volume which will be the T-VOL must be reserved (if assigned automatically) and simplex before being added to a ShadowImage pair. The Add Pair Dialog panel (see section 4.4) allows you to add (start) new ShadowImage volume pairs.

Note: The CESTPAIR and PPRCOPY ESTPAIR commands allow you to add (start) ShadowImage pairs. See Chapter 5 for further information on PPRC commands.

Initial Copy Operation

The ShadowImage initial copy operation takes place when you add a new ShadowImage pair (see Figure 2.2). The ShadowImage initial copy operation copies all data on the S-VOL to the associated T-VOL(s). The S-VOL remains available to all hosts for read and write I/Os throughout the initial copy operation. Write operations performed on the S-VOL during the initial copy operation will be duplicated at the T-VOL(s) by update copy operations after the initial copy is complete. The status of each pair is *pending* while the initial copy operation is in progress. The pair status changes to *duplex* when the initial copy operation is complete.

When adding pairs, you can select the pace for the initial copy operation(s): slower, medium, and faster. The slower pace minimizes the impact of ShadowImage operations on subsystem I/O performance, while the faster pace completes the initial copy operation(s) as quickly as possible.

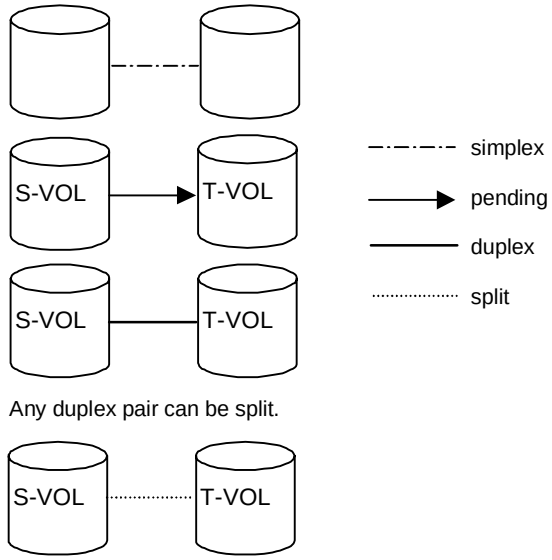

Figure 2.2 Adding a ShadowImage Pair

Update Copy Operation

The ShadowImage update copy operation updates the T-VOL of a ShadowImage pair after the initial copy operation is complete. Update copy operations take place only for duplex pairs. As write I/Os are performed on a duplex S-VOL, the 9900 stores a map of the S-VOL differential data, and then performs update copy operations periodically based on the amount of differential data present on the S-VOL as well as the elapsed time between update copy operations. Figure 2.3 illustrates an update copy operation in a ShadowImage pair with only one T-VOL. Update copy operations are not performed for ShadowImage pairs with the following status: *pending*, *SP-pend*, *V-Split*, *split*, *resync*, *resync-R*, and *suspend*.

Note: Update copy operations do not occur every time a host issues a write I/O operation to the S-VOL of a ShadowImage pair. The ShadowImage update copy operations are asynchronous.

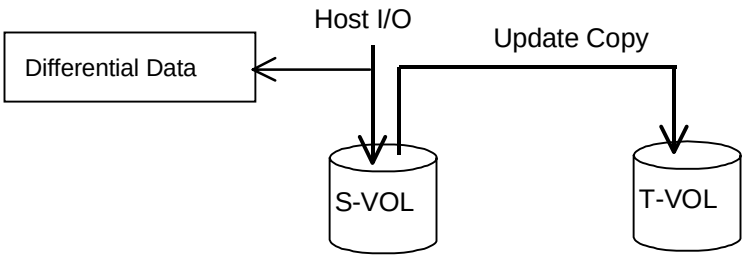

Figure 2.3 Update Copy Operation

2.3.3 Split Pair Operation

The ShadowImage split capability provides point-in-time backup of your data, and also facilitates real data testing by making the ShadowImage copies (T-VOLs) available for host access. The ShadowImage split operation performs all pending T-VOL updates (those issued prior to the split command and recorded in the S-VOL track map) to make the T-VOL identical to the state of the S-VOL when the split command was issued. When the split operation is complete, the 9900 stops performing further update copy operations to the T-VOL, but continues accepting write I/O operations to the S-VOL. If subsequent write I/O operations are accepted, the 9900 keeps track of the S-VOL tracks which are updated while the pair is split. While the pair is split, the 9900 also provides full read/write access to the split T-VOL and keeps track of the T-VOL tracks which are updated while the pair is split. When a split pair is resynced, the 9900 merges the T-VOL track map into the S-VOL track map and copies all flagged tracks from the S-VOL to the T-VOL. This method ensures that the S-VOL and T-VOL are correctly resynchronized and also reduces the time needed to resynchronize the pair.

The Split Volume Pair panel (see section 4.7) allows you to split existing ShadowImage pairs, and also allows you to add and split new ShadowImage pairs in one step.

- When splitting pairs, you can select the pace for the pending update copy operation(s): **slower**, **medium**, and **faster**. The slower pace minimizes the impact of ShadowImage operations on subsystem I/O performance, while the faster pace splits the pair(s) as quickly as possible.
- When splitting pairs, you can also select the split type: **Quick Split** or **Steady Split**.
  - When the quick split operation starts, the pair status changes to *V-split*, the T-VOL is available immediately for read and write I/Os, and the 9900 performs all pending update copy operations to the T-VOL in the background. When the quick split operation is complete, the pair status changes to *split*, and you have full read/write access to the split T-VOL (even though it is still reserved). The S-VOL also remains fully accessible.
  - When the steady split operation starts, the pair status changes to *SP-pending*, and the 9900 performs all pending update copy operations to the T-VOL. When the Steady Split operation is complete, the pair status changes to *split*, and you have full read/write access to the split T-VOL (even though it is still reserved). The S-VOL also remains fully accessible.

When the pair status changes to *split*, the 9900 establishes a track map for the split S-VOL **and** T-VOL and records all updates to **both** volumes. Split operations cannot be performed on suspended pairs.

Note: The CSUSPEND and PPRCOPY SUSPEND commands allow you to split ShadowImage volume pairs (quick split only). See Chapter 5 for further information on using PPRC commands to perform ShadowImage operations on the 9900 subsystem.

2.3.4 Resynchronize Pair Operations (Normal, Quick, Reverse, and Quick Restore)

ShadowImage allows you to perform four types of resync operations:

- **Normal.** The normal resync operation (see Figure 2.4) resynchronizes the T-VOL with the S-VOL. The copy direction for a normal resync operation is S-VOL to T-VOL. The pair status during a normal resync operation is *resync*, and the S-VOL remains accessible to all hosts for both read and write operations during a normal resync operation. The T-VOL becomes inaccessible to all hosts during a normal resync operation.
- **Quick.** The quick resync operation speeds up the normal resync operation by copying the S-VOL differential data map only without copying the S-VOL data to the T-VOL. The S-VOL and the T-VOL are resynchronized when update copy operations are performed for duplex pairs. The pair status during a quick resync operation is *resync* until the differential map is copied, and the S-VOL remains accessible to all hosts for both read and write operations. The T-VOL becomes inaccessible to all hosts during a quick resync operation.
- **Reverse.** The reverse resync operation (see Figure 2.5) synchronizes the S-VOL with the T-VOL. The copy direction for a reverse resync operation is T-VOL to S-VOL. Table 2.2 lists the operational requirements for the reverse resync operation. The pair status during a reverse resync operation is *resync-r*, and the S-VOL and T-VOL become inaccessible to all hosts for write operations during a reverse resync operation. As soon as the reverse resync operation is complete, the S-VOL becomes accessible. The reverse resync operation can only be performed on split pairs, not on suspended pairs.
- **Quick Restore**. The quick restore operation (see Figure 2.5) speeds up the reverse resync operation by changing the volume map in the 9900 subsystem to swap the contents of the S-VOL and T-VOL without copying the T-VOL data to the S-VOL. The S-VOL and T-VOL are resynchronized when update copy operations are performed for pairs in the *duplex* status. The pair status during a quick restore operation is *resync-r* until the volume map change is complete. The S-VOL and T-VOL become inaccessible to all hosts for write operations during a quick restore operation. Table 2.2 lists the operational requirements for the quick restore operation.

  Note on RAID level swap: During the quick restore operation, the RAID levels and HDD types of the T-VOL and S-VOL are exchanged, if they have different RAID levels and/or HDD types. For example, if the S-VOL has a RAID-1 level and the T-VOL has a RAID-5 level, the quick restore operation changes the RAID level of the S-VOL to RAID-5, and the RAID level of the T-VOL to RAID-1. To avoid any performance impact due to the quick restore operation, make sure that the S-VOL and T-VOL have the same RAID level and HDD type before performing the quick restore operation. If you want to restore the original RAID levels after quick restore, stop host I/Os to the pair, split the pair, perform the quick restore operation for that pair again, and then restart the host I/Os to the pair.

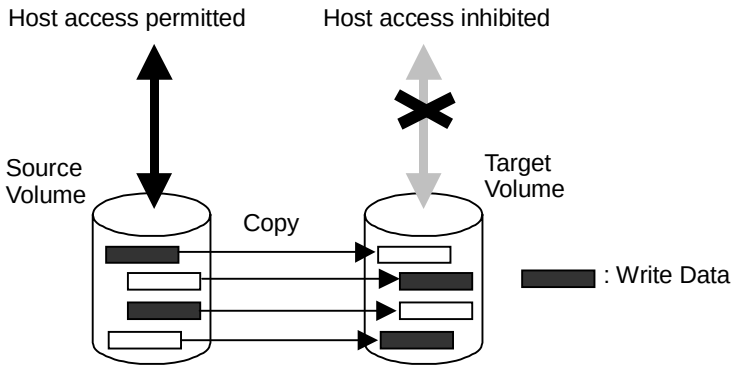

Figure 2.4 Normal and Quick Resync Operations

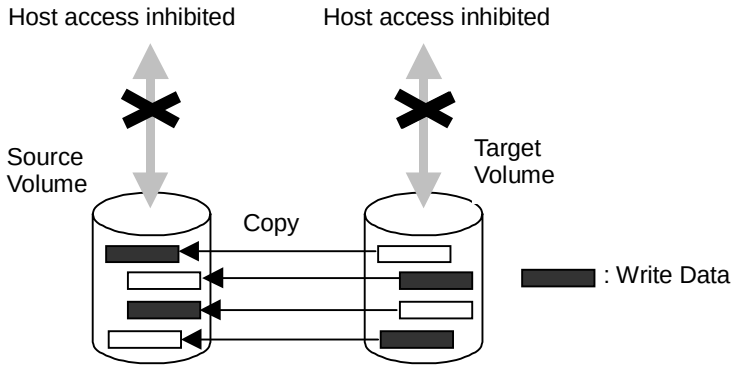

Figure 2.5 Reverse Resync and Quick Restore Operations

Table 2.2 Reverse Resync and Quick Restore Requirements

Parameter	Requirement(s)
Reverse resync or quick restore command.	The specified pair must be in the *split* state. If not, the reverse resync or quick restore command will be rejected. All other pairs which share the same S-VOL as the specified pair must also be in the *split* or *suspended* state. If not, the reverse resync or quick restore command will be rejected.
Reverse resync or quick restore command issued to a shared HMRCF/HRC volume.	1. If the ShadowImage S-VOL is also an HRC M-VOL, the reverse resync and quick restore operations cannot be performed. (The command will be rejected.) 2. If the ShadowImage S-VOL is also an HRC R-VOL, the reverse resync and quick restore operations cannot be performed. (The command will be rejected.) 3. If the ShadowImage T-VOL is also an HRC M-VOL, the reverse resync and quick restore operations cannot be performed. (The command will be rejected.) 4. During the reverse resync or quick restore operation, an HRC pair cannot be created. The HRC add pair command will be rejected when the ShadowImage pair status is *resync-r*.
Effect on other pairs which share the S-VOL.	If the reverse resync or quick restore operation is performed on one ShadowImage pair in a 1-to-n configuration (n>1), the S-VOL and the other T-VOLs are no longer synchronized. While this reverse resync or quick restore is in progress, you cannot perform add, split, or resync pair for any other pair which shares the same S-VOL (delete pair and suspend pair are allowed).
Reverse resync or quick restore ends abnormally; OR Suspend pair is requested during reverse resync or quick restore.	1. The pair status changes to *suspended*. 2. The S-VOL of the *suspended* pair is read/write-enabled for all hosts; however, the data on the S-VOL is not guaranteed. The T-VOL of the suspended pair remains write-disabled. 3. The status of other ShadowImage pairs which share the same S-VOL does not change.

ShadowImage allows you to perform normal/quick resync operations on split and suspended pairs, but reverse resync operations can only be performed on split pairs:

- **Resync for split pair.** When a normal/quick resync operation is performed on a split pair, the 9900 merges the T-VOL track map into the S-VOL track map and then copies all differential data from the S-VOL to the T-VOL. When a reverse resync or quick restore operation is performed on a split pair, the 9900 merges the S-VOL track map into the T-VOL track map and then copies all differential data from the T-VOL to the S-VOL. This ensures that the S-VOL and T-VOL are properly resynchronized in the desired direction, and also greatly reduces the time needed to resynchronize the pair.
- **Resync for suspended pair.** When a normal/quick resync operation is performed on a suspended pair, the 9900 copies all data on the S-VOL to the T-VOL, since all S-VOL tracks were flagged as difference data when the pair was suspended. Reverse pairresync or and quick restore operations cannot be performed on suspended pairs. The normal resync operation for suspended pairs is equivalent to and takes as long as the ShadowImage initial copy operation.

The Resynchronize Volume Pair panel (see section 4.8) allows you to resynchronize split and suspended ShadowImage pairs. When the resync operation starts, the pair status changes to *resync* or *resync-r*. When the resync is complete, the pair status changes to *duplex*. The 9900 resumes ShadowImage update copy operations after the pair status changes to *duplex*. The S-VOL remains fully accessible during a normal/quick resync operation, but becomes inaccessible to all hosts during a reverse resync or quick restore operation. This ensures that the data on the S-VOL is identical to the data on the T-VOL when the reverse resync or quick restore operation completes.

When resynchronizing pairs, you can select the pace for the resync operation(s): slower, medium, and faster. The slower pace minimizes the impact of ShadowImage operations on subsystem I/O performance, while the faster pace resynchronizes the pair(s) as quickly as possible. The quick resync option provides the fastest normal resync operation.

Note: The CESTPAIR and PPRCOPY ESTPAIR commands allow you to resynchronize split ShadowImage volume pairs. Reverse resync cannot be performed using PPRC commands. See Chapter 5 for further information on using PPRC commands to perform ShadowImage operations on the 9900 subsystem.

2.3.5 Suspend Pair Operation

The ShadowImage suspend pair operation suspends the ShadowImage update copy operations to the T-VOL of the pair. A ShadowImage pair can be suspended by the user at any time. When a ShadowImage pair is suspended, the 9900 stops performing ShadowImage update copy operations to the T-VOL, continues accepting write I/O operations to the S-VOL, and marks the entire S-VOL track map as difference data. When a resync operation is performed on a suspended pair, the entire S-VOL is copied to the T-VOL (T-VOL to the S-VOL for reverse resync). While the resync operation for a split pair can be very fast, the resync operation for a suspended pair will take as long as the ShadowImage initial copy operation.

The 9900 subsystem will automatically suspend a ShadowImage pair when it cannot keep the pair mirrored for any reason. When the 9900 suspends a pair, sense information is generated to notify the host. The 9900 will automatically suspend a pair under the following conditions:

- When the ShadowImage volume pair has been suspended or deleted from the host using TSO or ICKDSF commands,
- When the 9900 detects an error condition related to an update copy operation.
- When the S-VOL and/or T-VOL track map in shared memory is lost (e.g., due to offline microprogram exchange). This applies to *SP-pend* and *V-split* pairs only. For *duplex*, *split*, *resync*, or *resync-r* pairs, the pair is not suspended but the entire S-VOL (T-VOL for reverse resync) is marked as difference data.

The Suspend Volume Pair panel (see section 4.9) allows you to suspend ShadowImage pairs. When a pair is suspended, the pair status changes to *suspended*. When the resync operation starts, the pair status changes to *resync*. The S-VOL remains fully accessible while suspended and during the resync operation. The Resynchronize Volume Pair panel (see section 4.8) allows you to resynchronize suspended ShadowImage pairs.

Note: The PPRC commands do not support the ShadowImage suspend operation. You must use the HMRCF remote console software to suspend ShadowImage pairs. The CSUSPEND and PPRCOPY SUSPEND commands execute a ShadowImage split operation instead of a suspend operation. See Chapter 5 for further information on using PPRC commands to perform ShadowImage operations on the 9900 subsystem.

2.3.6 Delete Pair Operation

The ShadowImage delete pair operation stops the ShadowImage update copy operations to the T-VOL of the pair and changes the pair status of both volumes to *simplex*. A ShadowImage pair can be deleted by the user at any time except during the quick split operation (i.e., any status except *simplex* and *V-split*). After you delete a ShadowImage pair, the T-VOL is still not available for write operations until the reserve attribute is reset.

The Delete Volume Pair panel (see section 4.10) allows you to delete ShadowImage pairs. When a ShadowImage pair is deleted, pending update copy operations for the pair are discarded, and the status of the S-VOL and T-VOL is changed to *simplex*.

Caution: The T-VOL of a duplex pair may not be identical to its S-VOL, due to the asynchronous ShadowImage update copy operations. To synchronize the volumes before deleting the pair, you must split the pair first (see section 4.10 for instructions).

2.4 ShadowImage Pair Status

The HMRCF remote console software displays the ShadowImage pair status of all S/390® volumes under the specified CU image of the connected 9900 subsystem. Figure 2.6 illustrates the ShadowImage pair status transitions and the relationship between the pair status and the ShadowImage operations. Table 2.3 shows the allowable operations for each pair status.

