HITACHI
DATA SYSTEMS

Hitachi Freedom Storage™ Lightning 9900™

Hitachi Remote Copy (HRC) User and Reference Guide

(Synchronous and Asynchronous for S/390 ® Data)

Document Revision Level

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

- *DKC310 Disk Subsystem, Hitachi Remote Copy Reference Manual*, revision 11.
- MK-90RD009-S1, MK-90RD009-S1.1 (STR RAID400 documents).
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Changes in this Revision

- Added warnings and instructions for setting the Time Out (Copy Pending) group option to avoid HARC pair suspension due to timeout errors (see sections 2.4.1, 4.4.2, and 4.4.3).
- Added **sidefile overflow** suspension condition (Table 2.4).
- Added note on last two digits of the CESTPATH link parameter (Table B.1, new note under Table B.2).
- Added note on priority of HRC initial copy and update copy operations (section 2.2.2).
- Corrected description of Pair Status panel (does not display *suspending* or *deleting* status) (section 5.3).
- Added **Use Time-Saving Mode** function for adding, suspending, resuming, and deleting pairs (sections 5.2, 5.4, 5.5, 5.6, and E.3).
- Added note on 1-to-n HARC configurations (sections 2.1.4, 3.4).

Preface

The *Hitachi Lightning 9900™ HRC User's Guide* describes and provides instructions for performing HRC Synchronous and HRC Asynchronous operations for S/390® (mainframe) data stored on the Hitachi Lightning 9900™ subsystem. HRC Asynchronous (HRCA) is also called Hitachi Asynchronous Remote Copy (HARC). Throughout this document, the term "HRC" refers to both HRC Synchronous and HRC Asynchronous unless otherwise noted.

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™ disk array subsystem,
- the user has read and understands both the *Hitachi Lightning 9900™ User and Reference Guide* (MK-90RD008) and the *Hitachi Lightning 9900™ Remote Console User's Guide* (MK-90RD003), 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 Lightning 9900™ RAID subsystems, or contact your Hitachi Data Systems account team.

Note: This document does not cover Hitachi Open Remote Copy (HORC) for UNIX®-based and PC-server data. The HORC software allows you to perform HORC operations from the 9900 Remote Console PC. The Hitachi Command Control Interface (CCI) software allows you to perform HORC operations from the UNIX®/PC server host. For information and instructions on using the HORC remote console software, please refer to the *Hitachi Open Remote Copy (HORC) User's Guide* (MK-90RD010). For information and instructions on using CCI, please refer to the *Hitachi Command Control Interface (CCI) User's Guide* (MK-90RD011).

Note: The use of the HRC remote console 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 Remote Copy

The Hitachi Remote Copy (HRC) feature of the Hitachi Lightning 9900™ RAID storage subsystem enables you to create and maintain remote copies of the S/390® data stored on the 9900 subsystem for data duplication, backup, and disaster recovery purposes. HRC provides both synchronous and asynchronous copy modes to accommodate a wide variety of user requirements and data copy/movement scenarios. Hitachi Asynchronous Remote Copy (HARC) is unique to the Hitachi RAID disk subsystems and provides a superior hardware-based solution for data duplication, data migration, remote copy, and disaster recovery tasks.

Note: "HRC" will refer to HRC Synchronous and Asynchronous unless otherwise noted. Hitachi Asynchronous Remote Copy (HARC) is also called HRC Asynchronous (HRCA).

HRC operations are nondisruptive, allowing the main (primary) volume of each HRC pair to remain online to all hosts for both read and write I/O operations. Once established, HRC operations continue unattended to provide continuous data backup. HRC operations can be performed over distances of up to 43 km (27 miles) using standard ESCON® support, and long-distance solutions are provided, based on user requirements and workload characteristics, using approved channel extenders and communication lines. HRC is a key component of the Hitachi Data Systems CARE Copy suite software solution and several storage management solution offerings (see sections 1.2 and 1.3).

HRC can be performed in conjunction with Hitachi ShadowImage (see section 1.4) to provide multiple internal copies of HRC volumes. HRC also supports the Virtual LVI and FlashAccess features of the 9900 subsystem, ensuring that all S/390 user data can be protected by remote copy operations. See section 3.7 for further information on combining HRC with other data management features.

Once hardware connectivity between 9900 subsystems is established, HRC operations can be performed from the Remote Console PC and/or S/390 system software for maximum usability:

- The licensed HRC software for the 9900 Remote Console PC displays detailed HRC information and allows you to perform all HRC operations. The 9900 Remote Console PC is attached to and communicates directly with the 9900 subsystems via the 9900-internal LAN. In the event of a system failure or disaster at the main site, the HRC software also simplifies and expedites disaster recovery procedures. For operating systems which do not support Peer-to-Peer Remote Copy (PPRC) or ICKDSF PPRCOPY commands, HRC operations are performed using the 9900 Remote Console PC.
- HRC is functionally compatible with industry-standard IBM Peer-to-Peer Remote Copy (PPRC) host software functions. PPRC TSO commands (or ICKDSF PPRCOPY commands) combined with disaster recovery PTFs may be used to perform HRC and disaster recovery operations on 9900 subsystems. HRC supports the PPRC/Dynamic Address Switching (P/DAS) host software function, enabling you to use HRC to relocate volumes nondisruptively. HRC also supports the PPRC CGROUP TSO command which is used with IBM's Geographically Dispersed Parallel Sysplex® (GDPS) service offering.

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

1.3 Storage Management and Data Movement Solutions with HRC

Hitachi Data Systems offers several storage management and data movement solutions for the 9900 subsystem. HRC is a key component of the following solution offerings:

- Hitachi NanoCopy™, and
- BMC Software Enterprise Recovery Management.

For further information on these and other storage management solutions, please contact your Hitachi Data Systems account team, or visit Hitachi Data Systems online at http://www.hds.com/storage.

Note: HRC and Hitachi NanoCopy™ are available under a Hitachi Data Systems service agreement. The HRC remote console software is available under license from Hitachi Data Systems. BMC Software Enterprise Recovery Management is available from BMC Corporation.

1.3.1 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 Hitachi Asynchronous Remote Copy (HARC), which is used to move large amounts of data over any distance with complete data integrity and minimal impact on performance. HARC can be integrated with third-party channel extender products to address the "access anywhere" goal of data availability. HARC 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.

NanoCopy copies data between any number of primary subsystems and any number of secondary subsystems, located any distance from the primary subsystem, without using valuable server processor cycles. The copies may be of any type or amount of data and may be recorded on subsystems anywhere in the world.

NanoCopy enables customers to quickly generate copies of production data for such uses as application testing, business intelligence, and disaster recovery for business continuance. For disaster recovery operations, NanoCopy will maintain a duplicate of critical data, allowing customers to initiate production at a backup location immediately following an outage. This is the first time an asynchronous hardware-based remote copy solution, with full data integrity, has been offered by any storage vendor.

Hitachi Asynchronous Remote Copy (HARC) with Hitachi NanoCopy support is offered as an extension to Hitachi Data Systems' data movement options and software solutions for the Hitachi Lightning 9900™. Hitachi ShadowImage can also operate in conjunction with HRC Synchronous and Asynchronous to provide volume-level backup and additional image copies of data. This delivers an additional level of data integrity to assure consistency across sites and provides flexibility in maintaining volume copies at each site.

1.3.2 BMC Software Enterprise Recovery Management

The companion goals of "accessing any data" and "at any time" have been addressed by incorporating Hitachi's remote copy functions in a new Point-in-Time (PiT) backup solution developed collaboratively by Hitachi, Ltd. and BMC Software, Inc. The BMC Software Enterprise Recovery Management solution integrates the Hitachi Lightning 9900™'s HRC remote copy or ShadowImage functions with BMC Software's XBM Enterprise Snapshot software. This solution provides PiT backup of database files without the traditional requirement to manually quiesce the application or cause disruptions in service to end users. This product complements Hitachi NanoCopy™ by providing an application-specific database solution. Users can back up their data more frequently, thus reducing the amount of data to be recovered following a catastrophic failure at the production site and the recovery time needed to resume critical production processes.

1.4 Other Data Duplication Features of the 9900

In addition to HRC, the Hitachi Lightning 9900™ subsystem provides several other data duplication features which are described below. 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/storage.

1.4.1 Hitachi ShadowImage

The Hitachi ShadowImage data duplication feature of the Hitachi Lightning 9900™ subsystem enables you to set up and maintain multiple copies of logical volumes within the same 9900 subsystem. ShadowImage operations for S/390® data are performed using the Hitachi Multiple RAID Coupling Feature (HMRCF) remote console software, and can also be managed via TSO and/or ICKDSF commands. Open ShadowImage operations for UNIX®/PC server-based data are performed using the licensed Hitachi Open Multiple RAID Coupling Feature (HOMRCF) software on the 9900 Remote Console PC, or the Hitachi Command Control Interface (CCI) software on the UNIX®/PC server host.

The RAID-protected ShadowImage duplicates are created within the same 9900 subsystem at hardware speeds. ShadowImage can be used in conjunction with HRC/HORC to maintain multiple copies of critical data at your primary and/or secondary (remote) sites. The CARE Copy suite and the Hitachi NanoCopy™ solution include both HRC/HORC and ShadowImage for maximum flexibility in data backup and duplication activities. See section 3.7.1 for further information on combining HRC and ShadowImage operations.

This user's guide does not cover Hitachi ShadowImage operations. For information and instructions on performing ShadowImage operations, please refer to the *Hitachi ShadowImage User's Guide* or the *Hitachi Open ShadowImage User's Guide*, or contact your Hitachi Data Systems account team.

1.4.2 Hitachi Extended Remote Copy (HXRC)

The HXRC feature of the 9900 subsystem is functionally compatible with the industry-standard IBM Extended Remote Copy (XRC) host software function, and is provided as a program product. Please refer to the *Hitachi Lightning 9900™ Remote Console User's Guide* (MK-90RD003) for information on HXRC installation. 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.

Note: See Table 2.1 for important information on 9900 SVP modes for HXRC operations.

This user's guide does not cover HXRC operations. Please refer to the IBM documentation on XRC for further information and instructions: *Planning for IBM Remote Copy* (SG24-2595), and *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169).

Note: HXRC operations, as well as HARC operations, utilize additional cache to store the sidefile queue of asynchronous recordsets. If you are maintaining HXRC pairs as well as HARC pairs, you must make sure that your 9900 subsystems have adequate cache installed and available to support your asynchronous remote copy workloads. Please contact your Hitachi Data Systems account team to determine how much cache will be needed for your subsystem configuration.

1.4.3 Concurrent Copy (CC)

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

Note: CC operations also utilize sidefiles in cache. Subsystems performing CC in addition to HARC and/or HXRC must have sufficient cache installed to handle the increased sidefile usage. Insufficient cache can degrade subsystem I/O performance and cause command retry requests and state-change-pending (SCP) messages. See section 2.3.6 for further information on cache usage and sidefile thresholds.

1.4.4 Hitachi Open Remote Copy (HORC)

As an enterprise advantage, the 9900 subsystem can be concurrently connected to S/390® and a variety of UNIX®-based and PC-server hosts. Please contact your Hitachi Data Systems account team for the latest information on platform and version support. The Hitachi Open Remote Copy (HORC) feature of the 9900 subsystem allows you to maintain remote copies of the UNIX®/PC server data stored on the 9900 subsystem. HRC volumes and HORC volumes can exist concurrently in the same 9900 subsystem.

This user's guide does not cover HORC operations. For information and instructions on using the licensed HORC remote console software, please refer to the *Hitachi Open Remote Copy (HORC) User's Guide* (MK-90RD010).

The Hitachi Command Control Interface (CCI) software allows you to perform HORC operations from the UNIX®/PC server host. For information and instructions on using CCI, please refer to the *Hitachi Command Control Interface (CCI) User's Guide* (MK-90RD011).

Chapter 2 Overview of HRC Operations

HRC provides a storage-based hardware solution for concurrent data duplication, migration, and disaster recovery operations. Once HRC operations are established, remote copies of data are automatically maintained for backup and disaster recovery purposes. HRC supports both SMS- and non-SMS-managed data, is completely application-independent, and is designed to run unattended. During normal HRC operations, the main volumes remain online to all hosts and continue to process both read and write I/O operations.

HRC Synchronous provides:

- Volume-based real-time data backup and is ideal for high-priority data backup, duplication, and migration tasks. In the event of a disaster or system failure at the main site, the remote (secondary) HRC Synchronous data can be rapidly invoked to allow recovery at the volume level with an extremely high level of data integrity.

HARC represents a unique and outstanding disaster recovery solution for large amounts of data which span multiple volumes and even multiple 9900 subsystems. HARC's group-based update sequence consistency solution enables fast and accurate database recovery, even after a "rolling" disaster, without the need for time-consuming data recovery procedures. The HARC volume groups at the remote site can be recovered with full update sequence consistency, but the updates will be behind the main site due to the asynchronous remote copy operations.

HARC provides:

- Update sequence consistency for user-defined groups of volumes (e.g., large databases).
- Protection for write-dependent applications in the event of a disaster.

This overview of HRC operations describes:

- HRC components (see section 2.1),
- HRC operations (see section 2.2),
- HARC recordset operations (see section 2.3),
- HARC consistency group operations (see section 2.4),
- HRC volume pair status and suspend types (see section 2.5),
- PPRC support, including P/DAS and GDPS (CGROUP) operations (see section 2.6), and
- Subsystem performance considerations during HRC (see section 2.7).

2.1 HRC Components

HRC operations involve the 9900 subsystems (and/or 7700E subsystems) at the main and remote sites, the physical communications paths between the main and remote subsystems, and the 9900 Remote Console PC. HRC copies the original online data at the main site to the offline backup volumes at the remote site via the dedicated ESCON remote copy connections. The 9900 Remote Console PC hosts the HRC software, which provides a user-friendly Windows-based graphical user interface (GUI) for all HRC functions and operations. The I/O time-stamping host software function (provided by MVS DFSMSdfp) is required for HARC consistency groups which span multiple subsystems. Error reporting communications (ERC) is required for effective disaster recovery with HRC.

Figure 2.1 shows the HRC components and their functions. The HRC components are:

- Hitachi Lightning 9900™ subsystems
- Main and remote control units (MCUs and RCUs)
- Volume pairs (local M-VOLs and remote R-VOLs)
- HARC consistency groups
- Host I/O time-stamping function
- Remote copy connections
- Remote control ports (RCPs)
- 9900 Remote Console PC with HRC software
- Error reporting communications

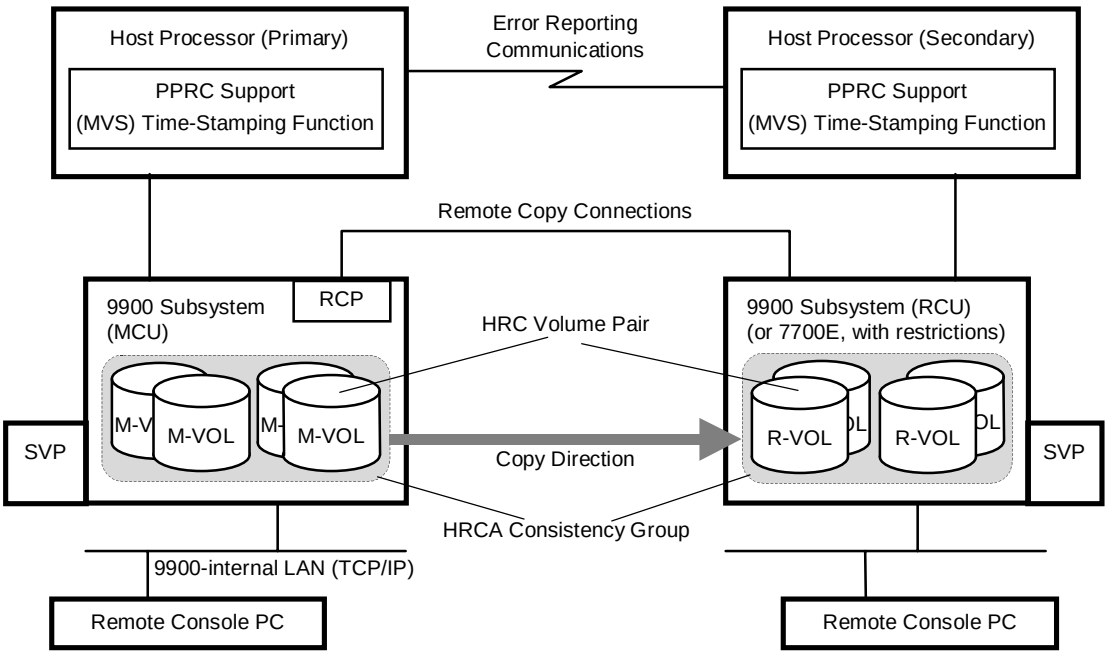


Figure 2.1 HRC Components

2.1.1 Hitachi Lightning 9900™ Subsystems

HRC operations involve the main (primary) disk subsystems and the remote (secondary) disk subsystems (MCUs and RCUs). This document covers HRC operations in which the main subsystem is a 9900 and the remote subsystem is a 9900 (or 7700E) subsystem. The main subsystems contain the HRC main volumes (M-VOLs), which contain the original data and are online to the host(s). The remote subsystems contain the HRC secondary volumes (R-VOLs), which are the synchronous or asynchronous copies of the M-VOLs. HRC supports all CU images and logical volumes of the 9900. All 9900 subsystems with HRC installed are compatible with IBM PPRC (see Appendix B for further information on PPRC). HRC also supports all physical hard drive options and RAID5/RAID1 configurations for the 9900.

To provide greater flexibility and to enable the 9900 to be tailored to unique customer operating requirements, additional operational parameters, or optional modes, are available for the 9900 subsystem. At installation, the 9900 modes are set to their default values, so make sure to discuss these settings with your Hitachi Data Systems team. The 9900 modes can only be changed by your Hitachi Data Systems representative. Table 2.1 shows the 9900 modes related to HRC (and HXRC) operations. ***Note:*** This mode information was current at the time of publication of this document, but it may change. Please contact your Hitachi Data Systems representative for the latest 9900 SVP mode information.

Note: 9900 subsystems performing HARC operations (MCUs and RCUs) utilize sidefiles in cache for storing the HARC recordsets. HXRC and Concurrent Copy (CC) also utilize cache sidefiles. Subsystems performing HARC, HXRC, and/or CC must have sufficient cache installed to handle the increased sidefile usage. Insufficient cache can degrade subsystem I/O performance and cause command retry requests and state-change-pending (SCP) messages. See section 2.3.6 for further information on cache usage and sidefile thresholds.

Table 2.1 9900 Modes for HRC (and HXRC) (continues on the next page)

Mode	Description
20	Enables HRC – R-VOL read-only function (RCU only).
21	Required ON for MCUs and RCUs which connect to CNT channel extenders.
36	HRC Synchronous – Selects function of CRIT=Y(ALL) or CRIT=Y(PATHS). Mode 36 ON: CRIT=Y(ALL) => equivalent to Fence Level = Data. Mode 36 OFF: CRIT=Y(PATHS) => equivalent to Fence Level = Status.
38	HRC – Changes SSB reported against the WRITE I/O to the M-VOL in critical state. Mode 38 ON: Intervention required. Mode 38 OFF: Command rejected (PPRC specification).
45	HXRC – Sleep Wait timer (see modes 97 and 98) used to delay sleep-wait activation. Mode 45 OFF: Sidefile threshold activates I/O processing delay. Mode 45 ON: Sidefile threshold does not activate I/O processing delay.
49	HRC – Changes reporting of SSIDs in response to CQUERY command (which is limited to four SSIDs). Must be ON for HRC, GDPS, and P/DAS operations. Mode 49 OFF: Report SSID specified for each 64 devices. Mode 49 ON: Report first SSID for all (256) devices in the logical CU.
59	HXRC – Variable RECSET size performance improvement for CNT channel extenders. Required ON for HXRC: Performance improvement activated (variable RECSET size). [Mode 59 OFF: Performance improvement de-activated (fixed RECSET size).]
64	HRC CGROUP – Defines scope of CGROUP command within the 9900. Must be OFF for GDPS. Mode 64 OFF: HRC volumes behind the specified LCU pair (main and remote LCUs). Mode 64 ON: All HRC volumes in this 9900 subsystem.

Table 2.1 9900 Modes for HRC (and HXRC) (continued)

Mode	Description
97	HXRC – Variable Sleep Wait timer duration (see modes 45 and 98). Mode 97 OFF: Sleep Wait timer duration = 100 ms @ 40% sidefile. Mode 97 ON: Sleep Wait timer duration = 10 ms @ 40% sidefile.
98	HXRC – Selects SCP or session cancel @ 50% sidefile (see modes 45 and 97). Mode 98 OFF: SCP @ 50% sidefile. Mode 98 ON: Forced session cancel @ 50% sidefile.
104	HRC CGROUP – Selects subsystem default for CGROUP FREEZE option. Must be ON for GDPS. Mode 104 ON: FREEZE enabled. Mode 104 OFF (default): FREEZE disabled.
114	HRC – Allows dynamic RCP/LCP setting through PPRC CESTPATH and CDELPATH command. Mode 114 ON: Set defined port to RCP/LCP mode as needed. Mode 114 OFF (default): Port must be reconfigured using Remote Console PC (or SVP).
118	HXRC, CC – SIM notification of 40% sidefile excess (see modes 45, 97, 98). Mode 118 ON: Generate SIM when sidefile exceeds 40%. Mode 118 OFF (default): No SIM generated when sidefile exceeds 40%.

2.1.2 Control Units (MCUs and RCUs)

The main control unit (MCU) and remote control unit (RCU) control HRC operations:

- The MCU is the control unit (CU) in the main subsystem which controls the M-VOLs of the HRC volume pairs. The Remote Console PC must be LAN-attached to the MCU of each HRC volume pair. The MCU communicates with the RCU via the dedicated ESCON remote copy connections. The MCU controls the host I/O operations to the HRC M-VOLs as well as the HRC initial copy and remote copy operations between the M-VOLs and R-VOLs. The MCU also manages the HRC pair status and configuration information.
- The RCU is the CU in the remote subsystem which controls the R-VOLs of the HRC volume pairs. The RCU assists in managing the HRC pair status and configuration (e.g., rejects write I/Os to HRC R-VOLs). The RCU executes the remote copy operations issued by the MCU. The secondary Remote Console PC should be LAN-attached to the RCUs at the remote site. The RCUs should also be attached to a host system to allow sense information to be reported in case of a problem with a secondary volume or remote subsystem and to provide disaster recovery capabilities.

The MCU and RCU can be defined separately for each HRC pair. The 9900 CU can function simultaneously as an MCU for one or more M-VOLs and as an RCU for one or more R-VOLs, provided the remote copy connections and serial interface ports are properly configured. The 9900 CU provides up to sixteen logical CU images. HRC operations can be performed on all logical devices (LDEVs) in all logical CU images. The HRC software allows you to select the desired CU image in the connected MCU and specify the desired CU image in the RCU.

HRC supports 3990-3, -6, and -6E controller emulation types for the MCU and RCU and allows the emulation type of the MCU and RCU to be different. The 3990-6 or 3390-6E CU emulation is required for SMS I/O time-stamping of HARC recordsets. The 3990-6E controller emulation supports only 3390-x logical volume images (LVIs).

Note: This document provides instructions for performing HRC operations with 9900 subsystems as the MCUs. If you are using 7700E subsystems as MCUs, please use the *Hitachi Remote Copy (HRC) User and Reference Guide* (MK-90RD009). The 7700E subsystem can be used as an RCU connected to a 9900 MCU for HRC Synchronous and/or HARC operations. The 7700 ("classic") subsystem cannot be connected to a 9900 for HRC.

2.1.3 Volume Pairs (M-VOLs and R-VOLs)

HRC performs remote copy operations for logical volume pairs established by the user. Each HRC pair consists of one main volume (M-VOL) and one remote volume (R-VOL) which are located in different subsystems. The HRC M-VOLs are the primary volumes which contain the original data, and the HRC R-VOLs are the secondary or mirrored volumes which contain the backup or duplicate data. During normal HRC operations, the HRC M-VOL remains available to all hosts at all times for read and write I/O operations. The RCU rejects all I/Os to an HRC R-VOL. The R-VOL read option (see section 2.2.4) allows read-only access to an HRC R-VOL while the pair is suspended.

Note: HRC supports all logical volume images (LVIs) available on the 9900 subsystem (e.g., 3390-1, 3390-2, 3390-3, 3390-3R, 3390-9; 3380-K, 3380-E, 3380-J). See section 3.2.4 for further information on HRC LVI requirements and support.

2.1.4 Remote Copy Connections

The remote copy connections are the physical paths used by the HRC MCUs to communicate with the HRC RCUs. The number of physical paths is limited to four per logical CU image in the MCU for a maximum of 64 per 9900 subsystem (depending on the availability of serial interface ports). The MCUs and RCUs are connected via serial interface (ESCON®) cables. For distances greater than 3 km (1.9 miles), ESCON directors (ESCDs) and/or ESCON repeaters are required. HRC Synchronous and Asynchronous operations can be performed at distances of up to 43 km (27 miles) using standard ESCON support, and long-distance solutions are provided, based on user requirements and workload characteristics, using approved channel extenders and communication lines (e.g., T1/T3/ATM).

HRC Synchronous and HARC support 1-to-n and n-to-1 remote copy connections ($n \leq 4$). One MCU can be connected to as many as four RCUs, and one RCU can be connected to as many as four MCUs (one MCU/RCU = one physical CU, including all CU images). HRC supports the dynamic switching capability of the ESCDs which is used to share the physical interface cables between the components. The ESCDs can accommodate channel-to-MCU and channel-to-RCU connections in addition to the remote copy connections.

Note: Hitachi Data Systems strongly recommends that you establish at least two independent remote copy connections (one per cluster) between each MCU and RCU to provide hardware redundancy for this critical communications path.

Note: For HRC Asynchronous 1-to-n configurations (one primary subsystem and multiple secondary subsystems), a consistency group cannot span remote subsystems.

2.1.5 Remote Control Ports (RCPs)

The remote control ports (RCPs) are the dedicated serial interface ports on the main disk subsystem (MCU) to which the RCUs are connected. The RCPs emulate host processor channels to enable the MCUs to send write I/O operations directly to the RCUs. The RCPs support the dynamic switching capability provided by the ESCDs. Any serial interface port of the 9900 subsystem can be configured as an RCP. The Port Change panel (see section 4.2.3) allows you to change the configuration of the 9900 serial interface ports from local control port (LCP) to RCP and from RCP to LCP as needed.

To fully support an automated environment, the 9900 subsystem is capable of automatically configuring a serial port as an RCP or LCP if required in response to the TSO CESTPATH and CDELPATH commands. See SVP mode 114 in Table 2.1.

Note: Two or more RCPs must be configured before you can add the RCUs and establish the HRC volume pairs. The RCPs cannot communicate with the host processor channels and are dedicated to HRC operations. The host channel interface paths must be connected to the other serial interface ports (and/or parallel ports) on the subsystem.

2.1.6 9900 Remote Console PC

The 9900 Remote Console PC hosts the remote console software products for the 9900 subsystem, including CARE suite components such as HRC. The Remote Console PC may be attached to as many as eight 9900 subsystems on the 9900-internal LAN via defined TCP/IP connections. The Remote Console PC communicates with the SVP of each attached 9900 subsystem, thus preventing simultaneous access to the subsystem by the SVP and Remote Console PC. The Remote Console PC at the main site must be connected to the MCU of each HRC volume pair. A second Remote Console PC should also be installed at the remote site and connected to the RCUs. Having another Remote Console PC at the remote site enables you to modify the HARC options of the RCU (pending update data rate, offloading timer) and access the HRC R-VOLs (e.g., to perform ICKDSF). If you need to perform HRC operations in the reverse direction from the remote site to the main site (e.g., disaster recovery), the HRC remote console software simplifies and expedites this process.

If you plan to perform HARC operations, you must use the HRC remote console software to add the consistency groups, select the desired group options, and select the desired HARC options before you can add any HARC pairs. These functions can only be performed using the HRC remote console software. Once the consistency groups and asynchronous options have been configured, the PPRC TSO commands can be used to establish and manage HARC pairs.

Note: For information on HARC configuration services, please contact your Hitachi Data Systems account team.

Note: If you are using Hitachi GRAPH-Track™ to monitor an HRC subsystem, you should disconnect GRAPH-Track from the subsystem before connecting to the subsystem using the 9900 Remote Console (RMCMAIN) software. This prevents timeouts from occurring due to heavy 9900 LAN traffic. See section 3.7.2 for instructions on performing HRC (or other) remote console operations for a subsystem which is monitored by Hitachi GRAPH-Track.

2.1.7 HARC Consistency Groups

A HARC consistency group is a user-defined set of volume pairs across which update sequence consistency is maintained and ensured at the remote site. Each HARC volume pair must be assigned to a consistency group. HARC allows you to configure up to 64 consistency groups (0-3F) for each MCU and provides group-based operations for consistency groups (e.g., suspend and resume group). Consistency groups enable you to maintain update sequence consistency for databases which span multiple volumes, allowing immediate database recovery at the remote site when needed. See section 2.4 for further information on HARC consistency group operations.

2.1.8 Host I/O Time-Stamping Function

If you plan to establish HARC consistency groups, the I/O time-stamping function must be installed on the host processor at the main (primary) site. The I/O time-stamp, which is provided by MVS DFSMSdfp, is the same time-stamp that is used by IBM XRC pairs. The RCU requires the I/O time-stamp information to process HARC recordsets. The I/O time-stamping function should also be installed on the host processor at the remote (secondary) site, so that time-stamps can be used when copying data in the reverse direction.

Note: If the main and/or remote system consists of several CPU complexes, a SYSPLEX timer is required to provide a common time reference for the I/O time-stamping function.

2.1.9 Error Reporting Communications

Error reporting communications (ERC), which transfers information between host processors at the main and remote sites, is a critical component of any disaster recovery effort. You can configure ERC using channel-to-channel communications, NetView technology, or other interconnect technologies, depending on your installation requirements and standards. Neither HRC nor the 9900/7700E remote console software provides ERC between the main and remote sites.

When HRC is used as a data migration tool, ERC is recommended but is not required. When HRC is used as a disaster recovery tool, ERC is required to ensure effective disaster recovery operations. When an HRC pair is suspended due to an error condition, the MCU generates sense information which results in an IEA491E system console message. This information should be transferred to the remote site via the ERC for effective disaster detection and recovery.

2.2 HRC Operations

Figure 2.2 illustrates the two types of HRC operations: initial copy and update copy. To reduce the overhead associated with these remote copy activities and maximize data transfer, the 9900 subsystem utilizes a special write command which is allowed only for HRC initial and update copy operations. This command transfers the control parameters and the FBA-format data for consecutive updated records in a track using a single write operation. The special HRC write command reduces interlocks on the ESCON interface protocol as well as the overhead required for performing FBA-to-CKD and CKD-to-FBA conversions.

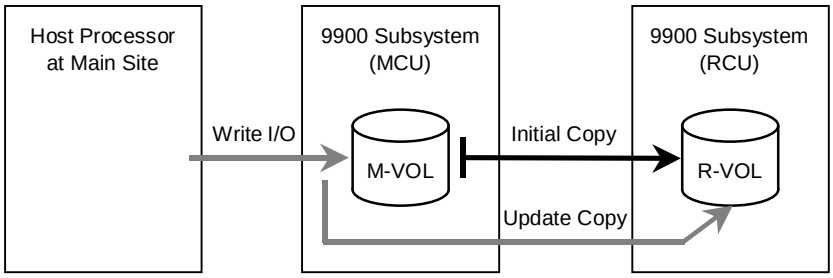


Figure 2.2 HRC Remote Copy Operations

2.2.1 Initial Copy Operations

The HRC initial copy operation synchronizes the M-VOL and R-VOL independently of host I/O processes. The initial copy operation is the same for HRC Synchronous and Asynchronous pairs. An HRC initial copy operation takes place when you add a new pair or resume a suspended pair. When a new pair is established, the entire contents of the M-VOL are copied to the R-VOL cylinder by cylinder, including the VTOC (volume table of contents) but not including the diagnostic and unassigned alternate tracks. For new pairs, you can also select **None** for the initial copy mode, which copies only the VOLSER (volume serial number) to the R-VOL. If **None** is selected, the user is responsible for ensuring that the M-VOL and R-VOL are already identical. The MCU cannot verify the contents of the volumes. When a suspended pair is resumed (also called a resync operation), only the VOLSER and out-of-sync cylinders (updated by write I/Os while the pair was suspended) are copied to the R-VOL.

For additional flexibility, HRC provides the following options for the initial copy operation:

- The **number of tracks** option allows you to specify how many tracks are copied simultaneously by the HRC initial copy operation when adding/resuming an HRC pair. This option can be specified using the HRC remote console software (Add Pair-Option) and the CESTPAIR TSO command (PACE parameter).
- The **initial copy priority** option allows you to specify the order in which the initial copy operations are performed when adding/resuming multiple HRC pairs. This option can only be specified using the HRC remote console software (Add Pair).
- The **maximum initial copy activity** option allows you to specify the maximum number of concurrent initial copy operations that each MCU can perform (not pair-specific). This option can only be specified using the HRC remote console software (RCU Option panel).

2.2.2 Update Copy Operations

An HRC update copy operation occurs when the host issues a write I/O operation to the M-VOL of an HRC pair. The update copy operation duplicates the M-VOL write I/O at the R-VOL to keep the M-VOL and R-VOL synchronized. HRC provides two modes for update copy operations: synchronous and asynchronous. The update copy mode is specified when you add an HRC pair and cannot be changed. HRC also allows you to specify whether the cache-fast-write (CFW) data is included in the update copy operations.

For synchronous update copy mode, the MCU ensures that the M-VOL and R-VOL are synchronized at all times. The MCU does not return device-end status for the M-VOL write I/O until both the M-VOL write and its associated update copy operation at the RCU are complete. For synchronous mode, the MCU starts the update copy operation when it receives:

- the last write command in the current domain, specified by the preceding locate record command, or
- a write command which requires switching to the next track, or
- a write command which was not preceded by a locate record command.

Note: If many consecutive records are updated by a single CCW chain which does not use the locate record command (e.g., long sequential chained write operations), subsystem performance may be significantly impacted.

For asynchronous update copy mode, the MCU stores the M-VOL updates along with additional control information in cache, and sends the updates and control information to the RCU completely independent of the host I/O processes. These updates with their associated control information are called HARC recordsets. The RCU stores the HARC recordsets in cache and performs the updates to the R-VOLs in the same order as they were performed at the MCU(s) according to the HARC time-stamp and sequence information. For further information on HARC recordset operations, see section 2.3.

Priority of initial and update copy: In both HRC Synchronous and HARC, update copy has higher priority than initial copy. However, initial copy is executed based on the copy pace (3 or 15 tracks), therefore, update copy must wait this interval if initial copy is being executed. For example, if the copy pace is 15 tracks, the update copy may wait up to 15 tracks (1 cylinder). In the case of HARC, update copy is executed asynchronously, but the same scheduling conflict can occur between the asynchronous update copy (write recordset) and initial copy.

2.2.3 Read and Write I/O Operations During HRC

When an MCU receives a read command for an HRC M-VOL, the MCU completes the read from the M-VOL. If the read fails, the redundancy provided by RAID technology recovers the failure. The MCU does not read the HRC R-VOL for recovery. The RCU does not allow an HRC R-VOL to be online and rejects all host-requested read and write I/O operations for an HRC R-VOL. The HRC R-VOLs must be offline during normal HRC operations. ***Note:*** HRC provides a special R-VOL read option which allows read-only access to the R-VOL while the pair is suspended (see section 2.2.4 for further information on the R-VOL read option).

When an MCU receives a write command for an HRC Synchronous M-VOL with *pending duplex* status (and the track has already been copied to the R-VOL), the MCU performs a synchronous update copy operation to complete the write at the R-VOL. When an MCU receives a write command for a *pending duplex* HARC M-VOL (and the track has already been copied to the R-VOL), the MCU performs an asynchronous update copy operation. When an MCU receives a write command for an M-VOL with *duplex* status, the user-selected update copy mode of the pair (synchronous or asynchronous) determines the sequence of events:

- **Synchronous Mode**. The MCU performs the write operation on the M-VOL, reports channel-end status to the host, starts the update copy operation for the R-VOL, and then reports device-end status to the host only after the update copy operation is complete. If the M-VOL write or R-VOL update copy operation fails, the MCU reports a unit check, and the host system and application program will regard that write operation to the M-VOL as failed. If a failure occurs at the M-VOL or the R-VOL, the corresponding volume of the HRC pair will decommit the update to maintain exact synchronization of the volumes.

- **Asynchronous Mode**. The MCU completes M-VOL write operations independently of the associated update copy operations at the R-VOL. The RCU manages the R-VOL updates according to the HARC recordset information and maintains time-based data consistency for the R-VOLs. If the M-VOL write operation fails, the MCU reports a unit check and does not create the HARC recordset for this operation. If the update copy operation fails, the RCU suspends either the affected pair or all HARC pairs in the consistency group, depending on the type of failure. When the suspended HARC pair or group is resumed, the MCU and RCU negotiate the resynchronization of the pair(s). See section 2.5.2 for further information on suspended HARC pairs.

2.2.4 R-VOL Read Option

For additional flexibility, HRC offers a special R-VOL read option. The Hitachi Data Systems representative enables the R-VOL read option on the RCU (mode 20). The HRC R-VOL read option allows you to read an HRC R-VOL only while the pair is suspended, that is, without having to delete the pair. The RCU will allow you to change only the VOLSER of the suspended R-VOL, so that the R-VOL can be online to the same host as the M-VOL while the pair is suspended. All other write I/O updates will be rejected by the RCU. The MCU copies the M-VOL VOLSER back onto the R-VOL when the pair is resumed. When the R-VOL read option is not enabled and/or the pair is not suspended, the RCU rejects all read and write I/Os to an HRC R-VOL.

2.3 HARC Recordset Operations

The HARC recordsets contain the HARC M-VOL updates and the associated control information, including the time-stamp of the M-VOL update, which enables the RCU to maintain update consistency of the HARC R-VOLs. HARC recordset operations include:

- Creating and storing recordsets at the MCU,
- Sending recordsets to the RCU,
- Storing recordsets at the RCU,
- Selecting and settling recordsets at the RCU,
- Types of recordsets, and
- Inflow control for sidefiles.

2.3.1 Creating and Storing Recordsets at the MCU

When an MCU performs an update (host-requested write I/O) on a HARC M-VOL, the MCU creates a HARC recordset which contains: the updated record, time-stamp information, sequence number, record location (device, cylinder, track, record number), and record length. The HARC recordsets are queued in the cache storage of the MCU and sent to the RCU independent of host I/O processes. The RCU utilizes the time-stamp and sequence number information in the recordsets to update the R-VOL(s) in the same order as the M-VOL(s).

The time-stamp information is acquired from the (MVS) host's I/O time-stamp function. This time stamp provides a protective measure for write-dependent applications and minimizes recovery time in the event of a disaster. The sequence number indicates the number of recordsets that the MCU has created for each consistency group. The recordset information, except for the updated records, is stored and queued in an area of cache known as sidefile cache (see section 2.3.6 for further information on sidefile cache).

2.3.2 Sending Recordsets to the RCU

The MCU sends the HARC recordsets to the RCU in a similar manner to the HRC Synchronous updates. The MCU's RCP ports act as host processor channels and issue special I/O operations, called remote I/Os (RIOs), to the RCU. The RIO transfers the recordsets in FBA format (not CKD) using a single channel command, eliminating the overhead associated with FBA-CKD conversion and thus providing more efficient transfer of user data. The MCU can send several recordsets using a single RIO, even if their sequence numbers are not contiguous. Therefore, HARC recordsets are usually sent to the RCU in a different order than the arrivals at the MCU. The RCU ensures that records are applied to the R-VOLs in the correct sequence. This method of remote I/O provides the most efficient use of MCU-to-RCU link resources.

Note: The parameter length and detailed specification of this HARC channel command are different than for HRC Synchronous RIOs. You must make sure that your channel extenders are capable of supporting this command. For further details, please contact your Hitachi Data Systems account team.

2.3.3 Storing Recordsets at the RCU

The RCU maintains queues to control the storing of recordsets in the sidefile and commitment of updating records in the R-VOLs. The RCU queuing mechanism uses time-stamping to control the sequence in which R-VOL updates are applied, and uses sequence numbers provided by the MCU to check for any missing updates.

Note: The MCU does not remove the sidefile entry for a recordset from its cache until it receives an I/O completion signal (device end) from the RCU. This is true even if the MCU and RCU are connected via a channel extender product. If a recordset is lost in transmission from the MCU to the RCU, the MCU's cylinder bitmap ensures that the missing recordset is identified and resent to the RCU.

2.3.4 Selecting and Settling Recordsets at the RCU

The RCU selects the recordset to be promoted to formal data (or "settled") as follows:

1. The RCU checks for a valid entry at the top of each queue in the consistency group. If the top of any queue is empty (i.e., recordset not yet received), the RCU waits for that entry.
2. When the top of each queue contains a valid entry (recordset), the RCU selects the entry which has the earliest time-stamp value, and then settles this recordset.
3. The RCU repeats steps (1) and (2) to select and settle HARC recordsets.

Figure 2.3 (next page) illustrates recordset selection and settling at the RCU. In this example, the top of the queue contains a valid entry: S1/T1. The RCU selects recordset S1/T1 to be settled, because T1 is the earliest time-stamp. When S1/T1 is removed from the MCU queue, recordset S2 becomes the top entry, but it is empty. When recordset S2 arrives (and its time-stamp is later than T1 and earlier than T3), the RCU selects S2/T2 as the next recordset to be settled. The recordset selected by the RCU is marked as "host-dirty" and treated as formal data. The time-stamp value of that recordset is promoted to the consistency time (C/T) of the group. The RCU settles the updated records in the recordset as follows:

- If the corresponding track is in cache (track-hit), the updated records in the recordset are copied to the existing cached track, and the cache space for the sidefile is released.
- If the corresponding track is not in cache (track-miss), the RCU changes the cache designation of the sidefile to formal data. The data is not physically moved.

2.3.5 Types of Recordsets

In addition to host update recordsets, the MCU passes control information to the RCU in special non-update recordsets. These special recordsets indicate when volume pair status changes and when an MCU power-off sequence is initiated, and also maintain sequence numbers in periods of low host activities.

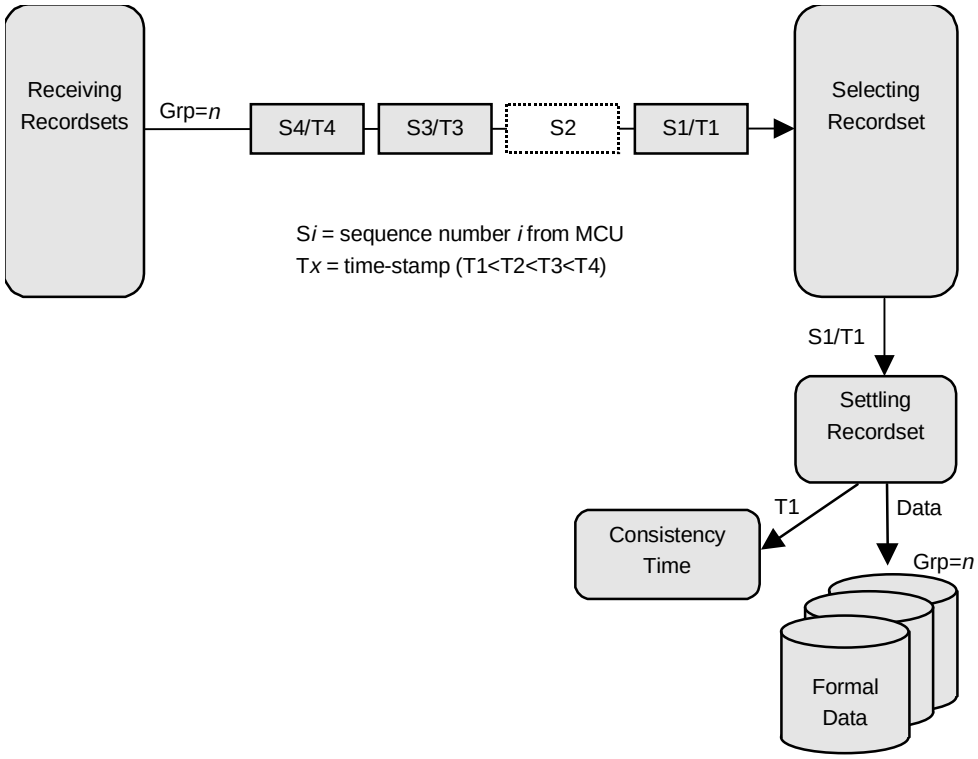


Figure 2.3 Selecting and Settling HARC Recordsets at the RCU

2.3.6 Inflow Control of Recordsets

As described in the previous sections (2.3.1-2.3.5), both the MCU and RCU create sidefiles for storing HARC recordsets. Since the sidefiles occupy exclusive space in cache, both the MCU and RCU perform inflow control to prevent an overload of the subsystem's cache resources. The 9900 subsystems use the following parameters for HARC cache inflow control, and the HRC Async Option panel (see section 4.4.1) allows you to modify these parameters:

- Sidefile (HARC) threshold = maximum cache % available for use by HARC sidefiles.
- Offloading timer = maximum time between HARC recordset transfers.

Inflow Control by MCU. When the amount of MCU sidefile cache reaches the user-specified threshold, the MCU responds to update I/Os from the main system with state-change-pending (SCP) or channel-command-retry requests. If the MCU is not able to send a recordset to the RCU within the user-specified offloading timer value, the MCU suspends all HARC volume pairs and resets the SCP condition to avoid hanging up the system.

Inflow Control by RCU. When the amount of RCU sidefile cache reaches the user-specified threshold, the RCU responds with channel-command-retry requests to the RIO commands which transfer the recordsets from the MCU. The only recordset accepted by the RCU is the recordset with the sequence number required to continue settling the pending recordsets. If the RCU is not able to settle a recordset within the user-specified offloading timer value, the RCU suspends all HARC volume pairs and resets the channel-command-retry condition to avoid hanging up the MCU.

In addition to HARC, HXRC and Concurrent Copy (CC) operations utilize a different cache sidefile. Table 2.2 shows the sidefile threshold values for HARC, HXRC, and CC and describes the actions that occur when each threshold is reached. Subsystems performing HARC in combination with HXRC and/or CC must have sufficient cache installed to handle the increased sidefile activity. If a "sidefile puncture" condition occurs (HXRC+CC sidefiles reach 60% of available cache), the CC session having the most sidefile usage is terminated (or XRC session if there is no CC session). ***Note:*** FlashAccess operations may decrease the total amount of cache available for HARC, HXRC, and CC operations but do not directly affect sidefile cache usage. Available cache is defined as the amount of physical cache memory installed on the subsystem minus any cache reserved for the FlashAccess feature.

Table 2.2 Sidefile Thresholds

Operation	Threshold(s)	Action(s)
HARC	Sidefile threshold = 50%. HARC threshold can be adjusted using the HRC remote console software (30, 40, 50, 60, or 70%).	MCU reaches threshold: command retry to host. RCU reaches threshold: command retry to MCU.
HXRC	[XRC+CC sidefile] / [avail cache] = 40%, 50%, 60%	40% = command retry. 50% = SCP message. 60% = puncture condition.
CC	[XRC+CC sidefile] / [avail cache] = 40%, 50%, 60%	50% = SCP message. 60% = puncture condition.
Write Pending	[write pending] / [avail cache - sidefile] = 70%	Command retry.

2.4 HARC Consistency Group Operations

HARC consistency groups enable update sequence consistency to be maintained across a group of volumes. The R-VOLs of the pairs in a consistency group must be located within one RCU (n-to-1 requirement). The HARC consistency group operations include:

- Group options,
- Group consistency time, and
- Group operations.

2.4.1 Group Options

HARC provides the following options for each consistency group: **timer type**, **copy pending timeout**, and **RCU ready timeout**. These options are selected when you add a group. If you want to change the **timeout** options of a group, you must suspend all pairs in the group first. If you want to change the **timer type** option, you must delete all pairs. The **timer type** and **copy pending timeout** options must be the same for all MCUs which contain M-VOLs in the group. The **RCU ready timeout** option can be different at each MCU if desired.

Timer Type. This group option determines how the MCU will acquire the time-stamp for the HARC recordsets:

- **System**. When the **System** timer option is selected, the MCU acquires the time-stamp information for each recordset as follows. When a HARC pair is established, the MCU reports state-change-interrupt (SCI) to all hosts. The host then issues a series of sense group commands to determine the device status change, and the MCU returns the same response as if the device had been added to an XRC session to activate I/O time-stamping for the device. Once I/O time-stamping is activated, the MVS IOS routine attaches the time-stamp information (contents of time-of-day (TOD) clock) to each write I/O operation for the device. The time-stamp indicates the time that the update was generated during start subchannel (SSCH) at the main host system, and the time-stamp is transferred to the MCU at the beginning of each I/O operation.
- **Local**. The **Local** timer option enables the MCU to generate the time-stamp for each update I/O using its own internal clock, rather than using the SMS I/O time-stamp.
- **None**. The **None** timer option should only be selected when establishing HARC pairs in the reverse direction (from secondary to primary). When the **None** option is selected, the MCU still acquires the time-stamp information from the host I/O time-stamping function.

Copy pending timeout. This group option specifies the maximum delay allowed for HARC copy operations. ***WARNING:*** See section 4.4.2 for instructions on selecting the correct **copy pending timeout** setting for your operational environment.

The RCU will suspend all R-VOLs in the group when:

- The RCU has not had any communication from the MCU within the specified time. This situation could indicate a disaster or failure at the primary site.
- The RCU has been receiving recordsets from the MCU(s) but has not been able to settle a recordset within the specified time. This situation may indicate that the RCU does not have enough resources to handle the remote copy and I/O workloads.

RCU ready timeout. This option specifies the maximum delay for re-establishing MCU-RCU communications following MCU power-off. During MCU power-on, the MCU re-establishes communication with all registered RCUs. If it is not able to re-establish communication with an RCU within the specified time, the MCU suspends all affected HARC volume pairs.

2.4.2 Group Consistency Time

During normal HARC operations, the consistency time (C/T) of a group corresponds to the time-stamp value of the most recently settled recordset at the RCU. The consistency time for the group is indicated as part of the HARC R-VOL pair status (also displayed by the CQUERY TSO command to the R-VOL). As the main system continues to update the HARC M-VOLs, the difference between the current system time and the group consistency time indicates the amount of time that the R-VOLs are behind the M-VOLs. The M-VOL updates which take place during this time may be lost when a disaster occurs.

When a HARC volume pair is suspended, the C/T of the suspended R-VOL is frozen. If the RCU can ensure the update sequence consistency between the suspended R-VOL and the other R-VOLs in the consistency group, the R-VOL C/T is frozen at the latest consistency time of the group. Otherwise, the R-VOL C/T is frozen at the time-stamp value of the most recent update that was successfully copied to the R-VOL. The C/T of a suspended R-VOL may be older than the C/T of other R-VOLs in the group, and if the entire group was not also suspended, the consistency time of the group is still ticking. For suspended HARC R-VOLs, the HRC Pair Status panel displays whether the C/T was frozen to the group or R-VOL time.

Once you have established HARC operations, you should monitor the consistency time of each group at the RCU(s). If the average delay is longer than your disaster recovery design can accept, you should consider adding remote copy resources (e.g., paths, cache) and/or reducing the I/O workload to improve subsystem performance. If the delay between the M-VOL update and the corresponding R-VOL update reaches the time specified by the **Copy Pending Timeout** group option, the MCU will suspend all affected volume pair(s) due to the heavy I/O workload (at MCU or RCU). To prevent timeout errors, you can increase the **Copy Pending Timeout** value, reduce I/O workload, and/or add remote copy resources.

2.4.3 Group Operations

HARC provides the following group-based operations to simplify and expedite disaster/failure recovery procedures:

- Group operations at the MCU:
  - Suspend all pairs in a consistency group. See section 5.4.1 for a description of the HARC **Group** suspend option (supported by CSUSPEND TSO command).
  - Resume all suspended pairs in a consistency group. See section 5.5.1 for a description of the HARC **Resume-Group** pair option (supported by the CESTPAIR TSO command with the parameter MODE=RESYNC).
  - Delete all pairs in a consistency group. See section 5.6.1 for a description of the HARC **Group** delete option (supported by CDELPAIR TSO command).
- Group operations at the RCU:
  - Suspend all pairs in a consistency group. See section 5.4.1 for a description of the HARC **Group** suspend option (supported by CSUSPEND TSO command).
  - Delete all suspended pairs in a consistency group except for any inconsistent pairs. See section 5.6.1 for a description of the HARC **C/T** delete option (not supported by CDELPAIR, CDELPAIR cannot be issued to the RCU).
  - Delete all pairs in a consistency group regardless of their consistency status. See section 5.6.1 for a description of the HARC **Group** delete option (not supported by CDELPAIR, CDELPAIR cannot be issued to the RCU).

HARC HARC also provides the **Error level** pair option (see section 5.2.2) which is used to trigger automatic suspension of an entire consistency group. When a HARC pair is suspended due to failure (not user-requested), this HARC pair option determines whether all pairs in the same consistency group will also be suspended. If you select the **Group** error level for a HARC pair, all pairs in the same group will be suspended. If you select the **Volume** error level, only the affected HARC pair will be suspended.

Note: The **Error level** pair option is very important for managing HARC groups and planning for disaster recovery. The **Group** error level should be selected for all HARC volumes which are essential to disaster recovery. Suspended HARC R-VOLs which have the **Volume** error level should not be used for disaster recovery.

2.5 HRC Volume Pair Status

HRC displays the pair status for each volume in the selected logical CU image (CUI) of the connected 9900 subsystem. The MCU maintains the status of the M-VOL and is responsible for keeping the M-VOL and its R-VOL synchronized. The RCU maintains the status of the R-VOL. The MCU can change the pair status of the M-VOL and R-VOL. The RCU can change the pair status of the R-VOL but not the M-VOL. The MCU will detect when the RCU changes the R-VOL status (if the path status is normal) and will change the M-VOL status accordingly. The HRC pair status can be acquired from the MCU and RCU using the HRC software (Pair Status) and the CQUERY TSO command.

Table 2.3 lists and describes the HRC volume pair status descriptions. A volume which is not assigned to an HRC volume pair has the status *simplex*. When an HRC pair is started, the MCU changes the status of both volumes (M-VOL and R-VOL) to *pending duplex*. When the initial copy operation is complete, the MCU changes the status of both volumes to *duplex*. When a pair is suspended from the MCU, the MCU changes the status of the M-VOL and R-VOL (if the path status is normal) to *suspended*. When a pair is suspended from the RCU, the RCU changes the status of the R-VOL to *suspended*, and the MCU detects the pair suspension (if the path status is normal) and changes the M-VOL status to *suspended*. When you delete a pair from the MCU, the MCU changes the status of the M-VOL and R-VOL (if the path status is normal) to *simplex*. When you delete a pair from the RCU, the RCU changes the R-VOL status to *simplex*, and the MCU detects the pair deletion (if the path status is normal) and changes the M-VOL status to *suspended*.

HARC-Specific Pair Status

The HARC *suspending* and *deleting* transitional states occur when a request to change HARC pair status has been accepted, but the change to the requested status (*suspended* or *simplex*) is not yet complete. These states are not reported to the host. In the case of *suspending*, both the user and the MCU can request the status change. In the case of *deleting*, only the user can request the status change. If the user requested the status change, the final status is reported at the end of the transition. If an error caused the status to change to *suspended*, the suspended status is reported at the beginning of the transition.

The HARC *SEQCHK* status is indicated when a HARC pair assigned to a consistency group with the **System** timer type accepts a non-time-stamped update from the primary system. The *SEQCHK* status does not affect HARC copy activities and will be removed when the next time-stamped update is successfully copied to the R-VOL. However, if a disaster or system failure occurs before the next time-stamped update, the update sequence consistency between the R-VOL and other R-VOLs in the consistency group is not ensured. To ensure effective disaster recovery, you should detect and remove the source of the *SEQCHK* status. The *SEQCHK* status can be caused by any of the following:

- An application may issue update I/Os bypassing the MVS standard I/O procedure.
- The I/O time-stamping function may not be active at the primary system.

Table 2.3 HRC Volume Pair Status

Pair Status	Description
Simplex	This volume is not currently assigned to an HRC volume pair. When this volume is added to an HRC volume pair, its status will change to *pending duplex*.
Pending Duplex	The HRC initial copy operation for this volume pair is in progress. This volume pair is not yet synchronized. When the initial copy is complete, the status changes to *duplex*.
Duplex	This volume pair is synchronized. Updates to the M-VOL are duplicated on the R-VOL.
Suspended (see Table 2.4 for suspend types)	This volume pair is not synchronized: – For HRC Synchronous only, if the MCU cannot keep the pair synchronized for any reason, the MCU changes the status of the M-VOL and R-VOL (if possible) to *suspended*. – For HARC only, if the MCU detects a HARC suspension condition (see section 2.5.2), the MCU changes the M-VOL status and R-VOL status (if possible) to *suspended*. – For HARC only, when the RCU detects a HARC suspension condition (see section 2.5.2), the RCU changes the R-VOL status to *suspended*. – For HRC Synchronous only, the MCU changes the status of all HRC Synchronous pairs to *suspended* when it performs the CGROUP/RUN command (see section B.3). – When you suspend a pair from the MCU, the MCU changes the status of the M-VOL and R-VOL (if possible) to *suspended*. When you suspend a pair from the RCU, the RCU changes the status of the R-VOL to *suspended*. – When the MCU detects that the pair was suspended or deleted from the RCU, the MCU changes the status of the M-VOL to *suspended*.
Pair Status for HARC only:	
Suspending	This pair is not synchronized. This pair is in transition from *duplex* or *pending duplex* to *suspended*. When the suspension is requested (by user, MCU, or RCU), the status of all affected pairs changes to *suspending*. When the suspension is complete, the status changes to *suspended*.
Deleting	This pair is not synchronized. This pair is in transition from *duplex*, *pending duplex*, or *suspended* to *simplex*. When the delete pair operation is requested (by user), the status of all affected pairs changes to *deleting*. When the delete pair operation is complete, the status changes to *simplex*.
SEQCHK	The RCU encountered a non-time-stamped recordset for a HARC pair using the **System** timer type option. This status can be displayed at the MCU and RCU, but the MCU may not have the most current information. Always use the pair status information displayed at the RCU for disaster recovery.

2.5.1 Suspended Pairs

Table 2.4 lists and describes the HRC suspend types, which indicate the reason for suspension. An HRC pair can be suspended by the user at any time after the initial copy operation is complete. The user must suspend an HRC pair in order to perform ICKDSF maintenance on the M-VOL or to access the R-VOL (read only mode). HRC pairs are also suspended when the CGROUP/ RUN command is processed (see section B.3). When an HRC Synchronous pair is suspended by the user, the MCU ensures synchronization by completing any pending update copy operation before changing the status to *suspended*. When a HARC pair is suspended by the user, the MCU and RCU ensure synchronization by either completing or discarding any pending update copy operations according to the user-specified drain/purge suspend option.

An HRC pair is suspended by the MCU when the following suspension conditions are detected. A HARC pair can also be suspended by the RCU (see section 2.5.2 for details).

- When the MCU detects that the user has deleted the volume pair from the RCU (e.g., to access an R-VOL at the remote site),
- When the MCU detects an error condition related to the RCU, R-VOL, an HRC Synchronous update copy operation, or a HARC recordset operation (see section 2.5.2),
- When the RCU cannot execute DFW (DASD fast write) to the R-VOL (only if **DFW required** is selected), or
- When the MCU is unable to communicate with the RCU.

If an HRC Synchronous update copy operation fails, the MCU maintains exact synchronization by reporting a unit check and decommitting the M-VOL update, so that the host system and application program regard that write operation to the M-VOL as failed. For information on failed HARC recordset operations, see section 2.5.2.

When an HRC pair is suspended, the MCU stops performing update copy operations to the R-VOL. For a suspended HRC Synchronous pair, the MCU may or may not continue accepting write I/Os for the M-VOL depending on the M-VOL fence level and suspend option (if user-requested). If the MCU accepts write I/Os for a suspended M-VOL, the MCU keeps track of the M-VOL cylinders which are updated while the pair is suspended. For a suspended HARC pair, the MCU and RCU keep track of any recordsets that were discarded during suspension, and the MCU continues accepting write I/Os for the M-VOL and keeps track of the M-VOL cylinders which are updated while the pair is suspended.

A suspended HARC R-VOL has an additional status called the consistency status which is displayed only at the RCU. The consistency status of a suspended HARC R-VOL indicates its update sequence consistency with respect to the other R-VOLs in the same consistency group. Table 2.5 lists and describes the consistency status descriptions for suspended HARC R-VOLs.

When an HRC pair is suspended, whether user-requested or due to failure, the MCU generates sense information to notify the host(s). If the host system supports IBM PPRC (and the PPRC support RCU option is enabled), this notification results in an IEA494I and/or IEA491E system console message which indicates the reason for suspension. See section B.4 for further information on the IEA494I and IEA491E system console messages.

Table 2.4 Suspend Types

Suspend Type	Applies to	Description
M-VOL by operator	M-VOL (HRC sync only)	The user suspended the pair from the MCU using the **M-VOL Failure** option. The R-VOL suspend type is *by MCU*.
R-VOL by operator	M-VOL, R-VOL	The user suspended the pair from the MCU or RCU using the **R-VOL** option.
by MCU	R-VOL	The RCU received a request from the MCU to suspend the volume pair. The M-VOL suspend type is *M-VOL by Operator* or *R-VOL by Operator*.
by RCU	M-VOL	The MCU detected an error condition at the RCU which caused the MCU to suspend the HRC volume pair. The R-VOL suspend type is *by MCU*.
Delete Pair to RCU	M-VOL	The MCU detected that the R-VOL status changed to *simplex* because the user deleted the pair from the RCU. The pair cannot be resumed because the R-VOL does not have the *suspended* status.
R-VOL Failure	M-VOL	The MCU detected an error during communication with the RCU or an I/O error during update copy. In this case, the R-VOL suspend type is usually *by MCU*.
MCU IMPL	M-VOL, R-VOL	The MCU could not find valid control information in its nonvolatile memory during the IMPL procedure. This condition occurs only if the MCU is completely without power for more than 48 hours (e.g., power failure and fully discharged backup batteries).
Initial Copy failed	M-VOL, R-VOL	The volume pair was suspended before the initial copy operation was complete. The data on the R-VOL is not identical to the data on the M-VOL.
by FREEZE	M-VOL, R-VOL (HRC sync only)	The volume pair was suspended by the CGROUP/RUN TSO command (see section B.3).
MCU P/S-OFF	R-VOL (HARC only)	The RCU received a request from the MCU to suspend the R-VOL due to MCU power-off. The RCU stops expecting recordsets from that MCU.
by sidefile overflow	M-VOL, R-VOL (HRCA only)	The amount of sidefile exceeds the specified "current pending update data rate", and the RCU data is not transferred within the specified "offloading timer".

Table 2.5 Consistency Status for Suspended HARC R-VOLs

Consistency Status	Description
Volume	This HARC volume pair was probably suspended alone. Update sequence consistency between this R-VOL and other R-VOLs in this consistency group is not ensured. This R-VOL cannot be used for disaster recovery at the secondary system. This status is indicated when: – This volume pair was suspended due to a failure that did not affect the entire consistency group, and the **Error Level** pair option for this pair is set to **Volume**. – This volume pair was suspended by a user-initiated suspend pair operation with the HARC **Suspend (Async)** suspend option set to **Volume**.
Group	This HARC volume pair was suspended along with the other pair in its consistency group. Update sequence consistency between this R-VOL and other R-VOLs in this consistency group is ensured. This R-VOL can be used for disaster recovery at the secondary system (after deleting the HRC volume pair from the RCU). This status is indicated when: – All volume pairs in this consistency group were suspended due to a failure that affected the entire consistency group (not just one pair) (e.g., MCU-RCU communication failure). – The volume pair was suspended due to a failure that did not affect the entire group, and the **Error Level** HARC pair option for this pair is set to **Group**. – This volume pair was suspended by a user-initiated suspend pair operation with the HARC **Suspend (Async)** suspend option set to **Group**.

2.5.2 Suspended HARC Pairs

HARC operations involve additional suspension conditions related to the asynchronous recordset operations. Both the MCU and RCU can detect HARC suspension conditions and suspend HARC pairs. Table 2.6 describes the HARC suspension conditions and indicates which CU detects the condition and which volume pairs are suspended. The HARC offloading timer asynchronous option (see section 4.4.1) and timeout group options (see section 4.4.3) are used to control the HARC suspension conditions. See Table 7.4 in section 7.1 for troubleshooting information for HARC suspension conditions.

Table 2.6 HARC Suspension Conditions

Suspension Condition	Detected by:	HARC Pairs to be Suspended
The MCU could not send a pending recordset to the RCU before the **offloading timer** asynchronous option expired (see section 2.3.6).	MCU	All HARC pairs with M-VOLs in the MCU.
During MCU power-on, the MCU could not establish communication with the RCU before the **RCU ready timeout** group option expired (see section 2.4.1).	MCU	All HARC pairs with M-VOLs in the MCU.
The RCU could not settle a pending recordset before the **copy pending timeout** group option expired.	RCU	All HARC R-VOLs in the consistency group.
The RCU could not communicate with the MCU before the **copy pending timeout** group option expired.	RCU	All HARC R-VOLs in the consistency group.
The RCU could not receive the recordset successfully due to a hardware failure.	RCU	Only the affected R-VOL.
The RCU detected a logical error while selecting the recordset to be settled.	RCU	All HARC R-VOLs in the group, or only the affected R-VOL, depending on the failure type and **error level** HARC pair option.
The RCU could not settle the recordset due to a hardware failure, a track condition, or a logical error.	RCU	

The MCU stores a cylinder bitmap in cache for each HARC M-VOL, and the RCU stores a cylinder bitmap in cache for each HARC R-VOL. When a HARC pair is suspended, the cylinders which contain the following records are marked in the cylinder bitmap as modified (to be copied during the resume pair operation):

- The recordsets that were created by the MCU but not yet sent to the RCU. After marking these cylinders as modified, the MCU discards these recordsets.
- The recordsets that were sent to the RCU but not acknowledged by the RCU. The MCU marks these M-VOL cylinders as modified and discards these recordsets. This ensures that recordsets which are lost during transmission to the RCU are identified and marked.
- The recordsets that reached the RCU but have not yet been settled. After marking these cylinders as modified, the RCU discards these recordsets.
- The M-VOL records updated by host-requested write I/Os after the volume pair was suspended (same function as for HRC Synchronous pairs).

When a suspended HARC pair is resumed (resynchronized), the contents of the RCU's cylinder bitmap are sent to the MCU and merged into the MCU's cylinder bitmap. The MCU then performs the resync copy operation according to the merged bitmap. This ensures that all cylinders containing recordsets that were discarded are resynchronized at this time.

2.6 PPRC Support

All Hitachi Lightning 9900™ subsystems with HRC installed support IBM PPRC host software functions. You can perform most HRC operations by issuing PPRC TSO (or ICKDSF PPRCOPY) commands from the host system console to the 9900 subsystem. Using PPRC commands, you can establish and delete remote copy communication paths; establish, suspend, resume, and delete HRC Synchronous and Asynchronous pairs/groups; and view HRC path and pair status. See Appendix B for further information on using PPRC TSO and ICKDSF commands with the Hitachi Lightning 9900™ subsystem.

If you plan to use PPRC commands instead of the HRC software to perform HRC operations, the following restrictions apply:

- SVP mode 114 (see Table 2.1) must be enabled to allow automatic port configuration in response to PPRC commands. To fully support an automated environment, the 9900 subsystem is capable of automatically configuring a serial port as an RCP or LCP if required in response to the TSO CESTPATH and CDELPATH commands. The 9900 subsystem will make sure that the specified MCU port is offline to the host, and will automatically configure it as an RCP if required. Similarly, the corresponding RCU port will also be configured as an LCP if required. When the CDELPATH command is issued, the HRC logical paths are removed, and if there are no more HRC or HORC logical paths on the port, the port is automatically changed from RCP mode to LCP mode.
- The PPRC commands do not allow you to change the RCU options. The current default RCU options are: minimum paths = 1, maximum initial copy activity = 4, SCP delay time = 120 seconds, incident of RCU = to any host, PPRC support = yes, HRC service SIM = not report, FREEZE option = disable. The HRC software* must be used to change any of these options.
- The PPRC commands do not allow you to change the HRC Asynchronous options. The current default values are: sidefile threshold = 50%, offloading timer = 5 minutes. The HRC software* must be used to change these options.
- The PPRC commands do not allow you to configure HARC consistency groups. Since each HARC pair must belong to one consistency group, the HRC software* must be used to add and configure the groups (timer type, copy pending timeout, RCU ready timeout) before you can add any HARC pairs. Once the asynchronous options, groups, and group options are configured, the PPRC commands can be used to control/monitor HARC pairs.
- The PPRC commands do not allow you to change the initial copy priority, CFW data option, or DFW to R-VOL option. If CESTPAIR is used to establish an HRC pair, the following initial copy and pair options will be used: initial copy priority = 0, CFW data = copy to R-VOL, and DFW to R-VOL = not required. The HRC software* must be used to change these initial copy and pair options.

For operating systems that do not support PPRC, the HRC remote console software must be used to control and monitor HRC operations. In this case, HRC provides only state-change-pending (SCP) notifications with service information messages (SIMs).

**Note:* If the HRC remote console software is not installed, please contact your Hitachi Data Systems account team for further information on HRC configuration services.

2.6.1 P/DAS Support

HRC Synchronous supports the IBM P/DAS host software function. P/DAS allows you to relocate or migrate data by redirecting all application I/Os from the M-VOL of an HRC pair to the R-VOL without interrupting access to the data. Please refer to the following IBM publications for important information on the requirements and procedures for P/DAS operations: *Planning for IBM Remote Copy* (SG24-2595), *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169). ***Note:*** HARC does not support P/DAS SWAP.

Restrictions:

- P/DAS does not support CFW operations. You must stop CFW applications before performing P/DAS operations on HRC volumes.
- P/DAS through channel extenders is not supported.
- P/DAS swap option #2 (switch pair & swap) is supported for P/DAS between the 9900 and 7700E subsystems (not supported between 9900 and 7700). If you plan to use the P/DAS swap option, SVP mode 49 must be enabled (see Table 2.1).
- If the 9900 subsystem which is involved in P/DAS operations is configured with multiple logical CUs, 9900 SVP mode 49 (see section 2.1.1) must be enabled.

Please contact your Hitachi Data Systems account team for the latest information on P/DAS support.

2.6.2 GDPS Support

HRC provides remote copy support for IBM's Geographically Dispersed Parallel Sysplex® (GDPS) facility. GDPS is an IBM service offering for mirroring data and balancing workload on subsystems spread across two or more sites up to 40 km (~20 miles) apart. With this support, users who are running IBM Parallel Sysplex systems can take advantage of the 9900 subsystem's suite of remote copy options for data availability.

GDPS operations feature automatic control of groups of PPRC-managed volumes using host-based scripts and PPRC commands (e.g., CGROUP (FREEZE/RUN), see section B.3). GDPS support may have additional installation requirements for the 9900 HRC MCUs and RCUs, depending on 9900 microcode levels and RMCMAIN software versions. Please check the following items with your Hitachi Data Systems representative:

- Consecutive SSIDs within each logical CU, and
- SVP modes (e.g., 49, 64, 104). For operations in a GDPS environment, mode 49 must be ON, mode 64 must be OFF, and mode 104 must be ON. For further information on 9900 SVP modes related to HRC operations, please refer to Table 2.1 in section 2.1.1.

Consecutive SSIDs, mode 49, and mode 104 must be installed before any HRC pairs are established in a GDPS environment. If HRC pairs have already been established, you must delete all HRC pairs and logical paths (CDELPAIR, CDELPATH), change the SSIDs and mode settings on the MCUs and RCUs, and then re-establish the paths and pairs (CESTPATH, CESTPAIR). Installation of mode 64 is nondisruptive and can be performed at any time.

For further information on GDPS, please refer to the following IBM publications: *Geographically Dispersed Parallel Sysplex: the S/390® Multi-site Application Availability Solution, Executive Summary* (GF22-5114); and *Geographically Dispersed Parallel Sysplex: the S/390® Multi-site Application Availability Solution* (GF22-5063).

2.7 Optimizing HRC Operations and Subsystem Performance

All HRC operations result in increased utilization of the 9900 subsystem's channel resources because of the additional write (remote copy) operations to the secondary volumes. The HRC update copy mode (synchronous or asynchronous) determines exactly how the remote copy operations will impact subsystem performance as follows:

- **Synchronous** copy mode (HRC Synchronous) has an additional effect on subsystem performance: increased service and disconnect time for write I/Os to HRC M-VOLs due to the delay between channel-end and device-end. The length of this delay increases as the distance between the M-VOL and R-VOL increases, so that the longest delay occurs when the main and remote volumes are the maximum distance apart.
- **Asynchronous** copy mode (HARC or HARC) eliminates all delays associated with HRC Synchronous operations while providing increased protections for write-dependent applications in the event of a disaster. Write I/Os for HARC M-VOLs are processed in the same way as writes for simplex volumes, without any increase in service or disconnect time. The asynchronous R-VOL updates are performed completely independent of all host I/O processes at the M-VOLs, and there are no restrictions on subsequent read/write operations to HARC M-VOLs. The only performance concerns for HARC are ensuring that adequate cache resources are available for sidefiles which are used to store the recordsets at both the MCUs and RCUs, and ensuring that sufficient ESCON paths are defined for copy operations.

In addition to the HRC update copy mode, several other factors can also affect 9900 subsystem performance. You can optimize both the HRC operations and the I/O performance of the subsystems by analyzing workloads and addressing system-level conditions (e.g., number of ESCON paths) which can affect subsystem performance. You can also control the impact of HRC operations on subsystem performance by selecting the appropriate RCU options for each MCU (see section 4.3.2) and the appropriate update copy mode (synchronous or asynchronous) and pair options (see section 5.2.2) for each HRC pair. In addition, you can upgrade the HRC hardware components and/or adjust the configuration of the components to improve subsystem performance under a wide range of operating conditions. Table 2.7 lists some of the conditions which affect subsystem performance and provides recommendations for addressing these conditions.

Table 2.7 Optimizing HRC Operations and 9900 Subsystem Performance

Condition	Description	Recommendation(s)
Write-intensive workloads	Write-intensive workloads, such as SPOOL volumes and database logging volumes, can have a significant impact on subsystem I/O response times.	Spread write-intensive data across several volumes to minimize queuing. Also consider increasing the duplex write line (DWL) of the subsystem using the Hitachi GRAPH-Track software product.
Large block size	Workloads with large write block sizes, such as DB2® deferred writes, can impact performance.	Spread workloads with large write block sizes across several volumes.
High host channel demand	The demand on the MCU's host channels can affect performance.	Spread the workload across several disk subsystems to utilize additional channels.
Sequential write operations	HRC operations can have a negative impact on workloads with a high percentage of sequential write operations, such as batch processing operations (e.g., dump/restore, sort operations).	Avoid performing restore operations to volumes which belong to HRC pairs. Instead, restore data to a scratch volume and then establish the HRC volume pair.
Cache size	Large cache size improves read hit performance, which allows more subsystem resources to be devoted to write operations. The resulting performance improvement can offset some or all of the performance loss due to the HRC remote copy operations. HARC, HXRC, and Concurrent Copy (CC) require additional cache for sidefile data. Insufficient cache resources can result in command retries, SCP notifications, and puncture conditions.	Consider increasing the cache size of the HRC subsystems to handle HARC, HXRC, and CC sidefile operations and to improve overall subsystem performance. For best results, the cache and NVS capacity of the main and remote subsystems should be the same (for HARC the RCU sidefile requirements are 2x that of the MCU) to enable the remote site to function adequately during disaster recovery.
RCU capacity	The performance of the RCUs directly affects the performance of the MCUs. If an RCU becomes overloaded with heavy update activity, MCU and system performance can also be degraded.	Distribute HRC remote copy operations among several remote subsystems to avoid overloading any one RCU.
ESCON paths	An inadequate number of ESCON paths may decrease subsystem performance. Performing HRC Synchronous operations over long distances can also degrade subsystem performance. HARC is recommended for long distances.	Make sure to install an adequate number of ESCON paths between the main and remote subsystems. This is especially important for subsystems which contain both M-VOLs and R-VOLs.

Chapter 3 Preparing for HRC Operations

3.1 System Requirements

HRC operations involve the 9900 MCUs and RCUs containing the main and remote volumes, the remote copy connections between the MCUs and RCUs, the S/390® host(s) at the main and remote sites, and the HRC remote console software. The HRC system requirements are:

- **MCU:** Hitachi Lightning 9900™ subsystem with HRC installed. ***Note:*** For information on performing HRC operations using the 7700E subsystem as an MCU, please refer to the *Hitachi Remote Copy (HRC) User and Reference Guide* (MK-90RD009).
- **RCU:** Hitachi Lightning 9900™ subsystem with HRC installed. ***Note:*** The 7700E subsystem can be used as an RCU connected to a 9900 MCU. For assistance with 9900/7700E mixed configurations, contact your Hitachi Data Systems account team and/or Support Center.

Note: HARC and HORC Asynchronous can coexist in the same 9900 subsystem.

Note: CGROUP support may have the following additional MCU and RCU installation requirements: consecutive SSIDs and SVP modes (e.g., 49, 64, 104) (see section B.3). For further information on 9900 SVP modes related to HRC operations, refer to Table 2.1.

- **Remote copy connections:** (see section 3.4 for further information)
  - Multimode serial interface (ESCON®) cables are required at both the MCU and RCU.
  - For distances from 3 km to 43 km, single-mode serial interface cables with IBM 9032 or 9033 ESCON directors (ESCDs) and/or 9036 ESCON repeaters are required.
  - For distances greater than 9 km, the extended distance facility (XDF) provided by the ESCDs and/or ESCON repeaters is required.
  - For distances greater than 43 km, approved third-party channel extender products and telecommunications lines are required. Long-distance HRC solutions are provided based on user requirements and workload characteristics. ***Note:*** Usage of channel extenders may require additional 9900 configuration (e.g., mode 21).
- **S/390 host:** MVS/DFP 3.2.0 + PTF, or VM/ESA® 2.1.0 + PTF.
  - Optional error recover procedure (ERP) functions require MVS/DFP 3.2.0 or later.
  - ICKDSF R16 + PTF functions require VM/ESA 2.1.0 or later.
  - If the primary and/or secondary system consists of several CPU complexes, a SYSPLEX timer is required to provide a common time reference for the host I/O time-stamping function.
- **9900 Remote Console PC:** The RMCMAIN and DKCMAIN HRC license key codes are required. If you are using HRC for disaster recovery, install a second Remote Console PC at the remote site. Please refer to the *9900 Remote Console User's Guide* (MK-90RD003) for instructions on installing and using the 9900 Remote Console PC.

  Note: Administrator access to RMCMAIN is required to perform HRC operations. Users without administrator access can only view HRC information.

3.2 HRC Requirements and Restrictions

HRC has the following requirements and restrictions:

- Track format
- One-to-one volume copy operations
- Logical volume image (LVI) (also called device emulation or type)
- Duplicate VOLSER
- Accessing HRC M-VOLs and R-VOLs
- Cache, NVS, and DASD fast write
- Consistency groups
- Powering off HRC components
- Combining HRC with other data management operations

3.2.1 Track Format

HRC has the following disk track format requirements which must be ensured by the user. HRC cannot detect exceptions to these requirements. The MCU will abort the HRC initial copy operation if the track format for both the M-VOL and R-VOL does not meet the following requirements.

- The HRC M-VOL and R-VOL must have the same track format.
- Record zero (R0) must be standard format, with key length of zero and data length of eight. The MCU will abort the initial copy operation if R0 is not standard format.
- The CCHH (logical cylinder address and logical head address) of R0 must be identical to the physical cylinder address and physical head address of the track.
- The CCHH of each user record in a track must be unique.

3.2.2 One-to-One Volume Copy Operations

HRC requires a one-to-one relationship between the logical volumes of the volume pairs. A volume can only be assigned to one HRC pair at a time. HRC does not support operations in which one M-VOL is copied to more than one R-VOL, or more than one M-VOL is copied to one R-VOL. Since HRC pairs are created on logical volumes rather than datasets, multivolume datasets require special attention. For complete duplication and recovery of multivolume datasets, make sure that all volumes of a multivolume dataset are copied to HRC R-VOLs, and use HARC to ensure update sequence consistency across the R-VOLs at the remote site.

3.2.3 Duplicate VOLSER

The HRC initial copy operation always copies the VOLSER of the M-VOL to the R-VOL, even if the **None** initial copy option is selected. For this reason, the M-VOL and R-VOL of an HRC pair must have the same VOLSER. Since the host operating system does not allow duplicate VOLSERs, the host system administrator must take precautions to prevent system problems related to duplicate VOLSERs. For example, the HRC R-VOLs must be defined in the system generation so they do not come online automatically (see **WARNING** below).

WARNING: If the volumes which will become HRC R-VOLs are physically attached to the same system images as the production volumes which will become the HRC M-VOLs, the following problems can occur:

- When an HRC pair is established using the TSO CESTPAIR command, the secondary volume might be online (PPRC allows this; HRC does not). This could produce a duplex secondary online to a host image, the results of which are not predictable.
- When an HRC pair is deleted, the old secondary volume is usually offline. If a host image is IPL'd, the operator will be offered both volumes and asked which volume should be left offline – the old duplicate volser message. This can be confusing and is prone to error.

To avoid these problems, Hitachi Data Systems strongly recommends that the user specify OFFLINE=YES if the secondary volumes are to be generated in the production host's IOCP and system generation.

3.2.4 Logical Volume Image (LVI)

HRC supports all mainframe LVIs which can be configured on the 9900 subsystem (e.g., 3390-1, -2, -3, -3R, -9; 3380-K, -E, -J). The 9900 multiplatform volumes (e.g., 3390-3A/B/C, 3380-KA/B/C) cannot be assigned to HRC pairs. HRC can copy data between volumes with the same LVI and capacity (e.g., 3390-3R to 3390-3R), and can also copy from smaller volumes to larger volumes* (e.g., 3390-2 to 3390-3R) of the same LVI type (VTOC expansion must be used). HRC also supports the Virtual LVI feature of the 9900 subsystem (also called CVS, custom volume size), enabling you to establish HRC pairs with custom-size LVIs as well as standard-size LVIs. When custom-size LVIs are assigned to HRC pairs, the R-VOL must have the same or larger capacity than the M-VOL. The HRC remote console software displays the LVI of the M-VOLs and R-VOLs.

Note: The host I/O time-stamping function is not supported by 3380 LVIs. If you plan to use HARC pairs, the HARC M-VOLs and R-VOLs must be 3390 LVIs.

**WARNING:* If you utilize HRC to copy from a smaller volume to a larger volume, you will not be able to perform HRC operations in the reverse direction (from the secondary site to the primary site) after a disaster has occurred and the secondary site was used for production. This restriction exists because HRC does not support copying from a larger volume to a smaller volume. Hitachi Data Systems strongly recommends that this capability (copying from a smaller volume to a larger volume) only be used for data migration purposes.

3.2.5 Accessing HRC M-VOLs and R-VOLs

Write operations to an HRC M-VOL which specify normal authorization are duplicated on the R-VOL of the HRC pair. Write operations with diagnostic or device support authorization (e.g., ICKDSF) are completed at the M-VOL but are not duplicated at the R-VOL. Therefore, you must suspend an HRC volume pair before performing ICKDSF media maintenance on the M-VOL. See section 5.7 for instructions on running ICKDSF on HRC volumes.

To ensure maximum data integrity during normal HRC operations, the RCU rejects all read and write operations issued by a host to an HRC R-VOL. If you need read-only access to an HRC R-VOL, you must have the R-VOL read option (see section 2.2.4) enabled on the RCU, and you must suspend the pair to read the R-VOL. The R-VOL read option can only be enabled by the Hitachi Data Systems representative. If you need write access to an HRC R-VOL (e.g., to perform ICKDSF), you must delete the pair from the RCU to change the R-VOL pair status to *simplex*. See section 5.7 for instructions on running ICKDSF on HRC volumes.