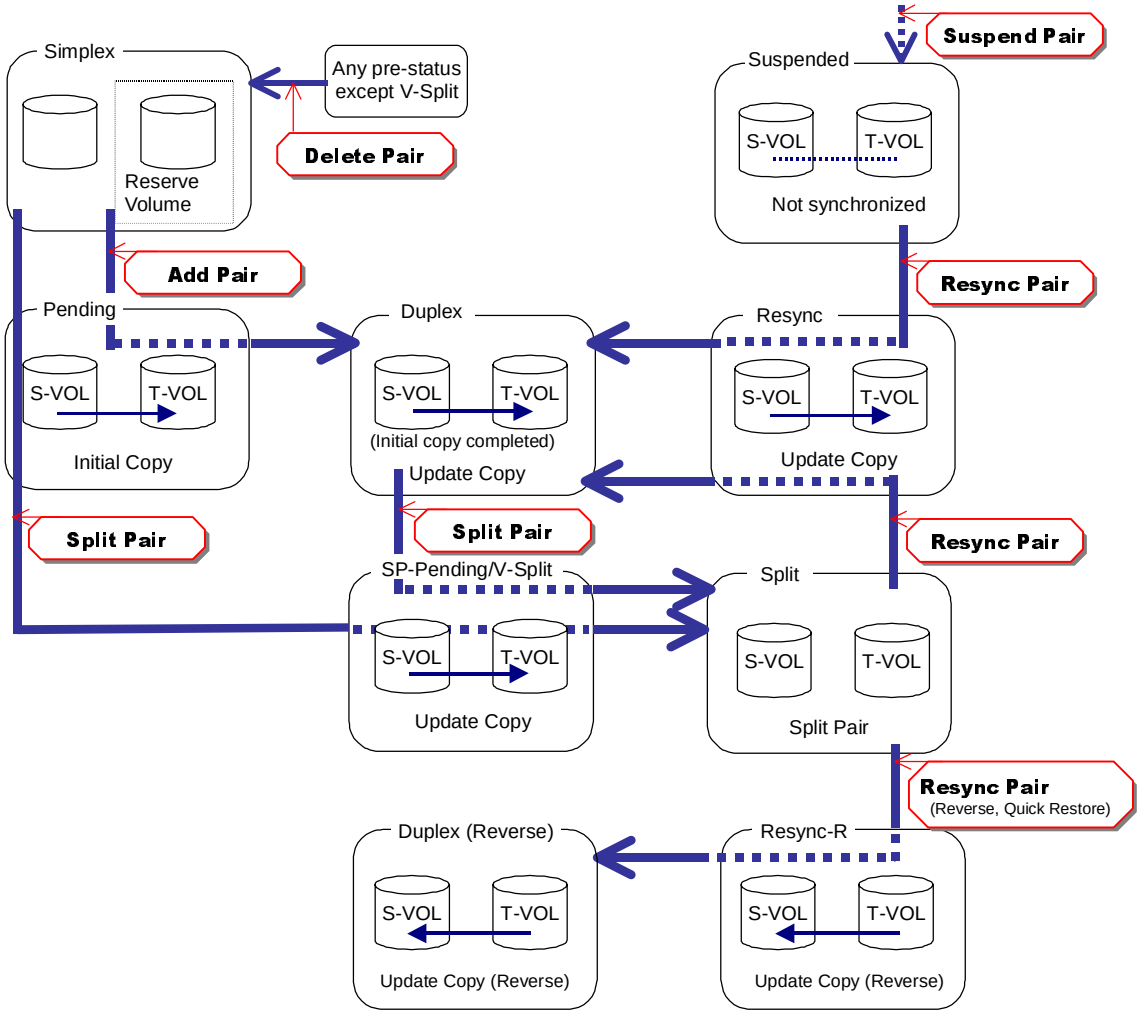

Figure 2.6 ShadowImage Pair Status Transitions

Table 2.3 Pair Status versus Allowable Operations

Operation	Pair Status								
	Simplex	Pending	Duplex	SP-Pend	V-Split	Split	Resync	Resync-R	Suspend
Split Pair	OK	OK	OK	x	x	x	x	x	x
Suspend Pair	x	OK	OK	OK	OK	OK	OK	x	OK
Resync Pair	x	x	x	x	OK	OK	x	x	OK
Reverse Resync	x	x	x	x	x	OK	x	x	x
Delete Pair	x	OK	OK	OK	x	OK	OK	OK	OK

Table 2.4 lists and describes the ShadowImage pair status conditions. If a volume is not assigned to a pair, its status is *simplex*. When you add a ShadowImage pair, the status of the S-VOL and T-VOL changes to *pending*. When the initial copy operation is complete, the pair status becomes *duplex*. If the 9900 cannot maintain *duplex* status for any reason, or if you suspend the pair, the pair status changes to *suspend*. When you split a pair, the pair status changes to *SP-pending* for steady split or *V-Split* for quick split. When the split is complete, the pair status changes to *split*, and you can access the split T-VOL. When you start a resync operation, the pair status changes to *resync*, and the T-VOL becomes inaccessible. When you specify reverse resync or quick restore, the pair status changes to *resync-r*, and the T-VOL and S-VOL are inaccessible during reverse resync/quick restore. When the resync is complete, the pair status changes to *duplex*. When you delete a pair, the pair status changes to *simplex*.

Table 2.4 ShadowImage (HMRCF) Pair Status

Status	Description	Host Status	S-VOL Access	T-VOL Access
Simplex	The volume is not assigned to an HMRCF pair. The 9900 accepts read and write I/Os for all *simplex* volumes which are not reserved.	S-VOL = SIMPLEX T-VOL = SIMPLEX	N/A (there is no S-VOL yet).	N/A (there is no T-VOL yet).
Pending	The initial copy operation is in progress. The 9900 continues to accept read and write operations for the S-VOL but stops accepting writes for the T-VOL. No update copy operations are performed.	S-VOL = PPRI-PNDG T-VOL = PSEC-PNDG	Read/write.	Read only.
Duplex	The initial copy operation is complete, and the 9900 starts performing asynchronous update copy operations from the S-VOL to the T-VOL as needed. The S-VOL and T-VOL of a duplex pair may not be identical. The 9900 rejects all write I/Os for T-VOLs with the status *duplex*.	S-VOL = PPRIMARY T-VOL = PSECONDRY	Read/write.	Read only.
SP-Pend	The status becomes *SP-Pend* when the Steady Split mode is selected for the split operation. All S-VOL updates prior to the split command are being copied to the T-VOL. When these updates are complete, the split T-VOL is identical to the state of the S-VOL when the split started. The 9900 rejects writes for *SP-Pend* T-VOLs.	S-VOL = PPRI-PNDG T-VOL = PSEC-PNDG	Read/write.	Read only.
V-Split	The status becomes *V-Split* when the Quick Split mode is selected for the split operation. Only the S-VOL differential data is being copied to the T-VOL in background. The 9900 accepts writes for *V-Split* T-VOLs. The *V-Split* pairs cannot be deleted.	S-VOL = PPRI-SUSP T-VOL = SIMPLEX	Read/write.	Read/write, can be varied online.
Split	The 9900 stops performing update copy operations for split pairs, and starts accepting write I/Os for split T-VOLs. The 9900 keeps track of all updates to the split S-VOL and T-VOL, so the pair can be resynced accurately and quickly.	S-VOL = PPRI-SUSP T-VOL = SIMPLEX	Read/write.	Read/write, can be varied online.
Resync	The 9900 does not accept write I/Os for *resync* T-VOLs. When a split pair is resynchronized in normal mode, only the S-VOL differential data is copied to the T-VOL. When a suspended pair is resynchronized, the entire S-VOL is copied to the T-VOL. No update copy operations are performed during resync operation.	S-VOL = PPRI-PNDG T-VOL = PSEC-PNDG	Read/write.	Read only.
Resync-R	The 9900 does not accept write I/Os for *resync-r* T-VOLs or S-VOLs. When a split pair is reverse resynchronized, the 9900 copies only the T-VOL differential data to the S-VOL. The reverse resync cannot be performed on suspended pairs. No update copy operations are performed during reverse resync or quick restore.	S-VOL = PPRI-PNDG T-VOL = PSEC-PNDG	Read only.	Read only.
Suspend	The 9900 continues accepting read and write I/Os for a suspended S-VOL, but does not perform update copy operations to a suspended T-VOL. The 9900 marks the entire S-VOL track map as differential data, so the entire S-VOL is copied to the T-VOL when the pair is resumed. Use resync command to resume a suspended pair. Reverse resync cannot be used for suspended pairs.	S-VOL = PPRI-SUSP T-VOL = PSEC-SUSP	Read/write.	Read only.

Chapter 3 Preparing for ShadowImage Operations

3.1 System Requirements

Hitachi ShadowImage operations involve the 9900 subsystem containing the source and target volumes, the HMRCF software on the 9900 Remote Console PC, and (optional) the S/390® host PPRC software functions. The ShadowImage system requirements are:

- Hitachi Lightning 9900™ subsystem. All 9900 hardware, microcode, and software required for ShadowImage operations must be installed and enabled.
- 9900 Remote Console PC and RMCMAIN software. Please refer to the *Hitachi Lightning 9900™ Remote Console PC User's Guide* for instructions on installing and using the Remote Console PC and RMCMAIN software. Make sure that the RMCMAIN version provides full support for ShadowImage.

  Note: Administrator access to RMCMAIN is required to perform ShadowImage operations. Users without administrator access can only view ShadowImage information.
- HMRCF remote console (RMCMAIN) license key (enables the HMRCF remote console software).
- HMRCF SVP (DKCMAIN) license key (enables the HMRCF option on the SVP).

3.2 Enabling the HMRCF Feature

The user enables the remote HMRCF option on the Remote Console PC and the HMRCF option on each 9900 subsystem using the RMCMAIN and DKCMAIN license key codes for HMRCF. *Note:* The RMCMAIN and DKCMAIN license key codes are identical. However, you must have separate DKCMAIN license key codes for each 9900 subsystem. You may not re-use the same DKCMAIN key code for multiple 9900 subsystems.

To enable the HMRCF feature:

1. Check with your Hitachi Data Systems representative to verify that the correct microcode and SVP software are installed and enabled on the 9900 subsystems which will perform HMRCF operations. Also make sure that your RMCMAIN software version is correct.
2. Make sure that the 9900 Remote Console PC and RMCMAIN software are installed and functioning properly. Refer to the *Hitachi Lightning 9900™ Remote Console PC User's Guide* for instructions on installing the Remote Console PC and RMCMAIN software.
3. Enable the remote HMRCF option on the Remote Console PC as follows:
   a) Start up and log in to the 9900 RMCMAIN software with administrator access.
   b) Select **Option…** to open the RMCMAIN Option Product panel (see Figure 3.1).
   c) On the Option Product panel, select **Remote HMRCF**, and then select **Install…** to open the Input Key Code panel (see Figure 3.2).
   d) Enter the license key code in the **Key Code** text box, and then select **OK**.
   e) If the key code is accepted, the Program Product (P.P.) Confirmation panel opens (see Figure 3.3). Confirm the information displayed on this panel, and select **Install**. The Option Product panel now displays **[Install]** for the **Remote HMRCF** option.
   f) Select **Close** on the Option Product panel to return to the Remote Console Main panel.
4. If not already done, add the attached 9900 subsystems to the Remote Console PC. Select **Controller…**, select **Add…**, enter the subsystem name, S/N, and IP address, and select **OK**. Then select the subsystem you just added on the Connection Control panel, and select **Entry**. Refer to the *Hitachi Lightning 9900™ Remote Console PC User's Guide* for more detailed instructions.
5. Enable the HMRCF option on each subsystem as follows:
   a) On the Connection Control panel, select the desired 9900 subsystem, and then select **Install…** to open the DKCMAIN Option Product panel (see Figure 3.4).
   b) Select **HMRCF**, select **Install…**, enter the license key code for the selected subsystem on the Input Key Code panel, and select **OK**.
   c) Confirm the information displayed on the P.P. Confirmation panel, and select **Install** to enable the selected HMRCF option on the selected subsystem. The DKCMAIN Option Product panel now displays **[Install]** for the HMRCF option.
6. After enabling the HMRCF option on all 9900 subsystems, you are now ready to prepare for HMRCF operations (see the next section).

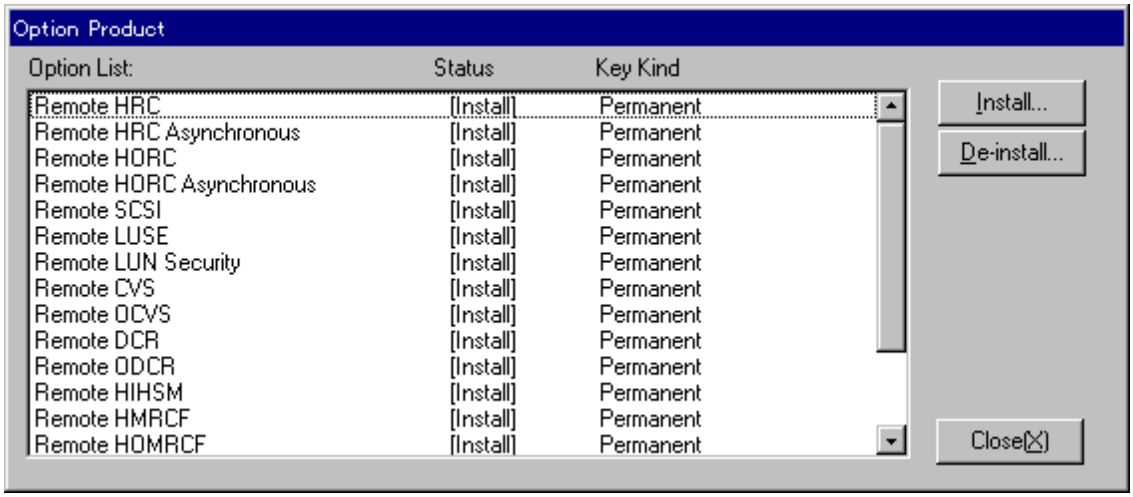

Figure 3.1 Enabling the Remote HMRCF Option

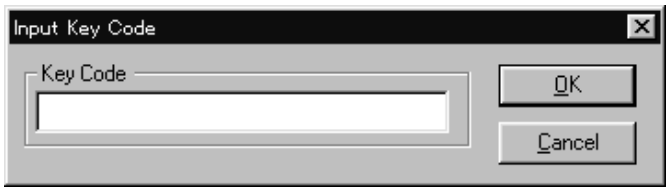

Figure 3.2 Entering the HMRCF License Key Code

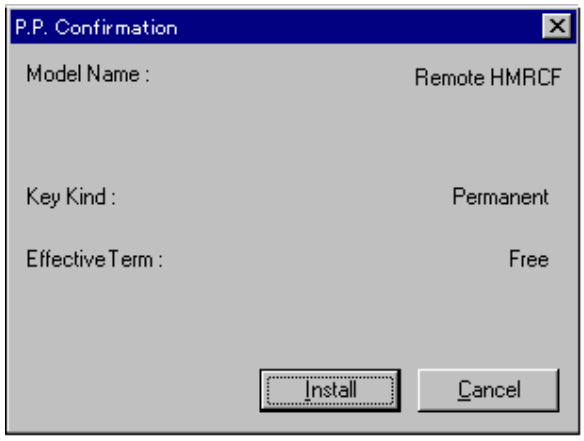

Figure 3.3 Confirming the HMRCF Key Code

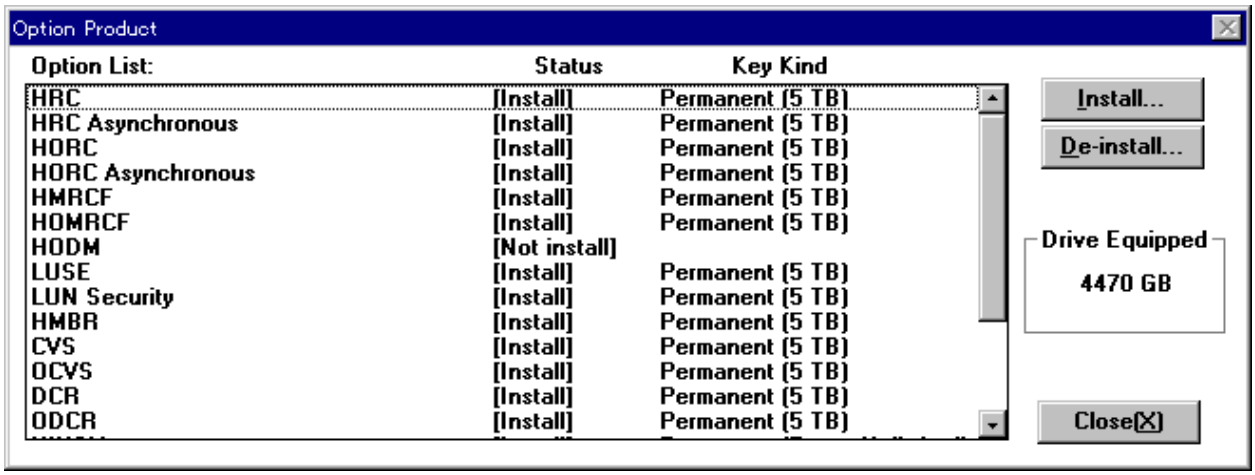

Figure 3.4 Enabling the HMRCF Option on Each Subsystem

3.3 Preparing for ShadowImage Operations

To ensure that you and your 9900 subsystem(s) are ready for ShadowImage operations, you should perform the following tasks to prepare for ShadowImage operations:

- ShadowImage operations affect the I/O performance of the 9900 subsystem because of the additional write operations to the T-VOLs. If you have not already done so, you should consider the relative importance of the subsystem's I/O performance and the backup ShadowImage copies. For example, assigning three T-VOLs to each S-VOL takes more resources than assigning only one or two. You can also use the ShadowImage copy pace option to reduce the impact of the ShadowImage initial copy operations. Using a slower copy pace minimizes the impact of ShadowImage operations on I/O performance, while a faster copy pace produces point-in-time copies more quickly but may affect I/O performance. The ShadowImage initial copy operation is performed only once to each T-VOL (unless the pair is suspended).
- Identify the volumes (LDEVs) that will be the ShadowImage volumes. For each volume, write down the CU image and LDEV ID, whether the volume will be an S-VOL or T-VOL, and the other volume(s) in its pair (see Figure 3.5 for a sample table). The HMRCF S-VOLs will remain fully accessible to all hosts throughout normal ShadowImage operations (except during reverse resync and quick restore). The T-VOLs will need to be varied offline before being reserved for ShadowImage operations. Once assigned to a pair, a ShadowImage T-VOL rejects all write I/Os, except when the pair is split.
- ShadowImage and HRC can function together in the same 9900 subsystem to provide both internal and remote backup for your important data. If you are planning to combine HMRCF and HRC, please read the important configuration information in the next section.