3.2.6 Cache, NVS, and DASD Fast Write

Cache and nonvolatile storage (NVS) must be operable for both the MCU and RCU of an HRC volume pair. If not, the Add HRC Pair operation will fail. DASD fast write (DFW) is required at the MCU and RCU when the **DFW-to-R-VOL required** HRC pair option is specified. The remote subsystem cache should be configured to adequately support the HRC remote copy workloads as well as any local workload activity.

Note: If DFW to an HRC R-VOL is blocked and the HRC pair was established with the **DFW required** pair option (see section 5.2.2), the MCU detects DFW OFF at the R-VOL and suspends the HRC pair. HRC pairs which are established using PPRC commands are not suspended when DFW to the R-VOL is blocked, since PPRC does not support the **DFW required** pair option.

3.2.7 Consistency Groups

The HARC consistency groups have the following requirements:

- All HARC pairs must be assigned to one and only one consistency group.
- The maximum number of volume pairs in one consistency group is 4,096 (entire RCU).
- The maximum number of consistency groups established for one MCU-RCU pair is 64. The RCU supports a maximum of 64 groups. This limit of 64 groups includes both HARC groups and HORC Asynchronous groups (e.g., 32 HARC + 32 HORC Asynchronous).
- Each update I/O to the M-VOLs in one consistency group must be time-stamped using a common timer facility. The primary host system cannot access volume pairs of the same consistency group if the pairs do not have a common timer reference.
- A consistency group must consist of HARC pairs or HORC Async pairs, but not both.

3.3 Hardware Installation

Initial installation of the HRC hardware is performed by the user and the Hitachi Data Systems representative. To install the hardware required for HRC operations:

1. **User**: Identify the HRC M-VOLs and R-VOLs (main and remote volumes), so that the HRC hardware can be installed and configured properly.
2. **User**: On the host operating system, make sure that the missing interrupt handler (MIH) value (also called host I/O patrol time) is set high enough to accommodate the number of volume pairs, the cable length between the MCUs and RCUs, and the initial copy pace. The recommended MIH value for HRC operations is 60 seconds. For MVS, the MIH value is specified in the SYS1.PARMLIB file. ***Note:*** The recommended MIH values for HXRC and HODM (Hitachi Online Data Migration) are different than for HRC. If you are performing HRC and HXRC or HODM on the same 9900 (or 7700E) subsystem at the same time, please contact the Hitachi Data Systems Support Center for assistance.
3. **User and Hitachi Data Systems Representative**: Install the 9900 Remote Console PC near the HRC MCU(s), and connect the Remote Console PC to the HRC MCU(s) via the 9900-internal LAN. Hitachi Data Systems recommends that you also install a Remote Console PC connected to the RCUs at the remote site. Refer to the *9900 Remote Console User's Guide* (MK-90RD003) for instructions on installing the Remote Console PC.
4. **Hitachi Data Systems Representative**: Enable HRC on all MCUs and RCUs. Make sure that the cache, NVS, and DFW of the MCUs and RCUs are properly configured for HRC operations (see section 3.2.6). If the user plans to perform HARC, HXRC, and/or Concurrent Copy operations in the same subsystem, make sure to install adequate cache to handle the increased sidefile usage. When determining the required amount of cache, you must also consider the amount of FlashAccess data to be stored in cache. Make sure that the desired SVP modes are enabled (see Table 2.1).
5. **Hitachi Data Systems Representative**: Make sure the MCUs are configured to report sense information to the host(s). The RCUs should also be attached to a host processor to enable reporting of sense information in case of a problem with an R-VOL or RCU. If the remote site is unattended, the RCUs should be attached to a host processor at the main site, so that the system administrator can monitor the operational condition of the RCUs.
6. **Hitachi Data Systems Representative**: If power sequence control cables are used, set the power select switch for the cluster to LOCAL to prevent the MCU from being powered off by the host. Also make sure the RCU will not be powered off during HRC operations. See section 5.9 for further information on powering off/on the HRC MCUs and RCUs.
7. **Hitachi Data Systems Representative**: If the user plans to use the **Local** HARC timer type option, set the SVP clock to local time so that the HARC time-stamps will be correct.
8. **Hitachi Data Systems Representative**: Install the HRC remote copy connections between the MCU(s) and RCU(s) using the hardware supplied by the user. See section 3.4 for remote copy configurations. Distribute the paths between different storage clusters and ESCDs to provide maximum flexibility and availability. The logical paths between the MCU and RCU must be separate from the logical paths between the host and RCU.

3.4 HRC Remote Copy Connections

Figure 3.1 shows the HRC remote copy connection configurations. The MCU and RCU of each HRC pair must be connected via multimode ESCON cables. For distances greater than 3 km, single-mode cables up to 20 km in length and IBM 9032/9033 ESCDs and/or 9036 ESCON repeaters are required. Dedicated ESCON channels may be installed, or existing ESCON channels connected by ESCDs may be used. The IBM 9032/9033 ESCD supports the extended distance facility (XDF), which uses single-mode ESCON cables up to 20 km. The IBM 9036 ESCON repeater supports single-mode-to-single-mode connection or single-mode-to-multimode connection. When HRC subsystems are more than 9 km apart, the XDF connections provided by the ESCDs or ESCON repeaters are required. HRC operations can be performed at distances of up to 43 km (27 miles) using standard ESCON support, and long-distance solutions are provided, based on user requirements and workload characteristics, using approved channel extenders and communication lines.

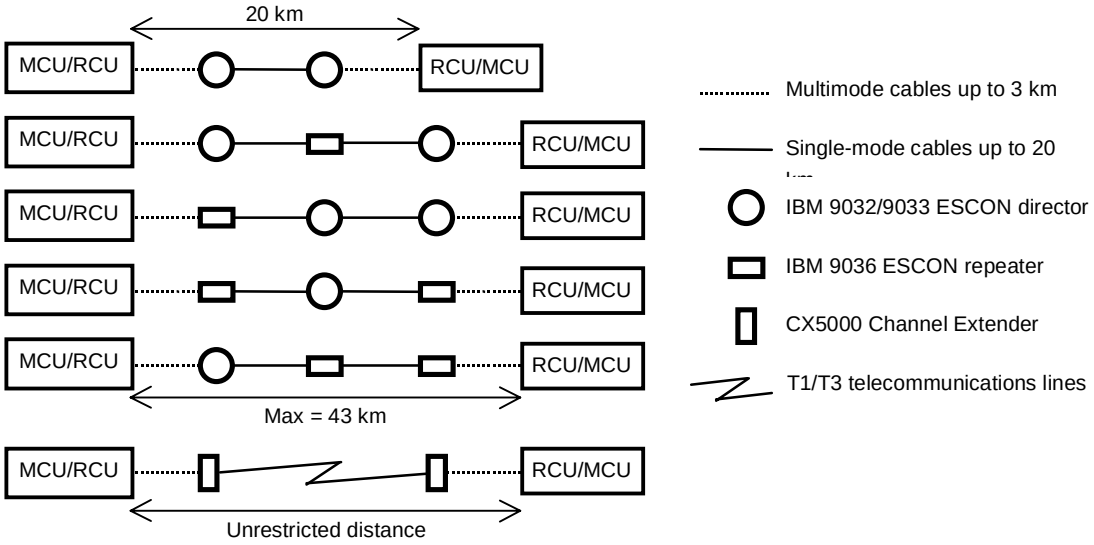


Figure 3.1 HRC Remote Copy Connection Configurations

The ESCDs can accommodate multiple MCU-RCU remote copy connections (see Figure 3.2). N-to-1 or 1-to-n remote copy connections (n≤4) can also be configured by using the dynamic switching capability of the ESCDs to share the physical interface cables between the components (see Figure 3.3). In addition, the ESCDs can accommodate channel-to-MCU and channel-to-RCU connections in addition to the remote copy connections (see Figure 3.4).

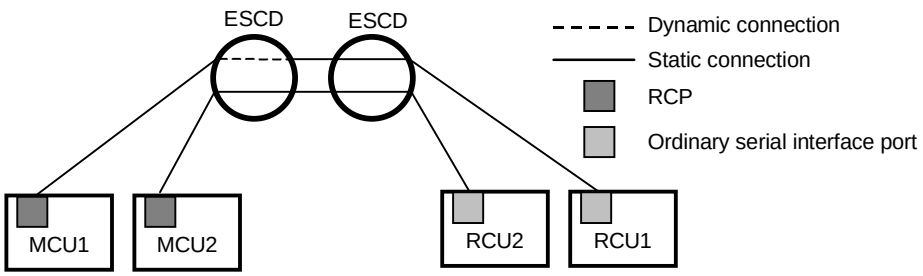


Figure 3.2 N Pairs of Remote Copy Connections

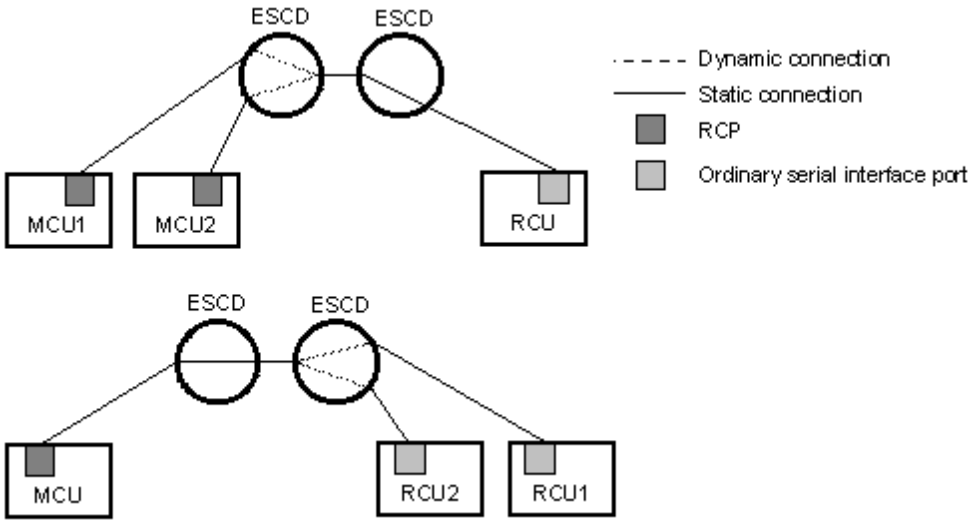


Figure 3.3 n-to-1 and 1-to-n Remote Copy Connections (n≤4)

Note: 1-to-n configurations (one main subsystem and multiple remote subsystems) are valid for HRC Asynchronous, as long as a consistency group does not span remote subsystems.

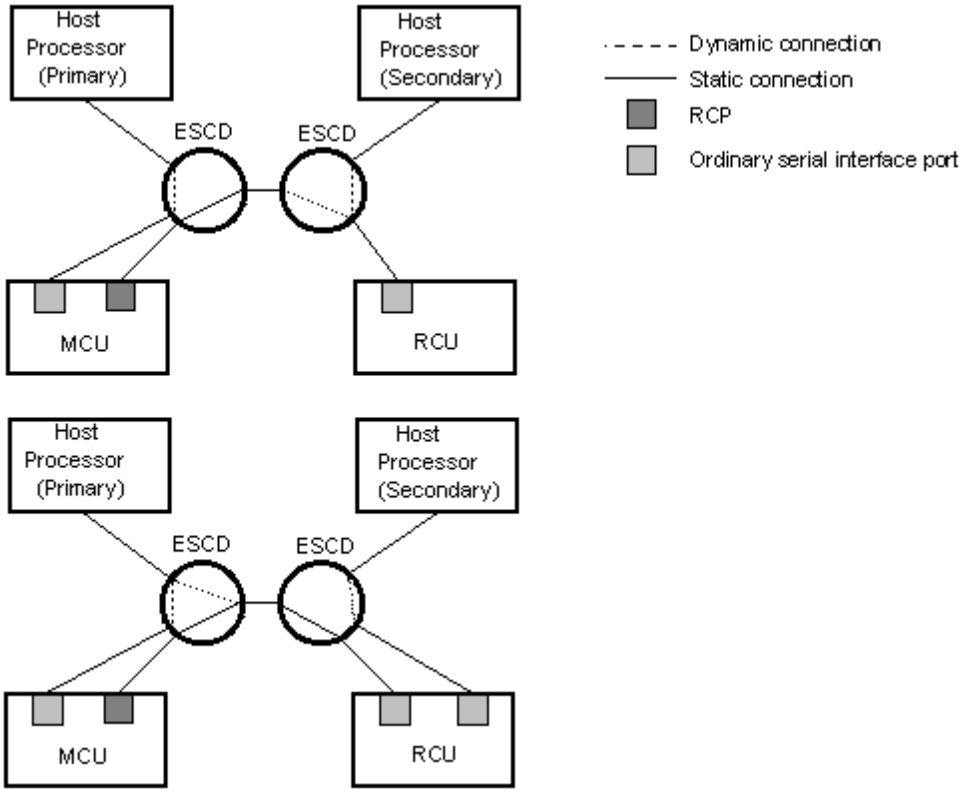
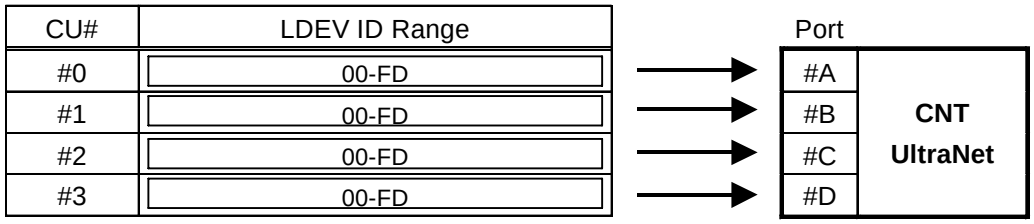


Figure 3.4 Remote Copy Connections Shared With Channel-to-RCU Connections

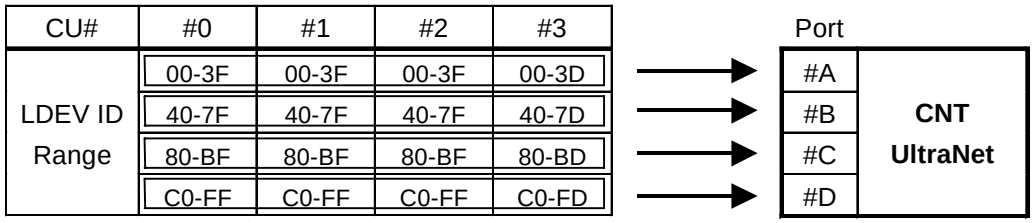
3.4.1 Using Channel Extenders

Hitachi Asynchronous Remote Copy (HARC) can be integrated with third-party channel extender products to provide remote data backup for distances greater than 43 km. The following information was current at the time of publication of this document, but may change. Please contact your Hitachi Data Systems account team for the latest information on channel extender support for HRC.

- HRC has been tested with the CNT UltraNet Storage Director:
  - UltraNet supports T3 and ATM (asynchronous transfer mode) communication lines.
  - UltraNet supports ATM OC-3 (optical carrier) levels. The transfer speed of OC-3 is a maximum of 155 Mb/s.
  - The transfer speed of T3 is a maximum of 44 Mb/s.
- The 9900 subsystems' serial numbers must be set on the channel extenders as follows. If the serial numbers are not set correctly, the HRC add pair operation will terminate with an error. For CNT UltraNet, this operation must be performed by the CNT representative.
  - Set the RCU serial number to the MCU-side extender.
  - Set the MCU serial number to the RCU-side extender.
  - Set the serial number on each CNT UltraNet port.
- Make sure that your channel extenders are capable of supporting the HARC channel command. The parameter length and detailed specification of the HARC channel command are different than for HRC Synchronous RIOs.
- The LDEV IDs of the S-VOLs must be assigned on each port of the MCU-side extender. The maximum number of LDEVs which can be assigned on each port is 254. Figure 3.5 shows the required LDEV assignment on each extender port. If the LDEV IDs are not assigned properly, the HRC add pair operation will terminate with an error. For CNT UltraNet, this operation must also be performed by the CNT representative.



Example 1: Assigning the same LDEV IDs of a specific CU number to each port.



Example 2: Assigning specific LDEV IDs on each CU number to each port.

Figure 3.5 Assigning S-VOL LDEV IDs to the Channel Extender Ports

3.5 Enabling the HRC Software

The user enables the remote HRC options on the Remote Console PC and the HRC copy options on each 9900 subsystem using the RMCMAIN and DKCMAIN license key codes for HRC. ***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 HRC 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 HRC 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 *9900 Remote Console User's Guide* for instructions on installing the Remote Console PC and RMCMAIN software.
3. Enable the remote HRC option(s) 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 3.6).
   c) On the Option Product panel, select **Remote HRC**, and then select **Install…** to open the Input Key Code panel (see Figure 3.7).
   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 3.8). Confirm the information displayed, and select **Install**. The Option Product panel now displays **[Install]** for the **Remote HRC** option.
   f) If you are also enabling HARC, repeat steps (c)-(e) for the **Remote HRC Asynchronous** option listed on the RMCMAIN Option Product panel. 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 and serial number, and select **OK**. Then select the subsystem you just added on the Connection Control panel, and select **Entry**. Refer to the *9900 Remote Console User's Guide* for more detailed instructions.
5. Enable the HRC copy option(s) on each subsystem (MCUs and RCUs) 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 3.9).
   b) Select **HRC** (must be enabled first), 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 HRC option on the selected subsystem. The DKCMAIN Option Product panel now displays **[Install]** for the selected HRC copy option.
   d) If you are also enabling HARC, repeat steps (a) through (c) for the **HRC Asynchronous** copy option listed on the DKCMAIN Option Product panel.
6. After enabling the HRC options on all 9900 subsystems, you are now ready to configure the 9900 subsystems as MCUs and RCUs for HRC operations (see the next section).

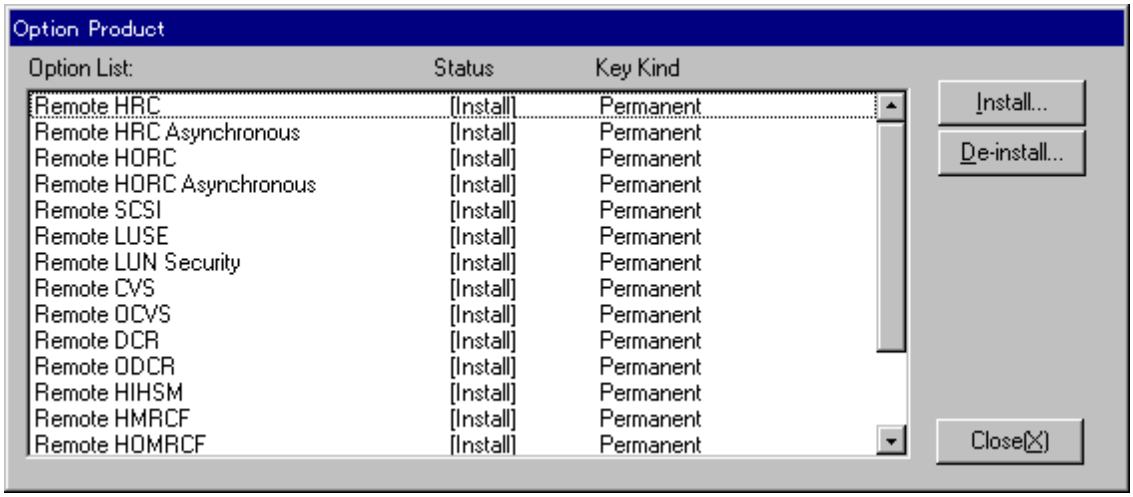


Figure 3.6 Enabling the Remote HRC Options

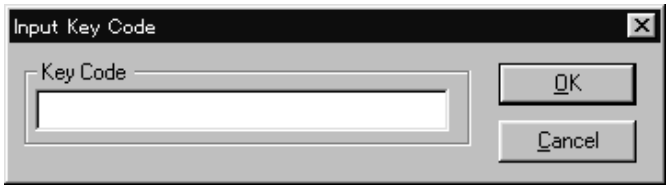


Figure 3.7 Entering the HRC License Key Code

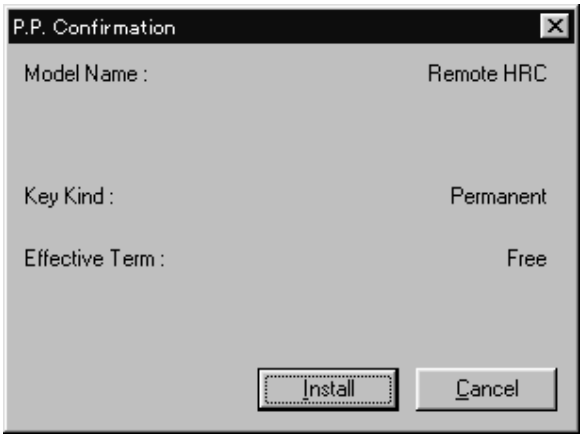


Figure 3.8 Confirming the HRC Key Code

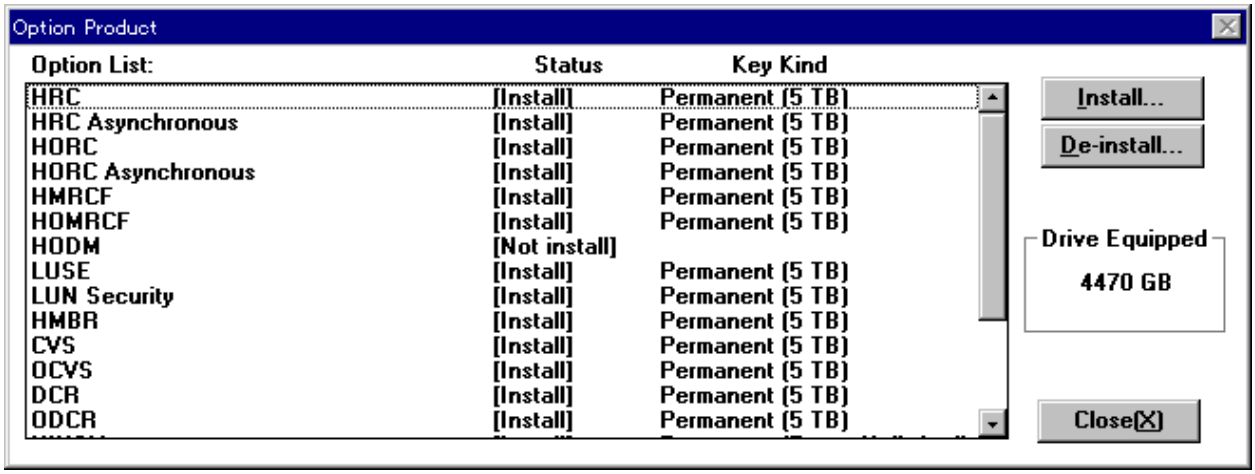


Figure 3.9 Enabling the HRC Copy Options on Each Subsystem

3.6 Configuring the MCUs and RCUs for HRC Operations

After you have added the subsystems to the Remote Console, installed the HRC software, and installed the HRC copy modes, you can configure the MCUs and RCUs for HRC operations.

To configure the MCUs and RCUs for HRC operations:

1. Identify the volumes that will become the HRC M-VOLs and R-VOLs. You need to know the subsystem S/N, SSID, and CU image of each HRC volume, so that you can configure the MCUs and RCUs correctly for your desired HRC volume pairs and HARC groups.
2. If Hitachi GRAPH-Track™ is connected to the subsystem to be configured as an HRC MCU, disconnect GRAPH-Track before connecting RMCMAIN to that subsystem.
3. Start up and log in to RMCMAIN with administrator access.
4. Select **Connect…** to open the Connection Control panel, select the subsystem that you want to configure as an HRC MCU, and then select **Connect**.
5. Select **HRC** to start the HRC software. The HRC Main Control panel displays the S/N of the connected subsystem and the selected CU image (CU 0 is displayed first).
6. Configure the serial interface ports which are connected to the RCUs as RCPs using the Port Change panel (see Figure 3.10) (see section 4.2.3 for instructions).
7. Add the desired RCU(s) to each MCU CU image using the Add RCU panel (see Figure 3.11) (see section 4.3.1 for instructions).
8. After adding all RCUs, verify the RCU options, and select **OK** to close the RCU Option panel (see Figure 3.12) (see section 4.3.2 for instructions).
9. If you plan to establish HARC pairs with M-VOLs in this MCU, configure the MCU asynchronous options (see Figure 3.13) (see section 4.4.1 for instructions), and then add the desired consistency group(s) to the MCU (see Figure 3.14) (see section 4.4.2 for instructions).
10. When you are finished configuring this MCU, exit HRC, and then disconnect RMCMAIN from the subsystem. If desired, you can reconnect GRAPH-Track to this subsystem now.
11. Repeat steps (4)–(10) for each subsystem which will function as an HRC MCU. After you have configured the MCUs, added the RCUs, and configured the HRC Asynchronous options and consistency groups, you are ready to begin HRC volume pair operations.

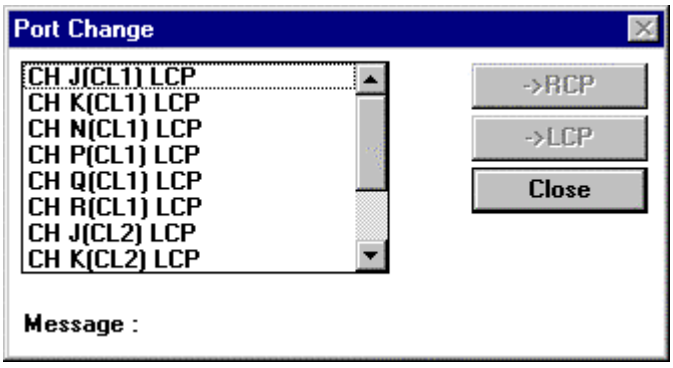


Figure 3.10 Configuring the RCPs (select port, click →RCP)

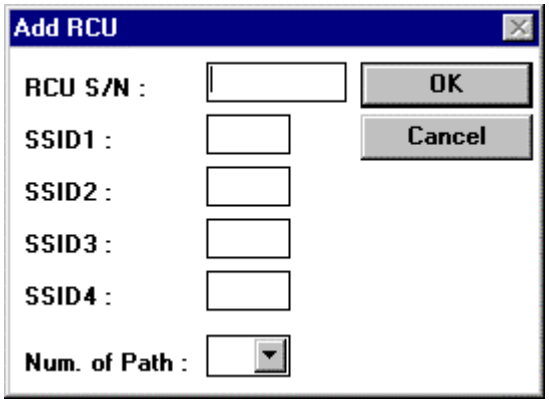


Figure 3.11 Adding the RCUs

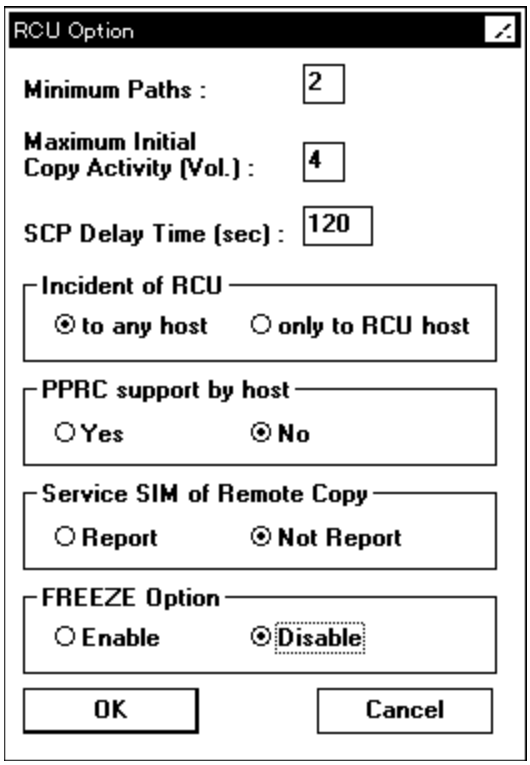


Figure 3.12 Configuring the RCU Options

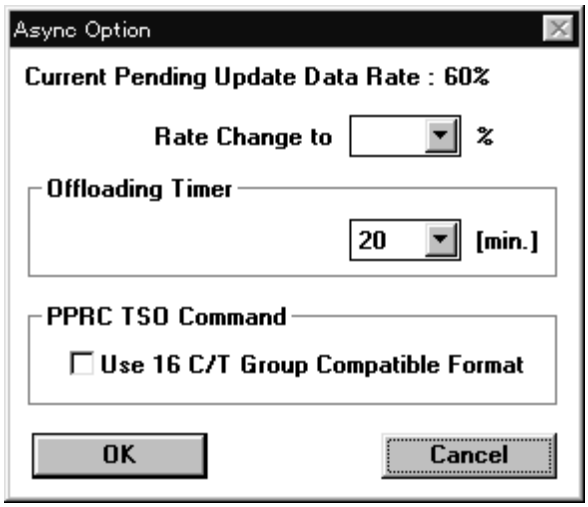


Figure 3.13 Setting the HRC Asynchronous Options

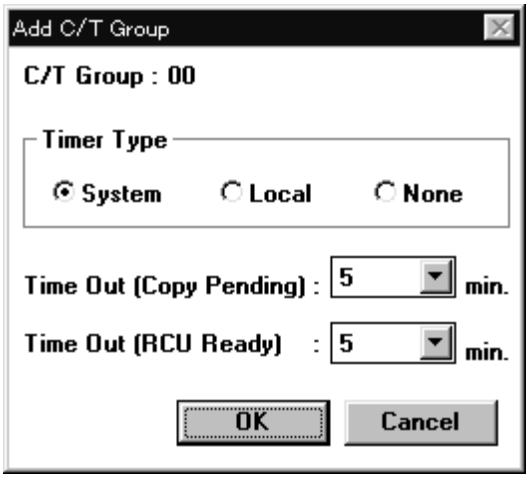


Figure 3.14 Adding the Consistency Groups

3.7 Combining HRC with Other Data Management Operations

HRC supports concurrent operations with the following data management functions:

- **Virtual LVI**. Virtual LVI volumes can be assigned to HRC pairs, as long as the R-VOL has the same or larger capacity than the M-VOL. If you need to perform Virtual LVI operations on an existing HRC M-VOL or R-VOL, you must delete the pair first to return the volume to *simplex* status.
- **FlashAccess**. FlashAccess volumes can be assigned to HRC pairs, and FlashAccess operations can be performed on HRC M-VOLs and R-VOLs.
- **Concurrent Copy** (CC). The Hitachi Lightning 9900™ subsystem is functionally compatible with the IBM 3990 Concurrent Copy function.
- **HXRC**. The Hitachi Lightning 9900™ subsystem is functionally compatible with the IBM Extended Remote Copy (XRC) function.
- **ShadowImage**. ShadowImage volumes can be assigned to HRC pairs, and HRC volumes can be assigned to ShadowImage pairs. See section 3.7 for information on HRC and ShadowImage shared volume configurations.

  Note: When HRC and ShadowImage are both active on the same 9900 subsystem, HRC cannot be used to copy *within* that subsystem. ShadowImage is recommended for intra-subsystem copy. If ShadowImage is not active, HRC Synchronous supports intra-subsystem copy and requires at least one external ESCON cable loop.
- **HODM**. Hitachi Online Data Migration (HODM) volumes cannot be assigned to HRC pairs, and HRC volumes cannot be assigned to HODM pairs. HRC and HODM can be performed concurrently in the same 9900 subsystem, but volumes cannot be shared between HRC and HODM. For further information on HODM, please contact your Hitachi Data Systems account team.

Note: When HRC and HORC coexist in the same 9900 subsystem, each consistency group must contain either HARC pairs or HORC Async pairs (not both), and HARC and HORC Asynchronous share the same cache sidefile area.

Combining HRC, HXRC, and CC. Table 3.1 shows the requirements and restrictions for combining HRC, HXRC, and CC operations on the same 9900 device. For further information on XRC and/or CC, please refer to the applicable IBM documentation.

Table 3.1 Requirements and Restrictions for Combining HRC, HXRC, and CC

Combination allowed?	HRC M-VOL	HRC R-VOL	HXRC Primary	HXRC Secondary	CC Source
HRC M-VOL	--	No	Yes for HRC Sync, No for HRC Async	Yes	Yes
HRC R-VOL	No	--	No	No	No
HXRC Primary	Yes for HRC Sync, No for HRC Async	No	--	Yes*	Yes
HXRC Secondary	Yes	No	Yes*	--	Yes
CC Source	Yes	No	Yes	Yes	--

**Note:* A 9900 volume which is an HXRC secondary device cannot also be an HXRC primary in the same XRC session, but it can be an HXRC primary device in another XRC session.

3.7.1 Combining HRC and ShadowImage

HRC and ShadowImage (also called HMRCF) can be used together in the same subsystem and on the same volumes to provide multiple copies of data at the main and/or remote sites. Table 3.2 describes the host pair status reporting for HRC volumes, ShadowImage volumes, and HRC/ShadowImage shared volumes. Table 3.3 shows the currency of the data on a shared HRC/ShadowImage volume based on HRC and ShadowImage pair status.

- For shared HRC/ShadowImage volumes, the HRC pair status is reported to the host if you query the R-VOL. To obtain the ShadowImage pair status, query the target volume (T-VOL) of the pair.
- ShadowImage supports multiple target volumes (T-VOLs) for each source volume (S-VOL). If you issue a pair status query to a ShadowImage S-VOL (e.g., CQUERY), the status for only one ShadowImage pair is reported (the pair with the T-VOL with the lowest LDEV ID). To obtain the pair status for the ShadowImage 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 (e.g., CQUERY DEVN parameter). The ShadowImage remote console software displays the LDEV ID and ShadowImage pair status of all T-VOLs associated with an S-VOL.

Table 3.2 Host Pair Status Reporting for HRC/ShadowImage Shared Volumes

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

Table 3.3 Data Currency of a Shared HRC/ShadowImage Volume

	ShadowImage Pair Status					
HRC Pair Status	Pending Duplex	Duplex	Split-Pending	Split	Resync	Suspended
Pending Duplex	Not current	Not current	Not current	CURRENT	Not current	Not current
Duplex	Not current	Not current	Not current	CURRENT	Not current	Not current
Suspended	Not current	CURRENT	CURRENT	CURRENT	CURRENT	Not current

Figures 3.15 through 3.18 show the various HRC/ShadowImage (HMRCF) configurations which share volumes. HRC supports synchronous and asynchronous operations for shared volumes. Figure 3.15 shows an example of a volume which is functioning as both an HRC M-VOL and an HMRCF S-VOL. This configuration allows you to:

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

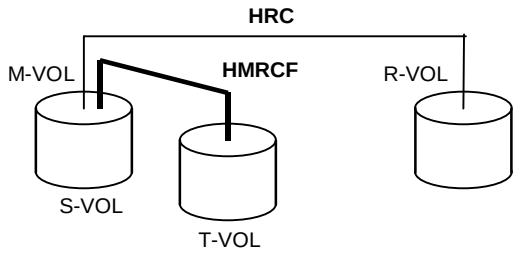


Figure 3.15 HRC and HMRCF: Shared M-VOL/S-VOL

Figure 3.16 shows an example of a volume which is functioning as both an HRC R-VOL and an HMRCF S-VOL. This configuration allows you to use HMRCF to provide additional remote copies of HRC M-VOLs.

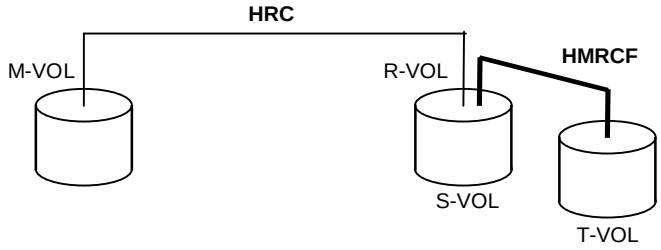


Figure 3.16 HRC and HMRCF: Shared R-VOL/S-VOL

Figure 3.17 shows an example of a volume which is functioning as both an HRC M-VOL and an HMRCF S-VOL, while the R-VOL of the same HRC pair is also functioning as the S-VOL of another HMRCF pair. This configuration allows you to:

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

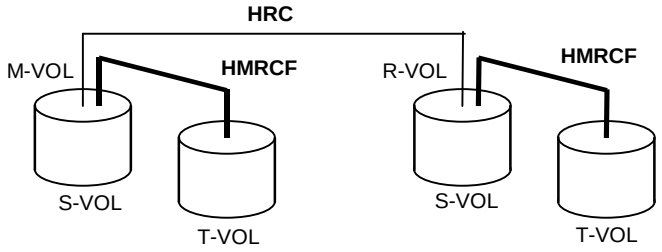


Figure 3.17 HRC and HMRCF: Shared M-VOL/S-VOL and R-VOL/S-VOL

Figure 3.18 shows an example of a volume functioning as both an HRC M-VOL and an HMRCF T-VOL. ***Note***: This configuration does not allow HMRCF and HRC to copy at the same time. Create the HMRCF pair first, and then split the pair before creating the HRC pair. You must suspend the HRC pair in order to resync the HMRCF pair.

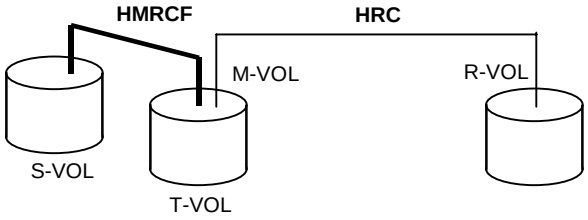


Figure 3.18 HRC and HMRCF: Shared M-VOL/T-VOL

3.7.2 Combining HRC and Hitachi GRAPH-Track

The Hitachi GRAPH-Track (GT) software product provides detailed information on the I/O activity and hardware performance of the 9900 (and 7700E) subsystems. GRAPH-Track can be used to monitor the 9900 subsystems which will be (or already are) performing HRC operations. The subsystem usage and performance data collected and displayed by GRAPH-Track enables you to:

- Identify the best times to perform HRC data duplexing operations (e.g., during periods of light system I/O activity),
- Adjust the cache settings of the subsystems to accommodate HRC operations (e.g., increase DW cache during HRC initial copy operations), and
- Determine the best locations for the HRC R-VOLs (e.g., in array groups with less frequently accessed volumes to avoid bottlenecks of backend activity),
- Monitor subsystem performance during HRC operations and during your testing activities.

GRAPH-Track data collection does not affect subsystem operations in any way. However, GRAPH-Track data collection can cause a significant amount of traffic on the 9900-internal LAN, especially when GRAPH-Track is collecting lots of LDEV data. To prevent timeouts from occurring while you are performing HRC operations on the Remote Console PC (or other operations on the Remote Console PC), you may want to decrease GRAPH-Track data collection activities before using the 9900 remote console software (RMCMAIN). This reduces 9900-internal LAN traffic, so that inquiries and commands issued by the Remote Console PC can be processed more quickly.

To perform HRC (or other) remote console operations while GRAPH-Track is collecting data for one or more subsystems on the same 9900-internal LAN:

1. If GRAPH-Track is collecting lots of LDEV data, consider disabling GRAPH-Track LDEV data collection for one or more subsystems before using the remote console software. Please refer to the GRAPH-Track online help for instructions on disabling LDEV data collection.
2. If GRAPH-Track is collecting data for more than three subsystems on the 9900-internal LAN, consider disconnecting GRAPH-Track from one or more subsystems before using the remote console software. Refer to the GRAPH-Track online help for instructions on disconnecting GRAPH-Track.
3. After you have disabled LDEV data collection and/or disconnected GRAPH-Track, you can connect to the subsystem using RMCMAIN, launch the HRC remote console software, and perform HRC operations (e.g., add/delete/suspend/resume pairs, view pair status).
4. When you are finished performing HRC operations, exit the HRC software, and then exit the Function Select panel to disconnect RMCMAIN from the subsystem.
5. After you have disconnected RMCMAIN, you can re-enable GRAPH-Track data collection.

Chapter 4 Performing HRC Configuration Operations

The HRC configuration operations include the MCU operations, RCU operations, HARC control operations, discontinuing HRC operations, and scripting. The HRC Main Control panel (see section 4.1) provides access to all HRC configuration operations.

The MCU operations (see section 4.2) configure the MCUs for HRC operations and include:

- Adding the MCUs,
- Changing the CU image,
- Configuring the MCU serial interface ports,
- Monitoring the MCU volume usage statistics, and
- Clearing the remote copy SIMs.

The RCU operations (see section 4.3) configure the RCUs for HRC operations and include:

- Adding the RCUs,
- Setting the RCU options,
- Adding/deleting logical paths to an RCU,
- Adding/deleting subsystem IDs (SSIDs) for an RCU,
- Viewing RCU status, and
- Deleting RCUs.

The HARC control operations (see section 4.4) configure HARC groups and asynchronous options and include:

- Setting the MCU asynchronous options,
- Adding consistency groups,
- Setting the consistency group options,
- Viewing consistency group status, and
- Deleting consistency groups.

If you want to discontinue HRC operations (see section 4.5), you must perform the required HRC operations (e.g., pair deletion, RCU deletion, port reconfiguration, etc.) in a specific order to ensure smooth operations and avoid command rejects and error conditions.

The HRC scripting function (see section 4.6) allows you to specify and execute a series of HRC operations without having to issue each command separately. Appendix E provides the syntax and format requirements for the HRC script files.

The HRC Main Control panel also provides access to all HRC volume pair operations: adding and deleting pairs, suspending and resuming pairs, and viewing pair status. Chapter 5 describes and provides instructions for performing the HRC volume pair operations.

4.1 HRC Main Control Panel

The HRC Main Control panel (see Figure 4.1) displays the HRC information for the selected CU image of the connected subsystem and provides access to all HRC functions. The HRC Main Control panel is accessed from the Function Select panel (**HRC** button).

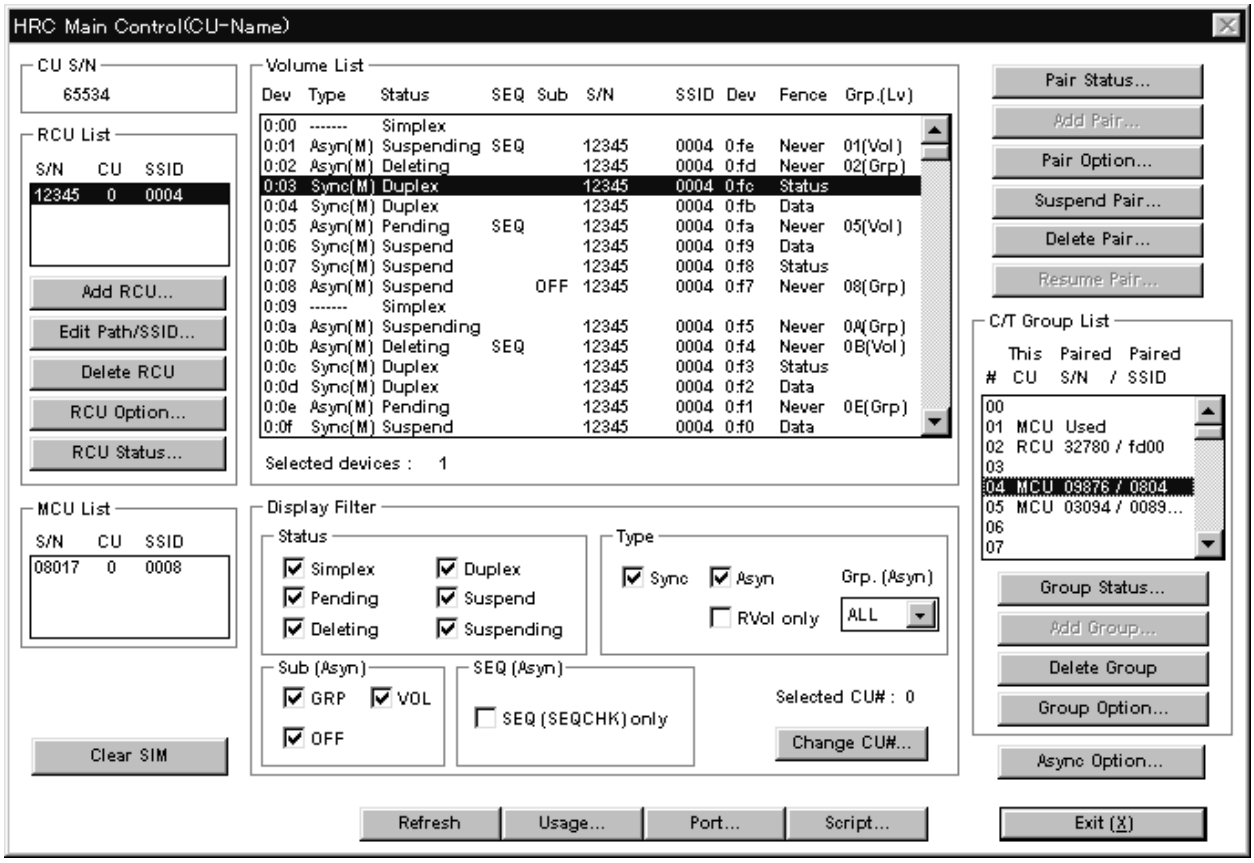


Figure 4.1 HRC Main Control Panel

To open the HRC Main Control panel:

1. Start up and log in to RMCMAIN. If you want to perform HRC operations, log in with administrator access. You do not need administrator access to view HRC information.
2. Connect to the desired 9900 subsystem using the Connection Control panel.
3. When the Function Select panel opens, select **HRC** to open the HRC Main Control panel.
4. The HRC Main Control panel displays the HRC pair information for the most recently selected CU image of the connected subsystem (CU 0 is the default CU image) and allows you to perform HRC operations. The HRC Main Control panel is described below.

The **CU S/N** field displays the serial number of the connected subsystem. The **RCU List** box displays the RCUs which have been added to the current CU image. The buttons below the **RCU List** box provide access to the RCU operations (see section 4.3): add RCU, edit path/SSID, delete RCU, RCU options, and RCU status. The **MCU List** box displays the MCUs for the R-VOLs in the current CU image.

The **Volume List** box displays the volumes in the current CU image of the connected subsystem and displays the HRC pair information (see section 4.4.1) for each volume. The **Display Filter** box (see section 4.1.2) allows you to control which volumes are displayed by pair status, pair type, and group number. The **Change CU#** button allows you to select the CU image to be displayed on the HRC Main Control panel. You must change CU images to access all 4,096 LDEVs in the 9900 subsystem.

The **Clear SIM** button allows you to clear all remote copy SIMs from the connected subsystem (see section 4.2.5). The **Refresh** button refreshes the information displayed on the HRC Main Control panel. The **Usage…** button opens the Remote Copy Monitoring panel (see section 4.2.4), which displays remote copy I/O statistics for the connected subsystem. The **Port…** button opens the Port Change panel (see section 4.2.3), which allows you to configure the serial ports of the connected subsystem. The **Script…** button opens the Script Monitor panel (see section 4.6), which allows you to run an HRC script.

The **Pair Status…**, **Add Pair…**, **Pair Option…, Suspend Pair…**, **Delete Pair…**, and **Resume Pair…** buttons allow you to perform HRC volume pair operations (see Chapter 5).

The **C/T Group List** box displays the consistency group information for the connected subsystem: group number, CU type of the connected subsystem (MCU and/or RCU), serial number and SSID of the other CU in the group. The buttons below the **C/T Group List** box provide access to the HARC control operations (see section 4.4): group status, add group, delete group, and group options. The **Async Option…** button opens the Async Option panel (see section 4.4.1), which allows you to select the HRC Asynchronous options for the connected MCU.

The **Exit** button closes the HRC Main Control panel, exits the HRC software, and returns you to the RMCMAIN Function Select panel. Exiting the HRC software does not affect the HRC activities in progress.

4.1.1 Volume List Box

The **Volume List** box on the HRC Main Control panel displays the following information for each volume in the current CU image of the connected subsystem:

- **Dev**. CU image:LDEV ID (CU images = 0-F (hexadecimal); LDEV IDs = 00-FF (hexadecimal).
- **Type**. Volume pair type:
  - ------ indicates simplex.
  - **Sync** indicates HRC Synchronous update copy mode.
  - **Asyn** indicates HRC Asynchronous update copy mode.
  - (**M**) indicates the volume is an M-VOL, (**R**) indicates the volume is an R-VOL.
- **Status**. HRC pair status (see section 2.5 for further information on HRC pair status):
  - **Simplex**. The volume is not currently assigned to an HRC volume pair. When the volume is assigned to an HRC pair, *simplex* changes to *pending duplex*.
  - **Pending**. The HRC initial copy operation is in progress. The data on the HRC pair is not fully identical. When the initial copy is complete, *pending* changes to *duplex*.
  - **Duplex**. The HRC initial copy operation is complete. The HRC pair is synchronized. All updates from the host processor to the M-VOL are being duplicated at the R-VOL.
  - **Suspend**. The HRC pair has been suspended. Open the Pair Status panel to view the suspend type (see section 2.5) and detailed pair status information.
  - **Suspending**. The HARC pair is being suspended. When the HARC suspend operation is complete, *suspending* changes to *suspended*.
  - **Deleting**. The HARC pair is being deleted. When the HARC delete operation is complete, *deleting* changes to *deleted*.
- **SEQ**. HARC *SEQCHK* pair status (displayed only for HARC R-VOLs).
- **Sub**. HARC consistency status (displayed only for suspended HARC R-VOLs).
- **S/N** and **SSID**. S/N and SSID of the other CU (MCU or RCU) in the volume pair.
- **Dev**. Device ID (CU:LDEV) of the other volume (M-VOL or R-VOL) in the volume pair.
- **Fence**. M-VOL fence level (see section 5.2.2) of the volume pair: data, status, or never.
- **Grp**. HARC consistency group number of the volume pair (HARC only).
- **Lv**. HARC error level (see section 5.2.2) of the volume pair (HARC only).

Note: Volumes which are currently assigned to ShadowImage pairs are displayed in the **Volume List** box as *simplex*. Volumes which are currently assigned to HODM volume pairs are not listed at all in the **Volume List** box. The user is responsible for managing volumes assigned to HXRC, ShadowImage, and HODM pairs.

4.1.2 Display Filter

The **Display Filter** box on the HRC Main Control panel (see Figure 4.2) allows you to control which volumes are displayed in the **Volume List** box by CU image, and within each logical CU image by pair status, pair type (synchronous or asynchronous), group number (HARC only), consistency status (HARC only), and *SEQCHK* status (HARC only).

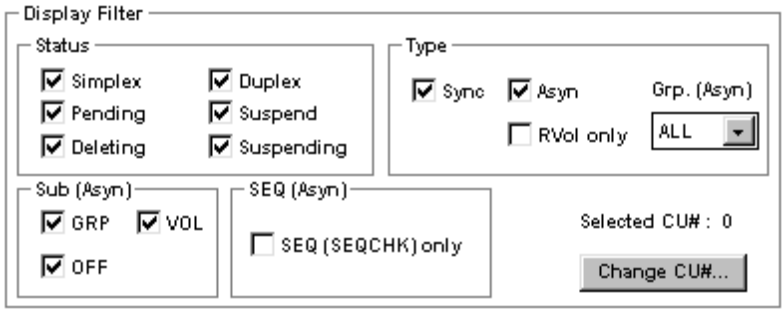


Figure 4.2 Display Filter on the HRC Main Control Panel

The **Status** box allows you to display only HRC volumes which have the selected pair status: **Simplex**, **Pending**, **Duplex**, **Suspend**, **Deleting** (HARC only), and/or **Suspending** (HARC only). Simplex volumes are always displayed (except when **SEQ** box is selected).

The **Type** box allows you to select the types of HRC volumes to be displayed: **Sync**, **Asyn**, and/or **RVol only**. The **Grp (Asyn)** drop-down list box allows you to select the group(s) to be displayed.

The **Sub(Asyn)** box allows you to display only volumes with the selected consistency status: **GRP**, **VOL**, and/or **OFF** (to display volumes which do not have a consistency status).

The **SEQ(Async)** box allows you to display only HARC volumes with the *SEQCHK* status. When this box is selected, the HRC Synchronous and simplex volumes are not displayed.

The **Selected CU#** field displays the current CU image. The **Change CU#...** button allows you to display another CU image (CU 0, 1, 2, …F) in the connected CU. The **Volume List** box displays only the volumes behind the selected CU image, and the HRC operations (e.g., add RCU, add pair) apply only to the volumes in the selected CU image. ***Note:*** When you are performing HRC operations, you must make sure to select the appropriate CU image to access the desired volumes and MCU-RCU paths.

4.2 MCU Operations

The MCUs are the disk control units which control the M-VOLs of the volume pairs. Each subsystem which is attached to the Remote Console PC on the 9900-internal LAN can function as an MCU. The MCUs receive and process HRC commands from the Remote Console PC and send the HRC copy operations to the RCUs. The MCUs can also function as RCUs, provided the remote copy connections are properly configured.

The MCU operations are:

- Adding MCUs (see section 4.2.1),
- Changing the CU image (see section 4.2.2),
- Configuring the MCU serial interface ports (see section 4.2.3),
- Monitoring the MCU remote copy I/O statistics (see section 4.2.4), and
- Clearing the remote copy SIMs (see section 4.2.5).

4.2.1 Adding MCUs

All HRC MCUs must be added to the Remote Console PC, so that you can connect and use the HRC software. The RMCMAIN Add Machine panel (see Figure 4.3) allows you to add 9900 subsystems to the Remote Console PC. Each subsystem added to the Remote Console PC can function as an HRC MCU, provided the remote copy connections are properly configured.

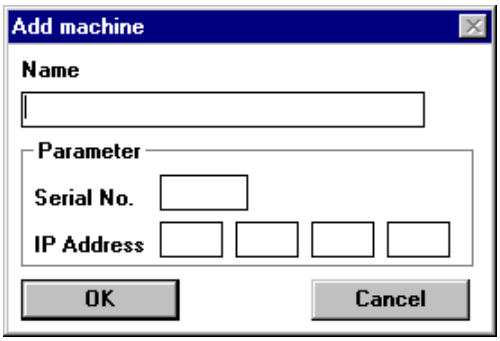


Figure 4.3 Add Machine Panel

To add a 9900 subsystem to the Remote Console PC:

1. Start up and log in to the RMCMAIN software with administrator access, and then select **Controller…** to open the Connection Control panel.
2. On the Connection Control panel, select **Add…** to open the Add Machine panel.
3. Enter the subsystem name, S/N, and SVP IP address on the Add Machine panel, and select **OK**. You are returned to the Connection Control panel.
4. Select the subsystem you just added, and select **Entry** on the Connection Control panel to confirm the LAN connection to and register the Remote Console PC with the SVP.
5. Select the subsystem again, select **Install…** on the Connection Control panel, and make sure the desired HRC modes are installed. If not, see section 3.5 for instructions.

4.2.2 Changing the CU Image

The 9900 subsystem provides sixteen CU images, one for each set of 256 LDEVs. The Change CU# panel (see Figure 4.4) allows you to select the CU image to be displayed on the HRC Main Control panel. To open the Change CU# panel, select the **Change CU#** button on the HRC Main Control panel. For further information on CU images, see section 2.1.2.

Note: The following HRC operations do not have to be performed separately for each CU image: configure MCU ports, add group, and set RCU options.

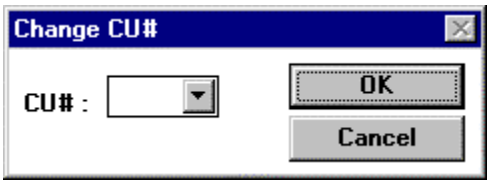


Figure 4.4 Change CU# Panel

The **CU#** drop-down list box allows you to select the desired CU image: 0-F. When the HRC Main Control panel first opens, the HRC information for CU 0 is displayed. To change the CU image:

1. On the HRC Main Control panel, select **Change CU#** to open the Change CU# panel.
2. On the Change CU# panel, select the desired CU number in the **CU#** drop-down list box, and then select **OK**. The HRC Main Control panel now displays the HRC information for the newly selected CU image.

4.2.3 Configuring the MCU Ports

All serial interface ports on the 9900 subsystem have a default setting of local control port (LCP). LCP mode is used for host processor channel interface. The 9900 serial interface ports which will be used for HRC communications to the RCUs must be configured as remote control ports (RCPs). RCP mode emulates a host processor channel to enable the MCU to send write I/O operations directly to the RCU. The HRC remote console software allows you to change the configuration of the 9900 ports as needed to accommodate the desired host and HRC communications paths. The RCPs must be configured before you can add the RCUs and establish the HRC volume pairs. For further information on the RCPs, see section 2.1.5.

To fully support an automated environment, the 9900 subsystem is capable of automatically configuring a serial port as an RCP or LCP if required in response to the TSO CESTPATH and CDELPATH commands. See SVP mode 114 in Table 2.1. The 9900 subsystem will check to ensure that the MCU port requested in the CESTPATH command is offline to the host, and will automatically configure it as an RCP if required. Similarly, the corresponding RCU port will also be configured as an LCP if required. When the CDELPATH command is issued, the HRC logical paths are removed, and if there are no more HRC or HORC logical paths on the port, the 9900 subsystem automatically changes the port from RCP mode to LCP mode.

The Port Change panel (see Figure 4.5) displays the serial interface ports of the connected subsystem and allows you to change the mode (local or remote) of each port. The Port Change panel is accessed from the HRC Main Control panel (**Port…** button).

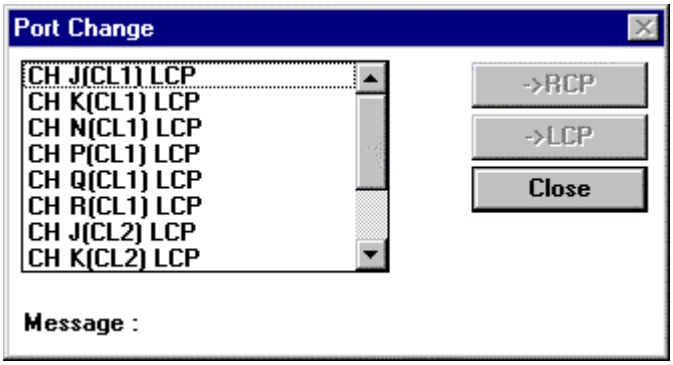


Figure 4.5 Port Change Panel

The Port Change panel displays the current configuration of each serial interface port of the connected subsystem. For example, **CH J(CL2) LCP** indicates that the port for channel J in cluster 2 is configured as an LCP. The **→RCP** button changes the selected port(s) from a local control port (LCP) to an remote control port (RCP). The **→LCP** button changes the selected port(s) from an RCP to an LCP. The **Message** area displays the status of the port configuration operation.

Note: Before changing the operation mode from LCP to RCP, all channel paths to the specified port must be removed using the host system console or ESCD commands.

LCP→RCP. To change one or more LCPs to RCPs:

1. Start RMCMAIN, connect to the desired subsystem, and start the HRC software.
2. On the HRC Main Control panel, select **Port…** to open the Port Change panel.
3. The Port Change panel displays all serial interface ports of the connected subsystem. Select the LCP(s) you want to reconfigure, and then select the **→RCP** button.
4. The Remote Console now displays a message asking you to vary the selected channel paths offline. Make sure the selected paths are offline from the host(s), and then select **OK**.
5. The **Message** area displays the status of the port change operation. The 9900's SVP makes sure the channels are offline, then blocks the channels, and loads the microcode.
6. When the port change operation is complete, the Remote Console displays a window asking you to exchange the channel cable connections. At this point you can remove the existing host connections and make the connections to the RCUs.
7. After the channel cable connections have been exchanged, select **OK**. The **Message** area will display the status of the port recovery operation. When the port recovery operation is complete, you may close the Port Change panel or reconfigure additional ports as needed.

RCP→LCP. After you have finished all HRC operations between an MCU and an RCU, you must delete the HRC volume pairs and delete the RCU from the MCU before you can change the RCP(s) back to LCP(s). See section 4.5 for instructions on discontinuing HRC operations.

To change one or more RCPs to LCPs:

1. Start RMCMAIN, connect to the desired subsystem, and start the HRC software.
2. Make sure that you have deleted all affected RCUs and volume pairs. Delete the volume pairs first (see section 5.6), and then delete the RCUs (see section 0).
3. On the HRC Main Control panel, select **Port…** to open the Port Change panel.
4. On the Port Change panel, select the RCP(s) you want to reconfigure, and then select the **→LCP** button.
5. The Remote Console displays a message window asking you to vary the selected channel paths offline. Make sure the selected paths are offline from the host(s), and then select **OK**.
6. The **Message** area displays the status of the port change operation. The 9900's SVP makes sure the channels are offline, then blocks the channels, and loads the microcode.
7. When the port change operation is complete, the Remote Console displays a window asking you to exchange the channel cable connections. At this point you can connect the host interface cables to the reconfigured ports.
8. After the channel cable connections have been exchanged, select **OK**. The **Message** area will display the status of the port recovery operation. When the port recovery operation is complete, you may close the Port Change panel.

4.2.4 Monitoring Remote Copy Activities

The Remote Copy Monitoring panel (see Figure 4.6) displays the user-selected remote copy I/O statistics for the selected LDEVs in the connected 9900 subsystem. The Remote Copy Monitoring panel is accessed from the HRC Main Control panel (**Usage...** button). Remote copy monitoring is available to all 9900 Remote Console users.

Table 4.1 lists and describes the remote I/O (RIO) statistics that can be displayed on the Remote Copy Monitoring panel. The RIO is a special I/O operation which transfers data to the RCU in FBA format (not CKD) using a single channel command, eliminating the overhead associated with FBA-CKD conversion and thus providing more efficient transfer of user data.

Note: The RIO statistics include both HRC and HORC remote copy operations (e.g., total RIO count = HRC RIOs + HORC RIOs), unless otherwise specified (e.g., restore copy IO counts apply to HODM only).

Figure 4.6 Remote Copy Monitoring Panel

The Monitoring panel plots the user-selected I/O statistics on an x-y graph. The x-axis displays time, and the y-axis displays the number of I/Os during the last sampling period. The user-selected data sampling rate is displayed to the right of the graph area, and the graph is updated at each sampling time. The user-selected data legend is located below the graph, providing a color coded key to identify the charted information. The **Monitor** pull-down menu allows you to begin monitoring another volume or exit the Monitoring panel. The **Window** menu lists the active monitoring panels and allows you to arrange the panels (cascade, tile or icon). The **Display** menu allows you to display the graph with or without the graphical legend.

To view the HRC I/O statistics for one or more volumes:

1. Start RMCMAIN, connect to the desired subsystem, and start the HRC software.
2. On the Main Control panel, select **Usage…** to open the Remote Copy Monitoring panel.
3. On the Remote Copy Monitoring panel, select the **Monitor** menu, and then select **Start**. The Monitoring Parameter panel opens (see Figure 4.7).
4. On the Monitoring Parameter panel, enter the desired subsystem data sampling rate (from one minute to 546 minutes in one-minute increments), and then select **OK**. The Select Logical Device panel now opens (see Figure 4.8).
5. On the Select Logical Device panel, select **Subsystem Total Count** to display I/O statistics for all LDEVs in the connected subsystem, or select **Logical Device Count** and then select the desired CU image and LDEV(s). When you are finished selecting LDEVs, select **OK**. The Select Monitoring Data panel now opens (see Figure 4.9).
6. On the Select Monitoring Data panel, select the I/O statistics you want to view, and then select **OK**. See Table 4.1 for a description of the I/O statistics.
7. The Remote Copy Monitoring panel now opens and displays the selected I/O statistics for the selected LDEV(s). To open another monitoring panel for another set of LDEVs, repeat steps (3) through (6). You can open several monitoring displays at the same time and use the Window menu commands to arrange the panels on screen.

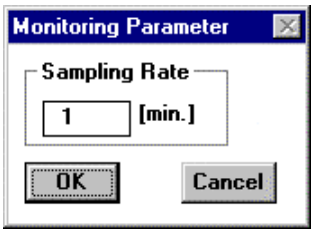


Figure 4.7 Monitoring Parameter Panel

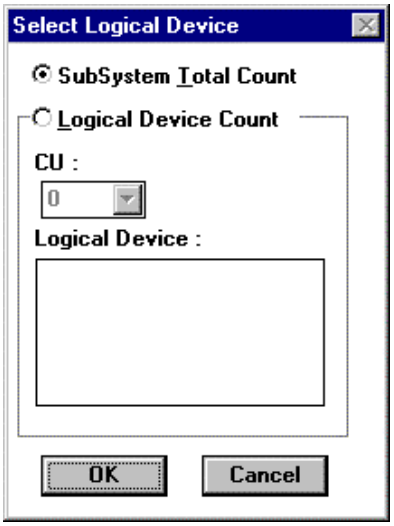
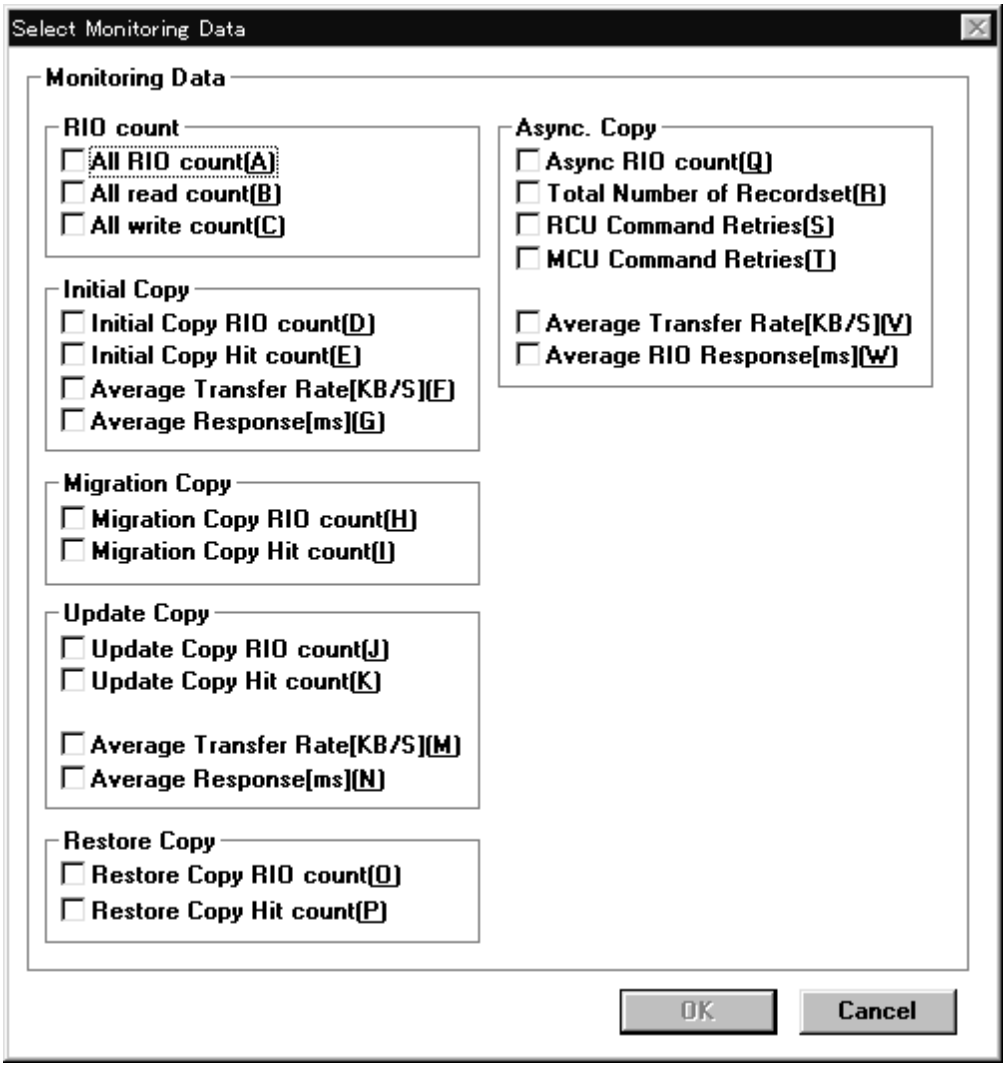


Figure 4.8 Select Logical Device Panel



Note: The migration copy and restore copy operations apply only to HODM volumes.

Figure 4.9 Select Monitoring Data Panel

Table 4.1 Monitoring Panel I/O Statistics

Statistic	Description
RIO count	
All RIO count	Total number of remote I/Os
All read count	Total number of remote read I/Os
All write count	Total number of remote write I/Os
Initial copy	
Initial copy RIO count	Number of initial copy remote I/Os
Initial copy hit count	Number of initial copy hits
Average transfer rate (KB/S)	Average transfer rate (KB/sec) for initial copy remote I/Os
Average response (ms)	Average response time (msec) for initial copy remote I/Os
Migration Copy (HODM only)	
Migration copy RIO count	Number of HODM migration copy remote I/Os
Migration copy hit count	Number of HODM migration copy hits
Update copy	
Update copy RIO count	Number of update copy remote I/Os
Update copy hit count	Number of update copy hits
Average transfer rate (KB/S)	Average transfer rate (KB/sec) for update copy remote I/Os
Average response (ms)	Average response time (msec) for update copy remote I/Os
Restore Copy (HODM only)	
Restore copy RIO count	Number of HODM restore copy remote I/Os
Restore copy hit count	Number of HODM restore copy hits
Asynchronous copy	
Asynchronous RIO count	Number of asynchronous update copy remote I/Os
Total number of recordsets	Number of HARC recordsets
RCU command retries	Number of command retries due to RCU channel-command-retry messages.
MCU command retries	Number of command retries due to MCU SCP messages.
Average transfer rate (kB/sec)	Average transfer rate (kB/sec) for HRC/HORC async update copy remote I/Os
Average RIO response (ms)	(Total RIO process time on a subsystem or selected volume for a certain interval period) / (Asynchronous RIO count); where RIO process time = time between the asynchronous data transfer request and the actual transfer of the recordset(s) to the RCU.

Note: The migration copy and restore copy statistics apply only to HODM volumes. All other RIO statistics include both HRC and HORC remote copy operations (e.g., async RIO count = HRC Async RIOs + HORC Async RIOs).

4.2.5 Clearing SIMs

The **Clear SIM** button on the HRC Main Control panel allows you to clear all remote copy SIMs (service information messages) from the connected subsystem. Remote copy SIMs include all SIMs issued for HRC, HORC, and HODM operations. The clear SIM function is intended for use during disaster recovery operations, while switching operations to the remote (secondary) backup site. Please see section 6.2 for specific instructions on clearing remote copy SIMs during disaster recovery operations.

To clear all remote copy SIMs from a 9900 subsystem:

1. Start RMCMAIN (log in as administrator), connect to the desired subsystem, and start the HRC software.
2. On the HRC Main Control panel, select the **Clear SIM** button.
3. On the Clear SIM confirmation panel (see Figure 4.10), select **Yes** to clear all remote copy SIMs from the connected subsystem, or select **No** to cancel your request to clear SIMs.
4. If you selected **Yes**, the subsystem verifies that the existing SIMs are being cleared (see Figure 4.11).

   Note: When all SIMs have been cleared, the subsystem MESSAGE lamp on the 9900 control panel turns off. This may take up to 30 minutes. If there are any existing SIMs which are not related to remote copy operations, the MESSAGE lamp will not turn off.

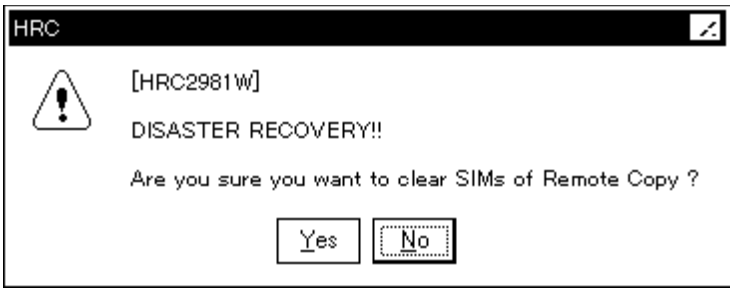


Figure 4.10 Clear SIM Confirmation Panel

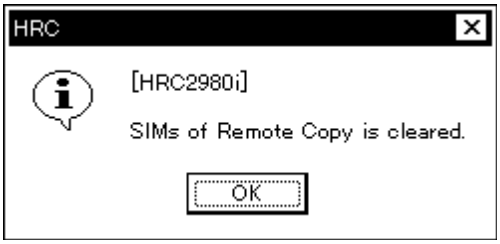


Figure 4.11 Clear SIM Completion

4.3 RCU Operations

The RCUs are the control units which control the R-VOLs of the volume pairs. The RCUs are connected to the MCUs via the remote copy connections and receive and process commands from the MCUs. For HRC operations, the secondary Remote Console PC at the remote site should be connected to the RCUs to allow HRC commands to be issued directly to the RCU (e.g., in case of disaster or failure at the main site).

The RCU operations are performed separately for each CU image of each MCU and RCU to provide maximum flexibility in HRC configurations. The RCU operations are:

- Adding RCUs (see section 4.3.1),
- Setting the RCU options* (see section 4.3.2),
- Determining the RCU path parameters (see section 4.3.3),
- Adding and deleting logical paths to an RCU (see section 4.3.4),
- Adding and deleting SSIDs for an RCU (see section 4.3.5),
- Viewing RCU status (see section 4.3.6), and
- Deleting RCUs (see section 0).

**Note:* The RCU options apply to all CU images of the MCU. All other RCU operations must be performed separately for each CU image of the MCU.

4.3.1 Adding an RCU

You can add up to four RCUs to each MCU, and you can establish up to four paths to each RCU. You must add each CU image as a separate RCU. The logical paths are established for the CU images of the MCU and RCU separately. The maximum number of logical paths for each MCU is 64 (4 paths per CU image × 16 CU images). The remote copy connections and MCU ports must be properly installed and configured before you can add an RCU. When you add an RCU, the current CU image of the MCU registers the specified CU image as an HRC RCU and establishes the specified number of logical paths to the RCU. After you have added an RCU (and path status is normal), you can establish HRC volume pairs which have R-VOLs in the newly added RCU.

The Add RCU panel (see Figure 4.12) allows you to add an RCU to the current CU image of the connected MCU. The Add RCU panel is accessed from the HRC Main Control panel (**Add RCU…** button).

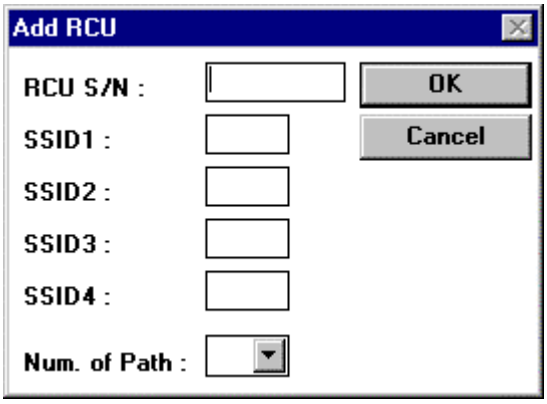


Figure 4.12 Add RCU Panel

The **RCU S/N** and **SSID** fields allow you to enter the serial number and SSID(s) of the RCU being added. The 9900 uses one SSID for each set of 256 volumes and four SSIDs per CU image. The **Num. of Path** box allows you to select the number of paths (up to four) to be established between the MCU and RCU. When you select **OK**, the RCU Option panel opens automatically (see section 4.3.2), followed by the Path Parameter panel (see section 4.3.3).

Note: The CESTPATH TSO command can also be used to add an RCU, once the MCU-to-RCU hardware connections are established. Refer to Appendix B for further information on PPRC TSO and ICKDSF commands.

To add an RCU to the connected MCU:

1. Make sure the remote copy connections and MCU ports are properly configured. Get the S/N of the RCU and the SSID(s) for the desired CU image in the RCU. The add RCU operation will fail without this information. The 9900 subsystem should have a label or tag indicating its S/N and SSIDs. The Hitachi Data Systems representative can also get the RCU S/N and SSIDs using the RCU's SVP (i.e., at the remote site).
2. On the HRC Main Control panel, make sure the correct CU image is selected (0-F). Use the **Change CU#** button to change CU images. You must add the RCUs to each CU image separately.
3. On the HRC Main Control panel, select **Add RCU…** to open the Add RCU panel.
4. On the Add RCU panel, enter the S/N of the RCU and the SSID(s) for the desired CU image. The MCU verifies the S/N when the paths are established, and verifies the SSIDs when the volume pairs are established. If desired, you can add and delete SSIDs later using the Edit SSID panel (see section 4.3.5).
5. Select the number of paths to be established to the RCU in the **Num. of Path** list box (1 through 4). The MCU will not allow you to establish less than the minimum number of paths as specified on the RCU Option panel (see section 4.3.2). If desired, you can add and delete paths later using the Edit Path panel (see section 4.3.4).
6. After entering the S/N, SSID(s), and number of paths, select **OK**. The RCU Option panel now opens.
7. On the RCU Option panel, enter/select the desired RCU options (see section 4.3.2): **Minimum Paths**, **Maximum Initial Copy Activity**, **SCP Delay Time**, **Incident of RCU**, **PPRC support by host**, **Service SIM of Remote Copy**, and **FREEZE Option**. After selecting the desired options, make sure to select **OK** on the RCU Option panel (even if you made no changes). The Path Parameter panel (see section 4.3.3) now opens.
8. On the Path Parameter panel, enter the parameters for the first path (**Port**, **Link Adr**., and **Logical Adr**.), and then select **OK**. See section 4.3.3 for further information on the RCU path parameters. If you selected more than one path in step (5), the Path Parameter panel will reset to allow you to enter the information for the next path. When you have entered the parameters for all paths, the Path Parameter panel will close when you select **OK**.
9. The new RCU is displayed in the **RCU List** box on the HRC Main Control panel. To check the path status for this RCU, select the RCU, and then select **RCU Status…**. Refer to Table 7.2 in section 7.1 for detailed information on the path status.

4.3.2 RCU Options

The RCU Option panel (see Figure 4.13) allows you to set the RCU options for the connected subsystem. The RCU options apply to all CU images of the current MCU and to all RCUs connected to the MCU. The RCU Option panel opens automatically when you add an RCU. The RCU Option panel can also be accessed from the HRC Main Control panel (**RCU Option…** button).

Note: The Minimum Paths and Maximum Initial Copy Activity settings are common to both HRC and HORC operations. The most recently entered values (entered on either the HRC or HORC RCU Option panel) will be applied to both HRC and HORC operations.

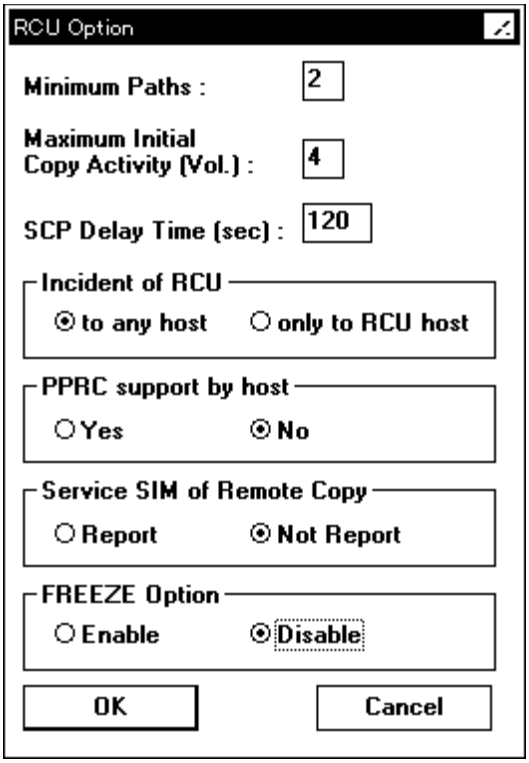


Figure 4.13 RCU Option Panel

The **Minimum Paths** option allows you to specify the minimum number of paths required for each RCU connected to the current MCU. If the number of paths falls below this number (e.g., due to a failed path), the MCU will suspend all affected HRC (and HORC) pairs to prevent remote copy operations from adversely affecting performance due to the inadequate number of paths. For HRC pairs which contain critical data for disaster recovery, the minimum number of paths should be set to one so that HRC operations continue even if there is only one path to an RCU. If you need to maintain high performance at the MCU, set the minimum paths to two or more (up to four per CU image), depending on the number of pairs managed by the MCU.

CAUTION: If HRC pairs are suspended because the number of paths has dropped below this setting, the M-VOL fence level pair option (see section 5.2.2) determines whether the HRC Synchronous M-VOLs are fenced (i.e., reject all write operations).

The **Maximum Initial Copy Activity** setting specifies the number of concurrent initial copy operations (minimum = 1, maximum = 4). HRC initial copy activities can impact the performance of the main subsystem, depending on the amount of I/O activity and the number of pairs being added at the same time. The maximum initial copy activity setting allows you to limit the impact of initial copy activities on subsystem performance. For example, if you set the maximum initial copy activity to four and then add five HRC pairs at the same time, the MCU starts the first four pairs and will not start the fifth pair until one of the first four pairs is synchronized. The maximum initial copy activity value can only be set when adding new pairs. Once you have added an HRC volume pair, this setting cannot be changed for that pair.

The **SCP Delay Time** setting specifies the state-change-pending (SCP) delay time in seconds (0-600 seconds). CGROUP/FREEZE utilizes the SCP state to suspend host I/Os to HRC M-VOLs (see section B.3). HARC utilizes the SCP state for inflow control to prevent cache storage overload (see section 2.3.6). Make sure to set the SCP delay time after you have added all MCU-RCU paths. ***Caution:*** You must select **OK** on the RCU Option panel to register the **SCP Delay Time** setting, even if you did not make any changes to the RCU options. Please make sure to select the appropriate SCP delay time for your HRC system configuration.

The **Incident of RCU** option allows you to specify which host(s) the RCUs will report link incident records to. When **to any host** is selected, the RCUs will send link incident records to all RCU hosts and to all MCU hosts. When **only to RCU host** is selected, the RCUs send link incident records only to the RCU host(s). Make sure that RCU link incidents are reported to the proper host(s) so that corrective action, if needed, can be taken. The **to any host** setting is recommended when HRC is being used for disaster recovery purposes.

The **PPRC support** option allows you to specify whether the MCU will generate sense information which is compatible with IBM PPRC. This option is extremely important for HRC disaster recovery planning. If the host does not support PPRC, select **No** to configure the MCU to report SIMs. If the host system supports PPRC, select **Yes** to configure the MCU to generate PPRC-compatible sense information when an HRC pair is suspended instead of a service information message (SIM). If **Yes** is selected, the MCU will still report moderate- and serious-level SIMs, as well as DF40 and DF48 device SIMs. Refer to Appendix B for further information on PPRC support. ***Note:*** If you plan to utilize the CGROUP (FREEZE/RUN) command for HRC pairs, you must select **Yes**.

The **Service SIM of Remote Copy** option allows you to specify whether the MCU will report the service-level HRC SIMs to the host(s). (The moderate-, serious-, and acute-level SIMs are always reported to the host.) Select **Report** to configure the MCU to report the service-level HRC SIMs to the host(s). The **Report** setting should be selected for HRC disaster recovery planning. Select **Not Report** to suppress HRC service-level SIMs reporting. See Appendix D for a description of the HRC and HARC SIMs. ***Note:*** All service-level SIMs will be logged in the SSB.LOG file on the 9900 SVP, regardless of this setting.

The **FREEZE Option** setting allows you to enable or disable support for the CGROUP (FREEZE/ RUN) PPRC TSO command (see section B.3). The FREEZE option is available only when PPRC support = Yes. If you select **Enable**, the MCU will accept and perform the CGROUP command. If you select **Disable**, the MCU will reject the CGROUP command. ***Note:*** Make sure to enable the FREEZE option after you have added all MCU-RCU paths.

Note: The PPRC commands do not allow you to change the RCU options. Refer to Appendix B for further information on PPRC TSO and ICKDSF commands.

4.3.3 RCU Path Parameters

The RCU path parameters are similar to the channel path definitions in the I/O configuration dataset (IOCDS). In the IOCDS, a logical path is specified with a subchannel number, link destination address, and logical address for the CU. HRC uses the "port" parameter instead of the subchannel number to specify the MCU's serial interface port. For the 9900 subsystem, the logical address must correspond to the CU image number. Figure 4.14 shows a typical HRC remote copy configuration with two paths and gives the PPRC path parameters.