CU #	LDEV	S-VOL?	Associated T-VOL(s)	T-VOL?	Associated S-VOL
0	00	Yes	0:10, 0:11	No	--
0	01	Yes	0:12, 0:13	No	--
etc.	…	…	…	…	…
0	0F	Yes	0:2E, 0:2F	No	--
0	10	No	--	Yes	0:00
0	11	No	--	Yes	0:00
0	12	No	--	Yes	0:01
etc.	…	…	…	…	…

Figure 3.5 Sample Table for ShadowImage Configuration Information

3.4 Combining ShadowImage with Other Data Management Operations

ShadowImage supports concurrent operations with the following data management functions:

- **Virtual LVI.** Virtual LVI (CVS) volumes can be assigned to ShadowImage pairs, provided that the T-VOL has the same capacity as the S-VOL. If you need to perform Virtual LVI operations on an existing ShadowImage S-VOL or T-VOL, you must delete the pair first to return the volume to *simplex* status.
- **FlashAccess.** FlashAccess volumes can be assigned to ShadowImage pairs, and FlashAccess operations can be performed on ShadowImage S-VOLs and T-VOLs.
- **Hitachi Remote Copy (HRC).** HRC volumes can be assigned to ShadowImage pairs, and ShadowImage volumes can be assigned to HRC pairs. Please read the next section (3.4.1) for important information on ShadowImage and HRC shared volume configurations.

  Note: ShadowImage is recommended for intra-subsystem copy operations. If ShadowImage is not installed, HRC (synchronous only) can be used to copy within the same 9900 subsystem. This HRC configuration requires at least one external ESCON® cable loop (minimum of two is recommended).
- **LDEV Security**. LDEV Security operations do not directly affect ShadowImage operations. Secure LDEVs can be assigned to ShadowImage pairs, and ShadowImage volumes can be secured. A secure LDEV will accept ShadowImage initial and update copy operations. When an S-VOL is secured by LDEV Security, this setting does not apply to the corresponding T-VOLs. ***Note:*** ShadowImage T-VOLs cannot be accessed by any host except when the pair is split.

Hitachi Online Data Migration (HODM). HODM volumes cannot be assigned to ShadowImage pairs, and ShadowImage volumes cannot be assigned to HODM pairs. ShadowImage and HODM operations can be performed concurrently in the same 9900 subsystem, but volumes cannot be shared between ShadowImage and HODM. For further information on HODM, please contact your Hitachi Data Systems account team.

3.4.1 Combining ShadowImage and HRC Operations

ShadowImage and HRC can function together in the same 9900 subsystem to provide both internal and remote backup for your important data. Table 3.1 describes the host pair status reporting for ShadowImage (HMRCF) volumes, HRC volumes, and HMRCF/HRC shared volumes. Table 3.2 lists the currency of the data on shared HMRCF/HRC volumes based on the HMRCF and HRC pair status.

- For shared HMRCF/HRC volumes, query the S-VOL of the HMRCF pair to obtain the HMRCF pair status. The HRC status is reported if you query the HRC M-VOL or R-VOL.
- ShadowImage supports multiple T-VOLs for each S-VOL. If you issue a pair status query to an HMRCF S-VOL, the status for only one HMRCF pair is reported (the pair with the T-VOL with the lowest LDEV ID). To obtain the pair status for the HMRCF pair(s) with the other T-VOL(s), you must direct the host query to the specific T-VOL using the T-VOL's LDEV ID in the host command. The HMRCF remote console software displays the LDEV ID and HMRCF pair status of all T-VOLs associated with an S-VOL.

Table 3.1 Host Pair Status Reporting for HMRCF/HRC Shared Volumes

Number of HMRCF S-VOLs	Number of HRC Pairs	Pair Status Reported by 9900
0	0	Simplex
1	0	HMRCF pair status
2 or more	0	HMRCF pair status for the pair whose T-VOL has the lowest LDEV ID
0	1	HRC pair status
1	1	HRC pair status
2 or more	1	HRC pair status

Table 3.2 Currency of a Shared HMRCF and HRC Volume

	HRC Pair Status		
HMRCF Pair Status	Pending	Duplex	Suspended
Pending	Not current	Not current	Not current
Duplex	Not current	Not current	CURRENT
SP-Pending	Not current	Not current	CURRENT
V-Split	Not current	Not current	CURRENT
Split	CURRENT	CURRENT	CURRENT
Resync, Resync-r	Not current	Not current	CURRENT
Suspended	Not current	Not current	Not current

The configuration shown in Figure 3.6 is an example of a volume which is functioning as both a ShadowImage S-VOL and an HRC M-VOL. This configuration allows you to:

- Use ShadowImage to provide on-site backup copies of HRC M-VOLs, and/or
- Use HRC to provide remote backup copies of ShadowImage S-VOLs.

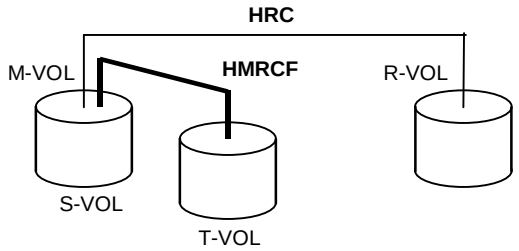

Figure 3.6 HMRCF and HRC: Shared S-VOL/M-VOL

The configuration shown in Figure 3.7 is an example of a volume which is functioning as both a ShadowImage S-VOL and an HRC R-VOL. This configuration allows you to use ShadowImage to provide additional remote copies of HRC M-VOLs.

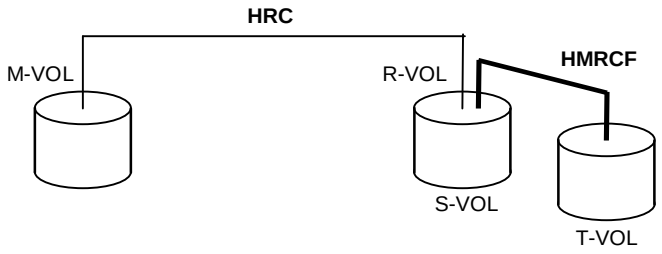

Figure 3.7 HMRCF and HRC: Shared S-VOL/R-VOL

The configuration shown in Figure 3.8 is an example of a volume which is functioning as both an HRC M-VOL and a ShadowImage S-VOL, while the R-VOL of the same HRC pair is also functioning as the S-VOL of another ShadowImage pair. This configuration allows you to:

- Use ShadowImage to provide on-site backup copies of HRC M-VOLs and R-VOLs, and/or
- Use HRC to provide remote backup of ShadowImage S-VOLs.

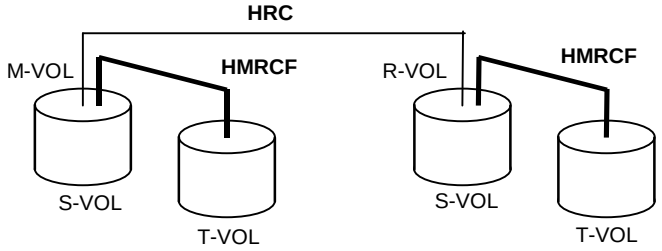

Figure 3.8 HMRCF and HRC: Shared S-VOL/M-VOL and S-VOL/R-VOL

The configuration shown in Figure 3.9 is an example of a volume functioning as both a ShadowImage T-VOL and an HRC M-VOL. ***Note***: This configuration does not allow ShadowImage and HRC to copy at the same time. Add the ShadowImage pair first, and then split the pair before creating the HRC pair. You must suspend the HRC pair in order to resync the ShadowImage pair. The HRC pair status cannot be changed when the HMRCF pair is in the *V-Split* status.

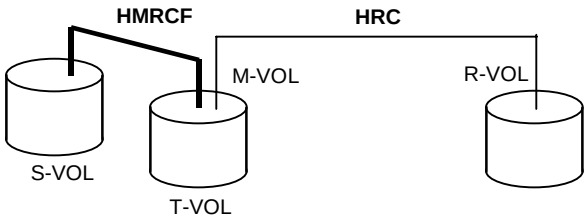

Figure 3.9 HMRCF and HRC: Shared T-VOL/M-VOL

3.5 Starting Up the HMRCF Software

After you have enabled the HMRCF software on the 9900 Remote Console PC and prepared for ShadowImage operations, you are ready to start up the HMRCF software:

1. If Hitachi GRAPH-Track™ (GT) is connected to the subsystem on which you will perform ShadowImage operations, you may want to disconnect GT from the subsystem. This will reduce the traffic on the 9900-internal LAN and decrease the chances of timeout conditions.
2. Start up and log in to the RMCMAIN software with administrator access privileges.
3. Connect to the 9900 subsystem on which you will perform ShadowImage operations:
   a) From the Remote Console Main panel, select the **Connect…** button to open the Connection Control panel.
   b) On the Connection Control panel, select the subsystem you want to connect to, and then select the **Connect** button to connect to the subsystem. The Function Select panel now opens (see Figure 3.10).
4. Select **HMRCF** on the Function Select panel to open the HMRCF main panel (see section 4.1). The HMRCF main panel displays the name of the connected 9900, the currently selected CU image, and all of the volumes (LVIs) installed under the current CU image.
5. You are now ready to perform ShadowImage operations. You will first reserve the volumes that you plan to use as ShadowImage T-VOLs (see section 4.2 for instructions), and then you will start adding the ShadowImage pairs (see section 4.4 for instructions).

Note: This panel displays differently depending on the version of the RMCMAIN software.

Figure 3.10 Starting the HMRCF Software

Chapter 4 Performing ShadowImage Operations

4.1 HMRCF Main Panel

The HMRCF main panel (see Figure 4.1) displays the ShadowImage volume and pair information for the selected CU image of the connected 9900 subsystem and allows you to perform all ShadowImage operations. To open the HMRCF main panel, connect to the desired 9900 subsystem using the RMCMAIN software, and select the **HMRCF** option.

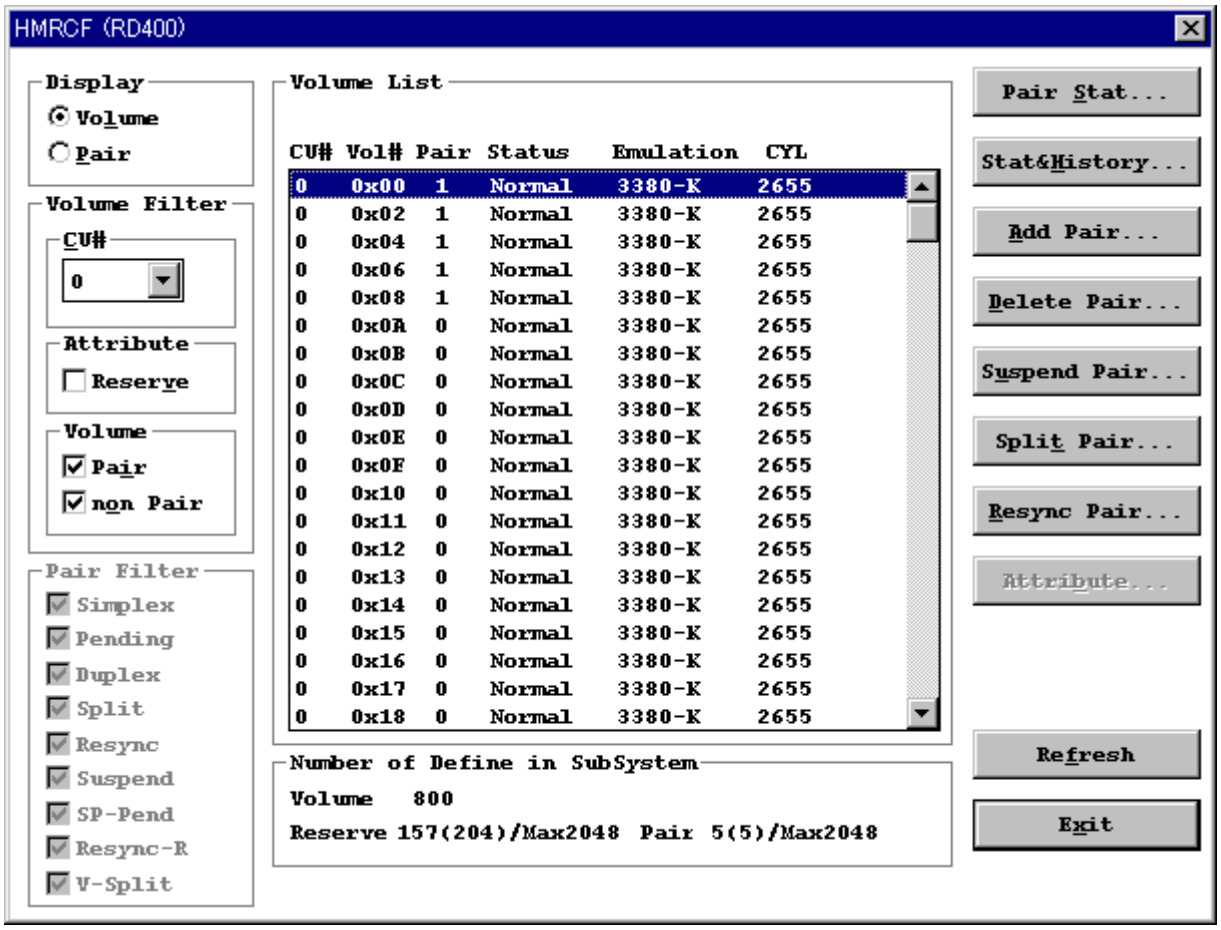

Figure 4.1 HMRCF Main Panel

The **Display** box allows you to select either **Volume** display mode or **Pair** display mode. The **Volume Filter** options allows you to "filter" the volumes displayed by CU image, reserve attribute, and pair condition. The **Attribute-Reserve** and **Volume-Pair/Non-Pair** options are available only when **Volume** display mode is selected. The **Attribute-Reserve** option allows you to display reserved volumes or unreserved volumes. The **Volume-Pair/Non-Pair** option allows you to display paired and/or unpaired volumes. The **Pair Filter** options (available only when **Pair** display mode is selected) allow you to display volumes according to pair status: **Simplex**, **Pending**, **Duplex**, **Split**, **Resync**, **Suspend**, **SP-Pend**, **Resync-R**, and **V-Split**.

The **Volume List** box (see section 4.1.1) displays ShadowImage volume information based on the selected CU image and the selected **Volume** or **Pair** display filter options.

The **Number of Define in Subsystem** box (bottom center) displays:

- **Volume**: The total number of volumes defined in the 9900 subsystem.
- **Reserve**: X(Y)/MaxZ, where X = total number of HMRCF reserved volumes
  Y = total number of HMRCF and HOMRCF reserved vols
  Z = maximum allowable number of reserved volumes
- **Pair**: X(Y)/MaxZ, where X = total number of HMRCF pairs
  Y = total number of HMRCF and HOMRCF pairs
  Z = maximum number of pairs (HMRCF/HOMRCF/HIHSM)

  Note: The value (Y) does not include HIHSM pairs. If HIHSM pairs exist, it is possible for the ShadowImage add pair operation to fail even when (Y) is less than 2048.

The buttons along the right side of the HMRCF main panel allow you to perform the following operations:

Pair Stat…	displays the pair status for the selected volume(s)/pair(s).
Stat&History…	displays the pair status and history for the selected volume(s)/pair(s).
Add Pair…	allows you to add new ShadowImage pairs.
Delete Pair…	allows you to delete ShadowImage pairs.
Suspend Pair…	allows you to suspend ShadowImage pairs.
Split Pair…	allows you to split ShadowImage pairs.
Resync Pair…	allows you to resynchronize and reverse-resync ShadowImage pairs.
Attribute…	allows you to set/reset the ShadowImage reserve attribute.
Refresh	updates the information displayed on the HMRCF main panel.
Exit	exits HMRCF, and returns you to the RMCMAIN Function Select panel.

4.1.1 Volume List Box

The **Volume List** box displays volume/pair information based on the selected CU image and on the options you select in the **Display**, **Volume Filter**, and **Pair Filter** boxes. When you select **Volume** display mode, the **Volume List** box displays volume information, and the **Pair Filter** options become disabled. When you select **Pair** display mode, the **Volume List** box displays pair information, and the **Attribute** and **Volume** display options become disabled.

Note: You can select up to 512 volumes/pairs at a time in the **Volume List** box.

When **Volume** display mode is selected, the **Volume List** box on the HMRCF main panel displays all installed S/390 volumes in the selected CU image and displays the following information for each volume (see Figure 4.2):

- **CU#:** Logical control unit (CU) image number (0-F).
- **Vol#:** LDEV number (hexadecimal 00-FF for each CU image).
- **Pair:** Number of ShadowImage pairs defined for the volume.
- **Status:** Status of the volume (normal, copying, format, correct, or blocked).

- **Emulation:** Emulation type (LVI) of the volume (e.g., 3390-9, 3380-K).
- **CYL:** Number of cylinders assigned to the volume. This field indicates CVS volumes.

When **Pair** display mode is selected, the **Volume List** box on the HMRCF main panel displays all ShadowImage pairs in the selected CU image and displays the following information for each pair (see Figure 4.3):

- **S-VOL Vol#:** CU#:LDEV of the ShadowImage S-VOL.
- **S-VOL Status:** Status of the S-VOL (normal, copying, or blocked).
- **T-VOL Vol#**: CU#:LDEV of the T-VOL.
- **T-VOL Status**: Status of the T-VOL (normal, copying, or blocked).
- **Pair Status:** ShadowImage pair status. For pending, SP-pending, V-split, resync, and resync-r, the percent completion of the sync/resync operation (0-100%) is also displayed.

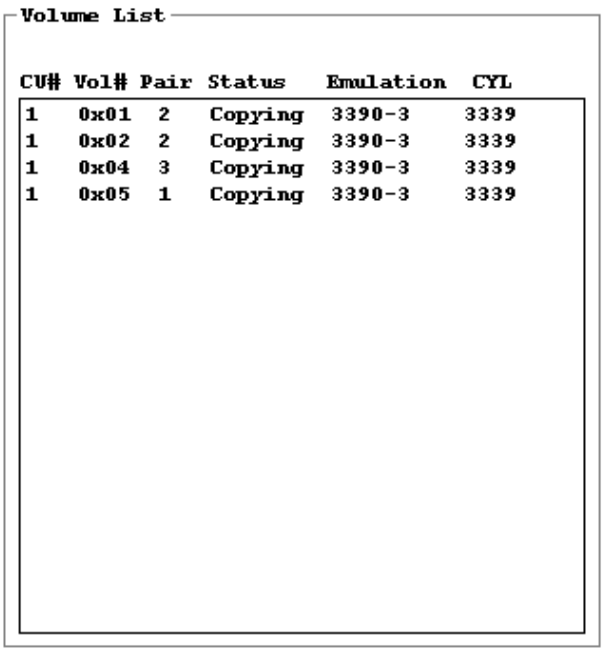

Figure 4.2 Volume Display Mode

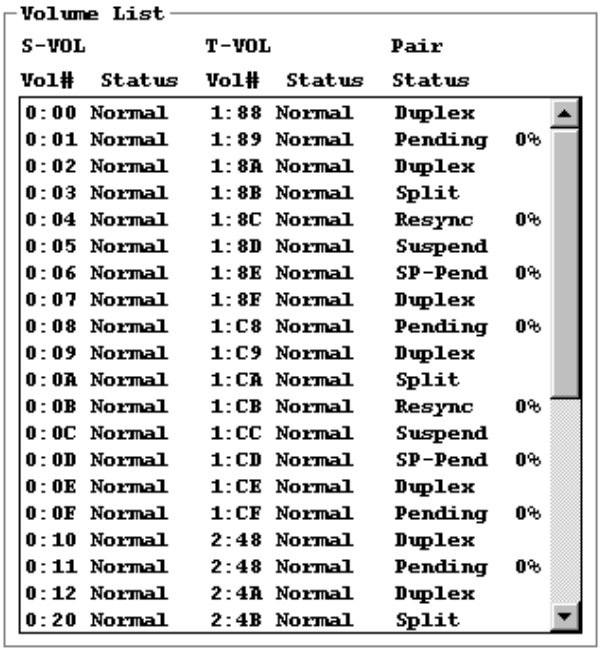

Figure 4.3 Pair Display Mode

4.2 Setting the Reserve Attribute

The Set Reserve Attribute panel (see Figure 4.4) enables you to set the reserve attribute for (i.e., reserve) the volume(s) selected on the HMRCF main panel. The Set Reserve Attribute panel is opened by selecting the **Attribute…** button on the HMRCF main panel.

Note: The reserve attribute is only required for HMRCF remote console operations. The PPRC commands require that the potential T-VOLs are offline to the host, but do not require that the T-VOLs have the reserve attribute setting.

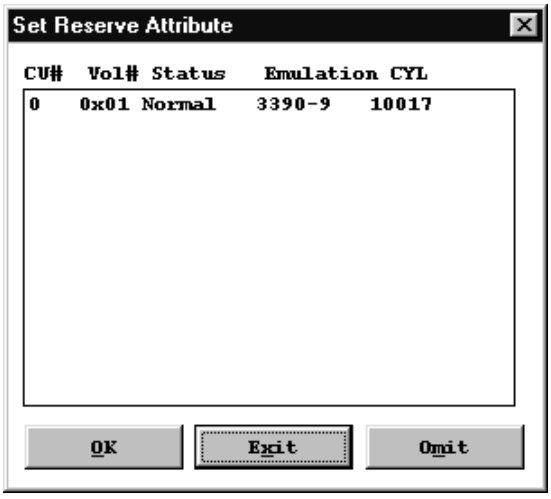

Figure 4.4 Set Reserve Attribute Panel

The Set Reserve Attribute panel displays the unreserved volume(s) that you selected on the HMRCF main panel. The **Omit** button allows you to remove one or more volumes from the list. The **OK** button sets the reserve attribute for all volumes in the list. The **Exit** button closes the Set Reserve Attribute panel and returns you to the HMRCF main panel.

To reserve one or more volumes as ShadowImage T-VOLs (set the reserve attribute):

1. Vary the volume(s) that you will be reserving offline. The 9900 will reject all write I/Os to reserved volumes (except when in the *split* state).
2. On the HMRCF main panel, select **Volume** display mode, select the desired CU image, deselect (uncheck) **Attribute-Reserve**, select **Volume-nonPair**, and deselect (uncheck) **Volume-Pair** to display only unreserved *simplex* (unpaired) volumes.
3. Select the volume(s) you want to reserve, and then select the **Attribute…** button to open the Set Reserve Attribute panel. If the **Attribute…** button is not enabled, you selected reserved volumes and/or paired volumes. Select only unreserved and unpaired volumes.
4. Verify that the Set Reserve Attribute panel displays the desired volume(s). If you want to remove any volumes from the list, select the volume(s), and select the **Omit** button.
5. When the Set Reserve Attribute panel displays the desired volume(s), select the **OK** button to set the reserve attribute for all volumes in the list.
6. HMRCF displays a warning message reminding you to vary the specified volume(s) offline. Select **OK** to continue, or select **Cancel** to cancel your reserve request.
7. When the reserve operation(s) are complete, you are returned to the HMRCF main panel.

4.3 Resetting the Reserve Attribute

The Reset Reserve Attribute panel (see Figure 4.5) enables you to reset the reserve attribute for (i.e., unreserve) the volume(s) selected on the HMRCF main panel. The Reset Reserve Attribute panel is opened by selecting the **Attribute…** button on the HMRCF main panel.

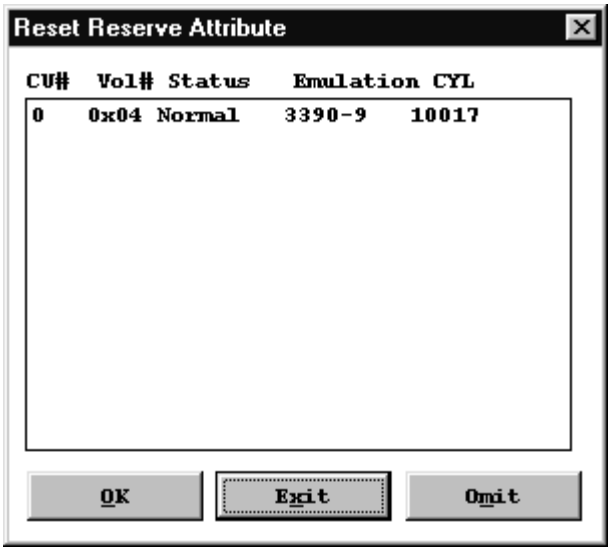

Figure 4.5 Reset Reserve Attribute Panel

The Reset Reserve Attribute panel displays the reserved volume(s) that you selected on the HMRCF main panel. The **Omit** button allows you to remove one or more volumes from the list. The **OK** button resets the reserve attribute for all volumes in the list. The **Exit** button closes the Reset Reserve Attribute panel and returns you to the HMRCF main panel.

To unreserve one or more volumes (reset the reserve attribute):

1. Make sure that the volumes you want to unreserve are no longer assigned to ShadowImage pairs as T-VOLs. See section 4.10 for instructions on deleting ShadowImage pairs.
2. On the HMRCF main panel, select **Volume** display mode, select the desired CU image, select **Attribute-Reserve**, select **Volume-nonPair**, and deselect (uncheck) **Volume-Pair** to display only reserved *simplex* (unpaired) volumes.
3. Select the volume(s) you want to unreserve, and then select the **Attribute…** button to open the Reset Reserve Attribute panel. If the **Attribute…** button is not enabled, you selected both reserved and unreserved volumes. Select only reserved volumes.
4. Verify that the Reset Reserve Attribute panel displays the desired volume(s). If you want to remove any volumes from the list, select the volume(s), and select the **Omit** button.
5. Make sure that the Reset Reserve Attribute panel displays the desired volume(s), because there is no confirmation for the reset reserve attribute operation. When the list is correct, select the **OK** button to reset the reserve attribute for all volumes in the list.
6. When the reset operation(s) are complete, you are returned to the HMRCF main panel.

4.4 Adding ShadowImage Pairs

The Add Pair Dialog panel (see Figure 4.6) displays the S-VOL and T-VOL information for the pair(s) being added and allows you to select the T-VOL(s) for each S-VOL, set the copy pace for all pairs being added, and start the add pair operation(s). The Add Pair Dialog panel is opened by selecting the **Add Pair…** button on the HMRCF main panel.

WARNING: The ShadowImage add pair operation overwrites all data on the T-VOLs. The user is responsible for backing up the data on the T-VOLs before adding ShadowImage pairs.

Note: ShadowImage supports the CESTPAIR/PPRCOPY ESTPAIR commands for adding (starting) ShadowImage pairs. See Chapter 5 for further information on using PPRC commands.

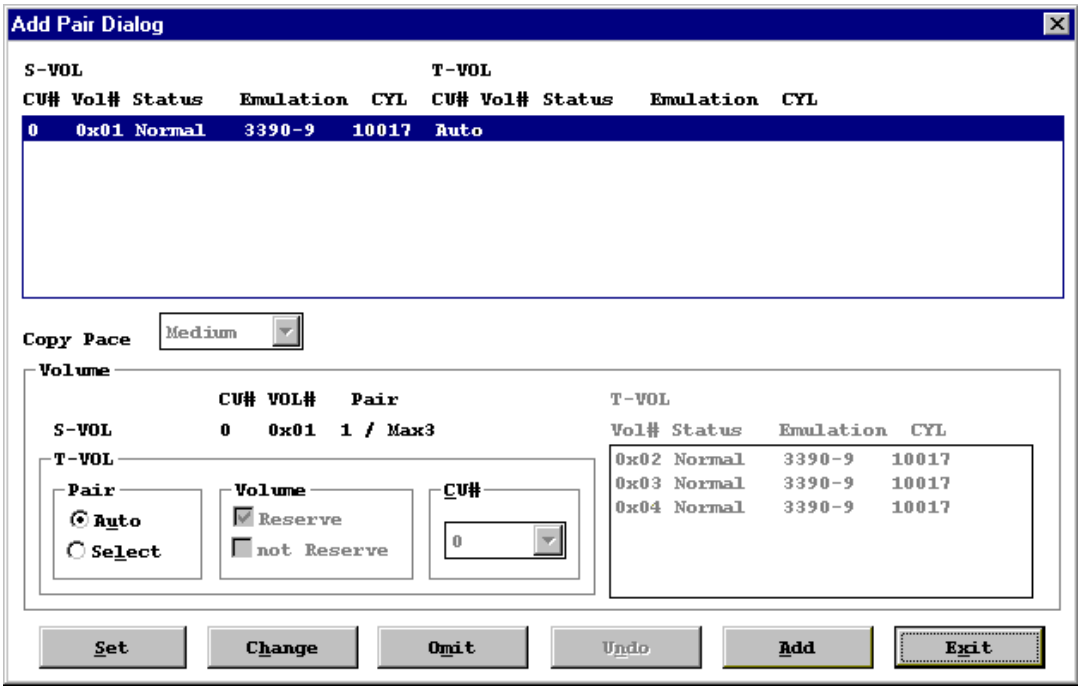

Figure 4.6 Add Pair Dialog Panel

The Add Pair panel displays the S-VOL and T-VOL information for each pair being added: CU image, LDEV ID, volume status, emulation type, capacity (cylinders). The T-VOL for each S-VOL is displayed only after being selected (using **Set** or **Change**). The **Copy Pace** pull-down selection box allows you to select the copy pace for all pairs being added: **Slower**, **Medium**, and **Faster**.

The **Volume** box displays the detailed volume information for the selected pair: S-VOL ID (CU:LDEV), number of existing pairs (0-3), and maximum number of pairs. The **T-VOL** box (within the **Volume** box) allows you to select a T-VOL automatically or manually: **Auto** = the SVP selects a T-VOL for the S-VOL, **Select** = you select a T-VOL for the S-VOL. When **Auto** is selected, the SVP selects the T-VOL from the set of reserved volumes by LDEV ID (in ascending order, lowest to highest). When **Select** is selected, use the **Volume** and **CU#** display options to display the available T-VOLs by reserve attribute and CU image.

The **Set** button adds the selected T-VOL to the selected S-VOL. The **Change** button replaces the T-VOL of the selected pair with the selected T-VOL. The **Omit** button deletes the selected volume(s)/pair(s) from the list. The **Undo** button undoes the **Set** or **Change** command. The **Add** button adds (starts) all pairs in the list. The **Exit** button closes the Add Pair panel.

Note: If you want to add new ShadowImage pairs and then split them immediately so that you can access the T-VOLs as soon as possible, use the split operation instead of the add pair operation to establish and split new pairs at the same time (see section 4.7 for instructions).

To add (start) one or more new ShadowImage pairs:

1. Make sure that the desired T-VOL(s) is/are reserved (see section 4.2) and offline.
2. On the HMRCF main panel, select **Volume** display mode to display volumes, and then select the desired CU image and volume display options. To display unreserved *simplex* volumes, check **Volume-nonPair** and uncheck **Attribute-Reserve** and **Volume-Pair**.
3. Select the desired S-VOL(s) for the new pair(s), and then select the **Add Pair…** button to open the Add Pair Dialog panel. ***Note:*** Do not select any reserved volumes.
4. Set the initial copy pace for all pairs being added: **Slower**, **Medium**, or **Faster**.
5. Verify that the Add Pair Dialog panel displays the desired S-VOL(s). If you want to remove any volumes from the list, select the volume(s), and select the **Omit** button.
6. Select the T-VOL(s) for each S-VOL as follows:
   a) Select the desired S-VOL on the Add Pair Dialog panel.
   b) If you want the SVP to assign a T-VOL automatically, select the **Pair-Auto** option. T-VOLs are assigned from the set of reserved volumes by LDEV ID. If you want to select the T-VOL manually, select **Pair-Select**, select **Volume-Reserve** to display reserved volumes, select the desired CU image, and select the desired T-VOL.

      Note: You can select an unreserved volume as the T-VOL. When you create the pair, the 9900 changes the reserve attribute to "reserved" automatically.
   c) Select the **Set** button to set the pair and add the T-VOL to the selected S-VOL. The S-VOL is now displayed in the list as a pair with the specified T-VOL.
   d) If you want to add a second and/or third T-VOL to the same S-VOL, repeat steps (b) and (c) to add each T-VOL to the selected S-VOL. Each pair to be added is displayed separately in the list of pairs on the Add Pair Dialog panel.
   e) If you want to change a T-VOL for a pair which is already set, select the pair, select the desired T-VOL to replace the existing T-VOL, and select the **Change** button.
7. Repeat step (6) until all desired pairs are displayed. Use the **Change** button to replace a T-VOL, use the **Set** button to add a T-VOL, and use the **Omit** button to remove pairs.
8. When the Add Pair Dialog panel displays the desired new pair(s), select the **Add** button to add all pairs in the list. When the confirmation panel appears, select **Yes** to add the pair(s), select **No** to cancel your request and return to the HMRCF main panel, or select **Cancel** to cancel your request and return to the Add Pair Dialog panel.
9. When the initial copy operation(s) start, the Pair Status Display panel opens automatically to show the new pairs with *pending* status. Select **Refresh** to monitor the progress of the ShadowImage initial copy operation(s), or select **OK** to return to the HMRCF main panel.

4.5 Viewing ShadowImage Pair Status

The Pair Status Display panel (see Figure 4.7) displays the pair status information for the pair(s) selected on the HMRCF main panel. The Pair Status Display panel is opened by selecting the **Pair Stat...** button on the HMRCF main panel. The Pair Status Display panel also opens automatically when you add and split pairs.

Note: ShadowImage supports the CQUERY/PPRCOPY QUERY commands for viewing ShadowImage pair status. See Chapter 5 for further information on using PPRC commands.

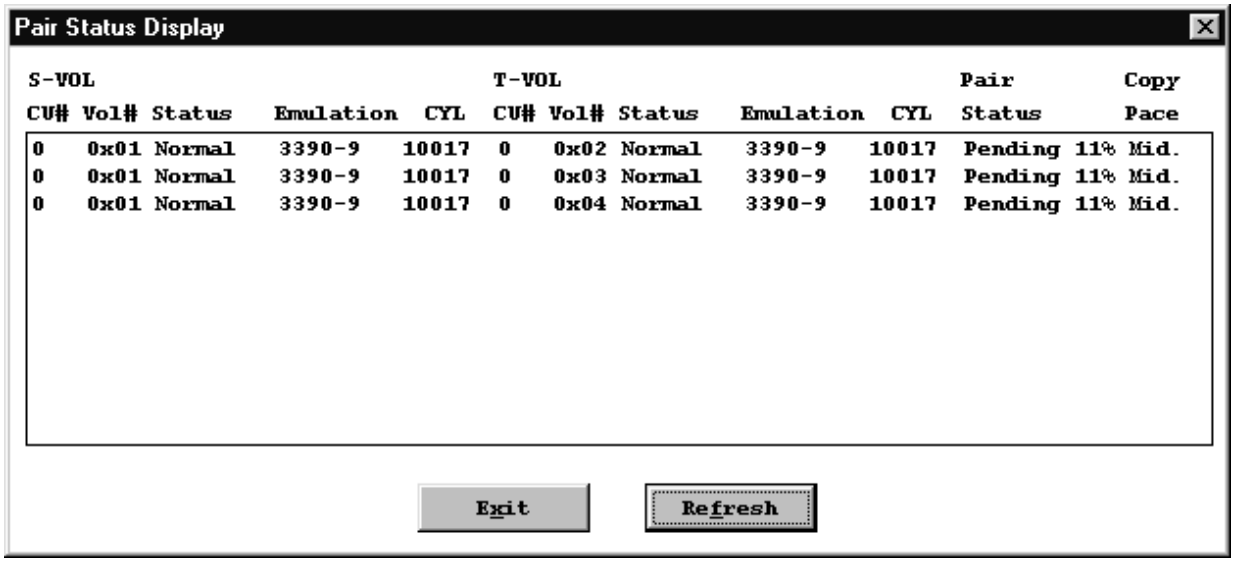

Figure 4.7 Pair Status Display Panel

The following information is displayed for each selected volume/pair:

- S-VOL and T-VOL ID, volume status, emulation, and capacity (cylinders).
- Pair status: **Simplex**, **Pending**, **Duplex**, **SP-Pend**, **V-Split**, **Split**, **Resync**, **Resync-r**, **Suspend**. When the pair status is *pending*, *SP-pend*, *V-Split*, *resync*, or *resync-R*, the percent completion of the operation is displayed (0-100%).
- Copy pace, displayed only when the pair status is *pending*, *SP-pend*, *V-Split*, *resync*, or *resync-R*: **Slower**, **Medium**, or **Faster**.