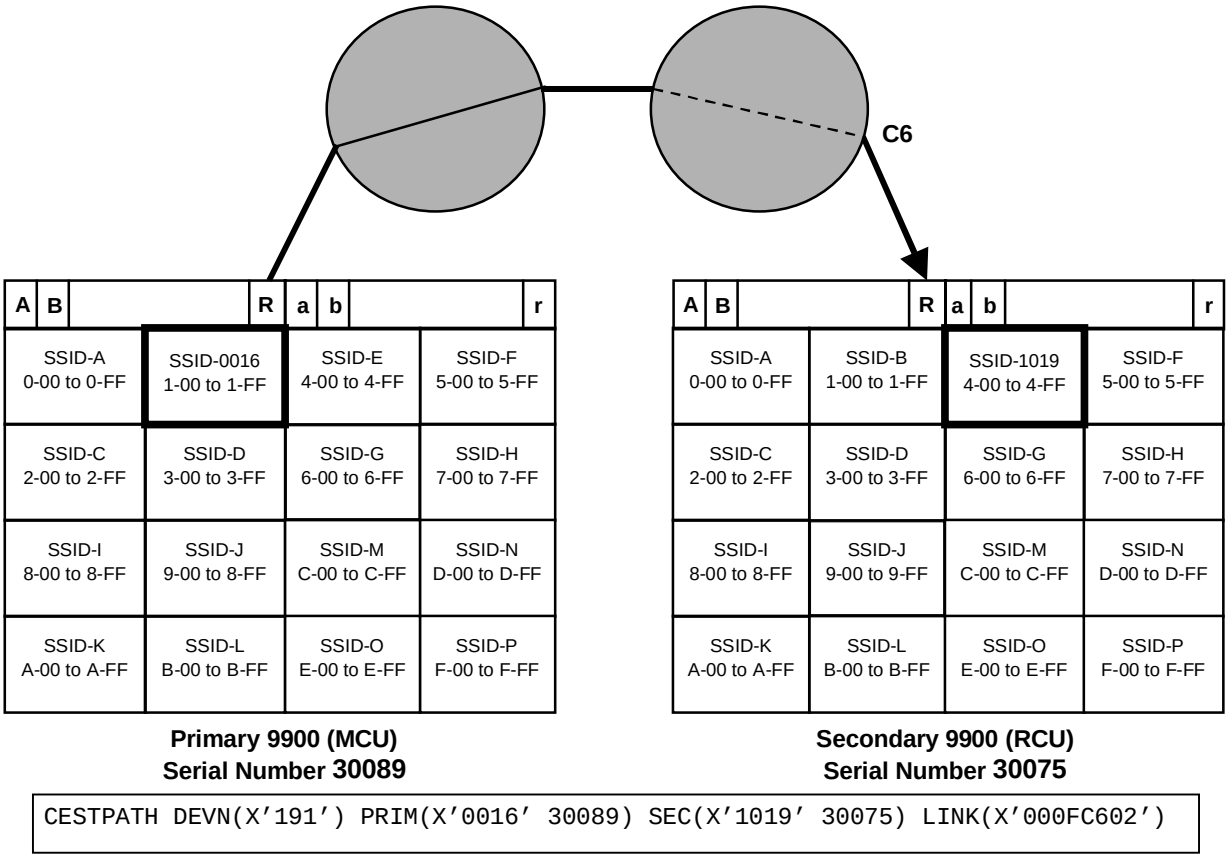


Figure 4.14 Adding an RCU: Remote Copy Connections and PPRC Path Parameters

The Path Parameter panel (see Figure 4.15) allows you to enter the parameters for a new logical path from the connected MCU to the specified RCU. The Path Parameter panel opens automatically when you add an RCU or add a path to an existing RCU.

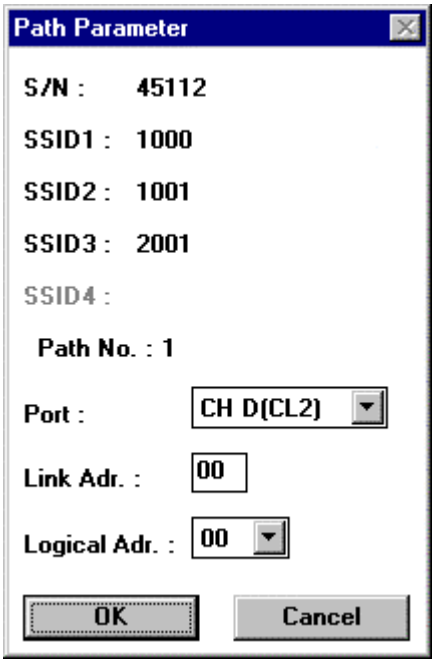


Figure 4.15 Path Parameter Panel

The Path Parameter panel displays the S/N and SSID(s) of the RCU to which the path is being established and allows you to enter the parameters for the new path. The **OK** button notifies the MCU to establish the specified path.

The RCU path parameters are:

- **Port**. The **Port** drop-down list box displays the remote control ports (RCPs) of the connected 9900. Only the ports which are already configured as RCPs are displayed.
- **Link Adr**. The **Link Adr**. field allows you to enter the link destination address for the new path. If the remote copy connection to the RCU is a dynamic link, the link address is the destination port address on the ESCD. If the remote copy connection to the RCU is a static link, the link address is 00.
- **Logical Adr**. The **Logical Adr**. drop-down list box allows you to select the logical CU address (CU 0-F) of the RCU.

4.3.4 Adding and Deleting Logical Paths for an RCU

The Path/SSID Edit panel (see Figure 4.16) provides access to the Edit Path panel and Edit SSID panel. The Edit Path panel (see Figure 4.17) allows you to add and delete logical paths from the MCU to an existing RCU. See section 4.3.5 for information on the Edit SSID panel. The Path/SSID Edit panel is accessed from the HRC Main Control panel.

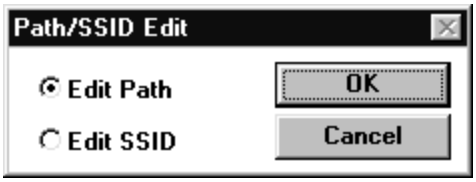


Figure 4.16 Path/SSID Edit Panel

Select the **Edit Path** button and click **OK** to add or delete paths to the selected RCU. Select the **Edit SSID** button and click **OK** to edit the SSIDs of the connected subsystem. See section 4.3.5 for information and instructions on editing SSIDs.

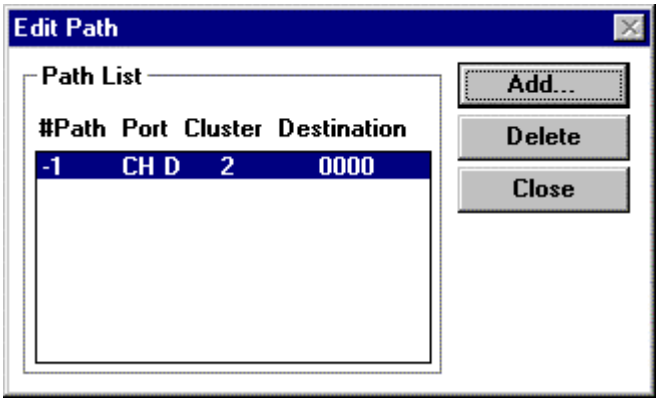


Figure 4.17 Edit Path Panel

The **Path List** box lists the existing paths between the MCU and the selected RCU by path number, displays the port, cluster, and link address for each path, and indicates the status of each path (+ normal, - not normal). Refer to Table 7.2 in section 7.1 for further information on the path status. The **Add…** button opens the Path Parameter panel, which allows you to enter the path parameters. The **Delete** button allows you to delete the selected path(s).

Before adding a path to an RCU, make sure that the remote copy connection is properly installed, that the appropriate MCU ports are configured as RCPs, and that the appropriate MCU CU image is selected. You can add up to four RCUs to each MCU CU image and establish up to four paths to each RCU. When you add a path to an RCU, HRC will automatically start using the new path to perform HRC copy activities.

To add a new logical path from the connected MCU to an existing RCU:

1. On the HRC Main Control panel, select the appropriate CU image, select the desired RCU in the **RCU List** box, and then select **Edit Path/SSID…** to open the Path/SSID Edit panel (refer to Figure 4.16).
2. On the Path/SSID Edit panel, select **Edit Path** and click **OK** to open the Edit Path panel (refer to Figure 4.17).
3. On the Edit Path panel, select **Add…** to open the Path Parameter panel.
4. On the Path Parameter panel, enter the parameters for the new path (refer to section 4.3.3), and then select **OK**. The Edit Path panel now displays the new path information.
5. Verify that the new path appears in the **Path List** box, and then close the Edit Path panel. The MCU will automatically begin using the new logical path for HRC activities.

Before deleting a path to an RCU, make sure that the remaining number of paths will be equal to or greater than the minimum number of paths setting (selected on the RCU Option panel). The delete path operation will fail if the number of remaining paths is less than the minimum number of paths.

To delete a path from the connected MCU to an existing RCU:

1. Open the RCU Option panel, and check the minimum number of paths setting. If the remaining number of paths will be less than this value, the delete path operation will fail. If needed, change the minimum number of paths so that you can delete the desired path.
2. On the HRC Main Control panel, select the appropriate CU image, select the desired RCU in the **RCU List** box, and then select **Edit Path/SSID…** to open the Path/SSID Edit panel.
3. On the Path/SSID Edit panel, select **Edit Path**, then select **OK** to open the Edit Path panel.
4. On the Edit Path panel, select the path to be deleted, and then select **Delete**. The Edit Path panel updates itself to reflect the new path information.
5. Verify that the specified path has been removed from the **Path List** box, and then close the Edit Path panel.

4.3.5 Adding and Deleting SSIDs for an RCU

The Edit SSID panel (see Figure 4.18) allows you to add and delete SSIDs for an existing RCU and provides access to the Add SSID panel (see Figure 4.19). The Edit SSID panel is accessed from the Path/SSID Edit panel (refer to Figure 4.16).

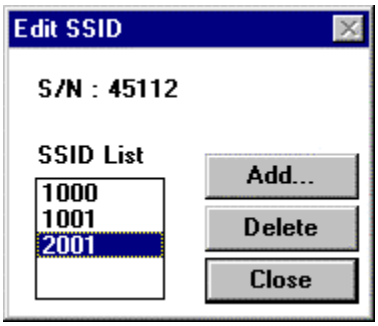


Figure 4.18 Edit SSID Panel

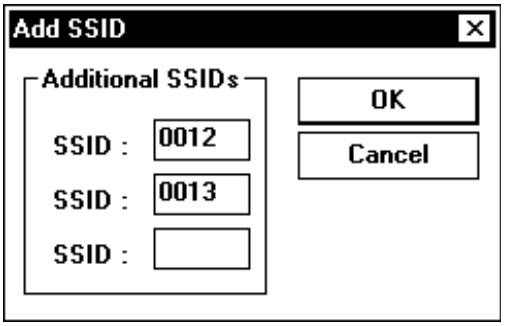


Figure 4.19 Add SSID Panel

The Edit SSID panel displays the S/N and current SSID(s) for the selected RCU. The **Add…** button opens the Add SSID panel, which allows you to add up to three SSIDs to the selected RCU CU image. The **Delete** button allows you to delete selected SSID(s). Before adding an SSID, make sure that the remote copy connection is properly installed. You can add up to three SSIDs to each RCU. Before deleting an SSID, make sure the remaining SSIDs are still valid, or the connection between the MCU and RCU may be lost.

To add or delete an SSID for an existing RCU:

1. On the HRC Main Control panel, select the appropriate CU image, select the RCU whose SSIDs you want to change, and then select the **Edit Path/SSID…** button to open the Path/SSID Edit panel (refer to Figure 4.16).
2. On the Path/SSID Edit panel, select **Edit SSID**, and then select **OK** to open the Edit SSID panel (refer to Figure 4.18).
3. To add an SSID:
   a) On the Edit SSID panel, select the **Add…** button to open the Add SSID panel (refer to Figure 4.19).
   b) On the Add SSID panel, enter the new SSID(s) in the SSID fields, and select **OK**.
   c) After the subsystem's SSIDs are reconfigured, the **SSID List** on the Edit SSID panel will reflect the additional SSID(s). When you are finished adding SSIDs, close the Edit SSID panel.
4. To delete an SSID:
   a) On the Edit SSID panel, select the SSID you want to delete, and select **Delete**. When the confirmation panel appears, select **Yes** to delete the selected SSID.
   b) After the subsystem's SSIDs are reconfigured, the **SSID List** on the Edit SSID panel will reflect the SSID deletion. Repeat step (a) for each SSID you wish to delete. When you are finished deleting SSIDs, close the Edit SSID panel.

4.3.6 Viewing RCU Status

The RCU Status panel (see Figure 4.20) displays the RCU options and the status of each logical path from the MCU to the selected RCU. Table 4.2 describes the RCU path status descriptions. The RCU Status panel is accessed from the HRC Main Control panel (select the desired CU image, select the desired RCU, and then select the **RCU Status…** button).

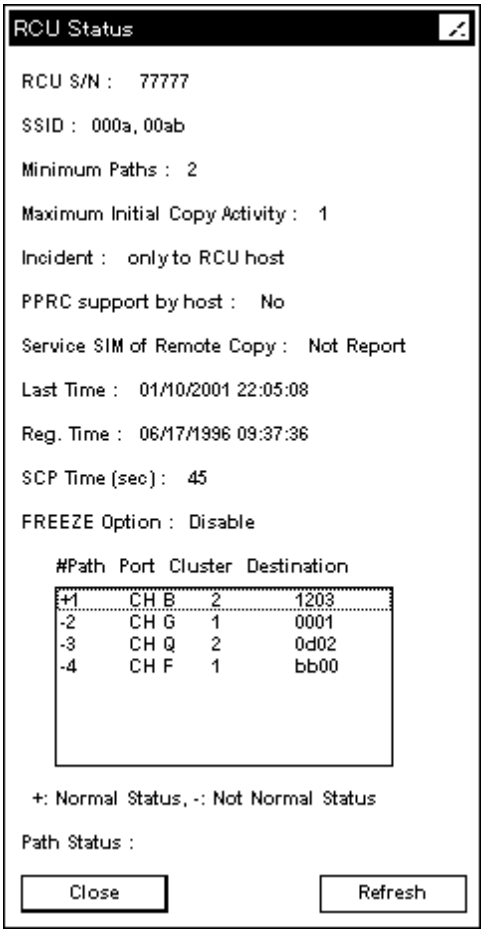


Figure 4.20 RCU Status Panel

The RCU Status panel displays the following information for the selected RCU:

- **S/N** and **SSID**(s) of the selected RCU.
- **RCU options** (see section 4.3.2): Minimum number of paths, Maximum initial copy activity, Incident of RCU, PPRC support by host, Service SIM of remote copy, SCP delay time, FREEZE option.
- **Last Time**. Date and time of the last RCU path status update.
- **Reg. Time**. Date and time that the RCU was added to the MCU (registered).
- **Paths**: The paths are listed by path number, port, cluster, and destination link address. A plus sign (+) indicates normal status, and a minus sign (-) indicates not normal status. To display the detailed path status, select the path. See section 7.1 for troubleshooting information for MCU-RCU paths.

Note: The CQUERY TSO command with the optional PATHS parameter can also be used to obtain RCU and path status information (see Appendix B).

Table 4.2 Logical Path Status

Status Description	Condition
Normal	This logical path has been successfully established and can be used for HRC copy activities.
Initialization Failed	The link initialization procedure with the RCU has failed because either the physical path connection between the MCU and the RCU or the connection between the MCU and the host was missing.
Communication Timeout	A timeout error has occurred between the MCU and RCU.
Resource Shortage	The establish logical path link function has been rejected by the RCU. All logical path resources in the RCU might be used for other connections.
Serial Number Mismatch	The serial number of the control unit which is connected to this logical path does not match the serial number specified by the **RCU S#** parameter.
Invalid Port	The serial interface port specified by the **Port** parameter is not in the RCP mode.

4.3.7 Deleting an RCU

You can delete an RCU from an MCU only after all HRC volume pairs between the MCU CU image and RCU CU image have been deleted. When you delete an RCU from an MCU, the MCU deletes all logical paths from the current MCU CU image to the selected RCU CU image. Deleting an RCU does not affect the HRC operations between the other MCU CU images and that RCU. After an RCU has been deleted, you can reconfigure the remote copy connections to add another RCU to the MCU, or you can remove the remote copy connections and change the MCU RCP(s) back to LCP(s) to provide additional host channels for the MCU.

The **Delete RCU** button on the HRC Main Control panel allows you to delete the selected RCU from the current MCU CU image. If all affected HRC pairs have not been deleted, the MCU will reject the delete RCU operation to prevent accidental deletion of HRC pairs.

To delete an RCU from an MCU:

1. Start RMCMAIN, connect to the desired MCU, and start the HRC software.
2. On the HRC Main Control panel, select the desired CU image using **Change CU#** button.
3. Make sure that all affected volume pairs have been deleted. The volume pairs which consist of an M-VOL in the connected MCU and CU image and an R-VOL in the selected RCU must be deleted.
4. On the HRC Main Control panel, select the RCU to be deleted in the **RCU List** box, and then select **Delete RCU**.
5. When the confirmation panel appears, select **OK** to delete the selected RCU.

Note: The CDELPATH TSO command can also be used to delete a logical MCU-RCU path. Refer to Appendix B for further information on PPRC TSO and ICKDSF commands.

4.4 HARC Control Operations

The HARC control operations are unique to the Hitachi Lightning 9900™ subsystem and can only be performed using the HRC remote console software. The PPRC TSO commands do not allow you to perform HARC control operations, but they can be used to establish and maintain HARC pairs after the groups are established. However, if you need to change any HRC Asynchronous options or group options, you must either use the HRC remote console software or ask your Hitachi Data Systems representative for assistance.

The HARC control operations include:

- Configuring the HRC Asynchronous options (see section 4.4.1),
- Adding consistency groups (see section 4.4.2),
- Setting the consistency group options (see section 4.4.3),
- Viewing consistency group status (see section 4.4.4), and
- Deleting consistency groups (see section 4.4.5).

4.4.1 Configuring the HRC Asynchronous Options

The Async Option panel (see Figure 4.21) allows you to change the asynchronous options for the connected subsystem. The asynchronous options apply to the entire physical control unit, including all M-VOLs and R-VOLs behind the control unit. The asynchronous options can only be modified when no HARC pairs exist in the connected CU (M-VOLs or R-VOLs). The Async Option panel is accessed from the HRC Main Control panel (**Async Option…** button).

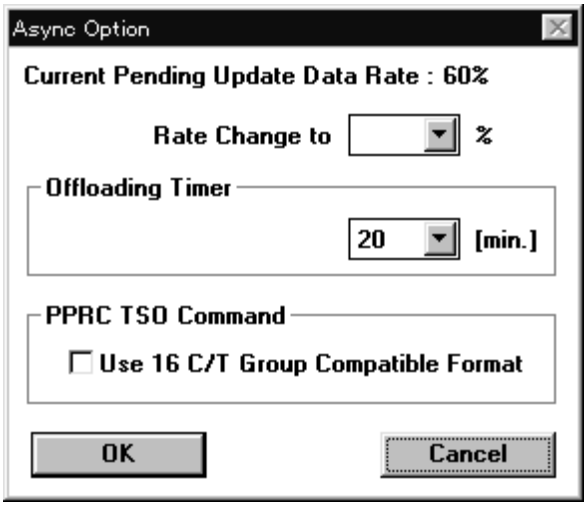


Figure 4.21 Async Option Panel

The HRC Asynchronous options are:

- **Current Pending Update Data Rate.** This option specifies the HRC (and HORC) Asynchronous sidefile threshold, which is the maximum amount of cache that can be used for storing asynchronous recordsets (sidefiles). You can select any value between 30% and 70% (in 10% increments). When the amount of cache storage being used for HRC (and HORC) recordsets reaches the specified threshold value, the MCU/RCU performs cache inflow control as follows:
  - The MCU responds to update I/Os from the primary system with the state-change-pending (SCP) or channel-command-retry request.
  - The RCU accepts only the one specific recordset that will enable it to settle the pending recordsets in the queue(s). For all other recordsets the RCU responds to the MCU with the channel-command-retry request.

  Note: The sidefile threshold setting is common to both HRC and HORC async operations. The most recently entered value (entered on either the HRC or HORC Async Option panel) will be applied to both HRC and HORC async operations.
- **Offloading timer.** This option specifies the amount of time the MCU can wait to send an HRC recordset to the RCU. If you select a time value for this option, the MCU will suspend all affected HARC volume pairs if it has not been able to offload a recordset to the RCU within the specified time (e.g., the RCU is still responding channel-command-retry). If you specify **None** for this option, the MCU will wait indefinitely to offload recordsets to the connected RCU(s).
- **PPRC TSO Command.** This option allows you to select the 7700E-compatible format for PPRC TSO commands (see Appendix B). This option should be selected only if you are using 7700E subsystems as RCUs connected to this 9900 subsystem. The 7700E format limits PPRC operations to sixteen consistency groups (0-F). The 9900-compatible format (default) enables you to perform PPRC operations for all 64 consistency groups (00-3F) of the 9900 subsystem.

4.4.2 Adding Consistency Groups

The Add C/T Group panel (see Figure 4.22) allows you to add a consistency group to the connected MCU and select the group options for the group. The Add C/T Group panel is accessed from the HRC Main Control panel (**Add Group…** button).

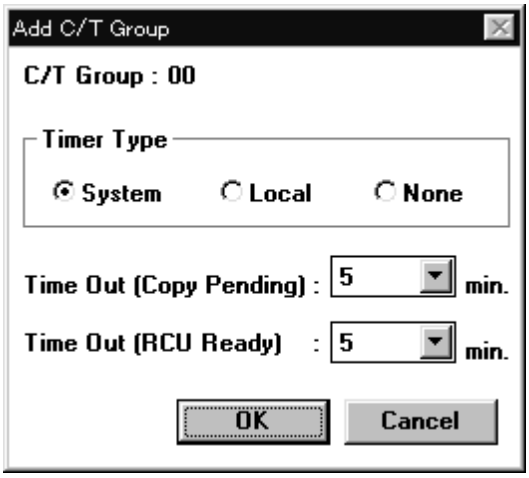


Figure 4.22 Add C/T Group Panel

The **C/T Group** field displays the group number (00-3F). The **Timer Type** box allows you to select the timer type option for the group (see Table 4.3):

- **System** = system timer (CPU TOD clock) provided by the I/O time-stamping function.
- **Local** = local timer (internal MCU TOD clock).
- **None** = system timer (CPU TOD clock) provided by the I/O time-stamping function. This timer type should only be selected when establishing HARC pairs in the reverse direction (to copy from the secondary site back to the primary site). When **None** is selected, the MCU still acquires the time-stamp information from the host I/O time-stamping function.

Table 4.3 Selecting the Timer Type for the Group

HARC System Configuration		Timer Type	
DFSMSdfp I/O Time-Stamping	MCU-to-RCU	For P-to-S Copy (Original Direction)	For S-to-P Copy (Copy Back)
Installed	n-to-1, n>1	System	None
	1-to-1	System	System
Not Installed	1-to-1	Local	Local

The **Time Out (Copy Pending)** field allows you to select the maximum delay allowed for HARC copy (maximum = 15 minutes, none = no timeout for HARC copy pending). If the delay between the HARC M-VOL update and the corresponding R-VOL update reaches the specified time, the RCU will suspend all R-VOLs in the group. A timeout occurs when either the RCU was not able to settle a recordset within the specified time, or when the RCU has not had any communication from one of the MCUs in the group within the specified time.

WARNING: See step (6) below for instructions on selecting the correct **Time Out (Copy Pending)** setting for your operational environment.

The **Time Out (RCU Ready)** field allows you to select the maximum delay allowed for re-establishing MCU-RCU communications following MCU power-off (none = no timeout for HARC RCU ready). If the MCU is not able to re-establish communication with the RCU within the specified time, the MCU will suspend all M-VOLs in the group (excluding M-VOLs in other MCUs).

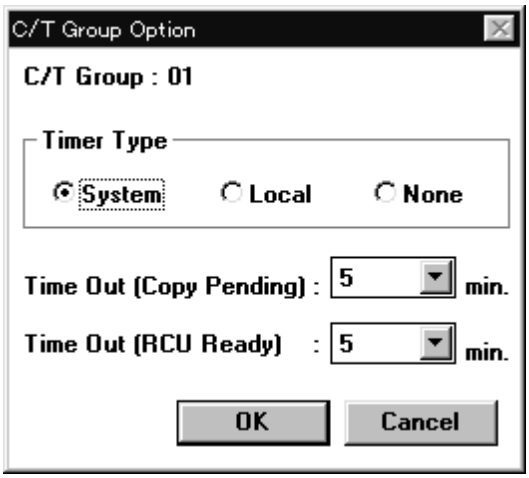
To add a consistency group:

1. Start RMCMAIN, connect to the desired MCU, and start the HRC software.
2. Make sure that the asynchronous options are configured as desired (see section 4.4.1).
3. On the HRC Main Control panel, select the desired (unassigned) group in the **Group List**, and then select the **Add Group…** button to open the Add C/T Group panel. The Add C/T Group panel displays the selected group number (00-3F).
4. On the Add C/T Group panel, select the desired group options: timer type, copy pending timeout, RCU ready timeout. Remember that you will not be able to modify the group options once you assign a pair to the group.
5. After selecting the desired group options, select **OK** to add the specified group to the MCU. The group is now assigned in the **Group List** on the HRC Main Control panel.
6. If you are using HRC Asynchronous in the n-to-1 configuration, reset the **Time Out (Copy Pending)** option as follows to avoid suspension of HRC pairs due to timeout errors:
   a) Suspend all pairs in the group, so that you can change the group options.
   b) Select the group on the Main panel, select **Group Option…**, change the **Time Out (Copy Pending)** option to **None** (see section 4.4.3), and select **OK**.
   c) Resume all pairs in the group, and then perform your normal HRC Async operations.
   d) Acquire the current HRC async copy delay time by calculating the difference between the host I/O time-stamp information and the consistency time shown on the Group Status panel (refer to section 4.4.4).
   e) Suspend all pairs in the group again, and set the **Time Out (Copy Pending)** group option to a value greater than the current copy delay time. If the value exceeds the maximum time (15 min.), reduce the host I/O rate, or set the option to **None**.
   f) Resume all pairs in the group.

4.4.3 Consistency Group Options

The C/T Group Option panel (see Figure 4.23) allows you to modify the group options for the selected group, and is accessed from the HRC Main Control panel (**Group Option…** button).

Note: If you want to change the Time Out options of a group, you must suspend all pairs in the group first. If you want to change the Timer Type group option, you must delete all pairs.



WARNING: See section 4.4.2 for instructions on selecting the correct **Time Out (Copy Pending)** setting for your operational environment.

Figure 4.23 C/T Group Option Panel

The **C/T Group** field displays the group number (00-3F). The **Timer Type** box displays the timer type option for the group: **System**, **Local**, or **None**. You cannot change the timer type option. Refer to section 4.4.2 above for further information on the HARC timer type options.

The **Time Out (Copy Pending)** field allows you to select the maximum delay allowed for HARC copy (max = 15 min, none = no timeout). If the RCU was not able to settle a recordset within the specified time, or the RCU has not had any communication from one of the MCUs in the group within the specified time, the RCU will suspend all R-VOLs in the group.

The **Time Out (RCU Ready)** field allows you to select the maximum delay allowed for re-establishing MCU-RCU communications following MCU power-off (none = no timeout). If the MCU is not able to re-establish communication with the RCU within the specified time, the MCU will suspend all M-VOLs in the group (excluding M-VOLs in other MCUs).

To change the group options:

1. Start RMCMAIN, connect to the desired MCU, and start the HRC software.
2. If you want to change the timeout options of a group, you must suspend all pairs in the group first. If you want to change the Timer Type group option, you must delete all pairs.
3. On the HRC Main Control panel, select the desired group, and then select the **Group Option…** button to open the C/T Group Option panel. If the **Group Option…** button is not enabled, you need to suspend or delete the remaining pairs in this group.
4. Change the group options as desired, and select **OK** to save your changes.
5. If this group is also assigned to other MCU(s), make sure to select the same Timer Type and Time Out (Copy Pending) options for this group at each MCU.
6. When you are finished changing group options, resume/restart all pairs in the group.

4.4.4 Viewing Consistency Group Status

The Group Status panel (see Figure 4.24) displays the detailed status information for the selected consistency group. The group status can be displayed at both the MCU and RCU. Table 4.4 describes the information displayed on the Group Status panel. The Group Status panel is accessed from the HRC Main Control panel (**Group Status…** button).

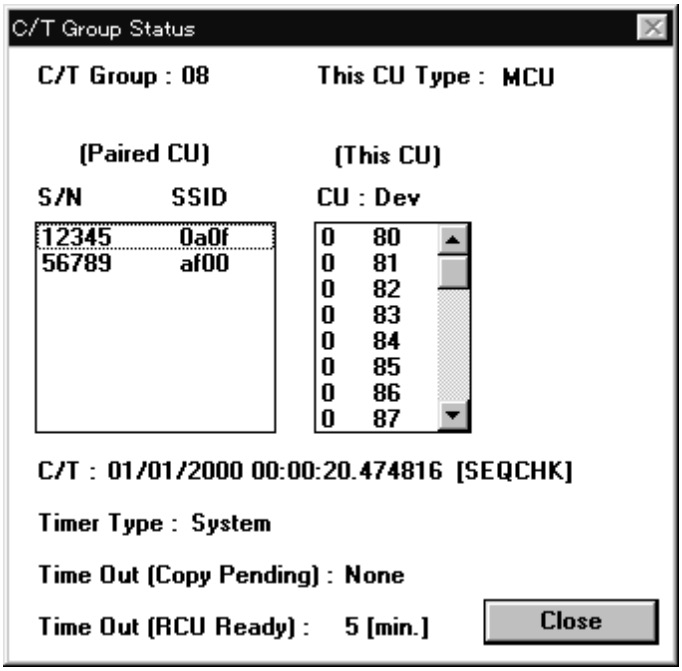


Figure 4.24 Group Status Panel

Table 4.4 Consistency Group Status

Item	Description	Displayed by: MCU	RCU
Group number	Consistency group number (00-3F, hexadecimal).	Yes	Yes
CU type	CU type (MCU, RCU, M&R) of connected subsystem.	Yes	Yes
RCU serial number/SSID	S/N and SSID(s) of the RCU for this group.	Yes	No
Volume list	List of volumes in this group (CU:LDEV).	Yes[1]	Yes
Consistency time	Current consistency time of this group.	Yes[2]	Yes
Timer type	Specified timer type of this group.	Yes	Yes
SEQCHK[3]	At least one pair of this group has *SEQCHK* status.	Yes[2]	Yes
Time Out (Copy Pending)	Specified copy pending timeout group option.	Yes	Yes
Time Out (RCU Ready)	Specified RCU ready timeout group option.	Yes	No

1. For n-to-1 (n>1) MCU-RCU configurations, the M-VOLs behind other MCUs are not displayed.
2. The RCU manages the C/T and *SEQCHK* status, and the MCU acquires these from the RCU. If MCU-RCU communications are down, the MCU may not display the latest C/T and SEQCHK information. Always use the group status and R-VOL status displayed at the RCU for disaster recovery.
3. The *SEQCHK* status is also displayed as a HARC pair status. To determine exactly which pair(s) in the group have the *SEQCHK* status, check the R-VOL pair status at the RCU.

4.4.5 Deleting Consistency Groups

A consistency group can be deleted only from the MCU and only if the MCU does not contain any M-VOLs still assigned to the group. Deleting a consistency group from an MCU does not affect the consistency groups registered at other MCUs. The RCU will automatically delete a consistency group when the last volume pair in the group is deleted.

The **Delete Group** button on the HRC Main Control panel allows you to delete the selected group from the current MCU. The MCU will not allow you to delete a group which still has M-VOLs in the current MCU.

To delete a consistency group from an MCU:

1. Start RMCMAIN, connect to the desired MCU, and start the HRC software.
2. On the HRC Main Control panel, select the group to be deleted in the **Group List** box, and then select the **Delete Group** button. If the **Delete Group** button is not enabled, the selected group still contains M-VOLs in this MCU.
3. When the confirmation panel appears, select **OK** to delete the selected group. The MCU clears the group assignment information for the selected group.

4.5 Discontinuing HRC Operations

If you plan to use HRC to perform nondisruptive data migration or duplication (see section 5.8), you will configure and establish HRC operations, allow HRC to synchronize the volumes, redirect application I/Os (if migrating), and then discontinue HRC operations. When you are ready to discontinue HRC operations, you will need to perform HRC operations in the correct order to avoid generating error messages. For example, HRC will not allow you to delete an RCU path until you have deleted all HRC pairs still using that path, and you cannot delete a group until you have deleted all HARC pairs in that group from the MCU.

To discontinue all HRC operations, perform the following actions in the following order:

1. First delete all HRC pairs from the MCU(s) (see section 5.6). For HARC pairs, you can use the **Group** delete option to delete all pairs in a group with one operation. Verify that the pair status has changed to *simplex* for all HRC volumes before continuing.
2. Delete the HARC group(s) from the MCU(s) (see section 4.4.5). The RCU will automatically delete a group when all pairs in the group have been deleted.
3. Delete the RCUs (see section 0). Check each CU image of each MCU to make sure that all RCUs have been deleted before continuing.
4. Remove the remote copy connections (physical paths). If you are not familiar with the operation of the remote copy hardware components (e.g., ESCON directors and repeaters), please call the Hitachi Data Systems Support Center for assistance.
5. Reset the RCP(s) to LCP(s) at the MCU(s) (see section 4.2.3). ***Note:*** If SVP mode 114 is enabled and you use the CDELPATH TSO command, the 9900 will automatically reset each port to LCP mode after the last path to an RCU is deleted.

4.6 Scripting

The HRC remote console software supports scripting for managing pre-defined HRC operations. The HRC scripting function enables you to define multiple HRC operations in a text file that the HRC remote console software reads and executes as a batch file. Scripting allows you to perform a series of HRC operations without having to issue the commands separately. Using HRC scripting, you can set up and execute a large number of HRC commands within a short period of time. The HRC scripting function enables you to:

- save time by executing multiple HRC operations with a single command,
- run a series of predefined and tested HRC operations after business hours or overnight, and/or
- allow a non-resident system administrator to set up and start an entire day's worth of HRC operations in the limited time that the administrator is on-site.

This section describes the selection and execution of an existing HRC script file. Appendix E describes and specifies the requirements for the HRC script files.

The Script Monitor panel (Figure 4.25) displays detailed information for the script being executed. To open the Script Monitor panel, select the **Script…** button on the HRC Main Control panel (see section 4.1).

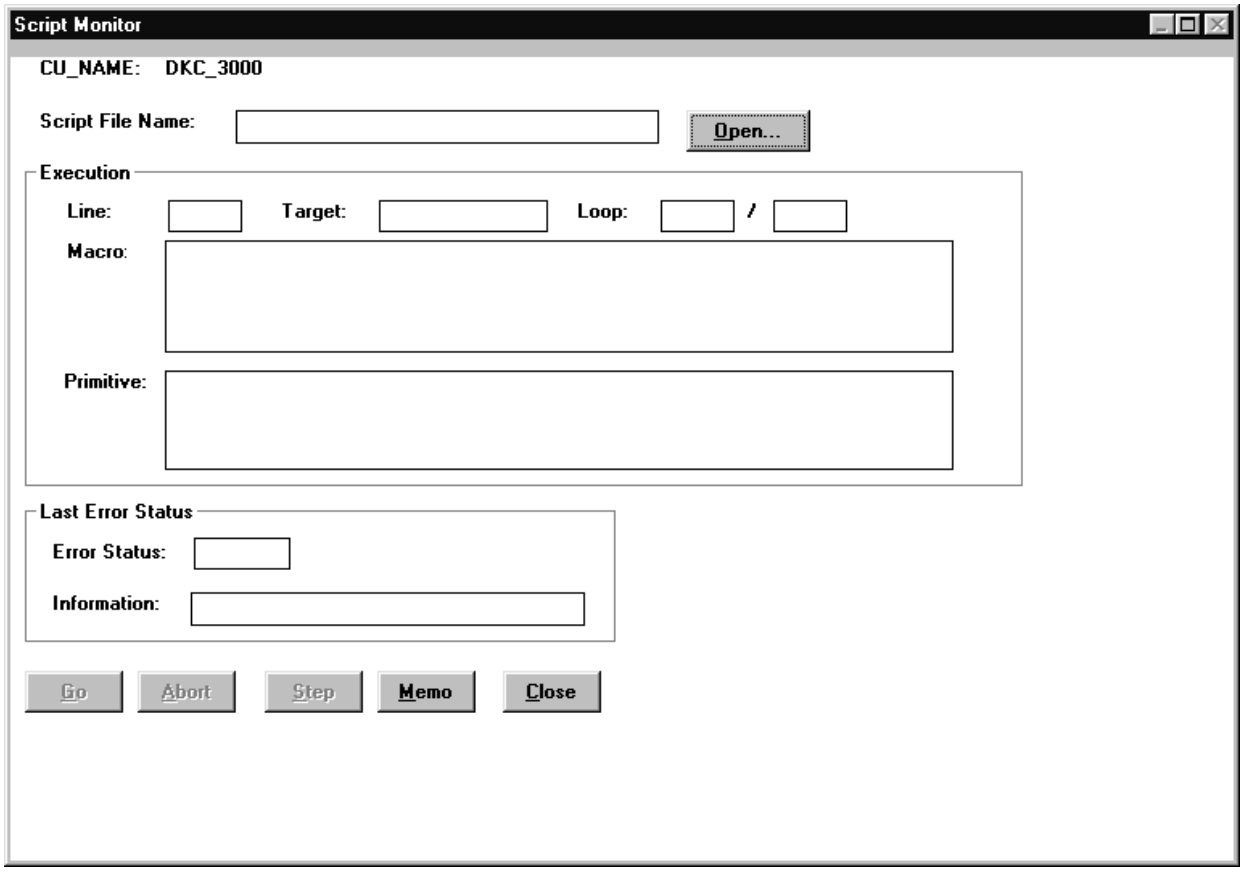


Figure 4.25 Script Monitor Panel

The **CU_NAME** field displays the name of the connected 9900 subsystem. The **Script File Name** field displays the name of the selected HRC script file. The script file name can have up to eight characters, and the file extension must be **.spt**. The **Open...** button opens the Open panel (see Figure 4.26), which allows you to select and open an existing HRC script file.

While an HRC script file is open, the **Execution** and **Last Error Status** boxes display the following detailed information (see Figure 4.27). All completed and attempted macros are logged in the macro trace file. All errors are logged in the error trace file.

Line	The script file line number being executed.
Target	The target device ID (LDEV ID) for the current operation.
Loop	The current/total repetition count for a looped command (e.g., 150/300).
Macro	The macro being executed. Macros which execute a process for a device are listed: Create-, Change-, Suspend-, Resume-, and DeleteHrcPair.
Primitive	The specified (or default) parameters for the current macro. For example: For script: ResumeHrcPair $Dev=1, $Fence="Never" Primitive: ResumeHrcPair $Dev=0x0001, $Priority=0x0001, $Fence=0x0000, $Sync=0x0000
Error Status	The most recent macro error (**None** = no errors).
Information	The time and script line location of the error in the **Error Status** box.

The **Go** button executes the selected script file. The **Abort** button stops the active script (after the current macro completes and before the next macro starts). The **Step** button executes the selected script file one macro at a time. The **Close** button exits the Script Monitor panel.

The **Memo** button opens the WordPad panel (see Figure 4.28), which allows you to open the current script file, macro trace file, or error trace file in Microsoft® WordPad.

- The **Script File** option has two functions. If a script file is open, this option opens the current script file. If a script file is not open (**Script File Name** is blank), this option opens a new WordPad document to allow you to create a new script file.
- The **Macro Trace File** option opens the text file (**macro.trc**) that traces the macros used (see Figure 4.29). Table 4.5 describes the contents of the macro trace file.
- The **Error Trace File** option opens the text file (**error.trc**) that details the errors that occurred while running scripts (see Figure 4.30). Table 4.6 describes the error trace file.

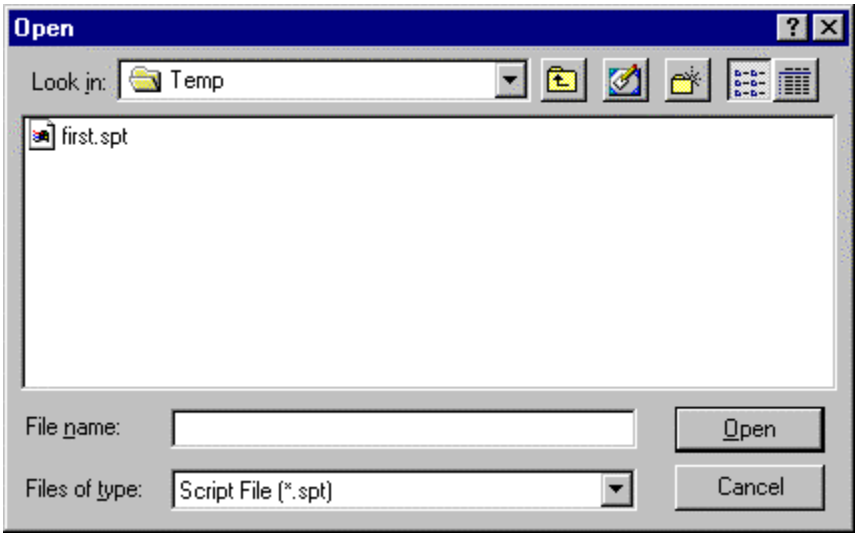


Figure 4.26 Open Panel

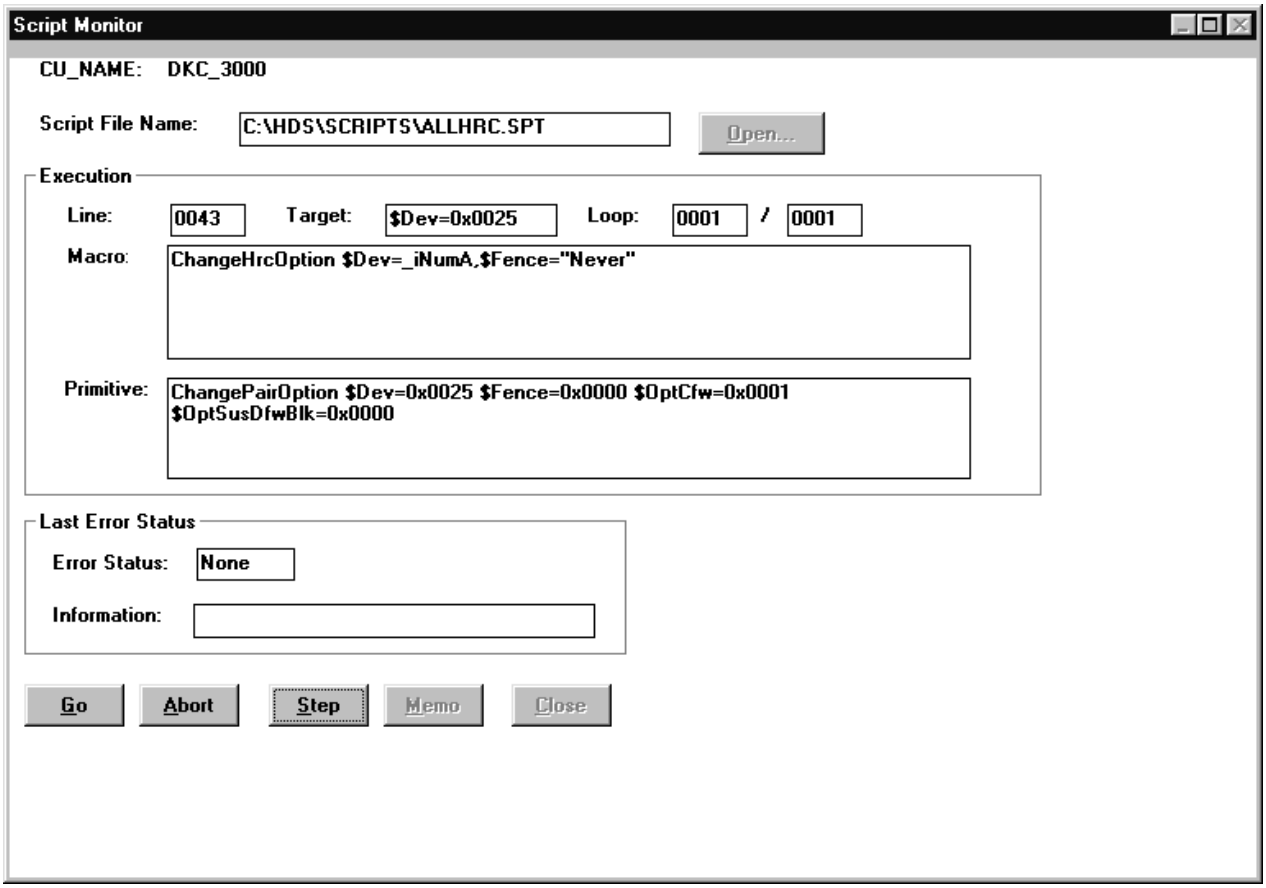


Figure 4.27 Script Monitor Panel During Execution of an HRC Script File

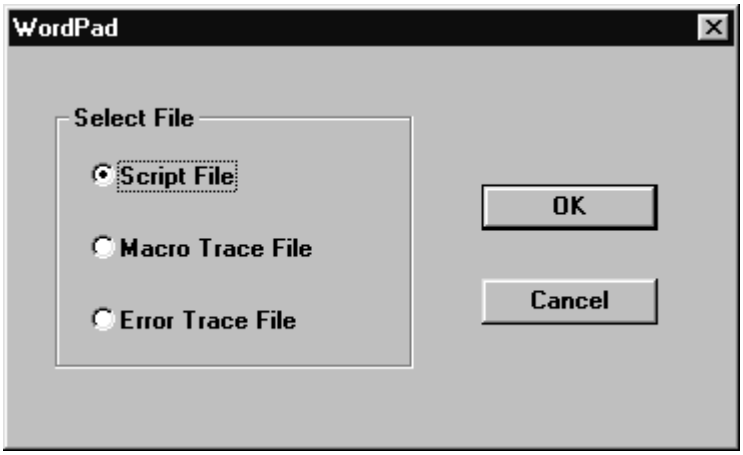


Figure 4.28 WordPad Panel

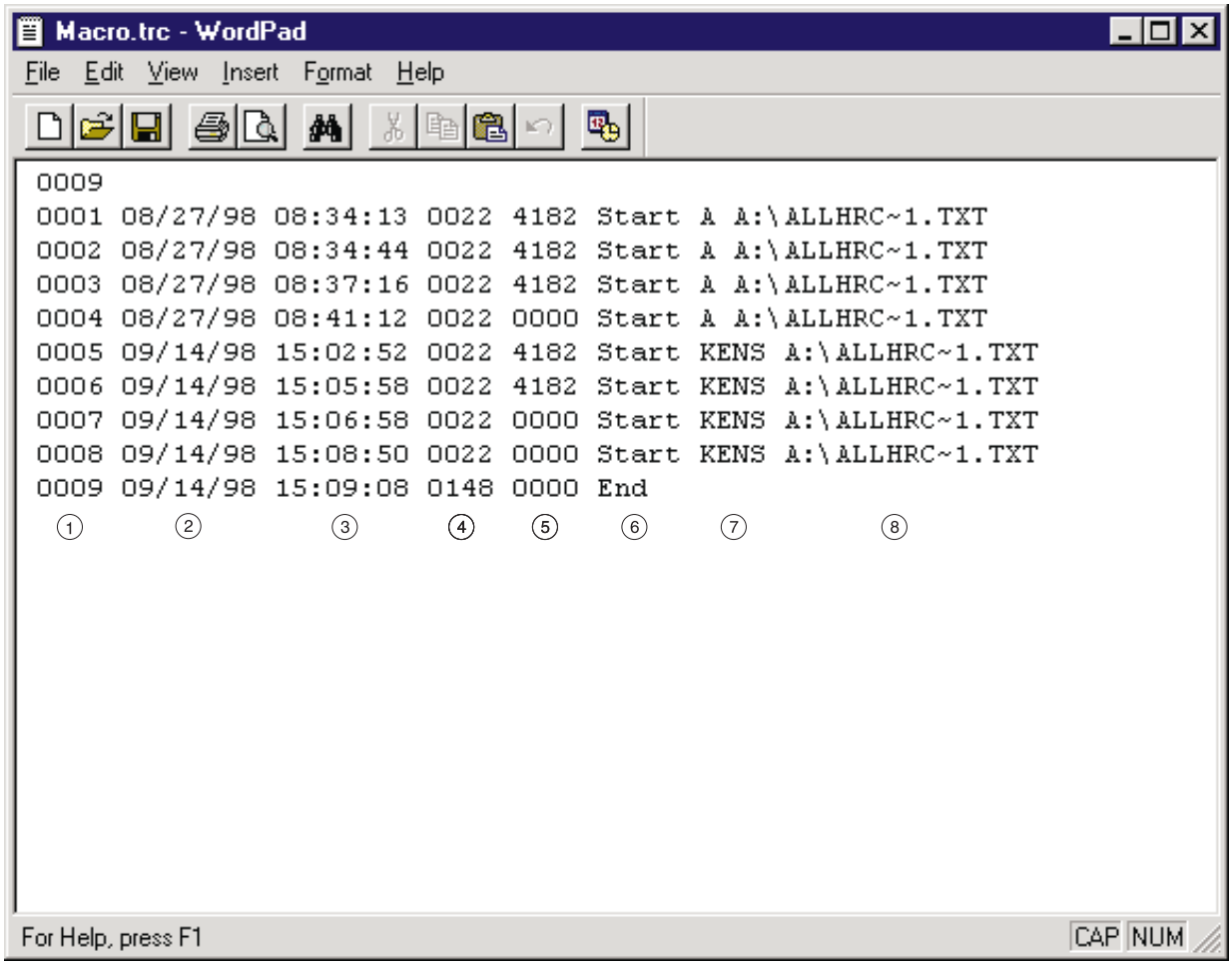


Figure 4.29 Macro Trace File

Table 4.5 Macro Trace File Information

Number	Description
①	All macros executed by HRC are listed in chronological order and numbered.
②	The date that the macro was executed.
③	The time that the macro was executed.
④	The location (script file line number) of the macro.
⑤	The HRC scripting error code (0000 = no error). See Table E.18 (Appendix E) for scripting error codes.
⑥	The last registered status of the macro. If the macro was not completed, the last registered status is **Start**. If the macro was completed successfully, the last registered status is **End**.
⑦	The name of the 9900 subsystem (usually MCU of specified HRC operation).
⑧	The name and location of the script file containing the specified macro.

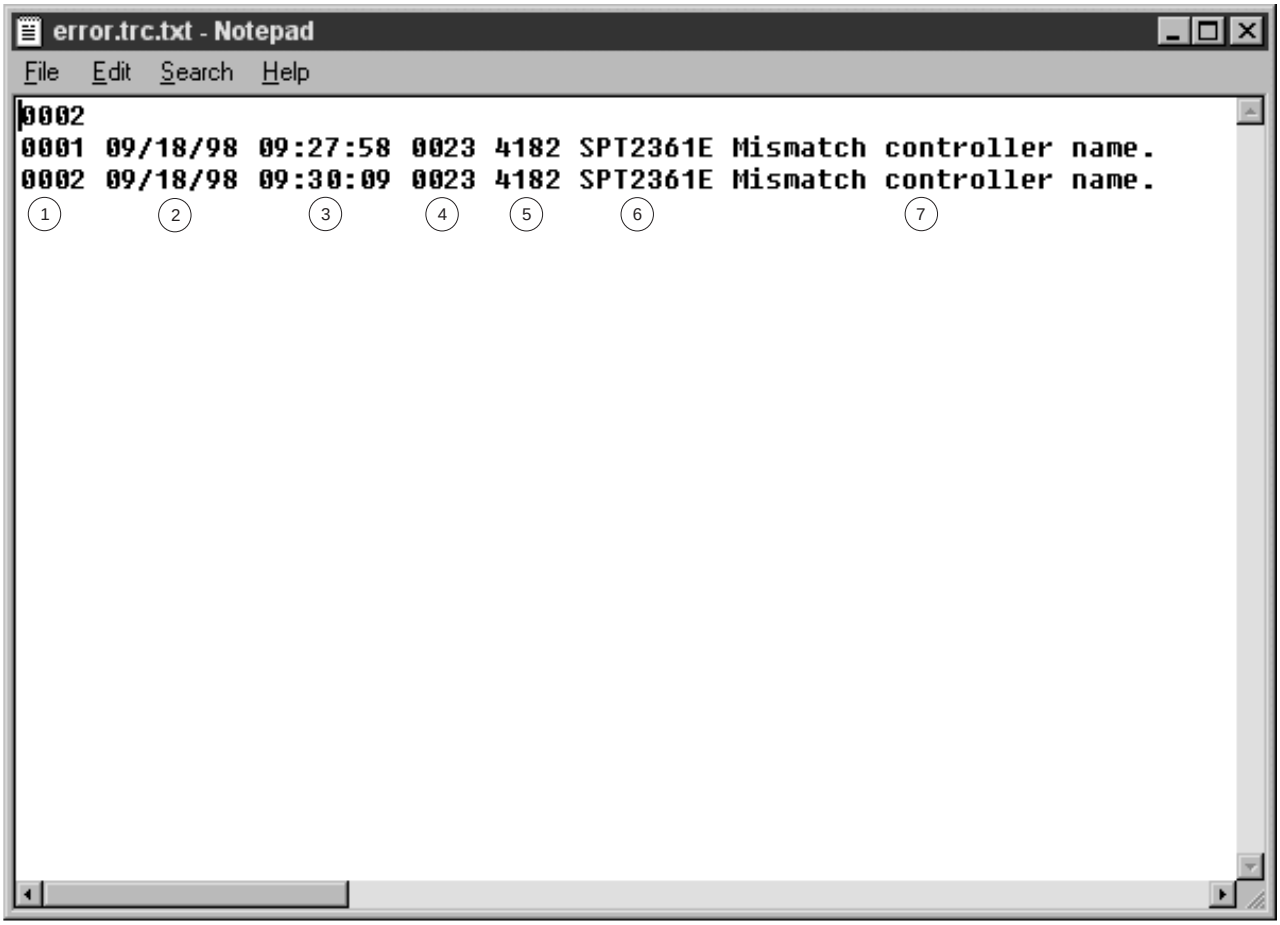


Figure 4.30 Error Trace File

Table 4.6 Error Trace File Information

Number	Description
①	All macro errors encountered by HRC are listed in chronological order and numbered.
②	The date that the macro error occurred.
③	The time that the macro error occurred.
④	The location (script file line number) of the macro that caused the error.
⑤	The HRC scripting error code (see Table E.18 in Appendix E).
⑥	The HRC scripting error code message ID (see Table E.18 in Appendix E).
⑦	Brief description of the error.

Chapter 5 Performing HRC Pair Operations

5.1 Preparing for HRC Volume Pair Operations

Before starting HRC operations, you must consider the relative importance of subsystem I/O performance and disaster recovery preparation. As described in section 2.7, HRC operations can affect the I/O performance of the MCUs and RCUs. HRC provides many options (initial copy options, pair options, group options, and asynchronous options) which allow you to control the impact of HRC operations on subsystem I/O performance. These options can be set separately for each HRC pair, for each HARC group, and for each MCU to provide maximum flexibility. You can select options which minimize the impact of HRC operations on subsystem performance, or options which maximize the effectiveness of HRC operations to ensure the best level of backup data integrity. System-level factors (e.g., number of ESCON® paths) can also affect HRC operations and subsystem performance (see Table 2.7).

For HRC disaster recovery operations, you should make sure that the RCUs are attached to a host processor to enable reporting of sense information and transfer of ERC information. If the remote site is unattended, you should attach the RCUs to a host processor at the main site, so that the system administrator can monitor the operational condition of the RCUs.

To prepare for HRC volume pair operations, you need to identify the volumes (by LDEV ID) for which you want to establish HRC remote copy operations. You should identify not only the volumes which contain the important data to be backed up (e.g., DB2® log files), but also the volumes which contain the catalog and control datasets (i.e., master catalog, key user catalogs, system control datasets). Copying these datasets to the remote site will enable faster disaster recovery than maintaining a current version of these files at the remote site. For large databases which span multiple volumes and even multiple 9900 subsystems, you should plan to establish a HARC consistency group for each database, so that the update sequence consistency of the database can be ensured at the remote site.

You can start establishing the HRC volume pairs as soon as you have:

- Identified the volumes which will become the HRC M-VOLs (and R-VOLs),
- Ensured that all system and HRC requirements have been met (see sections 3.1 and 3.2),
- Completed hardware and software installation (see sections 3.3, 3.4, and 3.5),
- Configured the MCUs and RCUs for HRC operations (see section 3.6).

Note: HRC and ShadowImage 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 HRC and HMRCF, please read the important configuration information section 3.7.

If you will be using the HRC remote console software to perform HRC operations, the Remote Console PC must be LAN-attached to the MCU of each HRC volume pair. You should also install and attach a Remote Console PC to the RCUs at your remote site. If you will be using PPRC commands instead of the HRC remote console software, please contact your Hitachi Data Systems account team for information on HRC configuration services. The following HRC operations cannot be performed using PPRC commands: MCU port configuration (LCP-RCP), HRC Asynchronous options, HARC group addition/deletion, and HARC group options. See Appendix B for further information on using PPRC commands with the 9900 subsystem.

5.2 Adding HRC Volume Pairs

The Add Pair panel (see Figure 5.1) allows you to add one or more new HRC pairs. The Add Pair panel is accessed from the HRC Main Control panel (**Add Pair…** button).

The Add Pair panel allows you to select the RCU, R-VOL, initial copy options (see section 5.2.1), update copy mode, and HARC group for the pair(s) being added. When you select **OK** on the Add Pair panel, the Pair Option panel opens (see Figure 5.2) to allow you to select the HRC pair options (see section 5.2.2) for the pair(s) being added. After you select the pair options, the Add Pair confirmation panel opens (see Figure 5.3) and displays the pair(s) to be added. The Add Pair confirmation panel allows you to change the initial copy and pair options for each pair, remove pair(s) from the list, and establish (start) the specified HRC pair(s).

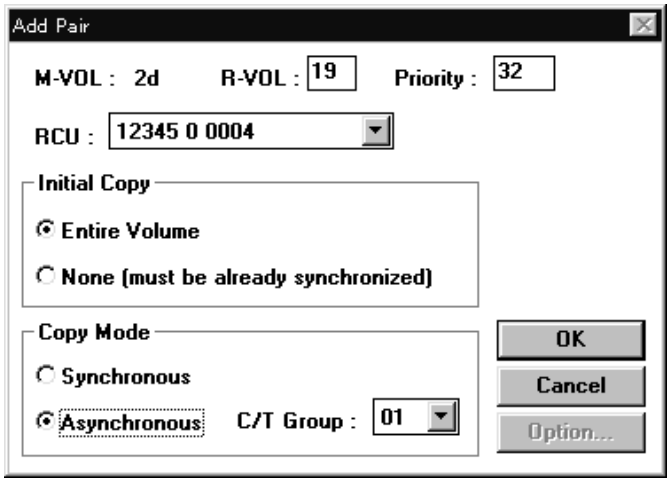


Figure 5.1 Add Pair Panel

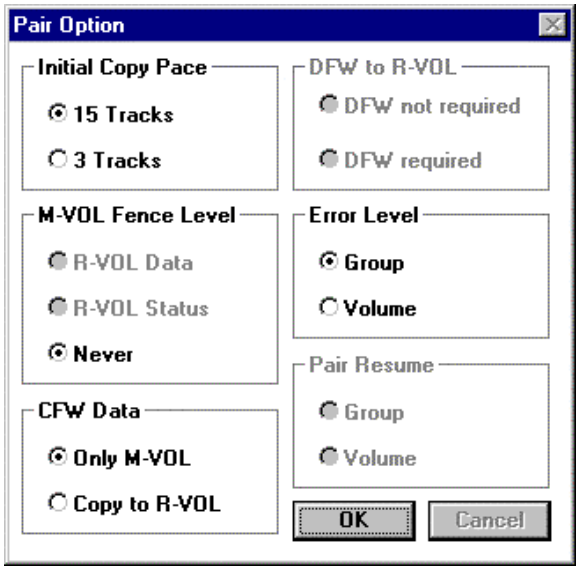


Figure 5.2 Pair Option Panel

The Add Pair panel displays the device ID of the volume selected on the HRC Main Control panel as the M-VOL. If you selected more than one volume, the volume with the lowest ID is displayed. The R-VOL field allows you to enter the R-VOL device ID for the specified M-VOL. If you selected more than one volume, R-VOLs will automatically be assigned to the rest of the selected M-VOLs based on device ID. The RCU drop-down list box allows you to select the RCU for the HRC pair(s) being added. The RCU must be the same for all pairs being added during this operation. The Priority field allows you to set the priority (scheduling order) of the initial copy operation. The Initial Copy box allows you to specify the initial copy mode (entire volume, or none). The Copy Mode box allows you to select the HRC update copy mode (synchronous or asynchronous) and the C/T Group (HARC only) for the pair(s) being added.

The **OK** button opens the Pair Option panel (refer to Figure 5.2) to allow you to select the pair options (see section 5.2.2) for the pair(s) being added. The **Option…** button also opens the Pair Option panel, but the **Option…** button is only available when the Add Pair panel is re-opened by selecting **Change…** on the Add Pair Confirmation panel.

The Pair Option panel displays and allows you to select the HRC pair options: initial copy pace, M-VOL fence level (HRC Synchronous only), CFW data, DFW to R-VOL (HRC Synchronous only), and error level (HARC only). See section 5.2.2 for further information on the pair options. The **OK** button applies the specified pair options to the pair(s) being added and opens the Add Pair confirmation panel (see Figure 5.3). (The **Pair Resume** options are available only when resuming split/suspended pairs.)

The Add Pair confirmation panel displays the following information for each pair being added: M-VOL device ID and LVI, RCU S/N and SSID, R-VOL device ID, initial copy priority, initial copy mode, update copy mode, HARC group number, and HARC error level. The **Use Time-Saving Mode** option allows you to execute the specified add pair operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **Omit** button removes the selected pair(s) from the Add Pair confirmation panel. The **Change…** button re-opens the Add Pair panel to allow you to change the R-VOL ID, initial copy options, and/or pair options for the pair(s) selected on the Add Pair confirmation panel. The **OK** button establishes (adds) all pairs listed on the Add Pair Confirmation panel.

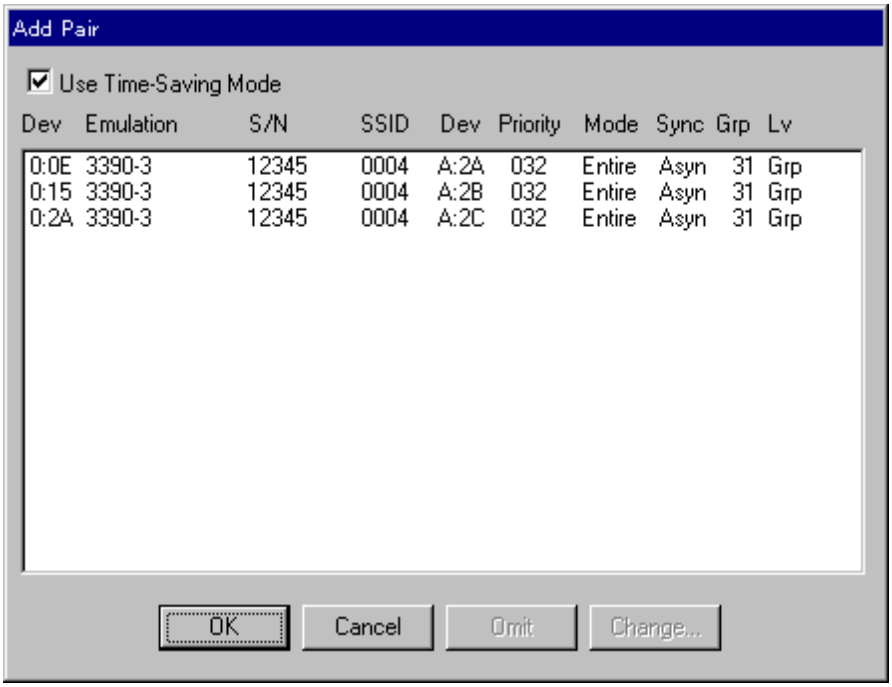


Figure 5.3 Add Pair Confirmation Panel

To add (establish) one or more HRC volume pairs:

1. Vary the volumes which will be the HRC R-VOLs offline from all hosts.
2. Start the Remote Console software, connect to the subsystem which contains the M-VOLs of the pair(s) you are creating, and start the HRC software. The RCPs must already be configured (see section 4.2.3), and the RCU(s) must already be added (see section 4.3.1).

Instructions continue on the next page.

3. On the HRC Main Control panel, select the desired CU image, and then select the volume(s) which will be the M-VOL(s) of the HRC pair(s). The pair status must be simplex. You can select more than one volume and establish more than one pair at a time only if the R-VOLs for these pairs are in the same RCU.
4. Select **Add Pair…** to open the Add Pair panel. If you selected more than one volume in step (3), the Add Pair panel displays the volume with the lowest device ID as the M-VOL.
5. On the Add Pair panel, select the **RCU**, enter the **R-VOL device ID** for the M-VOL, select the desired initial copy options (see section 5.2.1) (initial copy priority and mode, update copy mode, C/T group), and select **OK**. The Pair Option panel now opens.
6. On the Pair Option panel (see section 5.2.2), select the desired HRC pair options (copy pace, fence level, CFW data, DFW to R-VOL, error level), and select **OK**.
7. The Add Pair confirmation panel now opens and displays all pairs being added. If you selected more than one volume in step (3), R-VOLs are automatically assigned to the rest of the M-VOLs based on device ID. The initial copy options and pair options you selected are applied to all pairs, but you can customize the options for each pair as needed.
8. On the Add Pair confirmation panel, check the RCU S/N and SSID, R-VOL, and copy options for each pair. If you need to change the options for one or more pairs, select the pair(s), select **Change…** to re-open the Add Pair panel, make the desired changes (select **Option…** to access the Pair Option panel), and select **OK** to return to the Add Pair confirmation panel. Repeat this step until all HRC options for each new pair are correct.
9. If you want to execute the add pair requests quickly, select the **Use Time-Saving Mode** option on the Add Pair confirmation panel.
10. Select **OK** on the Add Pair confirmation panel to establish (start) the specified HRC pair(s). The MCU will start the initial copy operations according to the initial copy priority and the maximum initial copy activities setting.
11. On the HRC Main Control panel, verify that the new HRC pair(s) is/are displayed correctly (*pending* status) in the **Volume List** box. To monitor the status of the new pair(s), use the **Refresh** button to update the information in the **Volume List** box, or use the Pair Status panel (see section 5.3) to monitor the detailed status of each pair.

WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HRC Main Control panel for which volumes the add pair operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the add pair operation.

Note: The CESTPAIR TSO command can be used to add HRC Synchronous and HARC pairs (see Appendix B). CESTPAIR does not allow you to specify the initial copy priority, CFW data option, or DFW to R-VOL option.

5.2.1 HRC Initial Copy Options

The HRC initial copy options allow you to specify the initial copy priority, initial copy mode, update copy mode (see section 2.2.2), and C/T group. The initial copy options are selected on the Add Pair panel. Once the initial copy operation has started, the initial copy options cannot be changed unless you delete and then restart the pair.

Priority. The initial copy priority specifies the order in which the initial copy operations will be performed, if the number of requested initial copy operations is greater than the maximum initial copy activity setting on the RCU Option panel (see section 4.3.2). The highest priority is 1, and the lowest priority is 256 (current default = 32). The HRC initial copy priority option can be used to spread initial copy operations across array groups and/or array domains (ACP pairs) to reduce initial copy time as well as host I/O contention.

Example: Let's say that the maximum initial copy activity setting is 4, and you add 6 HRC pairs at the same time (for LDEVs 00 through 05) with the initial copy priority set as follows:

M-VOL of HRC pair	Priority
LDEV 03	1
LDEV 05	2
LDEV 00	3
LDEV 04	4
LDEVs 01, 02	5

The MCU will start the initial copy operations for LDEVs 03, 05, 00, and 04 immediately, then start LDEV 01 when one of the first four initial copy operations is complete, and then start LDEV 02 when the next initial copy operation is complete. If additional HRC pairs are added, the MCU also prioritizes the initial copy operations by time requested, so that all HRC pairs in the first group are started before any pair in the next group is started.

Note: The CESTPAIR TSO command does not support the initial copy priority option. When CESTPAIR is used to establish HRC pairs, the initial copy operations are performed in the order that the CESTPAIR commands are issued.

Initial Copy. This option specifies the initial copy mode for the new pair(s).

- If **Entire Volume** is selected, the initial copy operation will copy all cylinders on the M-VOL (except diagnostic and unassigned alternate tracks) to the R-VOL. This setting is functionally equivalent to the MODE=COPY parameter for the CESTPAIR command.
- If **None** is selected, the initial copy operation will not be performed. The MCU will begin performing update copy operations as needed. This setting is functionally equivalent to the MODE=NOCOPY parameter for the CESTPAIR command. ***CAUTION:*** The user must ensure that the M-VOL and R-VOL are already identical when using this setting.

Copy Mode. This option specifies the update copy mode (see section 2.2.2) for the pair(s) being added: **Synchronous** or **Asynchronous**. The selection of mode has the greatest impact on performance and must be considered carefully. Factors in mode selection include (but are not limited to) the use of HRC (for disaster recovery or migration), the number of pairs, and the write I/O activity to the M-VOLs.

C/T Group. This option specifies the consistency group for the pair(s) being added (HARC only). All HARC pairs must be assigned to a consistency group. ***Note:*** The CESTPAIR command can be used to start HARC pairs and assign them to groups, but the groups must already be configured (using the Add C/T Group panel, see section 4.4.2).

5.2.2 HRC Pair Options

The Pair Option panel (refer to Figure 5.2) displays and allows you to select the pair options for each HRC volume pair. The Pair Option panel can be accessed from the Add Pair panel, HRC Main Control panel (**Pair Option…** button), and Pair Status panel (see section 5.3).

The Pair Option panel opens automatically during the Add Pair process to allow you to set the pair options for the pair(s) being added. You can change the pair options for each pair being added by selecting the desired pair(s) on the Add Pair confirmation panel, selecting **Change…** to re-open the Add Pair panel, and then selecting **Option…** to open the Pair Option panel. You can also change the pair options for HRC pairs which have already been added by selecting the pairs on the HRC Main Control panel and then selecting the **Pair Options…** button.

The **Initial Copy Pace** option specifies the maximum number of tracks that can be copied at one time by the HRC initial copy operation before the MCU accepts another host request:

- The **15 Tracks** setting speeds up the initial copy operation but may affect the subsystem's I/O performance if the M-VOL is experiencing high write I/O activity. This setting is functionally equivalent to the PACE=2-255 parameter for the CESTPAIR TSO command.
- The **3 Tracks** setting slows down the initial copy operation to minimize the impact of the initial copy operation on the subsystem's I/O performance. This setting is functionally equivalent to the PACE=1 parameter for the CESTPAIR command.

The **M-VOL Fence Level** option (HRC Synchronous only) specifies the conditions under which the MCU will reject write operations to the M-VOL, which is known as "fencing." This option is very important for disaster recovery planning (see section 6.1.1). HARC M-VOLs are never fenced.

- If **R-VOL Data** is selected, the M-VOL will be fenced when the MCU cannot successfully execute an update copy operation for any reason. This setting is functionally equivalent to the CRIT(YES-ALL) parameter for the CESTPAIR command.
- If **R-VOL Status** is selected, the M-VOL will be fenced only if the MCU is not able to change the R-VOL pair status to suspended when an update copy operation fails. If the MCU changes the R-VOL pair status to suspended, subsequent write operations to the M-VOL will be permitted, and the MCU will keep track of all updates to the M-VOL while the pair is suspended. This setting is functionally equivalent to the CRIT(YES-PATHS) parameter for the CESTPAIR command.
- If **Never** is selected, the M-VOL will never be fenced. If the HRC volume pair is suspended, write operations to the M-VOL will be accepted. This setting is functionally equivalent to the CRIT(NO) parameter for the CESTPAIR command.

Note: For further information on the CESTPAIR CRIT parameter and its two modes of operation, CRIT(YES-PATHS) and CRIT(YES-ALL), please refer to the IBM document *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169).

The **CFW Data** option specifies whether the CFW data will be copied to the R-VOL:

- If **Copy to R-VOL** is selected, the MCU will copy the CFW data to the R-VOL.
- If **Only M-VOL** is selected, the MCU will not copy the CFW data to the R-VOL. This setting is recommended for two reasons: (1) copying the CFW data impacts subsystem performance, (2) CFW data is typically used for temporary files (e.g., sort work datasets) which are not usually required for disaster recovery.

  Note: IBM PPRC commands do not support the CFW data option. If CESTPAIR is used to establish an HRC pair, the CFW data option is set to the **Copy to R-VOL** setting.

The **DFW to R-VOL** option (HRC Synchronous only) specifies whether the MCU will suspend an HRC volume pair when the RCU cannot execute DFW to the R-VOL:

- If **DFW not required** is selected, the MCU will not suspend the HRC volume pair when DFW on the RCU is blocked. This option is recommended if you need to maintain synchronization of the HRC volume pair.
- If **DFW required** is selected, the MCU will suspend the pair when DFW on the RCU is blocked. This option is recommended if you need to maintain high MCU I/O performance.

  CAUTION: The interaction of the **DFW required** setting and the M-VOL fence level setting can cause a host application to fail with a permanent I/O error when attempting to update an M-VOL. Keep track of which volume pairs have the **DFW required** setting, and make sure that the DFW to the R-VOL is not blocked.

  Note: IBM PPRC commands do not support the DFW to R-VOL option. If an HRC (sync) pair is established using the CESTPAIR TSO command, the DFW to R-VOL option is set to the **DFW not required** setting. The DFW to R-VOL option does not apply to HARC.

The **Error Level (Async)** option (HARC only) specifies the error level for the HARC pair(s):

- **Group**: When the specified pair is suspended, all HARC pairs in the same consistency group will be suspended, even if the failure affects only that pair and not the entire group.

  Important: Select the **Group** error level for all HARC volumes which are essential to disaster recovery. Suspended HARC R-VOLs which have the **Volume** error level should not be used for disaster recovery.
- **Volume**: If the failure affects only the specified pair, then only that pair will be suspended. A failure that affects an entire group will always result in the suspension of all pairs in the group, as well as all other affected HRC pairs.

  Note: The CESTPAIR TSO command also allows you to specify the error level for HARC pairs (see Appendix B).

The **Pair Resume (Async)** option (HARC only) is available only when the Pair Option panel is opened during the resume HARC pair operation (see section 5.5). The HARC **Group** resume option allows you to resume all suspended HARC pairs in a group. The HARC **Volume** resume option allows you to resume only the selected HARC pair(s).

5.3 Monitoring the Status of HRC Volume Pairs

The Pair Status panel (see Figure 5.4) displays the detailed status of the selected volume pair and also provides access to the Pair Option panel (see section 5.2.2). The Pair Status panel is accessed from the HRC Main Control panel (**Pair Status…** button).

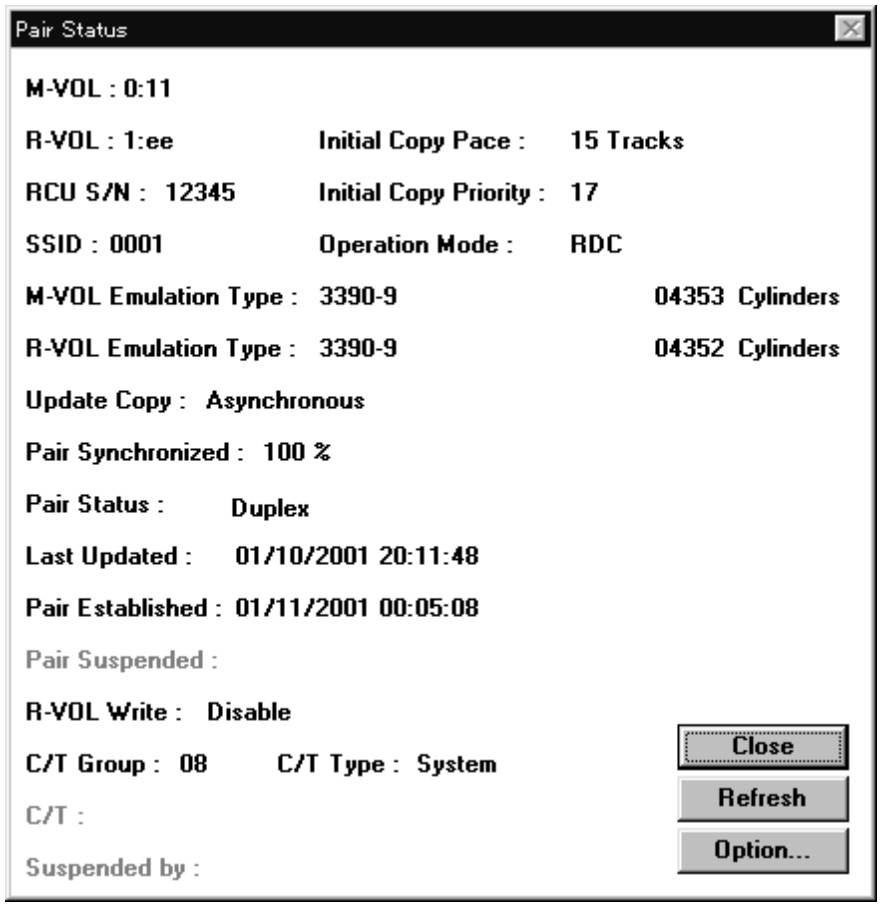


Figure 5.4 Pair Status Panel

The **Refresh** button refreshes the information displayed on the Pair Status panel. The **Option…** button opens the Pair Option panel to allow you to change the HRC pair options for the selected pair.

Note: The CQUERY TSO command can also be used to display HRC pair status for HRC Synchronous and HARC volume pairs at the MCU and RCU (see Appendix B).

The Pair Status panel displays the following information for the volume/pair selected on the HRC Main Control panel:

- **M-VOL and R-VOL**: Device ID of the M-VOL and R-VOL of the selected pair.
- **RCU S/N and SSID**: S/N and SSID of the RCU (or MCU if connected to the RCU).
- **Initial Copy Pace**: 3 tracks or 15 tracks (displayed during initial copy and resync copy).
- **Initial Copy Priority**: 1 - 256 (displayed during initial copy and resync copy).
- **Operation Mode**: RDC = remote dual copy or HRC (HODM is remote migration copy).
- **M-VOL/R-VOL Emulation Type**: LVI and size in cylinders (shows VLVI volumes).
- **Update Copy**: Synchronous or asynchronous.
- **Pair Synchronized**: For *pending duplex* pairs, this value indicates the percent completion of the initial copy operation. For *duplex* HRC Synchronous pairs, this value is always 100% after the initial copy operation is complete. For HARC pairs:

  For a *duplex* HARC pair, this value indicates the number of cylinders (% of total) that are marked as modified in the bitmap for resynchronization. The total number of cylinders = the number of M-VOL cylinders (since the R-VOL can be larger than the M-VOL).

  For a *suspended* HARC R-VOL, this value indicates the number of cylinders (% of total) containing recordsets lost at the RCU (reached the RCU but not settled before suspension).

  For a *suspended* HARC M-VOL, this value indicates the number of cylinders (% of total) which contain:
  - Tracks that have not yet been copied by the initial copy or resync copy operation (this applies only when suspended during initial copy or during resync copy), and
  - Records updated by the primary system after suspension, and
  - Recordsets lost at the MCU (created but not sent to the RCU before suspension), and
  - Recordsets lost at the RCU (if the MCU can get this information from the RCU).
- **Pair Status**: Current HRC pair status (see section 2.5) of the selected volume: *simplex*, *pending*, *duplex*, or *suspended*. If the pair status is *suspended*, the suspend type and consistency status (HARC only) are also displayed.
- **Last Updated**: Date and time that the volume pair status was last updated.
- **Pair Established**: Date and time that the volume pair was established.
- **Pair Suspended**: Date and time that the volume pair was suspended (displayed only when the current status of the volume pair is suspended).
- **C/T Group**: Consistency group to which the HARC volume pair is assigned.
- **C/T Type**: Timer type (system, local, or none) for the HARC group.
- **C/T**: Consistency time (see section 2.4.2) of the group (displayed only for the R-VOL).
- **SEQCHK**: Displayed when the HARC pair has the *SEQCHK* status. This status is managed by the RCU, and the MCU may not have the most current information. Always use the R-VOL pair status information displayed at the RCU for disaster recovery.
- **Suspended by**: Consistency status (see section 2.5.2) of the suspended HARC pair (group or volume).

5.4 Suspending HRC Volume Pairs

The Suspend Pair panel (see Figure 5.5) allows you to suspend HRC pairs and also provides access to the Suspend Pair option panel (see section 5.4.1). The Suspend Pair panel is accessed from the HRC Main Control panel (**Suspend Pair…** button). For further information on suspended HRC pairs, see section 2.5.

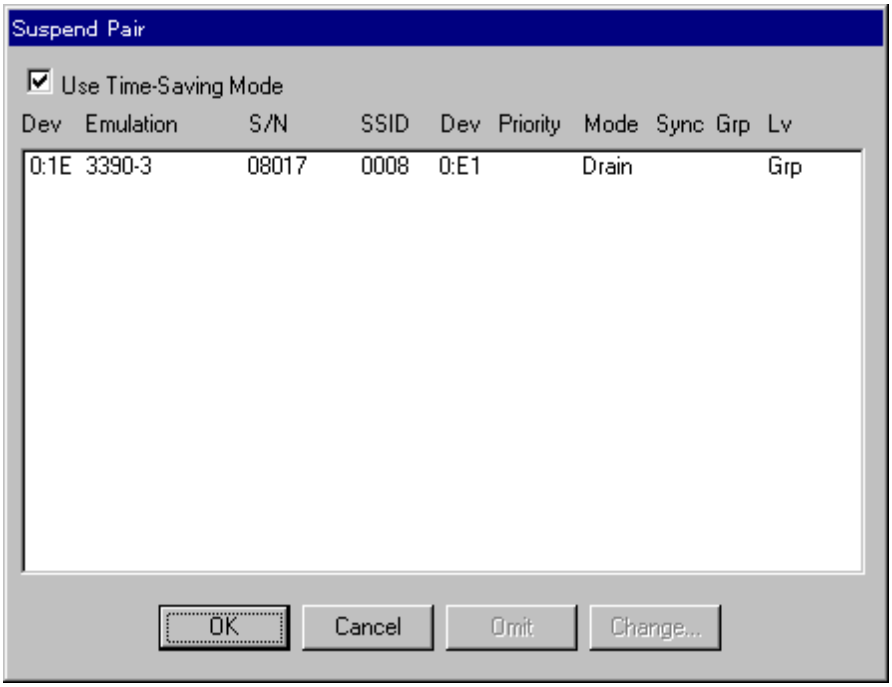


Figure 5.5 Suspend Pair Panel

The Suspend Pair panel displays the pair(s) selected on the HRC Main Control panel. If you are connected to the MCU, the pairs are displayed by M-VOL ID and LVI, RCU S/N and SSID, and R-VOL ID. If you are connected to the RCU, the pairs are displayed by R-VOL ID and LVI, MCU S/N and SSID, and M-VOL ID. For HARC pairs only, the suspend mode (drain or purge) and error level (group or volume) are also displayed. The **Use Time-Saving Mode** option allows you to execute the specified suspend pair operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **Omit** button removes the selected pair(s) from the Suspend Pair panel. The **OK** button suspends the specified pair(s). The **Change…** button opens the Suspend Pair option panel to allow you to change the suspend options for the selected pair(s). See section 5.4.1 for further information on the suspend options.

WARNING: The QUIESCE option of the CSUSPEND command 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 of the CSUSPEND command. Please check with your Hitachi Data Systems account team before using the CSUSPEND command with the QUIESCE option to suspend HRC volume pairs on 9900 (or 7700E) subsystems. If the CSUSPEND command with 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. HARC does not support the CSUSPEND/QUIESCE option.