The **Refresh** button updates the information displayed on the Pair Status Display panel. The **Exit** button exits the Pair Status Display panel and returns you to the HMRCF main panel.

To display the pair status of one or more ShadowImage pairs:

1. On the HMRCF main panel, select either **Volume** or **Pair** display mode to display either volumes or pairs, and then select the desired CU image and volume/pair display options.
2. Select the desired volume(s)/pair(s) in the **Volume List** box, and select the **Pair Stat...** button to open the Pair Status Display panel. ***Note***: Do not select any *simplex* volumes.
3. Use the **Refresh** button as needed to update the information displayed on the panel.
4. When you are done monitoring the status of the selected volume(s)/pair(s), select the **Exit** button to return to the HMRCF main panel.

4.6 Viewing ShadowImage Pair Status & History

The Status & History panel (see Figure 4.8) displays current ShadowImage pair status information as well as ShadowImage pair history information for the selected CU image. The Status & History panel is opened by selecting the **Stat&History** button on the HMRCF main panel.

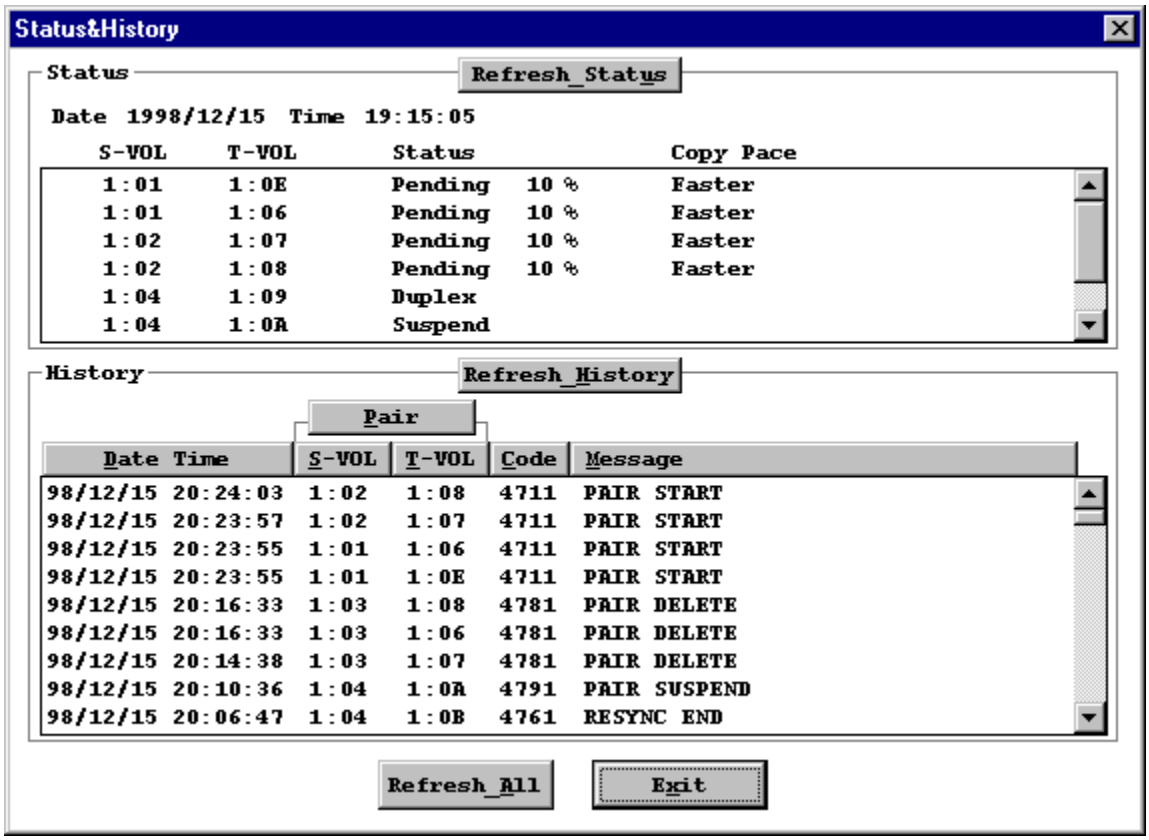

Figure 4.8 Status & History Panel

The **Status** box displays all ShadowImage pairs in the selected CU image (S-VOL and T-VOL, pair status, copy pace), and the **Date** and **Time** that the ShadowImage information was acquired (panel opened/refreshed). The **Refresh Status** button updates the information in the **Status** box.

The **History** box displays the ShadowImage pair activity for the selected CU image: date and time of action, S-VOL and T-VOL (CU:LDEV), and HMRCF code and message (see Table 4.1). The **Date Time**, **S-VOL**, **T-VOL**, and **Pair** buttons sort the list by date/time, S-VOL, T-VOL, and pair. The **Code** button sorts by code number. The **Message** button sorts by message type.

The **Refresh History** button refreshes the pair history information for the selected CU image. The **Refresh All** button updates all information on the Status & History panel. The **Exit** button exits the Status & History panel and returns you to the HMRCF main panel.

Table 4.1 HMRCF Status & History Reference Codes and Messages

Code	Message	Meaning
4710 – 471F	PAIR START	The HMRCF initial copy operation started.
4720 – 472F	DUPLEX END	The HMRCF initial copy operation ended, and the pair status changed to *duplex*.
4730 – 473F	SPLIT START	The HMRCF split operation started, and the pair status changed to *SP-pending* or *V-split*.
4740 – 474F	SPLIT END	The HMRCF split operation ended, and the pair status changed to *split*.
4750 – 475F	RESYNC START	The HMRCF resync operation started, and the pair status changed to *resync* or *resync-R*.
4760 – 476F	RESYNC END	The HMRCF resync operation ended, and the pair status changed to *duplex*.
4780 – 478F	PAIR DELETE	The HMRCF delete operation was performed, and the pair status changed to *simplex*.
4790 – 479F	PAIR SUSPEND	The HMRCF suspend operation was performed, and the pair status changed to *suspended*.
47A0 - 47AF	COPY WARNING END	A copy ended with a warning.
47D0 - 47DF	COPY ABNORMAL END	A copy ended abnormally (reason other than above).
47E7	COMPULSION PAIR SUSPEND	The pair was suspended compulsorily.
47E9	HMRCF SM INITIALIZATION START	The initialization of the HMRCF/HOMRCF extension table was started (SM = shared memory).
47EA	HMRCF SM INITIALIZATION END	The initialization of the HMRCF/HOMRCF extension table was completed (SM = shared memory).
47EB	HMRCF SM INITIALIZATION FAILED	The initialization of the HMRCF/HOMRCF extension table failed (SM = shared memory).
7FF1 – 02	COPY ABNORMAL END (MULTIPLE PAIRS)	Multiple copies ended abnormally. This reference code is reported at five-minute intervals (one report per five minutes). If a pair ended abnormally, pair status changed to *suspended*.
FFFF	Reference Code unknown	The reference code is unknown.

4.7 Splitting ShadowImage Pairs

The Split Volume Pair panel (see Figure 4.9) displays volume and pair information for the volume(s) and/or pair(s) selected on the HMRCF main panel and allows you to split existing ShadowImage pairs. The Split Volume Pair panel can also be used to simultaneously add and split new ShadowImage pairs (see section 4.7.1). The Split Volume Pair panel is opened by selecting **Split Pair…** on the HMRCF main panel.

Note: ShadowImage supports the CSUSPEND/PPRCOPY SUSPEND commands for splitting ShadowImage pairs. See Chapter 5 for further information on using PPRC commands.

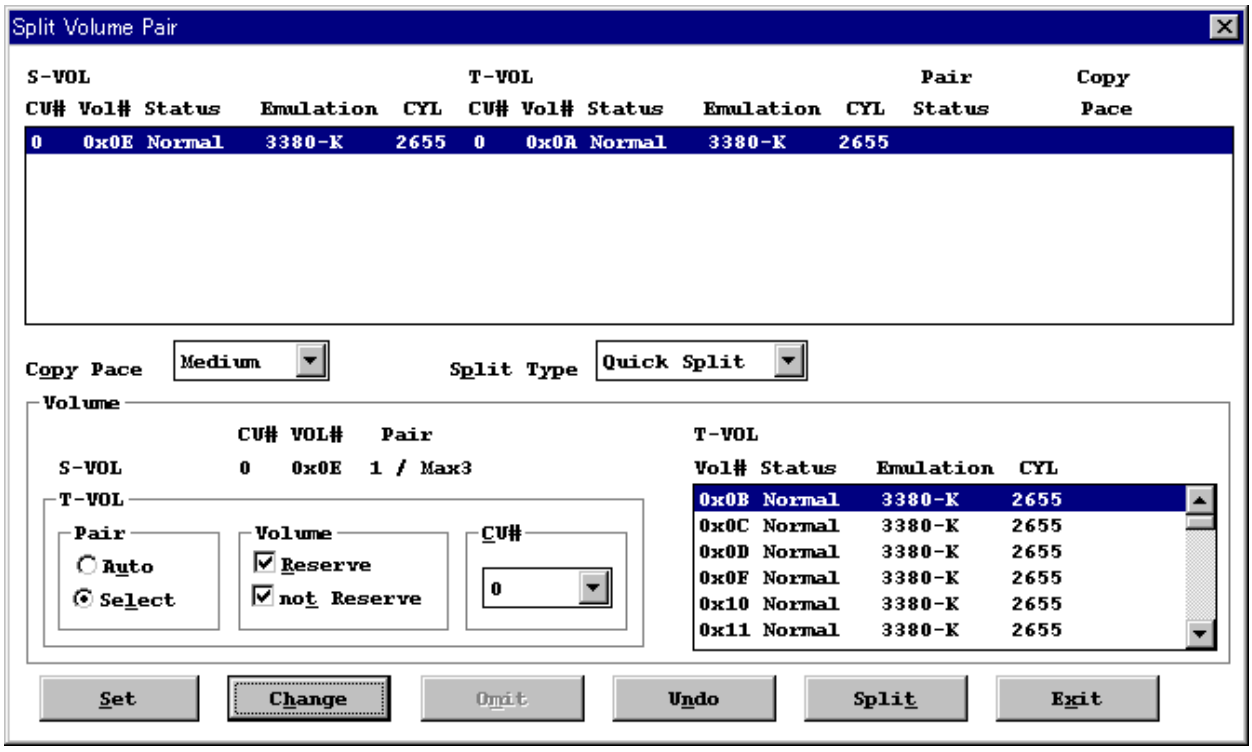

Figure 4.9 Split Volume Pair Panel

The Split Volume Pair panel lists the volume(s)/pair(s) selected on the HMRCF main panel and shows the pair status and copy pace for each pair. The **Copy Pace** pull-down selection box allows you to select the copy pace for all pairs that you are splitting: **Slower**, **Medium**, or **Faster**. The **Split Type** pull-down selection box allows you to select the split type for all pairs that you are splitting: **Quick Split** or **Steady Split**.

The **Volume** box displays the volume information for the selected volume/pair (CU:LDEV, number of existing pairs, max number of pairs) and allows you to add T-VOLs to the selected volume/pair. In the **T-VOL** box, the **Pair** options allow you to select a T-VOL automatically or manually: **Auto** = the SVP selects a T-VOL for the S-VOL, **Select** = you select a T-VOL for the S-VOL. When **Select** is selected, use the **Volume** and **CU#** display options to display the T-VOLs by CU image and reserve attribute. (When **Pair-Auto** is selected, these options and the list box are disabled.)

The **Set** button adds the selected T-VOL to the selected S-VOL. The **Change** button replaces the T-VOL of the selected pair with the selected T-VOL. The **Omit** button deletes the selected volume(s)/pair(s) from the list. The **Undo** button undoes the **Set** or **Change** command. The **Split** button splits all pairs in the list. The **Exit** button closes the Split Volume Pair panel.

To split one or more existing ShadowImage pairs:

1. If you want the split T-VOLs to be identical to the S-VOLs, stop all write operations to the S-VOLs before splitting the pairs. This ensures that there are no updates to the S-VOLs while the split operations are synchronizing the T-VOLs to the S-VOLs.
2. On the HMRCF main panel, select **Pair** display mode to display pairs, and then select the desired CU image and pair display options.
3. Select the pair(s) you want to split, and then select the **Split Pair…** button to open the Split Volume Pair panel. You cannot split a suspended pair.
4. Set the copy pace (**Slower**, **Medium**, or **Faster**) and split type (**Quick** or **Steady**) for all pairs being split.
5. Verify that the Split Volume Pair panel displays the desired pair(s). If you want to remove any pairs from the list, select the pair(s), and select the **Omit** button.
6. When the Split Volume Pair panel displays the desired pair(s), select the **Split** button to split all pairs in the list. When the confirmation panel appears, select **Yes** to split the pair(s), select **No** to cancel your request and return to the HMRCF main panel, or select **Cancel** to cancel your request and return to the Split Volume Pair panel.
7. When the split operation(s) start, the Pair Status Display panel opens automatically to show the new pairs with *SP-pend* or *V-Split* status. The *split* status is displayed right away if there were no pending update copy operations. Select **Refresh** to monitor the progress of the ShadowImage split operation(s), and select **OK** to return to the HMRCF main panel.

4.7.1 Adding and Splitting Pairs

The split operation can also be used to simultaneously add and split new ShadowImage pairs. In this case, the split operation changes the pair status from *simplex* to *SP-pending* or *V-split*, copies all data on the S-VOL to the T-VOL, and then changes the pair status to *split*.

To add and split one or more new ShadowImage pairs with a single remote console operation:

1. If you want the split T-VOLs to be identical to the S-VOLs, stop all write operations to the S-VOLs before adding and splitting the pairs. This ensures that there are no updates to the S-VOLs while the split operations are synchronizing the T-VOLs to the S-VOLs.
2. On the HMRCF main panel, select **Volume** display mode to display volumes, and then select the desired CU image and volume display options. To display unreserved simplex volumes, check **Volume-nonPair** and uncheck **Attribute-Reserve** and **Volume-Pair**.
3. Select the volume(s) which will be the S-VOL(s) of the new pairs to be added and split, and then select the **Split Pair…** button to open the Split Volume Pair panel.
4. Set the copy pace (**Slower**, **Medium**, or **Faster**) and split type (**Quick** or **Steady**) for all pairs being added and split.
5. Add the T-VOL(s) to the S-VOL(s) as follows:
   a) Select the desired S-VOL from the list of pairs to be split.
   b) If you want the SVP to select the T-VOL automatically, select the **Pair-Auto** option. If you want to select the T-VOL manually, select **Pair-Select**, select **Volume-Reserve** to display reserved volumes, select the desired CU image, and select the desired T-VOL.
   c) Select the **Set** button to add the T-VOL to the selected S-VOL. The T-VOL is now displayed next to the selected S-VOL.
   d) If you want to add another T-VOL to the same S-VOL, repeat steps (b) and (c) to add the next T-VOL to the selected S-VOL. Each pair to be added and split is displayed separately in the list of pairs.
6. Repeat step (5) until the desired pair(s) is/are displayed. Use the **Change** button to replace a T-VOL, the **Set** button to add a T-VOL, and the **Omit** button to remove pairs.
7. When the Split Volume Pair panel displays the desired pair(s), select the **Split** button to add and split all pairs in the list. When the confirmation panel appears, select **Yes** to add and split the pair(s), select **No** to cancel your request and return to the HMRCF main panel, or select **Cancel** to cancel your request and return to the Split Volume Pair panel.
8. When the split operation(s) start, the Pair Status Display panel opens automatically to show the new pairs with *SP-pend* or *V-split* status. Select **Refresh** to monitor the progress of the ShadowImage split operation(s), and select **OK** to return to the HMRCF main panel.

4.8 Resynchronizing ShadowImage Pairs

The Resynchronize Volume Pair panel (see Figure 4.10) displays pair information for the pair(s) selected on the HMRCF main panel and allows you to resynchronize the pair(s). The Resynchronize Volume Pair panel is opened by selecting the **Resync Pair...** button on the HMRCF main panel.

Note: ShadowImage supports the CESTPAIR/PPRCOPY ESTPAIR commands allow you to resynchronize split or suspended ShadowImage pairs. See Chapter 5 for further information on using PPRC commands.

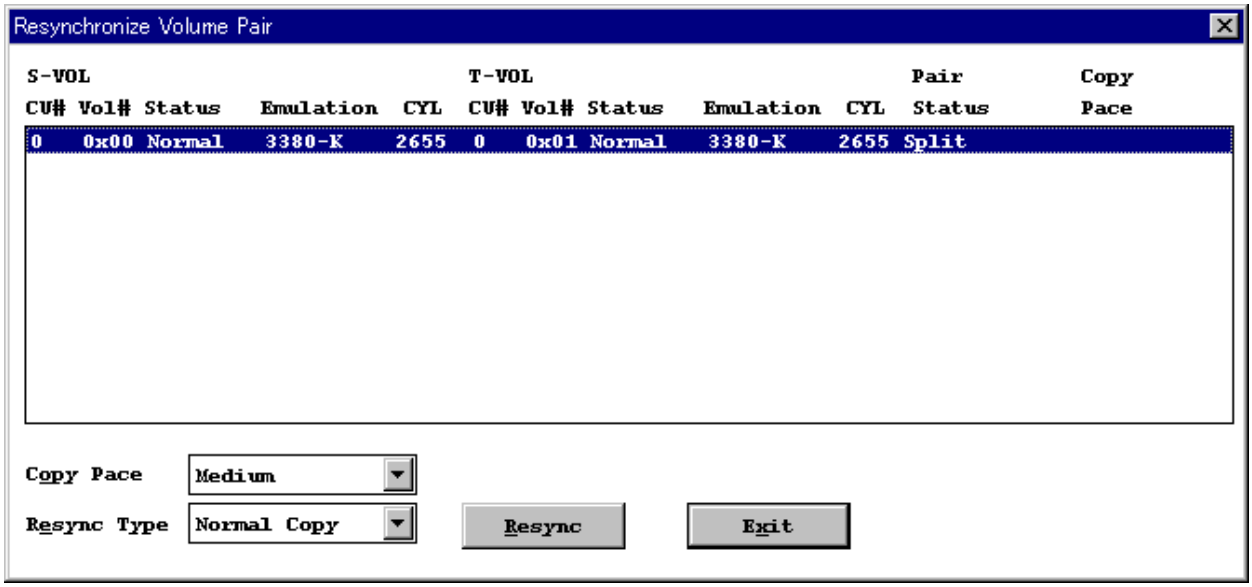

Figure 4.10 Resynchronize Volume Pair Panel

The Resynchronize Volume Pair panel lists the pair(s) selected on the HMRCF main panel and shows the pair status and copy pace for each pair. The **Copy Pace** pull-down selection box allows you to select the copy pace for the pairs being resynchronized: **Slower**, **Medium**, or **Faster**. The **Resync Type** pull-down selection box allows you to select the resync type for the pair(s) being resynchronized: **Normal Copy**, **Quick Resync**, **Reverse Copy**, or **Quick Restore**.

The **Resync** button starts the resync operation for the specified pair(s). The **Exit** button exits the Resynchronize Volume Pair panel and returns you to the HMRCF main panel.

To resynchronize one or more split or suspended ShadowImage pairs:

1. Vary the split T-VOLs offline before starting the resync operations. When the resync operation starts, the 9900 will stop accepting write I/Os to the T-VOL.
2. On the HMRCF main panel, select **Pair** display mode to display ShadowImage pairs, and then select the desired CU image and pair display options (e.g., select the **Pair-Split** and/or **Pair-Suspend** display options to display only split and/or suspended ShadowImage pairs).
3. On the HMRCF main panel, select the pair(s) you want to resync, and select the **Resync Pair…** button to open the Resynchronize Volume Pair panel.
4. On the Resynchronize Volume Pair panel, select the pair(s) you want to resync, select the desired **Copy Pace** (slower, medium, or faster) and **Resync Type** (normal, quick resync, reverse, or quick restore) for these resync operations, and then select the **Resync** button to start the resync operation for the selected pair(s).

   WARNING: Make sure to select the correct resync direction (normal or reverse).

   Note on RAID Swap for Quick Restore: During the quick restore operation, the RAID levels and HDD types of the T-VOL and S-VOL are exchanged, if they have different RAID levels and/or HDD types. To avoid any performance impact due to the quick restore operation, make sure that the S-VOL and T-VOL have the same RAID level and HDD type before performing the quick restore operation. If you want to restore the original RAID levels after quick restore, stop host I/Os to the pair, split the pair, perform the quick restore operation for that pair again, and then restart the host I/Os to the pair.
5. HMRCF displays a warning panel to remind you to vary the T-VOL(s) offline before starting resync operations. Make sure the T-VOL(s) are offline, and select **OK**.
6. When the confirmation panel appears, select **Yes** to resync the specified pair(s), select **No** to cancel your request and return to the HMRCF main panel, or select **Cancel** to cancel your request and return to the Resynchronize Volume Pair panel.
7. The Resynchronize Volume Pair panel now displays the result(s) of the resync operation(s) (i.e., pair status changed to *resync*, *resync-R*, or *duplex*). Repeat steps (4) through (6) to resync additional pairs in the list, or select **Exit** to return to the HMRCF main panel.

4.9 Suspending ShadowImage Pairs

The Suspend Volume Pair panel (see Figure 4.11) displays pair information for the pair(s) selected on the HMRCF main panel and allows you to suspend the pair(s). The Suspend Volume Pair panel is opened by selecting **Suspend Pair…** on the HMRCF main panel.

Note: The CSUSPEND/PPRCOPY SUSPEND commands execute a ShadowImage split operation. There is no TSO/ICKDSF command equivalent for manually suspending pairs. See Chapter 5 for further information on using PPRC commands.

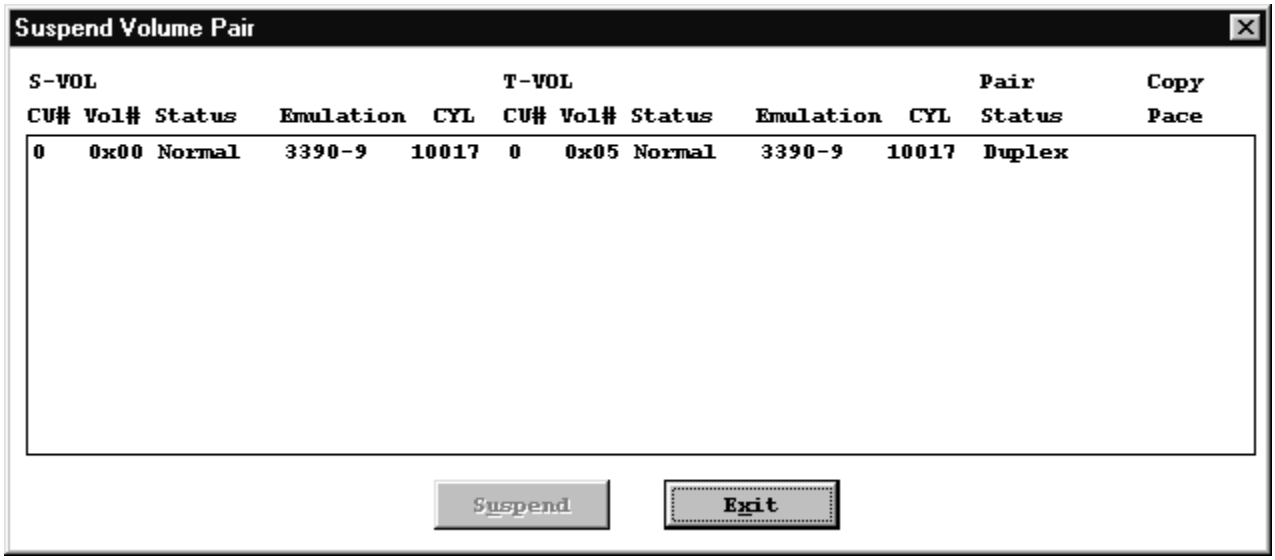

Figure 4.11 Suspend Volume Pair Panel

The Suspend Volume Pair panel lists the pair(s) selected on the HMRCF main panel and shows the pair status and copy pace for each pair. The **Suspend** button suspends the selected pair(s). The **Exit** button closes the Suspend Volume Pair panel and returns you to the HMRCF main panel.

To suspend one or more ShadowImage pairs:

1. On the HMRCF main panel, select **Volume** or **Pair** display mode to display volumes or pairs, and then select the desired CU image and volume or pair display options.
2. Select the pair(s) that you want to suspend (or the volume(s) whose pairs you want to suspend), and select the **Suspend Pair...** button to open the Suspend Volume Pair panel.
3. On the Suspend Volume Pair panel, select the pair(s) you want to suspend, and select the **Suspend** button.
4. When the confirmation panel appears, select **Yes** to suspend the selected pair(s), select **No** to cancel your request and return to the HMRCF main panel, or select **Cancel** to cancel your request and return to the Suspend Volume Pair panel.
5. The Suspend Volume Pair panel now displays the result(s) of the suspend operation(s) (i.e., pair status changed to *suspend*). Repeat steps (3) and (4) to suspend additional pairs in the list, or select **Exit** to return to the HMRCF main panel.

4.10 Deleting ShadowImage Pairs

The Delete Volume Pair panel (see Figure 4.12) displays pair information for the pair(s) selected on the HMRCF main panel and allows you to delete the pair(s). The Delete Volume Pair panel is opened by selecting the **Delete Pair…** button on the HMRCF main panel.

Note: ShadowImage supports the CDELPAIR/PPRCOPY DELPAIR commands for deleting ShadowImage pairs. See Chapter 5 for further information on using PPRC commands.

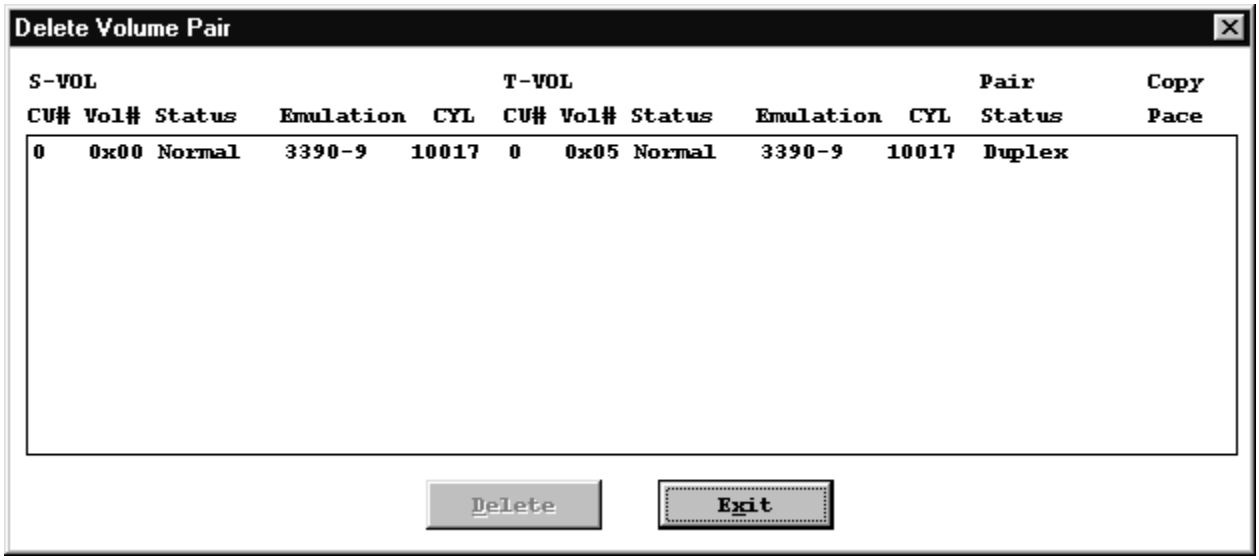

Figure 4.12 Delete Volume Pair Panel

The Delete Volume Pair panel lists the pair(s) selected on the HMRCF main panel and shows the pair status and copy pace for each pair. The **Delete** button deletes the selected pair(s). The **Exit** button closes the Delete Volume Pair panel and returns you to the HMRCF main panel.

To delete one or more ShadowImage pairs:

1. If you want to synchronize the S-VOL and T-VOL before deleting the pair:
   a) Wait until all write I/Os to the S-VOL are complete, and then take the S-VOL offline to prevent the S-VOL from being updated during or after the delete operation.
   b) After the S-VOL is offline, split the pair to copy all pending updates to the T-VOL.
   c) When the pair status changes to *split*, the S-VOL and T-VOL are synchronized.
2. On the HMRCF main panel, select **Volume** or **Pair** display mode to display volumes or pairs, and then select the desired CU image and volume/pair display options.
3. Select the pair(s) that you want to delete (or the volume(s) whose pairs you want to delete), and then select the **Delete Pair...** button to open the Delete Volume Pair panel.

   Note: Pairs with *V-Split* status cannot be deleted.

Instructions continue on the next page.

4. On the Delete Volume Pair panel, select the pair(s) you want to delete, and select the **Delete** button. When the confirmation panel appears, select **Yes** to delete the selected pair(s), select **No** to cancel your request and return to the HMRCF main panel, or select **Cancel** to cancel your request and return to the Delete Volume Pair panel.
5. If you deleted all pairs on the Delete Volume Pair panel, you are returned to the HMRCF main panel. If not, the Delete Volume Pair panel displays the remaining pair(s). Repeat step (4) to delete additional pairs, or select **Exit** to return to the HMRCF main panel.

Chapter 5 Using PPRC Commands for ShadowImage

ShadowImage supports both TSO PPRC commands and ICKDSF PPRCOPY commands to enable you to perform ShadowImage operations from the S/390® host system. This user's guide does not provide complete instructions for using PPRC commands. For detailed information on using PPRC TSO and ICKDSF commands, please refer to the following IBM user documents: *DFSMS/MVS V1 Remote Copy Guide and Reference* (SC35-0169) and *ICKDSF R16 Refresh User's Guide* (GC35-0033).

5.1 PPRC Command Support

Table 5.1 lists and describes the PPRC commands supported by ShadowImage. Table 5.2 lists and describes the TSO command parameters supported by ShadowImage. Table 5.3 lists and describes the ICKDSF command parameters supported by ShadowImage.

Note: The PPRC commands do not support the ShadowImage reverse resync or suspend pair functions. You must use the HMRCF remote console software to perform reverse-resync and user-requested suspend operations.

Table 5.1 PPRC Commands

HMRCF Remote Console Operation	TSO Command	ICKDSF Command	Function	Restrictions
Set Reserve Attribute (reserve)	Not required	Not required	Sets the reserve attribute of the specified volume.	The specified volume must be *simplex* and offline to the host.
Reset Reserve Attribute (unreserve)	Not required	Not required	Resets the reserve attribute of the specified volume.	The specified volume must be *simplex*.
Add Pair (duplex request)	CESTPAIR	PPRCOPY ESTPAIR	Adds a pair, starts initial copy operation.	The specified volume must *simplex* or *suspended*.
Split Pair	CSUSPEND	PPRCOPY SUSPEND	Splits a pair, starts split operation.	The specified volume must be *duplex*.
Resync Pair	CESTPAIR	PPRCOPY ESTPAIR	Resynchronizes a pair, starts normal resync.	The specified volume must be *split* or *suspended*.
Reverse Resync Pair	Not available*	Not available*	Resynchronizes a pair, starts reverse resync.	The specified volume must be *split*.
Quick Restore Pair	CESTPAIR	PPRCOPY ESTPAIR	Resynchronizes a pair, starts quick restore.	The specified volume must be *split*.
Delete Pair (simplex request)	CDELPAIR	PPRCOPY DELPAIR	Deletes a pair, changes status to simplex.	The specified volume cannot be *simplex*.
Suspend Pair	Not available*	Not available*	Stops update copy operations.	The specified volume cannot be *simplex*.
Pair Status Display (status check), Status & History	CQUERY	PPRCOPY QUERY	Displays detailed pair status information.	None.

****Note:*** You cannot request suspend or reverse resync operations for ShadowImage pairs using TSO/ICKDSF commands. The CSUSPEND/PPRCOPY SUSPEND commands execute split operations on ShadowImage pairs.

Table 5.2 TSO Command Parameters

Command	Parameter	Description
CESTPAIR	DEVN	Device number.
	PRIM	Primary volume (S-VOL): SSID, serial number, channel connection address. You can set an additional parameter corresponding to each request instead of a serial number. (1) Direct Split request This request is valid for MODE(COPY) only. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'S' = Direct Split Byte 9: MRCF Subcode-2 'F' = Fast Mode Byte 10-11: Not used (xF0*2) (2) Quick Resync request This request is valid for MODE(RESYNC) only. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'R' = Resync Byte 9: MRCF Subcode-2 'F' = Fast Mode Byte 10-11: Not used (xF0*2) (3) Quick Restore request This request is valid for MODE(RESYNC) only. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'R' = Resync Byte 9: MRCF Subcode-2 'Q' = Quick Mode Byte 10-11: Not used (xF0*2) If you set a parameter other than the above parameters, the command will be rejected.
	SEC	Secondary volume (T-VOL): SSID, serial number, channel connection address.
	MODE	COPY = Initial full-volume copy. NOCOPY = Same as COPY. RESYNC = Re-establish a split or suspended volume pair.
	PACE	1 (slow) - 255 (fast).
	CRIT	Not applicable.
	MSGREQ	YES = Applicable. NO = Not applicable.
CSUSPEND	DEVN	Device number.
	PRIM	Primary volume (S-VOL): SSID, serial number, channel connection address.
	SEC	Secondary volume (T-VOL): SSID, serial number, channel connection address.
	PRIMARY	Not applicable.
	QUIESCE	See section 5.5.1 for information on the QUIESCE parameter.

Table 5.2 TSO Command Parameters (continued)

Command	Parameter	Description
CDELPAIR	DEVN	Device number.
	PRIM	Primary volume (S-VOL): SSID, serial number, channel connection address. You can set an additional parameter corresponding to each request instead of a serial number. This request is valid for steady split. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'P' = SPLIT Byte 9: MRCF Subcode-2 'S' = Steady Split Byte 10-11: Not used (xF0*2) If you set a parameter other than the above parameters, the command will be rejected.
	SEC	Secondary volume (T-VOL): SSID, serial number, channel connection address.
CQUERY	DEVN	Device number.
	PATHS	Not applicable.
CRECOVER	CRECOVER is not used for HMRCF. Refer to the HRC documentation for information on CRECOVER.	
CGROUP	CGROUP is not used for HMRCF. Refer to the HRC documentation for information on CGROUP.	

Table 5.3 ICKDSF Command Parameters

Command	Parameter	Description
ESTPAIR	DDNAME | SYSNAME | UNITADDRESS	DDNAME = *dname* = JCL statement identifying the volume. SYSNAME = *sysxxx* = SYSNAME in the ASSGN system control statement. UNITADDRESS = *ccuu* = device number.
	PRI	Primary volume (S-VOL): SSID, serial number, channel connection address. You can set an additional parameter corresponding to each request instead of a serial number. (1) Direct Split request This request is valid for MODE(COPY) only. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'S' = Direct Split Byte 9: MRCF Subcode-2 'F' = Fast Mode Byte 10-11: Not used (xF0*2) (2) Quick Resync request This request is valid for MODE(RESYNC) only. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'R' = Resync Byte 9: MRCF Subcode-2 'F' = Fast Mode Byte 10-11: Not used (xF0*2) (3) Quick Restore request This request is valid for MODE(RESYNC) only. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'R' = Resync Byte 9: MRCF Subcode-2 'Q' = Quick Mode Byte 10-11: Not used (xF0*2) If you set a parameter other than the above parameters, the command will be rejected.
	SEC	Secondary volume (T-VOL): SSID, serial number, channel connection address.
	MODE	COPY = Initial full-volume copy. NOCOPY = Same as COPY. RESYNC = Re-established a split or suspended volume pair.
	PACE	1 (slow) - 255 (fast).
	CRIT	Not applicable.
	MSGREQ	YES = Applicable. NO = Not applicable.