To suspend one or more HRC volume pairs:

1. If you plan to suspend one or more HARC pairs using the **drain** suspend option, you must STOP all application I/Os to the HARC M-VOL(s) before suspending the pair(s). This ensures that all pending data in cache is written to the R-VOL(s) during pair suspension.
2. Start RMCMAIN, connect to the MCU (or RCU) of the pair(s) to be suspended, and start the HRC software. For HRC Synchronous, you must connect to the MCU. For HARC, you can connect to the MCU or RCU.
3. On the HRC Main Control panel, select the correct CU image, and then select the pair(s) to be suspended. If you plan to use the HARC **Group** suspend option, select only one HARC pair in the desired group.
4. Select **Suspend Pair…** to open the Suspend Pair panel. The Suspend Pair panel displays the pair(s) to be suspended and the HARC suspend mode (drain or purge). To remove one or more pairs from the Suspend Pair panel, select the pair(s) and then select **Omit**.
5. To verify/change the suspend options for one or more pairs, select the pair(s), select **Change…** to open the Suspend Pair option panel, select the desired suspend options for the pair(s), and then select **OK**. Repeat this step as needed until the suspend options for each pair are correct. See section 5.4.1 for further information on the suspend options.

   CAUTION: If you need to suspend a volume which is required for system operation (e.g., spool, page, or SYSRES volume), select the **R-VOL** suspend type (not **M-VOL Failure**) to ensure that the M-VOL continues accepting write I/Os.
6. If you want to execute the suspend pair requests quickly, select the **Use Time-Saving Mode** option on the Suspend Pair panel.
7. Select **OK** on the Suspend Pair panel to suspend the specified pair(s). For HRC Synchronous pairs, the MCU will complete all M-VOL write operations already in progress and the associated update copy operations at the R-VOL before suspending the pair, so that the pair is 100% synchronized at the time of suspension. For HARC pairs, the consistency time is determined by the drain or purge suspend option (see section 5.4.1).
8. To verify that your suspend pair request was completed successfully, check the detailed HRC pair status (suspend type) and/or the host console messages (IEA494I vs. IEA491E). Use the Resume Pair panel (see section 5.5) to resume the suspended pair(s).

WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HRC Main Control panel for which volumes the suspend pair operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the suspend pair operation.

5.4.1 Suspend Options

The Suspend Pair option panel (see Figure 5.6) displays and allows you to change the suspend options for the pair(s) selected on the Suspend Pair panel (see section 5.4). The Suspend Pair option panel is accessed from the Suspend Pair panel (**Change…** button).

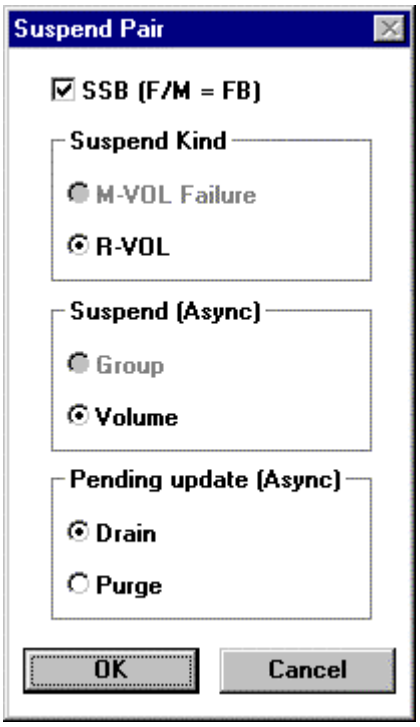


Figure 5.6 Suspend Pair Option Panel

The Suspend Pair option panel allows you to change the suspend options for the pair(s):

- **SSB (F/M = FB)**. When this option is enabled (and PPRC Support = Yes), the MCU will notify all attached hosts (IEA494I message) that the pair was suspended. This option should always be enabled. ***Note:*** If PPRC support = No, the x'FB' sense information will not be reported to the host, even if the **SSB (F/M = FB)** suspend option is enabled.
- **Suspend Kind**. This option specifies the suspend type of the selected pair(s):
  - **M-VOL Failure**. This setting can only be used for HRC Synchronous pairs. The MCU will reject all write I/O operations to the M-VOL while the pair is suspended, regardless of the fence level setting. This setting should be used if you need to maintain synchronization of the HRC pair. This setting is functionally equivalent to CSUSPEND with the optional PRIMARY parameter (without QUIESCE).
  - **R-VOL**. The M-VOL will accept all subsequent write I/O operations, and the MCU will keep track of updates while the pair is suspended. This setting should be used if you need to keep the M-VOL online. This setting is functionally equivalent to CSUSPEND without the optional PRIMARY parameter.

- **Suspend (Async)**. This option allows you to select the HARC suspend group operation. The CSUSPEND TSO command supports the HARC suspend group operation (see Appendix B).
  - **Group**. The MCU/RCU will suspend all other HARC pairs in the same consistency group as the specified pair(s).
  - **Volume**. The MCU/RCU will suspend only the specified HARC pair(s) (even if the error level of the pair is group).
- **Pending update (Async)**. This option specifies the HARC suspend mode. The CSUSPEND TSO command supports the HARC suspend mode option (see Appendix B).
  - **Drain**. The MCU will change the HARC pair status from *suspending* to *suspended* only after the RCU accepts the suspend operation and completes the following steps:
    (a) Finish settling all pending recordsets for the pair, and
    (b) Complete the negotiation with all MCUs (report ready-for-suspension to all MCUs and receive their acknowledgements) without further recordsets generated.

    Note: If the RCU is not able to complete these actions within the copy pending timeout setting, the RCU will discontinue the original suspend request and forcibly suspend the affected volume pairs. Thus, you can use the copy pending timeout parameter to limit the amount of time it takes to complete the suspend/drain operation.
  - **Purge**. The MCU will change the HARC pair status from *suspending* to *suspended* as soon as the RCU accepts the suspend operation. The MCU and RCU discard any pending recordsets and mark the cylinders that contain discarded recordsets as modified in the M-VOL and R-VOL bitmap, respectively. When the pair is resumed, the M-VOL and R-VOL bitmaps will be merged at the MCU, and all cylinders marked as modified will be copied to the R-VOL.

    Note: If the MCU does not receive acknowledgement of the suspend operation from the RCU within the copy pending timeout setting, the MCU will forcibly suspend all affected pairs and report an IEA491E host console message.

5.5 Resuming HRC Volume Pairs

While an HRC pair is suspended, the MCU does not perform any update copy operations. For a suspended HRC Synchronous pair, the MCU may or may not continue accepting write I/Os for the M-VOL depending on the M-VOL fence level and suspend option (if user-requested). If the MCU accepts write I/Os for a suspended M-VOL, the MCU keeps track of the M-VOL cylinders which are updated while the pair is suspended, and then copies the VOLSER and out-of-sync cylinders to the R-VOL when the pair is resumed. For a suspended HARC pair, the MCU and RCU keep track of any recordsets that were discarded during suspension, and the MCU continues accepting write I/Os for the M-VOL. When a HARC pair is resumed, the MCU merges the M-VOL and R-VOL cylinder bitmaps and then copies the VOLSER and out-of-sync cylinders to the R-VOL to resynchronize the pair.

The Resume Pair panel (see Figure 5.7) allows you to resume suspended HRC volume pairs and select the resume options for each pair. The Resume Pair panel is accessed from the HRC Main Control panel (**Resume Pair…** button).

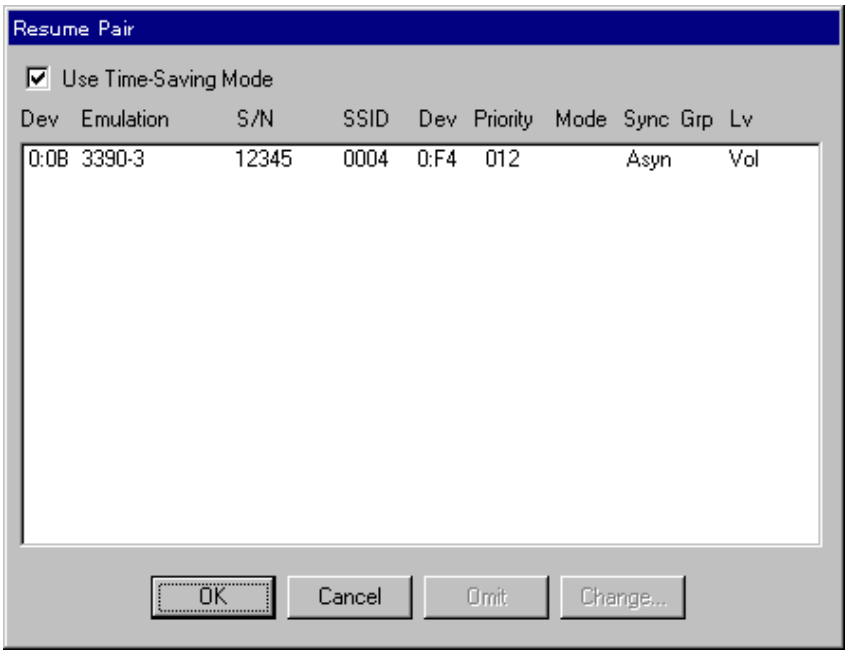


Figure 5.7 Resume Pair Panel

The Resume Pair panel displays the suspended HRC pair(s) selected on the HRC Main Control panel. Each pair is displayed by M-VOL device ID and LVI, RCU S/N and SSID, R-VOL device ID, priority, update copy mode, and HARC resume level (group or volume). The **OK** button resumes the specified pair(s). The **Use Time-Saving Mode** option allows you to execute the specified resume pair operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **Omit** button removes the selected pair(s) from the Resume Pair panel. The **Change…** button opens the Resume Pair option panel to allow you to change the resume options and/or pair options for the pair(s) selected on the Resume Pair panel. See section 5.5.1 for further information on the resume options.

Note: The CESTPAIR (MODE=RESYNC) command can be used to resume suspended HRC Synchronous and HARC pairs (see Appendix B).

To resume one or more suspended HRC volume pairs:

1. Determine if any data on the R-VOL has changed while the pair has been suspended. If so, do not resume the pair. You must delete the pair from the MCU and then restart the pair using the **Entire** initial copy mode option to resynchronize the M-VOL and R-VOL.
2. If any pair was suspended due to an error condition (use the Pair Status panel to view the suspend type), see section 7.1 and follow the instructions for troubleshooting suspended pairs. The MCU will not resume the pair(s) until the error condition has been removed.
3. Connect to the MCU of the volume pair(s) to be resumed, and start the HRC software.
4. On the HRC Main Control panel, select the correct CU image, and then select the pair(s) to be resumed. If you plan to use the HARC **Group** resume option, select only one pair.
5. Select **Resume Pair…** to open the Resume Pair panel. The Resume Pair panel displays the pair(s) to be resumed. To remove one or more pairs from the Resume Pair panel, select the pair(s) and then select **Omit**.
6. To change the resume options (see section 5.5.1) and/or pair options (see section 5.2.2) for one or more pairs, select the desired pair(s), select **Change…** to open the Resume Pair option panel, make the desired changes (select **Option…** to access the Pair Option panel), and select **OK** to return to the Resume Pair panel. Repeat this step as needed until all resume options and pair options for each pair are correct.

   Note: If you want to resume all suspended HARC pairs in a consistency group, make sure that the **Pair Resume (Async)** option on the Pair Option panel is set to **Group**.
7. If you want to execute the resume pair requests quickly, select the **Use Time-Saving Mode** option on the Resume Pair panel.
8. Select **OK** on the Resume Pair panel to resume the specified pair(s).
9. On the HRC Main Control panel, verify that the HRC volume pair(s) is/are displayed correctly (*pending* or *duplex* status) in the **Volume List** box.

WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HRC Main Control panel for which volumes the resume pair operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the resume pair operation.

5.5.1 Resume Options

The Resume Pair option panel (see Figure 5.8) allows you to change the resume options (priority and update copy mode) for the pair(s) selected on the Resume Pair panel. The Resume Pair option panel also provides access to the Pair Option panel (see Figure 5.9) to allow you to change the pair options and select the HARC resume option for the pair(s) being resumed. The Resume Pair option panel is accessed from the Resume Pair panel (**Change…** button).

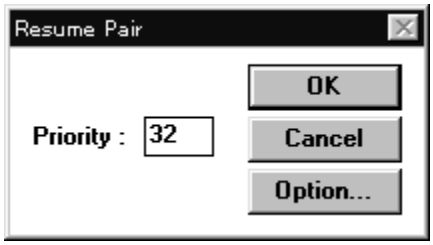


Figure 5.8 Resume Pair Option Panel

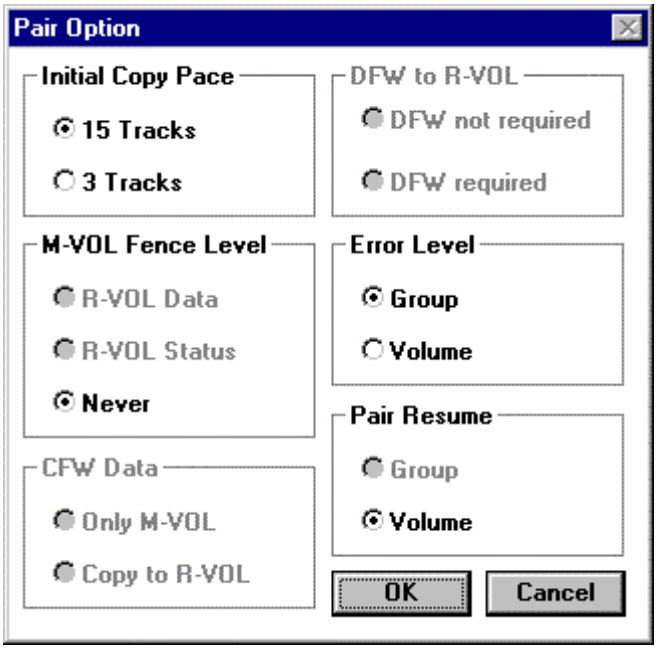


Figure 5.9 Pair Option Panel During Resume Operation

The **Priority** box allows you to select the priority for the resume operations, which determines the order in which the resume operations will be performed. The **OK** button applies the selected options to the selected pair(s). The **Option…** button opens the Pair Option panel to allow you to change the pair and HARC options for the selected pair(s).

When opened during the resume pair operation, the Pair Option panel allows you to change the following pair options (see section 5.2.2): **Initial Copy Pace** (for resync copy operation), **M-VOL Fence Level** (HRC Synchronous only), **CFW Data** (HRC Synchronous only), **DFW to R-VOL** (HRC Synchronous only), **Error Level** (HARC only), and **Pair Resume**. The **Volume** resume option allows you to resume only the selected HARC pair(s). The **Group** resume option allows you to resume all suspended HARC pairs in the same group as the selected pair (with M-VOLs in the current MCU).

Note: If an MCU/RCU is powered off and its backup batteries are fully discharged while HRC pairs are suspended, the M-VOL/R-VOL cylinder maps will not be retained. In this unlikely case, the MCU/RCU will mark all cylinders of all suspended HRC volumes as modified, so that the MCU will perform the equivalent of an entire initial copy operation when the pairs are resumed. (The R-VOL cylinder map is used only for HARC operations.)

5.6 Deleting HRC Volume Pairs

An HRC pair should be deleted from the MCU only when it is no longer necessary to maintain a remote copy of the M-VOL. When an HRC volume pair is deleted from the MCU, the MCU stops all HRC copy operations for that pair and changes the pair status of the M-VOL and R-VOL to *simplex*. After a pair is deleted, the MCU continues to accept all subsequent write I/O operations to the M-VOL and will not keep track of the M-VOL updates.

An HRC pair should be deleted from the RCU only if you need to access the R-VOL, for example, to perform ICKDSF on the R-VOL (see section 5.7) or for disaster recovery (see Chapter 6). When an HRC volume pair is deleted from the RCU, the RCU changes the R-VOL pair status to *simplex* but does not change the pair status of the corresponding M-VOL. When the MCU performs the next HRC operation, the MCU detects that the R-VOL status changed and changes the status of the M-VOL to *suspended-delete pair to RCU*. When you delete a pair from the RCU in order to access the R-VOL, remember that the R-VOL and M-VOL have the same VOLSER, and take appropriate precautions to prevent a system problem due to duplicate VOLSERs. To restart a pair which was deleted from the RCU, you must first delete the pair from the MCU, and then add the pair from the MCU using the appropriate initial copy option (**Entire Volume** or **None**) to restart the pair.

You can delete all HRC Synchronous pairs between an MCU and RCU (same CU image). You can also delete all HARC pairs in a consistency group by connecting to the MCU. The HARC pair status will change to *deleting* when the delete operation is accepted by the MCU and RCU, and then to *simplex* after the internal delete pair process is complete. In addition, you can delete HARC pairs according to their consistency status (e.g., for disaster recovery) by connecting to the RCU (the RCU maintains the consistency status). See section 5.6.1 for further information on these and other HRC delete options.

Note: The CDELPAIR TSO command can be used to delete HRC pairs and HARC groups of pairs from the MCU (see Appendix B).

WARNING: Please see the warning in section 3.3.3 about duplicate VOLSERs.

The Delete Pair panel (see Figure 5.10) allows you to delete one or more HRC volume pairs and also provides access to the Delete Pair option panel (see section 5.6.1). The Delete Pair panel is accessed from the HRC Main Control panel (**Delete Pair…** button).

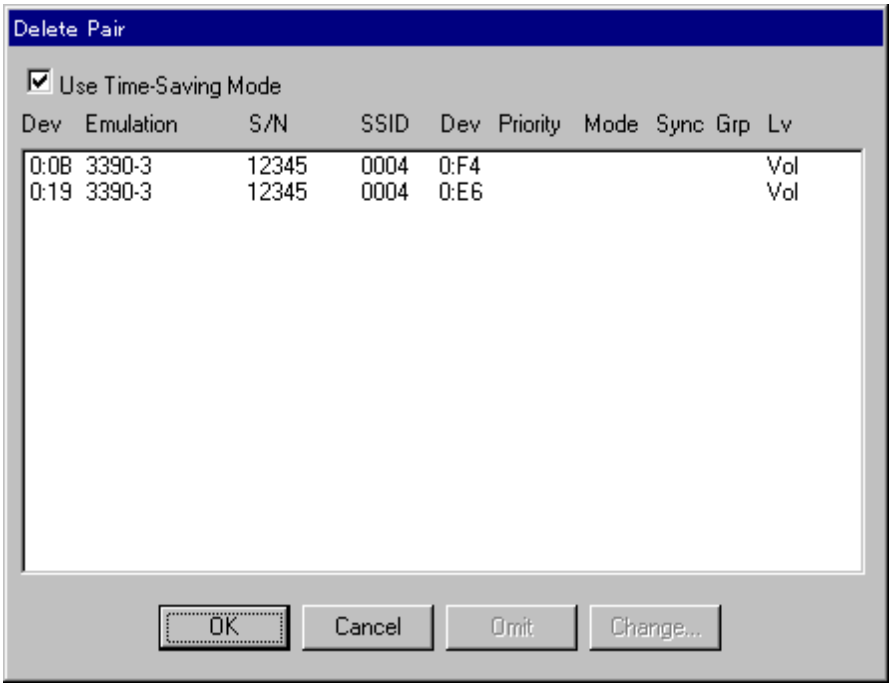


Figure 5.10 Delete Pair Panel

The Delete Pair panel displays the pair(s) selected on the HRC Main Control panel. If you are connected to the MCU, each pair is displayed by M-VOL device ID and LVI, RCU S/N and SSID, and R-VOL device ID. If you are connected to the RCU, each pair is displayed by R-VOL ID and LVI, MCU S/N and SSID, and M-VOL ID. The **Use Time-Saving Mode** option allows you to execute the specified delete pair operations quickly (i.e., requests for multiple pairs are entered simultaneously). The **OK** button deletes the specified pair(s). The **Omit** button removes the selected pair(s) from the Delete Pair panel. The **Change…** button opens the Delete Pair option panel to allow you to change the delete options. See section 5.6.1 for further information on the delete options.

To delete one or more HRC volume pairs:

1. If you need to delete the volume pair(s) from the RCU in order to access the R-VOL(s) (e.g., to perform ICKDSF), connect to the MCU(s) and suspend the volume pair(s) first (see section 5.4 for instructions).
2. Connect to the MCU or RCU of the pair(s) to be deleted, and start the HRC software. If you plan to use the HARC C/T delete option, you must connect to the RCU.
3. On the HRC Main Control panel, select the correct CU image, and select the pair(s) that you want to delete. If you plan to use the HRC Synchronous **Delete All Pairs** option, you must select only one HRC Synchronous pair. If you plan to use the HARC **C/T** or **group** delete option, you must select only one HARC pair.

4. Select the **Delete Pair…** button. When the delete pair confirmation message appears, select **Yes** to open the Delete Pair panel, or select **No** to cancel your delete pair request.
5. The Delete Pair panel displays the pair(s) selected on the HRC Main Control panel. To remove one or more pairs from the Delete Pair panel, select the pair(s) and then select **Omit**. To change the delete options for one or more pairs:
   a) Select the pair(s), and then select **Change…** to open the Delete Pair option panel.
   b) On the Delete Pair option panel, select the desired delete options (see section 5.6.1) for the selected pair(s), and then select **OK** to return to the Delete Pair panel.
   c) Repeat steps (a) and (b) as needed to set the desired delete options for each pair.
6. If you want to execute the delete pair requests quickly, select the **Use Time-Saving Mode** option on the Delete Pair panel.
7. Select **OK** on the Delete Pair panel to delete the specified pair(s).
8. When deleting HARC pairs, verify that the delete pair request was completed successfully by checking the detailed HRC pair status (should be *simplex*, not *deleting* or *suspended*) and/or the host console messages (IEA494I vs. IEA491E).
9. When deleting HRC Synchronous pairs, verify that the delete pair request was completed successfully by checking the pair status on the HRC Main Control panel (*simplex* status).
10. To restart a pair which was deleted from the RCU, first delete the pair from the MCU, and then use the Add Pair panel with the appropriate HRC initial copy option (**Entire Volume** or **None**) to restart the pair.

WARNING: If a timeout error occurs when the **Use Time-Saving Mode** option is selected, confirm on the HRC Main Control panel for which volumes the delete pair operation could not be performed. Deselect the **Use Time-Saving Mode** option for the failed volumes, and retry the delete pair operation.

5.6.1 Delete Options

The Delete Pair option panel (see Figure 5.11) allows you to change the delete options (by force, and HARC delete group) for the pair(s) selected on the Delete Pair panel. The Delete Pair option panel can only be accessed from the Delete Pair panel (**Change…** button).

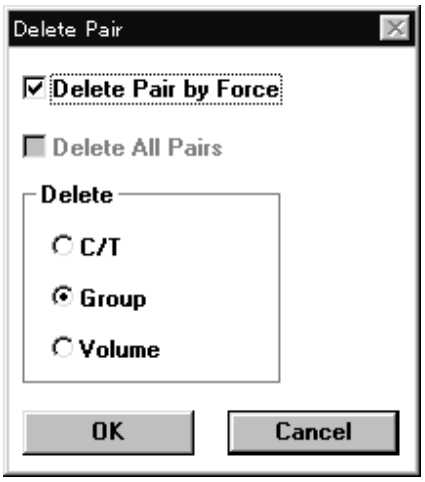


Figure 5.11 Delete Pair Option Panel

The **Delete Pair by Force** option allows you to override the restrictions on deleting an HRC volume pair. If this option is selected, the pair(s) will be deleted even if the MCU is unable to communicate with the RCU. This option may be used to free a host waiting for device-end from an MCU which cannot communicate with its RCU, thus allowing host operations to continue. If this option is not selected, the pair(s) will only be deleted if the MCU is able to change the pair status of the M-VOL and R-VOL to *simplex*.

The **Delete All Pairs** option allows you to delete all HRC Synchronous pairs with the same MCU and RCU (same CU image) as the selected pair. This option can be selected from the MCU or RCU, and the **Delete Pair by Force** option must also be selected. This option deletes the pairs more quickly than if you select all pairs on the Main Control panel and delete them.

The **Delete** box allows you to select the HARC delete option. This option simplifies disaster recovery operations for HARC consistency groups at the secondary subsystem. The HARC delete options are:

- **C/T**. When the **C/T** delete option is specified (RCU only), the RCU will delete all HARC pairs in the same group as the specified pair which meet the following conditions: the pair status must be *suspended*, and the consistency status (see section 2.5.1) must be *group*. This option is used when deleting pairs at the RCU during disaster recovery.
- **Group**. When the **Group** delete option is specified, the MCU/RCU will delete all HARC pairs in the same consistency group as the specified pair, regardless of pair status and consistency status. The MCU can only delete the HARC pairs with M-VOLs in the current MCU. The RCU can delete all pairs in the consistency group. Do not use this option when deleting pairs at the RCU during disaster recovery.
- **Volume**. When the **Volume** delete option is specified, the MCU/RCU will delete only the specified HARC pair(s). This option can be used to remove individual volumes from consistency groups, or to perform ICKDSF on a HARC R-VOL.

5.7 ICKDSF Considerations for HRC Volumes

The Hitachi Lightning 9900™ subsystem supports the use of the ICKDSF utility program. ICKDSF performs functions for the installation, use, and maintenance of DASD as well as service functions, error detection, and media maintenance. Please refer to the IBM document *ICKDSF R16 Refresh User's Guide* (GC35-0033) for further information on ICKDSF. Please refer to the *Hitachi Lightning 9900™ User and Reference Guide* (MK-90RD008) for further information on using ICKDSF with the 9900 subsystem.

5.7.1 ICKDSF on an HRC M-VOL

ICKDSF activities involve write I/O operations with device support authorization instead of normal authorization. Since the MCU does not duplicate write I/O operations with device support authorization at the R-VOL of an HRC volume pair, you must suspend an HRC pair before running ICKDSF on an HRC M-VOL. To perform ICKDSF on an HRC M-VOL:

1. Connect to the MCU of the volume pair, and then start the HRC software.
2. Suspend the volume pair, if not already suspended, using the **R-VOL** suspend option and the HARC **Volume** and **Purge** suspend options (see section 5.4.1). You can also use the CSUSPEND TSO command to suspend the pair.
3. After the M-VOL status changes to *suspended/R-VOL by operator*, run ICKDSF to repair the M-VOL.
4. When volume repairs are complete, resume the HRC pair. When resuming a suspended HARC pair, make sure to use the appropriate **Resume** level pair option (see section 5.2.2). You can also use the CESTPAIR (MODE=RESYNC) command to resume the pair.

5.7.2 ICKDSF on an HRC R-VOL

If you need to run ICKDSF on an HRC R-VOL, you must change the pair status of the R-VOL to *simplex* to allow the R-VOL to be accessed by the host. The HRC pair must then be restarted using the appropriate initial copy options. To perform ICKDSF on an HRC R-VOL:

1. For HRC Synchronous pairs, you can stop write I/Os to the M-VOL while the R-VOL is being repaired. To do this, suspend the pair from the MCU using the **M-VOL Failure** suspend option (see section 5.4.1) (or use CSUSPEND to suspend the pair).
2. Connect to the subsystem containing the R-VOL, and then start the HRC software.
3. On the HRC Main Control panel, locate and select the R-VOL to be repaired, and then delete the pair. For a HARC R-VOL, make sure to use the **Volume** delete option (see section 5.6.1). You can also use CRECOVER to delete the pair at the RCU.
4. If necessary, change the R-VOL VOLSER to avoid problems due to duplicate VOLSERs.
5. Vary the R-VOL online, and run ICKDSF to repair the R-VOL. When the volume repairs are complete, vary the R-VOL offline.
6. Connect to the MCU, locate and select the M-VOL, note the group number, and delete the pair. For a HARC M-VOL, make sure to use the **Volume** delete option.
7. Restart the pair using the Add Pair panel (or CESTPAIR). Use the **Entire Volume** initial copy option to resynchronize the M-VOL and R-VOL. ***Note:*** If you are absolutely sure that the M-VOL and R-VOL are still identical, you can restart the pair using the **None** option.

5.8 Using HRC for Data Migration and Duplication

5.8.1 Data Migration Using HRC Synchronous

HRC Synchronous can be used for device or workload migration with minimal impact to host applications. You may need to migrate data from one volume to another for any of the following reasons:

- To load data onto new or scratch volumes (e.g., new or upgraded subsystem),
- To temporarily move data off a volume to accommodate other activities (e.g., repair), or
- To relocate volumes to balance workloads and distribute I/O activity evenly within and across subsystems for the purpose of improving subsystem and system performance.

Note: HRC operations within one 9900 subsystem can only be performed if the ShadowImage option is not active on the subsystem.

The HRC initial copy operation copies the entire contents of the M-VOL to the R-VOL. The data migration is complete when the initial copy operation completes and the pair status changes from *pending duplex* to *duplex*. The P/DAS host software function is used with HRC Synchronous to complete the data migration nondisruptively. ***Note:*** If you are migrating data between subsystems, both subsystems must be the same type (Hitachi 9900 or 7700E). If not, please contact your Hitachi Data Systems account team for information on the Hitachi Online Data Migration (HODM) feature, which is used to migrate data from other vendors' subsystems as well as older Hitachi subsystems onto the 9900 subsystem.

To use HRC Synchronous to migrate data from one volume to another:

1. Vary the R-VOL(s) offline from all attached hosts. The R-VOLs are the target volumes onto which you are migrating the data. The M-VOLs (source volumes) can remain online.
2. Connect to the subsystem containing the volume(s) to be migrated, and then start the HRC software. If not already done, install the remote copy connections and configure the RCPs (if migrating between subsystems), and then add the RCUs.
3. On the HRC Main Control panel, select the correct CU image and the desired volume(s), and then start the HRC Synchronous pair(s) using the Add Pair panel (see section 5.2).
4. Monitor the progress of the initial copy operation(s) and the status of the pair(s) on the Pair Status panel (see section 5.3). Refresh the panel as needed. When the status has changed from *pending duplex* to *duplex*, the M-VOL and R-VOL are identical and synchronized.
5. Use the IBM P/DAS host software function (see section 2.6.1) to redirect all application I/Os to the R-VOL(s) nondisruptively. If the host system does not support P/DAS, use the following procedure to stop using the M-VOL(s) and switch to the R-VOL(s):
   a) Quiesce all applications using the M-VOL(s).
   b) When all update activity to the M-VOL(s) has stopped, connect to the MCU, select the correct CU image, and delete the HRC volume pair(s) (see section 5.6).

c) If the M-VOL(s) and R-VOL(s) are attached to the same host, vary the M-VOL(s) offline first, and then vary the R-VOL(s) online. The M-VOL(s) and R-VOL(s) have the same VOLSERs and cannot be online to the same host(s) at the same time.

d) If an R-VOL contains more cylinders than its M-VOL, update the R-VOL volume table of contents (VTOC) using ICKDSF/REFORMAT.

e) If you want to keep the volumes synchronized, establish the same HRC pair(s) in the reverse direction using the **None** initial copy option (see section 5.2.1). If the original M-VOL(s) will be temporarily unavailable for update copy operations, you can suspend the new pair(s) so that the new MCU keeps track of changes.

f) Start the applications with the R-VOL(s). When the original M-VOL(s) become available, you can resume the pair(s) using the Resume Pair panel (see section 5.5).

5.8.2 Point-in-Time (PiT) Data Duplication Using HARC

HARC enables you to make Point-in-Time (PiT) duplicates of groups of volumes. The HARC **Group** and **Drain** suspend options can be used together to create a PiT copy, relative to an application, of an entire HARC consistency group of volumes. To produce a PiT duplicate of an existing HARC consistency group:

1. Quiesce the applications accessing the HARC M-VOLs to stop all update activity to all M-VOLs in the group.
2. After all M-VOL updates have completed, suspend the HARC group using the **Group** and **Drain** suspend options. If you are suspending the group at the main site, you need to issue the suspend/group command to one M-VOL in the MCU. If you are suspending the group at the remote site, issue the suspend/group command to one R-VOL in the RCU.

   Note: The copy pending timeout setting for the group determines the maximum amount of time that the suspend/drain operation can take (see description of **Drain** above).
3. When the status for all HARC pairs in the group has changed to *suspended*, the duplicate set of volumes is complete. If desired, you can restart the application at the main site.

5.9 Powering Off/On HRC Components

The user is responsible for controlling power-off activities for subsystems involved in HRC operations. If you need to power off the 9900 subsystem, please call your Hitachi Data Systems representative or the Hitachi Data Systems Support Center for assistance. Sections 5.9.1 through 5.9.3 provide instructions for performing planned outages of HRC components.

If power is removed from an MCU while HRC operations are in progress, the HRC pairs are not affected, but the update sequence consistency of the HARC groups at the RCU may be affected (see section 5.9.1 for further information). When power is restored to an MCU, the MCU communicates with its RCU(s) to confirm the pair status of the R-VOLs. Make sure that HRC communications are fully restored (all RCU paths have normal status) before beginning I/O operations to the M-VOLs. If the MCU accepts a write I/O operation for an M-VOL before this confirmation is complete, the MCU will suspend the pair and change the status of the M-VOL to *suspended-by RCU* (the MCU will not be able to change the pair status of the R-VOL).

If power is removed from an RCU or remote copy connection while HRC operations are in progress, the MCU(s) will detect the communication failure, suspend all affected pairs, and generate SIMs and console messages reporting the failures. The MCU will change the status of the M-VOLs to *suspended-by RCU* but will not be able to change the status of the R-VOLs.

Note: If an MCU/RCU is powered off and its backup batteries are fully discharged while HRC pairs are suspended, the M-VOL/R-VOL cylinder maps will not be retained. In this unlikely case, the MCU/RCU will mark all cylinders of all suspended HRC volumes as modified, so that the MCU will perform the equivalent of an entire initial copy operation when the pairs are resumed. (The R-VOL cylinder map is used only for HARC operations.)

5.9.1 Planned Outage of the MCU

A planned MCU outage does not affect HRC Synchronous pairs. For HARC operations, the MCU must communicate with the RCU even when there are no M-VOL update I/Os from the primary system. During the power-off sequence, the MCU will automatically suspend all HARC pairs in the *duplex* and *duplex pending* state (suspend type = MCU P/S-OFF). During power-on-reset sequence, the MCU will automatically resume these suspended pairs (pairs with other suspend types are not automatically resumed).

If a HARC group contains M-VOLs in the MCU being powered off and in other MCU(s) which is/are not being powered off, the pairs behind the other MCU(s) will not be suspended and will continue to be updated. If you need to maintain a fully consistent group at the RCU during the planned MCU outage, take the following steps:

1. Quiesce the applications using all M-VOLs in the consistency group.
2. Suspend the group at the RCU using the **Group** suspend option. You can use the **Purge** or **Drain** suspend option since the M-VOL updates have stopped.
3. Perform the planned outage of the HRC MCU.
4. When the MCU is fully powered on and ready to resume operations, resume the HARC pairs at all MCUs that were powered off (use the resume group option).

5.9.2 Planned Outage of the RCU or Remote Copy Connection

You must suspend all affected HRC pairs prior to a planned outage of an RCU or of a remote copy connection component (e.g., ESCON director, channel extender). If you do not suspend the pairs first, the MCU(s) will detect the communication failure, suspend all affected pairs, and generate SIMs and console messages reporting the failures. To perform a planned outage of an HRC RCU or remote copy connection component:

1. Identify all HRC M-VOLs which will be affected by the equipment outage. You need to know the MCU, CU image, and LDEV ID for each of these M-VOLs.
   e) For RCU power-off, identify all M-VOLs which are paired with R-VOLs in the RCU to be powered off.
   a) For remote copy connection outage, identify all M-VOLs in all MCUs which use the path/component to be powered off.
2. Connect to each MCU which contains affected M-VOLs, and suspend all affected HRC pairs. Make sure to confirm the pair status changes (HRC Pair Status panel or CQUERY TSO command).
3. Perform the planned outage of the RCU or remote copy connection.
4. When the RCU is fully powered on and ready to resume operations, resume all HRC pairs at each MCU. Make sure to confirm the pair status changes.

5.9.3 Planned Outage of the MCU and RCU

When you plan an outage of HRC MCUs and RCUs at the same time, the MCUs must be powered off before the RCUs and powered on after the RCUs. To perform a planned outage of an HRC MCU and RCU:

1. If RCU power-on will be difficult to control (e.g., Power-Control-Interface setting), you should consider increasing or disabling the **RCU ready timeout** group option (see section 2.4.1) for each HARC group with R-VOLs in the RCU(s) to be powered off.
2. Perform the planned outage of the MCU(s) as described in section 5.9.1. Do not power-on the MCU(s) yet.
3. If an RCU to be powered off is connected to an MCU which is not powered off, make sure to suspend those HRC pairs before powering off the RCU as described in section 5.9.2.
4. Perform the planned outage of the RCU(s).
5. Power on the RCU(s). Make sure that they are fully operational and ready to resume operations before powering on the MCUs.
6. Power on the MCU(s), and make sure that they are ready to resume operations. If you suspended any pairs in step (3), you can also resume those pairs now.

Chapter 6 HRC Disaster Recovery Operations

6.1 Preparing for Disaster Recovery

The type of disaster and the status of the HRC volume pairs will determine the best approach for disaster recovery. For example, if all HRC volume pairs are in the *duplex* state when a total system failure occurs at a single point in time, the R-VOLs are current and recovery is straightforward. Unfortunately, some disasters are not so "orderly" and involve intermittent or gradual failures occurring over a longer period of time. The user should anticipate and plan for all types of failures and disasters. For additional information on planning for disaster recovery, please refer to *Planning for IBM Remote Copy*, IBM document SG24-2595.

The major steps in preparing for disaster recovery are:

1. Identify the volumes and volume groups which contain important files and data for disaster recovery, for example, DB2® log files, master catalog, key user catalogs, and system control data sets. In addition to supporting HRC remote copy operations as well as PPRC commands, the 9900 subsystem provides battery-backed nonvolatile duplexed cache, full hardware redundancy, dynamic sparing, and an advanced RAID-5 implementation to ensure full data integrity in the event of a sudden power outage or other failure.
2. Install the Remote Console and HRC hardware and software, and establish HRC operations for the volumes and groups identified in step (1). Make sure to select the proper CU images to access the desired volumes. Refer to Chapter 3 for HRC installation instructions. Refer to Chapters 4 and 5 for instructions on performing HRC operations.
3. Use the appropriate combination of HRC options for disaster recovery:
   - RCU options: **Incident of RCU**, **PPRC Support**, **Service SIM of HRC**, and **FREEZE Option** (see section 4.3.3).
   - HARC **offloading timer** asynchronous option (see section 4.4.1), and HARC **copy pending timeout** group option (see section 4.4.3). The **copy pending timeout** group option can be used to limit the time duration during which updates may be lost.
   - HARC **Error Level** pair option, and **M-VOL Fence Level** pair option for HRC Synchronous pairs (see section 5.2.2).
4. Establish file and database recovery procedures. These procedures should already be established for recovering volumes which become inaccessible due to control unit failure.
5. Install and configure error reporting communications (ERC) between the main and remote sites. ERC is essential if you use the M-VOL fence level setting of **R-VOL Status** or **Never** for any HRC volume pairs.
6. Configure the primary host system to use the IEA494I message as a trigger for automation rather than the IEA491E message. The IEA491E message is reported to only one host, whereas the IEA494I message is reported to all attached MVS hosts each time the M-VOL pair status changes. See section B.4 for further information on the IEA494I and IEA491E system console messages.

6.1.1 Considering the M-VOL Fence Level Setting

The M-VOL fence level setting (see section 5.2.2) for each HRC Synchronous volume pair determines whether the M-VOL will be fenced when HRC remote copy operations fail. Table 6.1 summarizes the effect of the fence level setting on an HRC Synchronous M-VOL.

Note: The M-VOL fence level setting does not apply to HARC pairs. The HARC M-VOL is never fenced due to suspension of the pair.

Table 6.1 Effect of the Fence Level Setting on an HRC M-VOL

Type of Failure		Fence Level Setting		
		R-VOL Data (CRIT=YES-ALL)	R-VOL Status (CRIT=YES-PATHS)	Never (CRIT=NO)
The update copy operation failed, and the MCU was able to change the status of the R-VOL to *suspended*.	Write I/O operations to the M-VOL will be:	REJECTED	Accepted	Accepted
The update copy operation failed, and the MCU was NOT able to change the status of the R-VOL to *suspended*.	Write I/O operations to the M-VOL will be:	REJECTED	REJECTED	Accepted

R-VOL Data (CRIT=YES-ALL). When this fence level setting is selected, the M-VOL will be fenced if an update copy operation fails. This M-VOL fence level setting ensures that the R-VOL remains identical to the M-VOL once the HRC volume pair is synchronized, but makes the M-VOL inaccessible to applications for updates whenever HRC remote copy operations fail. This setting should be considered for the most critical volumes for disaster recovery. This setting will reduce the amount of time required to analyze the currency of the R-VOL during disaster recovery efforts. This setting is also designed for applications which can continue to operate with another device pair (e.g., IMS logger dual write log files).

R-VOL Status (CRIT=YES-PATHS). When this fence level is selected, the M-VOL is fenced only if the MCU is not able to change the R-VOL pair status to suspended. If the MCU successfully changes the R-VOL pair status to suspended, subsequent write I/O operations to the M-VOL will be accepted, and the MCU will keep track of updates to the M-VOL. This allows the volume pair to be resumed quickly using the resync (out-of-sync-cylinders) copy operation (MODE=RESYNC). This setting will also reduce the amount of time required to analyze the R-VOL currency during disaster recovery.

Never (CRIT=NO). When this fence level is selected, the M-VOL is never fenced when the pair is suspended. This M-VOL fence level setting ensures that the M-VOL remains available to applications for updates, even if all HRC copy operations have failed. The R-VOL may no longer be in sync with the M-VOL, but the MCU will keep track of updates to the M-VOL while the pair is suspended. ERC is essential if this fence level setting is used. For disaster recovery, the currency of the R-VOL is determined by using the sense information transferred via ERC or by comparing the R-VOL contents with other files confirmed to be current.

Note: For further information on the CESTPAIR CRIT parameter and its two modes of operation, CRIT(YES-PATHS) and CRIT(YES-ALL), please refer to the IBM document *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169).