Table 5.3 ICKDSF Command Parameters (continued)

Command	Parameter	Description
SUSPEND	DDNAME | SYSNAME | UNITADDRESS	DDNAME = dname = JCL statement identifying the volume. SYSNAME = sysxxx = SYSNAME in the ASSGN system control statement. UNITADDRESS = ccuu = device number.
	PRI	Primary volume (S-VOL): SSID, serial number, channel connection address. You can set an additional parameter corresponding to each request instead of a serial number. This request is valid for steady split. The parameter locations and descriptions are as follows: Byte 0-6: fixed value (xF0*7) Byte 7: Indication of MRCF 'M' = MRCF Byte 8: MRCF Subcode-1 'P' = SPLIT Byte 9: MRCF Subcode-2 'S' = Steady Split Byte 10-11: Not used (xF0*2) If you set a parameter other than the above parameters, the command will be rejected.
	SEC	Secondary volume (T-VOL): SSID, serial number, channel connection address.
	PRIMA	Not applicable.
	QUIESCE	See section 5.5.1 for information on the QUIESCE parameter.
DELPAIR	DDNAME | SYSNAME | UNITADDRESS	DDNAME = dname = JCL statement identifying the volume. SYSNAME = sysxxx = SYSNAME in the ASSGN system control statement. UNITADDRESS = ccuu = device number.
	PRI	Primary volume (S-VOL): SSID, serial number, channel connection address.
	SEC	Secondary volume (T-VOL): SSID, serial number, channel connection address.
QUERY	DDNAME | SYSNAME | UNITADDRESS	DDNAME = dname = JCL statement identifying the volume. SYSNAME = sysxxx = SYSNAME in the ASSGN system control statement. UNITADDRESS = ccuu = device number.
	PATHS	Not applicable.
	PRIMAINT	Directs PPRC to reject all write I/Os to the S-VOL except ICKDSF media maintenance channel programs. Causes the 9900 to unit check all application write I/Os to the S-VOL. Use only as part of a media maintenance procedure.
RECOVER	PPRCOPY RECOVER is not used for HMRCF.	

5.1.1 PPRC Restrictions

Table 5.4 lists and describes the restrictions for using TSO/ICKDSF commands with ShadowImage volumes. Table 5.5 lists the conditions for accepting TSO/ICKDSF commands.

Table 5.4 Restrictions for PPRC Commands

Command/Parameter	Restriction	Error Report
ESTPAIR Command SUSPEND Command	Do not issue ESTPAIR or SUSPEND command to a PENDING device.	PPRC PENDING STATUS CC = 12
RECOVER Command	Recovery commands are not valid, because HMRCF pairs are constructed within the same 9900 subsystem. ***Note:*** If a recovery command is used by mistake, the result is the same as a delete pair command, except when VOLID is specified.	PPRC PENDING STATUS CC = 4
PRIMARY Parameter	HMRCF does not support use of the primary parameter within the SUSPEND command.	HMRCF ignores this parameter.
Set Path	Not needed for HMRCF.	HMRCF ignores this parameter.

Table 5.5 Accepting PPRC Commands

TSO PPRC Command	ICKDSF PPRCOPY Command	Issued to S-VOL	Issued to T-VOL
CESTPAIR	ESTPAIR	OK	Not accepted
CESTPAIR with MODE(RESYNC)	ESTPAIR with MODE(RESYNC)	OK	Not accepted
CSUSPEND	SUSPEND	OK	OK
CDELPAIR	DELPAIR	OK	Not accepted
CQUERY	QUERY	OK	OK

5.1.2 PPRC Commands with ShadowImage and HRC

Both ShadowImage and HRC support PPRC commands. The user must ensure that commands are being executed by the correct program against the correct volumes. A PPRC command issued to the 9900 subsystem will be executed by ShadowImage against ShadowImage pairs if all of the following conditions are met. If any of these conditions is not met, the PPRC command will be executed by HRC against HRC pairs.

1. The ShadowImage (HMRCF) feature and software must be installed and enabled on the 9900 subsystem.
2. The serial numbers of the S-VOL and the T-VOL must be the same.
   a) If you enter different serial numbers for an existing ShadowImage S-VOL and T-VOL, the command will fail.
   b) If you enter different serial numbers and the specified ShadowImage pair does not exist, the command will be executed by HRC.
3. If the 9900 subsystem contains HRC pairs, at least one ShadowImage pair must exist before the command is issued.
   a) If the 9900 subsystem contains both ShadowImage and HRC pairs, PPRC and PPRCOPY commands which specify the same serial number for the primary (source) and secondary (target) volumes will be executed by ShadowImage.
   b) If the 9900 subsystem does not contain any ShadowImage or HRC pairs, PPRC and PPRCOPY commands which specify the same serial number for the primary (source) and secondary (target) volumes will be executed by ShadowImage.
   c) If the 9900 subsystem contains HRC pairs but no ShadowImage pairs, PPRC and PPRCOPY commands which specify the same serial number for the primary (source) and secondary (target) volumes will be executed by HRC.
   d) To start ShadowImage operations on a 9900 subsystem which already contains HRC pairs, you must use the HMRCF remote console software to add at least one ShadowImage pair. After a ShadowImage pair exists, the condition in 3(a) is met.

5.2 PSF and DEVSERV Commands

The perform subsystem function (PSF) commands key the 9900 subsystem to accept commands and requests from the user. Table 5.6 describes the operability of PSF commands on ShadowImage volumes. Table 5.7 describes the PSF Read Subsystem Data and DEVSERV Sense Subsystem Status results for ShadowImage volumes.

Table 5.6 PSF Command Operability for ShadowImage Volumes

Item	Operability for ShadowImage
Device pair status.	See Table 5.7.
Percent completion of the copy operation.	Not available for ShadowImage, because the ShadowImage differential bitmap format is different than the HRC differential bitmap format.
S-VOL with 2 or more T-VOLs.	Displays information for the pair having the T-VOL with the lowest LDEV ID.
Path status.	Active.
Path number.	If the volume does not also belong to an HRC pair, 1 is displayed with HRC info.

Table 5.7 PSF and DEVSERV Results for ShadowImage Volumes

	PSF Read Subsystem Data		DEVSERV Sense Subsystem Status	
Pair Status	S-VOL	T-VOL	S-VOL	T-VOL
Pending	PPRI-PNDG	PSEC-PNDG	PPRI-PNDG	PSEC-PNDG
Duplex	PPRIMARY	PSECONDRY	PPRIMARY	PSECONDRY
SP-Pend	PPRI-PNDG	PSEC-PNDG	PPRI-PNDG	PSEC-PNDG
V-Split	PPRI-SUSP	PSEC-SUSP	PPRI-SUSP	SIMPLEX
Split	PPRI-SUSP	PSEC-SUSP	PPRI-SUSP	SIMPLEX
Suspend	PPRI-SUSP	PSEC-SUSP	PPRI-SUSP	PSEC-SUSP
Resync	PPRI-PNDG	PSEC-PNDG	PPRI-PNDG	PSEC-PNDG

Note: PPRIMARY and PSECONDRY indicate that the volume is in the DUPLEX state.

5.3 Adding Pairs: CESTPAIR and PPRCOPY ESTPAIR

The CESTPAIR and PPRCOPY ESTPAIR commands are equivalent to the HMRCF add pair operation (changes pair status to *pending*). Figure 5.1 shows an example of the CESTPAIR command. Figure 5.2 shows an example of the PPRCOPY ESTPAIR command. The CESTPAIR and PPRCOPY ESTPAIR commands must be issued to the S-VOL of the pair being created, and the T-VOL must be offline to the host before these commands are issued.

```
CESTPAIR   DEVN (X 'DE80' )  PRIM (X '0080' ,30158,X '00' ) SEC (X '0080' ,30158,X '01' )
            MODE (COPY)  PACE (15)
```

Figure 5.1 Example of CESTPAIR Command

```
//EPAIR     JOB
//            EXEC  PGM=ICKDSF
//SYSPRINT  DD  SYSOUT=*
//DD1         DD  UNIT=SYSDA,DISP=SHR,VOL=SER=DKDE80
//SYSIN       DD   *
PPRCOPY   ESTPAIR DDNAME(DD1) PRI(X'0080',30158,X'00') SEC(X'0080',30158,X'01')
           MODE(COPY) PACE(15)
/*
//
```

Figure 5.2 Example of PPRCOPY ESTPAIR Command

5.4 Displaying Pair Status: CQUERY, PPRCOPY QUERY, DEVSERV

The CQUERY TSO and PPRCOPY QUERY ICKDSF commands are equivalent to the HMRCF pair status display and status & history functions. Figure 5.3 shows an example of the CQUERY command. Figure 5.4 shows an example of the PPRCOPY QUERY command.

The DEVSERV command can also be used to display ShadowImage pair status. Figure 5.5 shows an example of the DEVSERV command. Refer to Table 5.7 for a description of the DEVSERV command results for ShadowImage volumes.

ShadowImage supports multiple T-VOLs for an S-VOL, and ShadowImage and HRC can both be defined for the same volume. When multiple pairs exist on one volume, the CQUERY and PPRCOPY QUERY commands can only report the status of one pair. Table 5.8 lists the status displayed by the host for the ShadowImage and/or HRC volume pair configurations.

- If the 9900 contains only ShadowImage pairs, the CQUERY and PPRCOPY QUERY commands will report the ShadowImage pair status.
- If the 9900 contains only HRC pairs, the CQUERY and PPRCOPY QUERY commands will report the HRC pair status.
- If the 9900 contains both ShadowImage and HRC pairs, the CQUERY and PPRCOPY QUERY commands will report the HRC pair status. ***Note:*** To obtain the HRMCF pair status, issue the status command to the ShadowImage T-VOL or use the HMRCF remote console software to view the ShadowImage status.
- If an S-VOL has multiple T-VOLs, the status command will report pair status for the pair whose T-VOL has the lowest LDEV ID. To obtain the status of an ShadowImage pair with one of the other T-VOLs, issue the status command to the desired T-VOL.

```
CQUERY   DEVN (X 'DE80' )
97244  13:04:38.57  TSU00684    ANTP0030I CQUERY VOLUME FORMATTED 695
       695 ************************************************************************
       695 *                                                    (PRIMARY)   (SECONDARY)   *
       695 *                                                     SSID CCA     SSID CCA    *
       695 *DEVICE   LEVEL      STATE       PATH STATUS  SERIAL#      SERIAL#          *
       695 *------  ---------  ---------- ------------ --------     --------          *
       695 * DE80   PRIMARY..  DUPLEX....  ACTIVE..      0080 00      0080  01         *
       695 *         CRIT(NO)                             000000030158 000000030158   *
       695 * PATHS SAID/DEST STATUS: DESCRIPTION                                      *
       695 * ----- --------- ------  ------------------                                *
       695 *   1    FFFF FFFF    01    PATH ESTABLISHED...                             *
       695 *         ---- ----   00     NO PATH                                       *
       695 *         ---- ----   00     NO PATH                                       *
       695 *         ---- ----   00     NO PATH                                       *
       695 ************************************************************************
97244  13:04:39.57  TSU00684    ANTP0001I CQUERY COMMAND COMPLETED. COMPLETION CODE: 00
```

Figure 5.3 Example of CQUERY Command

```
//EQUERY    JOB
//           EXEC  PGM=ICKDSF
//SYSPRINT  DD  SYSOUT=*
//DD1        DD  UNIT=SYSDA,DISP=SHR,VOL=SER=DKDE80
//SYSIN      DD   *
PPRCOPY   QUERY DDNAME(DD1)
/*
//

               QUERY REMOTE COPY - VOLUME
                                                  (PRIMARY)   (SECONDARY)
                                                   SSID CCA     SSID CCA
DEVICE   LEVEL      STATE       PATH STATUS  SERIAL#      SERIAL#
------  ---------  ---------- ------------ --------     --------
 DE80   PRIMARY     DUPLEX       ACTIVE       0080 00      0080  01
                                          30158         30158
 PATHS SAID/DEST STATUS: DESCRIPTION
 ----- --------- ------  ------------------
   1    FFFF FFFF    01    PATH ESTABLISHED...
         ---- ----   00     NO PATH
         ---- ----   00     NO PATH
         ---- ----   00     NO PATH
```

Note: Status display is the same as the CQUERY TSO command.

Figure 5.4 Example of PPRCOPY QUERY Command

```
97244  13:04:37.39      DS P,DE80,1
97244  13:04:38.57      IEE459I  13.04.37 DEVSERV PATHS 692
                      692  UNIT DTYPE  M  CNT VOLSER CHPID=PATH STATUS
                      692        RTYPE   SSID CFW TC DFW  PIN  DC-STATE CCA DCA
                      692  DE80,33903 ,0,000,DKDE80,54=+ 1C=+ D4=+ 9C=+
                      692                 0080  Y  YY. YY.   N  PPRIMARY  00   00
```

Figure 5.5 Example of DEVSERV Command

Table 5.8 Pair Status Reported by the Host for Volumes in Multiple Pairs

Number of HMRCF Pairs	Number of HRC Pairs	Status Displayed by Host
0	0	SIMPLEX
1	0	HMRCF pair status
2 or more	0	HMRCF pair whose T-VOL has the lowest LDEV ID
0	1	HRC pair status
1	1	HRC pair status
2 or more	1	HRC pair status

5.5 Splitting Pairs: CSUSPEND and PPRCOPY SUSPEND

The CSUSPEND and PPRCOPY SUSPEND commands are equivalent to the ShadowImage split pair operation (changes pair status to *SP-pend*). Figure 5.6 shows an example of the CSUSPEND command. Figure 5.7 shows an example of the PPRCOPY SUSPEND command. The CSUSPEND and PPRCOPY SUSPEND commands must be issued to the S-VOL, and the pair status must be *duplex*. See section 5.5.1 below for information on the optional QUIESCE parameter for the CSUSPEND TSO command.

```
CSUSPEND  DEVN (X 'DE80' )  PRIM (X '0080' ,30158,X '00' ) SEC (X '0080' ,30158,X '01' )
```

Figure 5.6 Example of CSUSPEND Command

```
//EPAIR     JOB
//           EXEC  PGM=ICKDSF
//SYSPRINT  DD  SYSOUT=*
//DD1        DD  UNIT=SYSDA,DISP=SHR,VOL=SER=DKDE80
//SYSIN      DD   *
PPRCOPY   SUSPEND DDNAME(DD1) PRI(X'0080',30158,X'00') SEC(X'0080',30158,X'01')
/*
//
```

Figure 5.7 Example of PPRCOPY SUSPEND Command

5.5.1 CSUSPEND QUIESCE Parameter

Please refer to the following IBM documents for important information on the optional QUIESCE parameter for the CSUSPEND TSO command: *Planning for IBM Remote Copy* (SG24-2595), *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169).

WARNING: The CSUSPEND QUIESCE option has been disabled by APAR OW15247 or APAR OW15248. Refer to either of these APARs and the latest IBM PPRC documentation for detailed information on the QUIESCE option. Please check with your Hitachi Data Systems account team before using the QUIESCE option with the 9900 subsystem. If the QUIESCE option is issued to certain volumes (e.g., active SPOOL, PAGE, or CATALOG datasets, active SYSRES volume), the attached host(s) may enter a deadlock condition and may require a storage control IML to correct the condition.

The QUIESCE parameter is used to modify the functionality of the CSUSPEND TSO command. For example, if the QUIESCE parameter is specified, the pair will be quiesced and subsequent write requests to the S-VOL will be suspended by the host until the QUIESCE condition is released. If the QUIESCE parameter is not specified, subsequent write operations will be rejected and write-reserved write requests will be processed. Table 5.9 lists the requirements for using the QUIESCE parameter with ShadowImage pairs.

Table 5.9 QUIESCE Parameter Requirements for ShadowImage

Pair Status	QUIESCE Accepted?
Simplex	No
Pending	No
Duplex	Yes
SP-Pend	No
V-Split	No
Split	No
Resync	No
Suspend	No

If a ShadowImage S-VOL has more than one T-VOL, the QUIESCE parameter is effective if at least one pair is specified. Write requests at the S-VOL will start when all QUIESCE conditions are released. The following conditions cause the 9900 subsystem to automatically release the QUIESCE condition:

- A CSUSPEND TSO command without the QUIESCE parameter is accepted.
- A CDELPAIR TSO command is accepted.
- A Delete, Suspend, or Split Pair command (from the Remote Console PC) is accepted.
- Subsystem power-on-reset is executed.

Note: If a ShadowImage pair is suspended because of an internal subsystem error condition, the QUIESCE option is applied. In this case, release the QUIESCE condition by deleting the pair.

Note: ShadowImage and HRC are processed independently. The CSUSPEND/QUIESCE command is effective for either the ShadowImage or HRC pair specified in the command.

5.6 Resynchronizing Pairs: MODE(RESYNC) Parameter

The MODE(RESYNC) option of the CESTPAIR and PPRCOPY ESTPAIR commands is equivalent to the ShadowImage normal resync operation (changes pair status to *resync*). Figure 5.8 shows an example of the CESTPAIR command with the MODE(RESYNC) parameter. Figure 5.9 shows an example of the PPRCOPY ESTPAIR command with the MODE(RESYNC) parameter. The CESTPAIR and PPRCOPY ESTPAIR commands must be issued to the S-VOL, and the pair status must be *split* or *suspend* when MODE(RESYNC) is specified.

```
CESTPAIR   DEVN (X 'DE80' )  PRIM (X '0080' ,30158,X '00' ) SEC (X '0080' ,30158,X '01' )
            MODE (RESYNC)  PACE (15)
```

Figure 5.8 Example of CESTPAIR with MODE(RESYNC) Parameter

```
//EPAIR     JOB
//           EXEC  PGM=ICKDSF
//SYSPRINT  DD  SYSOUT=*
//DD1        DD  UNIT=SYSDA,DISP=SHR,VOL=SER=DKDE80
//SYSIN      DD   *
PPRCOPY   ESTPAIR DDNAME(DD1) PRI(X'0080',30158,X'00') SEC(X'0080',30158,X'01')
           MODE(RESYNC) PACE(15)
/*
//
```

Figure 5.9 Example of PPRCOPY ESTPAIR with MODE(RESYNC) Parameter

5.7 Deleting Pairs: CDELPAIR and PPRCOPY DELPAIR

The CDELPAIR and PPRCOPY DELPAIR commands are equivalent to the ShadowImage delete pair operation (changes pair status to *simplex*). Figure 5.10 shows an example of the CDELPAIR command. Figure 5.11 shows an example of the PPRCOPY DELPAIR command. The CDELPAIR and PPRCOPY DELPAIR commands must be issued to the S-VOL.

A DELPAIR command performed when pair status is *split* enables the T-VOL to be accessed by the host. A DELPAIR command performed when pair status is other than *split* allows non-reserved T-VOLs to be accessed by the host. Reserved *simplex* volumes cannot be accessed.

WARNING: For *duplex* ShadowImage pairs, the S-VOL and its associated T-VOL(s) are usually not identical, because ShadowImage update copy operations are asynchronous. Therefore, if a pair is deleted with status other than *split*, the data integrity of the T-VOL cannot be guaranteed.

```
CDELPAIR   DEVN (X 'DE80' )  PRIM (X '0080' ,30158,X '00' ) SEC (X '0080' ,30158,X '01' )
```

Figure 5.10 Example of TSO Delete Command

```
//EPAIR     JOB
//           EXEC  PGM=ICKDSF
//SYSPRINT  DD  SYSOUT=*
//DD1        DD  UNIT=SYSDA,DISP=SHR,VOL=SER=DKDE80
//SYSIN      DD   *
PPRCOPY   DELPAIR DDNAME(DD1) PRI(X'0080',30158,X'00') SEC(X'0080',30158,X'01')
/*
//
```

Figure 5.11 Example of ICKDSF Delete Command

Chapter 6 Troubleshooting

6.1 General Troubleshooting

If you have a problem with the 9900 Remote Console or RMCMAIN software, please refer to the *Hitachi Lightning 9900™ Remote Console PC User's Guide*. If an HMRCF error message is displayed on the Remote Console PC, refer to section 6.2 for a description of the HMRCF error codes. If you need to call the Hitachi Data Systems Support Center, refer to section 6.3 for instructions.

Table 6.1 provides general troubleshooting instructions for ShadowImage operations. For troubleshooting information on ICKDSF and TSO operations, please refer to the IBM user documentation: *Planning for IBM Remote Copy* (SG24-2595),and *Remote Copy Guide and Reference* (SC35-0169).

Table 6.1 General ShadowImage Troubleshooting

Error	Corrective Action
The system hangs, or HMRCF operations do not function properly.	Shut down Hitachi GRAPH-Track before starting RMCMAIN. Make sure all ShadowImage requirements and restrictions are met. Make sure the 9900 subsystem is powered on and fully functional (NVS, cache, DFW). Please refer to the *Hitachi Lightning 9900™ User and Reference Guide* for operational and troubleshooting information for the 9900 subsystem. Check all input values and parameters to make sure you entered the correct information on the Remote Console PC (e.g., S-VOL and T-VOL IDs).
If any channel enable LED indicators (on the 9900 control panel) are off or flashing.	Please call the Hitachi Data Systems Support Center for assistance.
The volume pairs are not displaying correctly.	Make sure the correct CU image is selected.
An R-SIM warning is displayed on the 9900 Remote Console PC.	Locate the SIM using the RMCMAIN R-SIM panel (see the *9900 Remote Console PC User's Guide* for instructions). Refer to the *Hitachi Lightning 9900™ User and Reference Guide* for a listing of 9900 SIMs.
An HMRCF error message is displayed on the Remote Console PC.	Refer to section 6.2 for a description of the HMRCF error codes.
There is a problem with the Remote Console PC or HMRCF remote console software.	Make sure the problem is not the PC or LAN hardware or software. Try restarting the PC and reconnecting to the subsystem.

6.2 HMRCF Error Codes

The HMRCF software displays error messages on the Remote Console PC when error conditions occur during ShadowImage operations. The HMRCF Error List panel (see Figure 6.1) displays the ID (CU number and LDEV ID; also port, TID, and LUN) of the affected volume and the HMRCF error code and message. Table 6.2 lists and describes the HMRCF error codes and provides instructions for resolving each error condition.

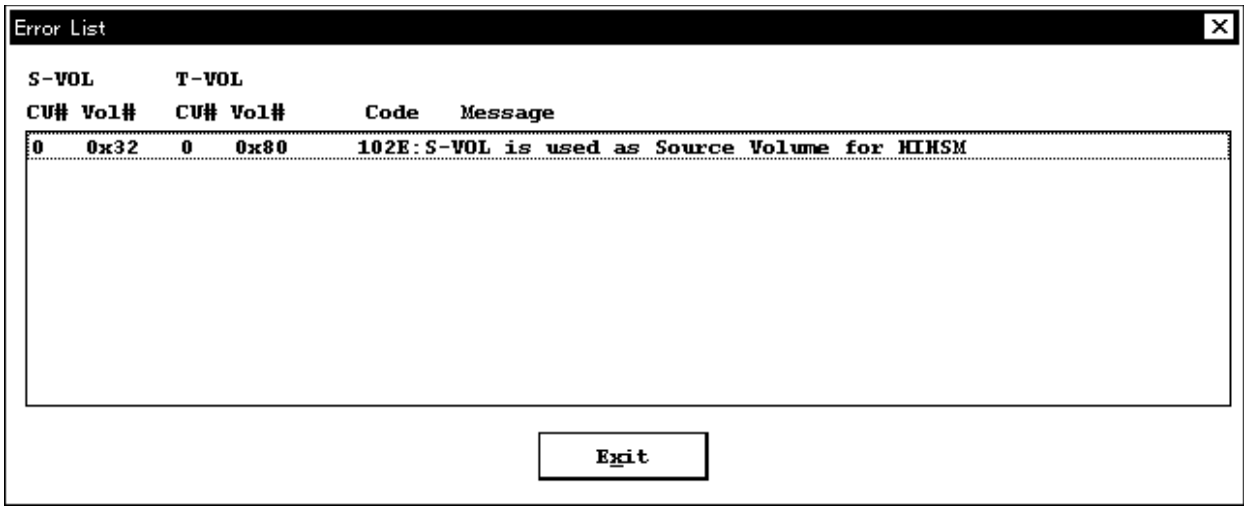

Figure 6.1 Error List Panel

Table 6.2 HMRCF Error Codes

Error Code	Description	Corrective Action
0401	A locking time-out was detected during an internal processing.	A retry may result in a normal termination. Retry about five seconds later.
0402	A command (Pair, Split, or Reserve Volume) could not be completed because it was not in the SMPL status internally.	A retry may result in a normal termination. Retry about five seconds later.
0801	The HMRCF feature could not be used.	Make sure the 9900 subsystem has the correct ACP boards and microcode level for HMRCF, the SVP has HMRCF installed and enabled, and the Remote Console PC has HMRCF installed and enabled.
0810	The specified command cannot be accepted in this status. (The command was rejected.)	Check the pair status, and make sure the pair status is correct for the desired command.
0811	The specified command is treated as an NOP.	The specified command is treated as an NOP. (NOP means that the command can end without errors but executes nothing.)
0812	The new pair could not be created because a path group is set.	Disconnect from the host, or cancel the HRC path.

Table 6.2 HMRCF Error Codes (continued)

Error Code	Description	Corrective Action
0813	The Split command was issued to a pair in the PSUS status.	The Split command cannot be issued because the pair is already in the PSUS status.
0814	The Add Pair command was issued to the pair in the duplex status.	The Add Pair command cannot be issued because the pair is already in the duplex status.
0815	The Split command with Quiesce specification was issued to a T-VOL.	Issue the command without specifying Quiesce, or if issue it with the Quiesce specification, change the volume to an S-VOL.
0816	A command with the PRIMA specification was issued to a T-VOL.	Issue the command without specifying the PRIMA, or if issue it with the PRIMA specification, change the volume to an S-VOL.
0817	A Reserve volume cannot be set because a path group is set.	Disconnect the volume to be reserved from the host, or delete the HRC path.
0818	The resync or suspend pair command cannot be issued because a path group is set.	Disconnect the T-VOL from the host, or delete the HRC path.
081F	Command Reject. S-VOL is used from HOST or by HRC.	Disconnect from the host, or cancel the HRC path.
0830	A pair cannot be created because the track format is different.	Make sure that the emulation type of the S-VOL and T-VOL is the same.
0831	A pair cannot be created because a number of slots is different.	Make sure that the capacity of the S-VOL and T-VOL is the same.
0834	The emulation type of the specified S-VOL is not supported by MRCF.	Make sure that the emulation type of the S-VOL is supported by the MRCF.
0835	The emulation type of the specified T-VOL is not supported by MRCF.	Make sure that the emulation type of the T-VOL is supported by MRCF.
0836	The pair cannot be created.	The emulation type of the S-VOL and T-VOL is not the same.
0840	Logical contradiction.	Call the Support Center for assistance.
0841	Logical contradiction.	Call the Support Center for assistance.
0842	Logical contradiction.	Call the Support Center for assistance.
0848	Logical contradiction.	Call the Support Center for assistance.
0849	Logical contradiction.	Call the Support Center for assistance.
084A	Logical contradiction.	Call the Support Center for assistance.
084B	Logical contradiction.	Call the Support Center for assistance.
0852	Command Reject. S-VOL and T-VOL are used from HOST or by HRC.	Disconnect from the host, or cancel the HRC path.
0880-08FF	Logical contradiction.	Call the Support Center for assistance.
0C70	An S-VOL is not installed.	Volumes which are not installed cannot be processed.
0C71	The S-VOL cannot be used.	Call the Support Center to make the S-VOL status normal.

Table 6.2 HMRCF Error Codes (continued)

Error Code	Description	Corrective Action
0C72	The S-VOL is being formatted.	Wait until the formatting of the S-VOL completes.
0C80	The T-VOL is not installed.	Volumes which are not installed cannot be processed.
0C81	The T-VOL cannot be used.	Call the Support Center to make the S-VOL status normal.
0C82	The T-VOL is being formatted.	Wait until the formatting of the T-VOL completes.
0C90	The volume to be Reserved is not installed.	Volumes which are not installed cannot be processed.
0C91	The volume to be Reserved cannot be used.	Call the Support Center to make the volume status normal.
0C92	The volume to be Reserved is being formatted.	Wait until the formatting of the volume completes.
1001	Logical contradiction.	Call the Support Center for assistance.
1002	Logical contradiction.	Call the Support Center for assistance.
1003	Logical contradiction.	Call the Support Center for assistance.
1004	Logical contradiction.	Call the Support Center for assistance.
1005	Logical contradiction.	Call the Support Center for assistance.
1007	Logical contradiction.	Call the Support Center for assistance.
1009	The number of MRCF pairs exceeded the maximum.	Delete some of the pairs.
1010	Logical contradiction.	Call the Support Center for assistance.
1011	The number of the volume specified to be a Reserve volume has already been used for a Reserve volume.	Change the volume number for specifying a Reserve volume.
1012	The number of the volume specified to be a Reserve volume has already been used for a primary MRCF volume.	Change the volume number for specifying a Reserve volume.
1013	The number of the volume specified to be a Reserve volume has already been used for a hierarchical control primary volume.	Change the volume number for specifying a Reserve volume.
1014	The number of the volume specified to be a Reserve volume has already been used for a hierarchical control destination volume.	Change the volume number for specifying a Reserve volume.
1015	The volume specified to be a Reserve volume is not set as a Reserve volume.	Check the volume status.
1016	The volume can appropriately be allocated as a T-VOL does not exist among Reserve volumes.	Delete any Reserve volume which can be allocated as a T-VOL.
1017	A Reserve volume cannot be set because the max. number of Reserve volumes was exceeded.	Delete any of the Reserve volumes
101E	The Reserve volume itself does not exist in the system.	Set one or more Reserve volumes.
102E	S-VOL is used as source volume for HIHSM.	Confirm a matching condition.
102F	S-VOL is used as destination volume for HIHSM.	Confirm a matching condition.

Table 6.2 HMRCF Error Codes (continued)

Error Code	Description	Corrective Action
1030	The specified S-VOL number does not exist.	Retry after refreshing the screen.
1031	The specified S-VOL has been set as a Reserve volume.	Check the pair status.
1032	No more pair can be created for the specified S-VOL.	Delete any of the pairs formed by the S-VOL.
1033	The specified S-VOL is not really an S-VOL.	Check the pair status.
1037	The specified S-VOL has been set as an MRCF T-VOL.	Check the pair status.
1038	The specified S-VOL has been set as a HODM M-VOL. (Displayed only if HODM is installed.)	Delete the HODM pair.
103A	The Pairresync command was issued to a device in the SMPL status.	Check the pair status.
103E	A new pair was created with an S-VOL forming the HRC cooperation pattern.	Place the HMRCF pair in the SMPL status, or place the HRC pair which uses the MRCF T-VOL as an S-VOL in the SMPL status.
103F	A pair status cannot be changed to form the HRC cooperation pattern.	Place the HRC pair which uses the MRCF T-VOL as an S-VOL in the PSUE or SMPL status.
1040	The specified T-VOL does not exist.	Set one or more Reserve volumes.
1042	T-VOL is used as destination volume for HIHSM.	Confirms a matching condition.
1043	The specified T-VOL number has already been used as that of a T-VOL.	Check the pair status.
1044	The specified T-VOL is not an MRCF T-VOL.	Check the pair status.
1046	The specified secondary volume is being used as an HRC M-VOL.	Delete the HRC pair.
1047	The specified secondary volume is being used as an HRC R-VOL.	Delete the HRC pair.
1048	The specified secondary volume is being used as a HODM M-VOL.	Delete the HODM pair.
104A	The specified secondary volume is being used as an MRCF S-VOL.	Check the pair status.
104B	T-VOL is used as source volume for HIHSM.	Confirm a matching condition.
104C	The volume specified as a Reserve volume is being used as a HODM M-VOL. (Displayed only if HODM is installed.)	Delete the HODM pair.
104D	The volume specified as a Reserve volume is being used as a HODM R-VOL. (Displayed only if HODM is installed.)	Delete the HODM pair.
104E	The volume specified as a Reserve volume is being used as an HRC M-VOL.	Delete the HRC pair.
104F	The volume specified as a Reserve volume is being used as an HRC R-VOL.	Delete the HRC pair.

Table 6.2 HMRCF Error Codes (continued)

Error Code	Description	Corrective Action
1050	The specified S-VOL and T-VOL are not an HMRCF pair.	Check the pair status.
1051	The volume numbers of the specified S-VOL and T-VOL are the same.	Retry after refreshing the screen.
1070	The status mode specification (status modec) in the Status Check command is incorrect.	Call the Support Center for assistance.
1071	The status classification (statusindc) in the Status Check command is incorrect.	Call the Support Center for assistance.
1072	The CU number specified by the Status Check command (volume status) does not exist.	Call the Support Center for assistance.
1084	Volume was used for reserve volume of HIHSM.	Check the volume, or cancel the reserve volume of HIHSM.
1085	S-VOL was used for reserve volume of HIHSM.	Check the S-VOL, or cancel the reserve volume of HIHSM.
1086	T-VOL was used for reserve volume of HIHSM.	Check the T-VOL, or cancel the reserve volume of HIHSM.
1087	S-VOL is used as source volume for HIHSM.	Confirm a matching condition.
1095	Request could not be accepted because status of pair who shared with S-VOL was Reverse-copy.	Confirm a matching condition.
1098	Reverse-Copy could not be accepted because pair status was not Split.	Confirm a matching condition.
109A	Reverse-copy could not be accepted because S-VOL was shared with HRC M-VOL whose status was not Suspend.	Confirm a matching condition.
109B	Reverse-copy could not be accepted because S-VOL was shared with HRC R-VOL whose status was not Suspend.	Confirm a matching condition.
109C	Reverse-copy could not be accepted because T-VOL was shared with HRC M-VOL.	Confirm a matching condition.

6.3 Calling the Hitachi Data Systems Support Center

If you need to call the Hitachi Data Systems Support Center, make sure to provide as much information about the problem as possible, including the circumstances surrounding the error or failure and the exact content of any error messages and/or codes displayed on the Remote Console PC and/or logged at the host.

The worldwide Hitachi Data Systems Support Centers are:

- Hitachi Data Systems North America/Latin America
  San Diego, California, USA
  1-800-348-4357
- Hitachi Data Systems Europe
  Contact Hitachi Data Systems Local Support
- Hitachi Data Systems Asia Pacific
  North Ryde, Australia
  011-61-2-9325-3300

Appendix A Acronyms and Abbreviations

ACP	array control processor
CU	control unit (logical control unit)
CVS	Custom Volume Size (also called Virtual LVI)
DASD	direct-access storage device
DCR	Dynamic Cache Residency (also called FlashAccess)
DFW	DASD fast write
DKA	disk adapter
ESCON	Enterprise System Connection (IBM trademark for optical channels)
GT	Hitachi GRAPH-Track™
HMBR	Hitachi Multiplatform Backup/Restore
HMRCF	Hitachi Multiple RAID Coupling Feature (also called ShadowImage)
HODM	Hitachi Online Data Migration
HOMRCF	Hitachi Open Multiple RAID Coupling Feature (also called Open ShadowImage)
HORC	Hitachi Open Remote Copy
HRC	Hitachi Remote Copy
LAN	local-area network
LDEV	logical device
LVI	logical volume image
MRCF	Multiple RAID Coupling Feature
NVS	nonvolatile storage
PC	personal computer
PDEV	physical device
RAID	redundant array of independent disks
RMCMAIN	Remote Console Main
R-SIM	remote service information message
SIM	service information message
SM	shared memory
S-VOL	source volume
SVP	service processor
T-VOL	target volume

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