6.1.2 Transferring Sense Information Between Sites

When the MCU (or RCU for HARC) suspends an HRC pair due to an error condition, the MCU/RCU sends sense information with unit check status to the appropriate host(s). This sense information is used during disaster recovery to determine the currency of the R-VOL. If the host system does not support IBM PPRC, you must transfer the sense information to the remote site via the error reporting communications (ERC). If the host system supports IBM PPRC and receives PPRC-compatible sense information related to an HRC pair, the host operating system will:

1. Temporarily suspend all application I/O operations to the M-VOL.
2. Enter an IEA491E message in the system log (SYSLOG) which indicates the time that the M-VOL was suspended. Make sure that the system log is common to both the main and remote operating systems.
3. Place specific information about the failure (SIM) in the SYS1.LOGREC dataset for use by service personnel. See Appendix D for further information on the HRC SIMs.
4. Wait for the IEA491E message to reach the remote system.
5. Resume all host application I/O operations to the M-VOL. If the M-VOL fence level setting does not allow subsequent updates, the MCU will return a unit check for all subsequent write I/O operations, and the application will terminate.

Note: Make sure that the MCUs and RCUs are configured to report the service-level SIMs to the host. Select the **Service SIM of HRC** = **Report** setting on the RCU Option panel.

6.1.3 File and Database Recovery Procedures

When an HRC Synchronous pair is suspended, or when the MCU fails due to a disaster, the R-VOL may contain in-process data. A data set could be open, or transactions may not have completed. Even if you use the **R-VOL Data** fence level for all HRC Synchronous pairs, you need to establish file recovery procedures. These procedures should be the same as those used for recovering any volume which becomes inaccessible due to control unit failure. These procedures are more important if the **R-VOL Status** or **Never** fence level settings are used.

HARC does not provide any procedure for detecting and retrieving lost updates. To detect and recreate lost updates, you must check other current information (e.g., database journal log file that was active at the primary system when the disaster occurred). Note that the journal log file entries of most DBMS have the same system TOD clock information that is used for the I/O time-stamps (when timer type = system). The HARC group consistency time can be extremely useful when performing this detection and retrieval. Since this detection/retrieval process can take a while, your disaster recovery scenario should be designed so that detection and retrieval of lost updates is performed after the application has been started at the secondary system.

You should prepare for file and database recovery by using:

- Files for file recovery (e.g., DB2 log files which have been verified as current). To ensure the currency of these files, use the **R-VOL Data** fence level setting for the HRC pairs which contain these important files.
- The sense information with system time stamp which will be transferred via ERC.

Important: Remote copy and disaster recovery procedures are inherently complex. Consult your Hitachi Data Systems account team on sense-level settings and recovery procedures.

Note: See Appendix C for information on recovering a pinned track on an HRC volume.

6.1.4 CSUSPEND/QUIESCE TSO Command

Please refer to IBM documents SG24-2595 and SC35-0169 for important information on the optional QUIESCE parameter for the CSUSPEND TSO command.

WARNING: The QUIESCE option of the CSUSPEND command 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 of the CSUSPEND command. Please check with your Hitachi Data Systems account team before using the CSUSPEND command with the QUIESCE option to suspend HRC volume pairs on 9900 (or 7700E) subsystems. If the CSUSPEND command with 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. HARC does not support the CSUSPEND/QUIESCE option.

6.1.5 IEA494I System Console Message

The IEA494I message is recommended as a trigger for automation over the IEA491E message, because the IEA494I message is reported to all attached MVS hosts each time the M-VOL pair status changes, whereas the IEA491E message is reported to only one host system. See section B.4 for further information on the IEA494I and IEA491E messages.

6.2 Switching Operations to the Remote Site

If a disaster or failure occurs at the main site, the first disaster recovery activity is to switch your operations to the remote backup site. The HRC Synchronous R-VOLs are recovered individually based on the pair status and M-VOL fence level information for each pair. The HARC R-VOLs are recovered based on pair status, consistency status, and consistency time.

The basic procedures for switching operations to the remote backup site are:

1. Analyze the currency of the HRC Synchronous R-VOLs (see section 6.2.1) and the consistency of the HARC R-VOLs (see section 6.2.2).
2. Record the consistency time (C/T) of each group. The suspended HARC R-VOLs with consistency status of *group* will indicate the same C/T.
3. Perform file recovery as needed (see section 6.1.3). The C/T of each HARC group can be used to retrieve lost updates.
4. At the remote site, suspend all pairs by issuing the CSUSPEND TSO command to the R-VOLs. This command changes the R-VOLs to the *simplex* state. Use the HARC group and drain suspend options to destage pending updates in cache to the R-VOLs.

   Note: If PPRC is not installed, connect to each RCU, and delete all HRC pairs. For HARC pairs, use the **C/T** delete option to delete all consistent pairs in the group at the same time. This option prevents you from accidentally using inconsistent pairs for disaster recovery. Delete all HRC sync pairs using the **Delete by Force** and **Delete All Pairs** options.

   Caution: Once an R-VOL changes to the *simplex* state, you cannot distinguish it from a non-HRC *simplex* volume. The HARC C/T is also discarded when the pair is deleted.
5. If necessary, use ICKDSF REFORMAT to change the labels (VOLSERs) of the R-VOLs.
6. Make sure that all required file recovery procedures have been completed before varying the R-VOLs online. If an IPL of the remote host system is not required, bring the R-VOLs online. If an IPL is required:
   a) Clear the remote copy SIMs from the RCUs before OS IPL. Connect to each RCU and select the **Clear SIM** button on the HRC Main Control panel (see section 4.2.5).
   b) Perform IPL of the remote host system.
   c) Wait until the IPL is complete, and then vary the R-VOLs online (if they did not come online automatically).
7. At this point you may start critical applications at the remote site with the previous R-VOLs taking the place of their M-VOLs.

6.2.1 Analyzing the Currency of HRC Synchronous R-VOLs

Table 6.2 shows how to determine the currency of an HRC Synchronous R-VOL based on its pair status and M-VOL fence level setting. For HRC Synchronous pairs with an M-VOL fence level setting of **Never**, further analysis will be required to determine the currency of these R-VOLs. The currency of these R-VOLs can be determined by using the sense information transferred via the ERC or by comparing the contents of the R-VOL with other files which are confirmed to be current (e.g., DB2 log files). These R-VOLs should be recovered using the files which are confirmed to be current.

Table 6.2 Analyzing the Currency of HRC Synchronous R-VOLs

Status of R-VOL	Fence Level	Currency of R-VOL
Simplex	Data Status Never	**Inconsistent**. This R-VOL does not belong to an HRC volume pair. (***Note:*** Even if you established an HRC pair for this volume, you must regard this volume as inconsistent.)
Pending Duplex	Data Status Never	**Inconsistent**. This R-VOL is not synchronized because not all cylinders have been copied from the M-VOL yet. This R-VOL must be initialized (or copied from the M-VOL at a later time).
Duplex	Data Status	**Current**. This R-VOL is synchronized with its M-VOL.
	Never	**Needs to be analyzed**. This R-VOL requires further analysis to determine its level of currency.
Suspended - initial copy failed	Data Status Never	**Inconsistent**. This R-VOL is not synchronized because not all cylinders have been copied from the M-VOL yet. This R-VOL must be initialized (or copied from the M-VOL at a later time).
Suspended - R-VOL by operator	Data Status Never	**Suspect**. This R-VOL is not synchronized with its M-VOL if any write I/Os were issued to the M-VOL after the pair was suspended. This pair should be restarted using the **Entire Volume** initial copy option, but the **None** option can be used if you are sure no data on the M-VOL changed.
Suspended - all other types	Data	**Current**. This R-VOL is synchronized with its M-VOL.
	Status Never	**Suspect**. This R-VOL is not synchronized with its M-VOL if any write I/Os were issued to the M-VOL after the pair was suspended. Restore the consistency of this R-VOL and update it, if required. The system time stamp information transferred through ERC or the time of suspension indicated on the Pair Status panel will help to determine the last time this R-VOL was updated.

6.2.2 Analyzing the Consistency of HARC R-VOLs

Table 6.3 shows how to determine the consistency of a HARC R-VOL based on its pair status and consistency status. For HARC R-VOLs with a consistency status of **Volume**, the volume is not consistent with other volumes in the same group, and further analysis will be required to determine the currency of each of these R-VOLs. The currency of these R-VOLs can be determined by using the sense information transferred via the ERC or by comparing the contents of the R-VOL with other files which are confirmed to be current (e.g., DB2 log files). These R-VOLs should be recovered using the files which are confirmed to be current.

Table 6.3 Analyzing the Consistency of HARC R-VOLs

Status of R-VOL	Usable for Recovery?	Description
Duplex Pending Duplex Simplex	No No No	These states do not usually occur during HARC disaster recovery, because the RCU suspends all HARC pairs when communication with the MCU is lost. HARC R-VOLs in these states should not be used for disaster recovery. ***Note:*** Simplex volumes cannot be distinguished from R-VOLs which have already been deleted by the Delete Pair operation.
Suspended-Group	Yes	The update sequence consistency across these R-VOLs is ensured at the point in time indicated by the group consistency time. These R-VOLs can be used for disaster recovery at the secondary system. ***Note:*** Updates which were performed at the primary system after the indicated consistency time were probably lost.
Suspended-Volume	No	The contents of this R-VOL may be behind the other R-VOLs in the consistency group. If this volume must be consistent with the other volumes in the same group, this R-VOL should not be used for disaster recovery. The cause for this status is: – The HARC **Error Level** pair option for this pair is **Volume** (not **Group**), AND – This pair was suspended before the disaster/failure, at the beginning of the rolling disaster, or during the initial copy operation.

6.3 Transferring Operations Back to the Main Site

Once the applications are running at the remote site, the next activity is to restore the main site and transfer operations back to the main site. To transfer operations to the main site:

1. Bring up the host system at the main (primary) site, and ensure that all HRC components are fully operational.
2. At the main site, delete all HRC pairs at the MCUs. The **Delete Pair by Force** option must be used because the previous R-VOLs are now in the *simplex* state at the remote site. Use the **Delete All Pairs** option to delete all HRC sync pairs in each CU image. Use the **Delete-Group** option to delete all HARC pairs in each group. Make sure to connect with all MCUs and all CU images to delete all HRC pairs.
3. At the main site, delete all HARC consistency groups at the MCUs.
4. At the main site, delete the RCUs. Remember to connect with each MCU and each CU image to make sure that all RCUs have been deleted.
5. At the main site, configure the MCU serial interface ports as needed. If you plan to use the same remote copy connections to copy back, change the existing RCPs to LCPs. If SVP mode 114 is enabled on all MCUs and RCUs, the ports will reconfigure automatically if you use the TSO CESTPATH command to add the pairs at the remote (secondary) site.
6. If you plan to use the same channel extenders, change the operating mode to the opposite direction. The boxes/nodes connected to the MCUs must be set to channel-mode, and the boxes/nodes connected to the RCUs must be set to device-mode.
7. At the remote site, configure the RCU serial ports to enable HRC operations in the reverse direction (change LCPs to RCPs). This enables the original RCUs to send HRC remote copy operations to the original MCUs to bring the original M-VOLs up to date. If SVP mode 114 is enabled on all MCUs and RCUs, the ports will reconfigure automatically if you use the TSO CESTPATH command to add the pairs at the remote site.
8. At the remote site, establish the same HARC groups and HRC pairs in the reverse direction to synchronize the original M-VOLs with the R-VOLs. Make sure to use the **Entire Volume** HRC initial copy option. Table 6.4 shows the correct timer types for performing HARC operations in the reverse direction.

Table 6.4 Selecting the Correct Timer Type for HARC Disaster Recovery

Original Configuration		Timer Type for Copy Back	
		I/O Time-Stamp Function at Secondary System?	
MCU-RCU Configuration	Timer Type	Yes	No
n-to-1 (n>1)	System	None	None
1-to-1	System	System	None
	Local	Local	Local

6.4 Resuming Normal Operations at the Main Site

Once the HRC pairs have been established in the reverse direction, you are ready to resume normal operations at the main site. Remember that the HRC terminology is now reversed: the original RCUs and R-VOLs (remote site) are now the MCUs and M-VOLs, and the original MCUs and M-VOLs (main site) are now the RCUs and R-VOLs.

To resume normal operations at the main site:

1. At the remote site, make sure that all HRC pairs are in the *duplex* state. This indicates that the HRC initial copy operations are complete.
2. Halt the applications at the remote site, and vary the M-VOLs (original R-VOLs) offline at the remote site. This maintains synchronization of the HRC Synchronous pairs.
3. At the remote site, suspend all HRC pairs at the MCUs (original RCUs) to destage any pending data from cache. Confirm that the pairs are suspended before proceeding. If an error occurs, resolve it before proceeding.
4. At the remote site, delete all HRC pairs at the MCUs (original RCUs) using the **Delete All Pairs** option for HRC sync pairs and the **Delete-Group** option for HARC pairs. For HARC pairs, the MCU and RCU complete all pending updates before changing the pair status to *simplex*.
5. At the remote site, change the HRC settings at the MCUs (original RCUs) to prepare for normal HRC operations. Delete the HARC groups and the RCUs (original MCUs). If you plan to use the same remote copy connections, reconfigure the serial interface ports to change the RCPs back to LCPs. If SVP mode 114 is enabled on all MCUs and RCUs, the ports will reconfigure automatically if you use the TSO CESTPATH command to add the pairs at the main site.
6. If you plan to use the same channel extenders, change the operating mode back to the original direction. The boxes/nodes connected to the MCUs must be set to channel-mode, and the boxes/nodes connected to the RCUs must be set to device-mode.
7. At the main site, configure the RCPs, add the RCUs, and add the HARC groups. If SVP mode 114 is enabled on all MCUs and RCUs, the ports will reconfigure automatically if you use the TSO CESTPATH command to add the pairs at the main site.
8. At the main site, establish all HARC groups and HRC pairs in the original direction. You may use the **None** initial copy option because all M-VOLs and R-VOLs are synchronized. If there is any possibility that the volumes are not 100% synchronized, use the **Entire Volume** initial copy option to be safe.
9. Vary the MCU and M-VOLs online, and start the applications at the main site.

Chapter 7 Troubleshooting

7.1 Troubleshooting HRC Operations

In the unlikely event of a problem with the 9900 Remote Console PC or RMCMAIN software, first make sure that the problem is not being caused by the PC or Ethernet hardware or software, and try restarting the PC. Restarting the Remote Console PC does not affect HRC operations already in progress. See section 7.2 for a description of the HRC error messages displayed on the Remote Console PC. If you need to call the Hitachi Data Systems Support Center, refer to section 7.3 for instructions.

Table 7.1 provides general troubleshooting instructions for HRC. Table 7.2 provides troubleshooting instructions for RCU paths. Tables 7.3 and 7.4 provide troubleshooting instructions for suspended HRC pairs. For troubleshooting information on HRC scripting, see Appendix E. For troubleshooting information on PPRC and P/DAS operations, please refer to the IBM PPRC and P/DAS user documentation: *Planning for IBM Remote Copy* (SG24-2595), and *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169).

Table 7.1 General HRC Troubleshooting

Error	Corrective Action
The Remote Console PC hangs, or HRC operations do not function properly.	Disconnect Hitachi GRAPH-Track™ from the subsystem before connecting to the same subsystem using RMCMAIN. Make sure that all HRC requirements and restrictions are met (e.g., track format, LVI, VOLSER, DFW). See sections 3.1 and 3.2. Make sure the MCU and RCU are powered on and fully operational (NVS, cache, DFW). Refer to the *Hitachi Lightning 9900™ User and Reference Guide* for operational and troubleshooting information for the 9900. Check all input values and parameters to make sure you entered the correct information on the Remote Console PC (e.g., RCU S/N and SSID, path parameters, M-VOL and R-VOL IDs).
If any RCP 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 and/or RCUs are not displaying correctly.	Make sure that 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 User's Guide* for instructions). See Appendix D for SIMs related to HRC operations. Refer to the *Hitachi Lightning 9900™ User and Reference Guide* for a listing of all SIMs.
An HRC error message is displayed on the Remote Console PC.	Resolve the specified error condition, and then try the HRC operation again.
There is a problem with the Remote Console PC or HRC remote console software.	Make sure that the problem is not the PC or LAN hardware or software. Try restarting the PC and reconnecting to the subsystem.
The RCU path status is not normal.	Check the path status (RCU Status panel) and see Table 7.2.
The pair status is *suspended*.	Check the detailed pair status (Pair Status panel) and see Tables 7.3 and 7.4 for suspend types and corrective action for suspended HRC pairs.

Table 7.2 Troubleshooting RCU Path Status Problems

Path Status	Description	Corrective Action
Initialization Failed	The link initialization procedure to the RCU failed.	Make sure that you entered the correct RCU S/N and SSID and path parameters (port, link address, logical address). Make sure that the correct MCU port is configured as an RCP. Make sure the correct RCU port is configured as an LCP.
Communication Time Out	Communication between the MCU and RCU timed out.	Make sure that the RCU is powered on and fully functional (NVS and cache ON). Make sure that the remote copy connection hardware (cables, connectors, ESCDs) is properly configured and functional. Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.
Resource Shortage (MCU/RCU)	The MCU/RCU rejected the establish logical path link control function because all logical path resources in the MCU/RCU are being used for other connections.	Delete the failed path, and also delete all paths and RCUs not currently in use. The MCU can be connected to up to four RCUs with up to four paths to each RCU. Make sure all MCU and RCU ports are properly configured: LCPs for hosts and MCUs, RCPs for RCUs. If necessary, connect to the RCU to delete paths/RCUs and reconfigure ports, then reconnect to the MCU. Add the path/RCU again using Edit Path or Add RCU.
Serial Number Mismatch	The RCU's S/N does not match the specified S/N.	Make sure that you entered the correct RCU S/N and SSID and path parameters (port, link address, logical address). Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.
Invalid Port	The specified port is not configured as an RCP, or this path already exists.	Make sure that the correct MCU port is configured as an RCP. Make sure the correct RCU port is configured as an LCP. Make sure that you entered the correct RCU S/N and SSID and path parameters (port, link address, logical address). Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.
<blank>	This path was not established.	Delete the failed path. You may need to change the minimum paths setting or delete the RCU in order to delete the path. Then add the path/RCU using Edit Path or Add RCU.

Table 7.3 Troubleshooting Suspended HRC Pairs

Suspend Type	Applies to	Description	Corrective Action
M-VOL by Operator	M-VOL	The user suspended the pair from the MCU using the **M-VOL Failure** option. The R-VOL suspend type is *by MCU*.	Resume the pair from the MCU.
R-VOL by Operator	M-VOL, R-VOL	The user suspended the pair from the MCU or RCU using the **R-VOL** option.	Resume the pair from the MCU.
by MCU	R-VOL	The RCU received a request from the MCU to suspend the pair. The M-VOL suspend type is *M-VOL by Operator* or *R-VOL by Operator*.	Resume the pair from the MCU.
by RCU	M-VOL	The MCU detected an error condition at the RCU which caused the MCU to suspend the volume pair. The R-VOL suspend type is *by MCU*.	Clear the error condition at the RCU or R-VOL. If you need to access the R-VOL, delete the pair from the RCU. If any data on the R-VOL has changed, delete the pair from the MCU and then restart the pair (Add HRC Pair). If not, resume the pair from the MCU.
Delete Pair to RCU	M-VOL	The MCU detected that the R-VOL status changed to *simplex* because the user deleted the pair from the RCU. The pair cannot be resumed because the R-VOL does not have the *suspended* status.	Delete the pair from the MCU, and then restart the pair. You should use the **Entire Volume** initial copy option to resynchronize the pair. You can use the **None** initial copy option only if no data on the M-VOL or R-VOL changed.
R-VOL Failure	M-VOL	The MCU detected an error during communication with the RCU or an I/O error during update copy. In this case, the suspend type for the R-VOL is usually *by MCU*.	Check the path status on the RCU Status panel (see Table 7.2). Clear any error conditions at the RCU/R-VOL. If you need to access the R-VOL, delete the pair from the RCU. If any data on the R-VOL has changed, delete the pair from the MCU and then restart the pair (Add HRC Pair). If not, resume the pair from the MCU.
MCU IMPL	M-VOL, R-VOL	The MCU could not find valid control information in its nonvolatile memory during the IMPL procedure. This error occurs only if the MCU is without power for more than 48 hours (power failure and fully discharged batteries).	Resume the pair from the MCU. The MCU will perform an entire initial copy operation in response to the resume pair request.
Initial Copy Failed	M-VOL, R-VOL	The MCU suspended this pair during the initial copy operation. The data on the R-VOL is not identical to the data on the M-VOL. Invalid track format can cause this suspension.	Delete the pair from the MCU. Clear all error conditions at the MCU, M-VOL, RCU, and R-VOL. Reformat failed track using ICKDSF. Restart the initial copy operation using the Add Pair panel.
by FREEZE	M-VOL, R-VOL	All HRC Synchronous pairs in the MCU were suspended by the CGROUP/RUN command.	Resume the pair(s) from the MCU using Resume Pair or the CESTPAIR (MODE=RESYNC) TSO command.
MCU P/S-OFF	R-VOL (HARC)	The MCU suspended all HARC pairs due to MCU power-off.	None. The MCU will automatically resume these HARC pairs during power-on.
by Sidefile Overflow	M-VOL, R-VOL	The amount of sidefile exceeds the specified current pending update data rate, and the RCU data is not transferred within the specified offloading timer.	Add cache memory, increase the number of paths between MCU and RCU, or decrease the number of Async pairs or host I/Os.

Table 7.4 provides troubleshooting instructions for the HARC suspension conditions caused by the offloading timer asynchronous option, the group timeout options (copy pending and RCU ready), and recordset errors. Hardware failures which affect the cache storage/shared memory of the MCU or RCU may also cause the HARC volume pairs to be suspended.

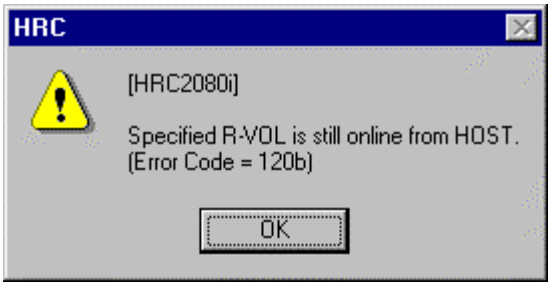
Table 7.4 Resolving HARC Suspension Conditions

Classification	Causes of Suspension	SIM	Recovery procedure
MCU/RCU hardware	Hardware redundancy has been lost due to some blockade condition. As a result, MCU-RCU communication, creating or receiving recordset, or the staging or de-staging process could not complete. The pending recordset cannot be retained because one side of cache storage or shared memory has been blocked due to hardware failure. MCU-Creating/sending recordset failed due to unrecoverable hardware failure. RCU-Reading/Settling recordset failed due to unrecoverable hardware failure. The drive parity group has been in the correction-access status while the HRC volume pair was in pending state.	DB0x DB1x DB2x	According to SIM, remove the hardware blockade or failure. Re-establish failed volume pairs (Resume Pair).
MCU-RCU communication	During the power-on-reset sequence, the MCU could not communicate with the RCU within the specified RCU ready timeout. The RCU could not settle the pending recordset or could not communicate with the MCU before the copy pending timeout due to MCU not-ready or inoperative facilities on the remote copy connections.	DB0x DB1x	Remove the failed condition at the RCU/MCU or on the remote copy connection. Re-establish failed pairs (Resume Pair).
RIO overload	The unrecoverable RIO (remote I/O) timeout occurred due to overload of the RCU or the communication facilities on the remote copy connections. No recordset could be sent within the specified copy pending timeout. The RCU could not settle the pending recordset before the copy pending timeout due to overload of the RIO or the RCU itself.	DB1x	Delete failed pairs (Delete Pair). Reconsider the performance resources necessary, and increase resources as needed (cache amount, number of MCU-RCU paths, etc.). Re-establish failed pairs (Add Pair).
RIO failure	The RIO (remote I/O) could not complete due to the failure at the RCU.	DB2x	According to SIM generated at the RCU, remove the failure. Re-establish failed pairs (Resume Pair).
MCU planned outage	The HARC pairs were temporarily suspended due to a planned outage of the MCU.	DB8x	No recovery procedure is required. The MCU will automatically remove the suspension condition during the next power-on-reset sequence.

7.2 HRC Software Error Codes

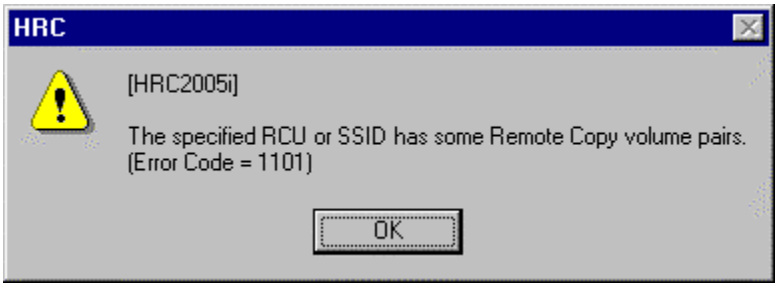
The HRC software displays error messages on the Remote Console PC when error conditions occur during HRC operations (see Figures 7.1 through 7.3). The error message describes the error and provides a four-digit error code (**Error Code = 120b** in Figure 7.1). The first two digits of the error code indicate the error type, and the last two digits provide more specific information about the error. The error message may also include a 9900 SVP error code (**[HRC2005i]** in Figure 7.2). If you need to call the Hitachi Data Systems Support Center for assistance, please report the HRC and SVP error codes.

Please refer to the *Hitachi Lightning 9900™ Remote Console User's Guide* (MK-90RD003) for a list of error codes displayed on the 9900 Remote Console PC.



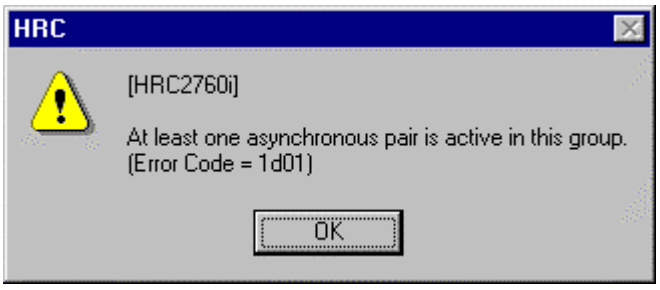
Add pair failed because the R-VOL was in use.

Figure 7.1 HRC Error Message for Failed Add Pair Operation



Delete RCU failed because the RCU still contains one or more pairs with the current MCU.

Figure 7.2 HRC Error Message for Failed Delete RCU Operation



Delete group failed because the group contained one or more pairs.

Figure 7.3 HRC Error Message for Failed Delete Group Operation

7.3 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 Hitachi Data Systems Support Center may ask you to send them the history log files (on the Remote Console PC) for analysis. Please refer to the *9900 Remote Console User's Guide* (MK-90RD003) for additional troubleshooting information for the RMCMAIN software and the Remote Console PC.

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
Adr	address
async	asynchronous
ATM	asynchronous transfer mode
CCHH	cylinder, cylinder, head, head
CCI	Command Control Interface
CCW	channel command word
CFW	cache fast write
CH	channel
CL	cluster
CNT	Computer Network Technologies
C/T	consistency time
CU	control unit
CUI	CU image
CYL	cylinder
DASD	direct access storage device
DB2	DATABASE 2
DFSMS	Data Facility Storage Management Subsystem
DFP	Data Facility Product
DFW	DASD fast write
DSF	Device Support Facilities
DWL	duplex write line
ELB	extended long busy
ERC	error reporting communications
ERP	error recovery procedure
ESA	Enterprise Systems Architecture
ESCON	Enterprise System Connection (IBM trademark for optical channels)
ESCD	ESCON director
FBA	fixed-block architecture
F/M	format/message
GDPS	Geographically Dispersed Parallel Sysplex
GUI	graphical user interface
HARC	Hitachi Asynchronous Remote Copy
HCPF	Hitachi Concurrent Processing Facility
HD	head
HDS	Hitachi Data Systems Corporation
HMRCF	Hitachi Multiple RAID Coupling Feature
HODM	Hitachi Online Data Migration
HOMRCF	Hitachi Open Multiple RAID Coupling Feature
HORC	Hitachi Open Remote Copy

HRC	Hitachi Remote Copy
HRCA	HRC Asynchronous (another term for HARC)
HS	Hitachi Storage
HVR	Hitachi Volume Relocation
HXRC	Hitachi Extended Remote Copy
I/O	input/output
IBM	International Business Machines Corporation
ICKDSF	A DSF program used to perform media maintenance
IDCAMS	access method services (a component of Data Facility Product)
IML	initial microcode load
IMPL	initial microprogram load
IMS	Information Management System
IOCDS	I/O configuration dataset
IPL	initial program load
JCL	job control language
kB	kilobytes
km	kilometers
LAN	local-area network
LCP	local control port
LCU	logical control unit
LDEV	logical device
LED	light-emitting diode
LU	logical unit
LVI	logical volume image (also called device emulation or device type)
MCU	main control unit
MIH	missing interrupt handler
MPSD	multiple path storage director
ms	milliseconds
M-VOL	main volume
MVS	Multiple Virtual Storage
NVS	nonvolatile storage
P/DAS	PPRC dynamic address switching
PC	personal computer system
PiT	Point-in-Time
PPRC	Peer-to-Peer Remote Copy
PS	power supply
PTF	program temporary fix
RAID	redundant array of independent disks
RAID-1/5	specific RAID architectures
RC	reference code
RCP	remote control port
RCU	remote control unit
RDC	remote dual copy (a factory term for HRC)

RIO	remote I/O
RMCMAIN	Remote Console Main software
R-VOL	remote volume
SAID	system adapter ID
SCI	state-change-interrupt
SCP	state-change-pending
SIM	service information message
SMS	Storage Management Subsystem
S/N	serial number (also abbreviated as s#)
SSB	sense byte
SSCH	start subchannel
SSID	storage subsystem identification
SVP	service processor
sync	synchronous
S#	serial number (also abbreviated as S/N)
TOD	time-of-day
TSO	Time Sharing Option
VLVI	Virtual LVI
VM	Virtual Machine
VOL	volume
VOLSER	volume serial number
VSE	Virtual Storage Extended
VTOC	volume table of contents
XRC	Extended Remote Copy

Appendix B Using PPRC Commands for HRC

B.1 Overview of PPRC Commands

The Hitachi Lightning 9900™ subsystem supports IBM Peer-to-Peer Remote Copy (PPRC) TSO and ICKDSF commands to enable you to perform HRC operations from the S/390® host system. PPRC TSO commands are issued from the system console to the M-VOL or R-VOL of an HRC pair. PPRCOPY ICKDSF commands are issued from JCL job cards. The HRC feature must be installed on the 9900, and IBM PPRC must be installed on the host operating system. For HARC operations, special switches and parameters are used to control and monitor HARC pairs and groups using PPRC commands.

The following HRC operations cannot be performed using PPRC commands: HRC Async options, and HARC group addition/deletion. The HARC options and groups must be configured using the Remote Console PC before you can add any HARC pairs (CESTPAIR). Port configuration (LCP↔RCP) is supported via the CESTPATH and CDELPATH TSO commands only when SVP mode 114 is enabled (refer to Table 2.1). If SVP mode 114 is not enabled, the RCPs must be configured using the Remote Console PC before you can add the HRC paths (CESTPATH). You also cannot change the RCU options, initial copy priority, or the CFW data or DFW to R-VOL pair options using PPRC commands. See section 2.6 for further information on the restrictions associated with using PPRC commands instead of the HRC remote console software.

Table B.1 lists the HRC operations and describes the corresponding PPRC TSO and ICKDSF commands. Section B.2 provides instructions for using the PPRC TSO commands with HARC pairs. Table B.2 gives the 9900 system adapter ID (SAID) values for the LINK parameter of the CESTPATH TSO command.

Note: The PPRC TSO and ICKDSF commands have required and optional parameters which are not described in detail in this document. For further information on using PPRC TSO and PPRCOPY ICKDSF commands, refer to IBM publications *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169) and *ICKDSF R16 Refresh User's Guide* (GC35-0033).

Note: The PPRC TSO and ICKDSF commands use slightly different command/keyword names to provide equivalent PPRC functions. For example, the **CESTPAIR** TSO command is equivalent to the **PPRCOPY ESTPAIR** ICKDSF command. This document describes the PPRC TSO commands. Please refer to the IBM PPRC and ICKDSF documentation for complete information on using PPRCOPY ICKDSF instead of PPRC TSO commands.

WARNING: The QUIESCE option of the CSUSPEND command 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 of the CSUSPEND command. Please check with your Hitachi Data Systems account team before using the CSUSPEND command with the QUIESCE option to suspend HRC volume pairs on 9900 (or 7700E) subsystems. If the CSUSPEND command with 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. HARC does not support the CSUSPEND/QUIESCE option.

Table B.1 HRC Operations versus PPRC TSO and ICKDSF Commands

HRC Operation	TSO Command	ICKDSF Command	Command Issued to:	Description
Configure Port (LCP-to-RCP)	-----		-----	If SVP mode 114 is OFF, the ports must be configured using the HRC remote console software. If SVP mode 114 is ON, the ports are configured automatically (LCP/RCP to RCP/LCP) in response to the CESTPATH and CDELPATH TSO commands.
Add RCU	CESTPATH	PPRCOPY ESTPATH	MCU	Establishes logical paths from an MCU to an RCU. The default RCU options are used (see section 2.6). Table B.2 lists the SAID values for the LINK parameter of the CESTPATH TSO command. ***Note:*** The last two digits of the link parameter must specify the logical CU: 00, 01, 02, or 03.
Delete RCU	CDELPATH	PPRCOPY DELPATH	M-VOL	Deletes all active paths between an MCU and an RCU.
RCU Status	CQUERY/PATHS	PPRCOPY QUERY/ PATHS	MCU	Displays the status of all paths for the CU specified by the DEVN parameter. HRC supports the optional FORMAT/UNFORMAT and VOLUME/PATHS parameters.
Asynchronous Options	-----	-----	MCU/RCU	The default HRC Asynchronous options are used (see section 2.6).
Add Group	-----	-----	MCU	Must be performed using the HRC software (see section 4.4.2). The group options are selected during add group (see section 4.4.3).
Group Status	-----	-----	MCU/RCU	Must be performed using the HRC software (see section 4.4.4).
Delete Group	-----	-----	MCU	Must be performed using the HRC software (see section 4.4.5).
Add Pair	CESTPAIR (MODE=COPY)	PPRCOPY ESTPAIR	M-VOL	Establishes an HRC pair and sets the initial copy and pair options (copy mode = synchronous or asynchronous only, priority = 0, CFW data = copy to R-VOL, DFW to R-VOL = not required). HRC supports the optional MODE, PACE, and CRIT parameters. The MSGREQ parameter defaults to NO (not applicable to HARC). See section B.2.1 for details on using CESTPAIR for HARC.
Suspend Pair	CSUSPEND	PPRCOPY SUSPEND	M-VOL or R-VOL	Suspends an HRC pair (or HARC group). HRC supports the optional PRIMARY parameter. See important information above on the QUIESCE parameter. See section B.2.2 for details on using CSUSPEND for HARC.
Delete Pair (to MCU)	CDELPAIR	PPRCOPY DELPAIR	M-VOL	Deletes an HRC pair (or HARC group) from the MCU. See section B.2.3 for details on using CDELPAIR for HARC.
Delete Pair (to RCU)	CRECOVER	PPRCOPY RECOVER	R-VOL	Deletes an HRC pair (or HARC group) from the RCU. See section B.2.4 for details on using CRECOVER for HARC.
Pair Status	CQUERY/ VOLUME	PPRCOPY QUERY/ VOLUME	M-VOL or R-VOL	Displays the HRC & HARC pair status of the volume. HRC supports the optional FORMAT/UNFORMAT and VOLUME/PATHS parameters. See section B.2.5 for details on using CQUERY for HARC.
Resume Pair	CESTPAIR (MODE= RESYNC)	PPRCOPY ESTPAIR	M-VOL	Resumes an HRC pair (or HARC group), and sets the HRC initial copy options and pair options. HRC supports the optional MODE, PACE, and CRIT parameters. See section B.2.1 for details on using CESTPAIR/RESYNC for HARC.
-----	P/DAS SWAP	-----	M-VOL and R-VOL	Supported by HRC Synchronous. Command is rejected by HARC pairs. Redirects application I/Os from the M-VOL to the R-VOL. See section 2.6.1 for details on using P/DAS SWAP with HRC.
-----	CGROUP (FREEZE/RUN)	-----	MCU (M-VOL or simplex)	Supported by HRC Synchronous. Command is rejected by HARC pairs. See section B.3 for details on using CGROUP (FREEZE/RUN) with HRC Synchronous pairs.

Table B.2 SAID Values for the LINK Parameter of the CESTPATH TSO Command

Port in RCP Mode			Port in RCP Mode		
Cluster	Port	SAID Value	Cluster	Port	SAID Value
1	CH'A'	X'0000'	2	CH'A'	X'0010'
	CH'B'	X'0001'		CH'B'	X'0011'
	CH'C'	X'0002'		CH'C'	X'0012'
	CH'D'	X'0003'		CH'D'	X'0013'
	CH'E'	X'0004'		CH'E'	X'0014'
	CH'F'	X'0005'		CH'F'	X'0015'
	CH'G'	X'0006'		CH'G'	X'0016'
	CH'H'	X'0007'		CH'H'	X'0017'
	CH'J'	X'0008		CH'J'	X'0018
	CH'K'	X'0009		CH'K'	X'0019
	CH'L'	X'000A		CH'L'	X'001A
	CH'M'	X'000B		CH'M'	X'001B
	CH'N'	X'000C		CH'N'	X'001C
	CH'P'	X'000D		CH'P'	X'001D
	CH'Q'	X'000E		CH'Q'	X'001E
	CH'R'	X'000F		CH'R'	X'001F

Note: The last two digits of the link parameter must specify the logical control unit (CU) number (00-0F for 9900, 00-03 for 7700E).

B.2 Using PPRC TSO Commands with HARC

For HARC operations, special switches and parameters are utilized to control and monitor HARC pairs and groups using PPRC commands. This section describes this special use of PPRC TSO commands for HARC volumes on 9900 subsystems. Table B.3 describes the typographic conventions used for the PPRC TSO commands described in this section.

The **PPRC TSO Command** option on the Async Option panel allows you to select the 7700E-compatible format for PPRC TSO commands (groups 0-F instead of 00-3F). If this option is selected, please refer to the *7700E HRC User and Reference Guide* for information on using the 7700E-compatible format for PPRC TSO commands.

Note: The DEVSERV PATHS command displays the pair status of a HARC volume in the DC-STATE field. The contents of this field are the same as for HRC Synchronous. Note that the HARC transition states (*suspending* and *deleting*) are not displayed.

Note: This section does not specifically address the equivalent PPRCOPY ICKDSF commands. Please use caution when issuing ICKDSF commands to HARC volumes, and refer to IBM publications *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169) and *ICKDSF R16 Refresh User's Guide* (GC35-0033).

Table B.3 Typographic Conventions for PPRC TSO Commands

Typeface/Symbol	Example	Usage
Normal text	CRIT(YES)	Command/keyword names or console outputs.
Italics	*ssid*	Parameter to be replaced with an appropriate character or numeric string.
Bold	**cmd_param**	Command/keyword names, parameters, or console outputs that involve/denote special meaning for HRC Asynchronous.
Square brackets	[PACE(15)]	Keywords/parameters that can be omitted.
Vertical pipe	(YES|NO)	List of keywords to be selected.
Underline	(YES|<u>NO</u>)	The default keywords/parameters.
Strikethrough	[~~QUIESCE~~]	Invalid keywords/parameters for HRC Asynchronous.

B.2.1 CESTPAIR

Table B.4 describes how to use the CESTPAIR command to establish HARC pairs and resume HARC pairs and groups. The syntax for the CESTPAIR command is:

CESTPAIR DEVN(X'*dev#*') PRIM(X'*ssid*' ***cmd_param*** X'*cca*') SEC(X'*ssid*' *serial#* X'*cca*')
[MODE(COPY|NOCOPY|RESYNC)] [PACE(*pace*)] [**CRIT(YES|NO)**] [MSGREQ(YES|NO)]

Table B.4 Using CESTPAIR to Establish and Resume HARC Pairs

Parameter	Contents	Description
cmd_param	AG*nn*0 (*nn*=00-3F)	Without MODE(RESYNC): Specifies the consistency group number nn to which the volume pair will belong. With MODE(RESYNC): Specifies that all M-VOLs in the consistency group should be resynchronized (resumed). nn must specify the consistency group number of the addressed device.
	AV*nn*0 (*nn*=00-3F)	With MODE(RESYNC) : Specifies that only the addressed device should be re-synchronized. nn must specify the consistency group number of the addressed device.
PACE	(*pace*)	Specifies the pace of the initial copy operation: 1-255, default=15 tracks.
CRIT	(YES)	Specifies the Error Level (HARC pair option) of Group.
	(NO)	Specifies the Error Level (HARC pair option) of Volume.

Notes:

- If the first digit of the ***cmd_param*** is other than A, the subsystem interprets this command as pair establishment for HRC Synchronous or ShadowImage.
- The consistency group *n* must be registered prior to this command. Otherwise this command will be rejected.
- When MODE(RESYNC) is specified, the consistency group number *n* must be the consistency group number to which the addressed device belongs. If a different number is specified, this command will be rejected.
- When MODE(RESYNC) is specified, the copy mode (synchronous or asynchronous) cannot be changed. If a different copy mode is specified, this command will be rejected.
- If the consistency group requirements (see section 3.2.7) are not satisfied, this command may/may not be rejected.
- When ***cmd_param*** AGxxx is specified, this command ends *before* the actual pair establishment/re-establishment successfully starts. Confirmation by CQUERY or IEA494I console message is recommended after this command.

B.2.2 CSUSPEND

Table B.5 describes how to use the CSUSPEND command to suspend HARC pairs and groups. The syntax for the CSUSPEND command is:

CSUSPEND DEVN(X'*dev#*') PRIM(X'*ssid*' ***cmd_param*** X'*cca*') SEC(X'*ssid*' *serial#* X'*cca*')
[PRIMARY] [QUIESCE]

Table B.5 Using CSUSPEND to Suspend HARC Pairs

Parameters	Contents	Description
cmd_param	AGD00	Specifies that all the volume pairs in the consistency group should be suspended after all pending recordsets are settled (**Drain** suspend option).
	AGP00	Specifies that all the volume pairs in the consistency group should be suspended. Pending recordsets are not always settled before suspension (**Purge** suspend option).
	AVD00	Specifies that only addressed volume pair should be suspended after the pending recordset for addressed volume settled (**Drain** suspend option).
	AVP00	Specifies that only the addressed volume pair should be suspended. Pending recordsets for addressed volume are not always settled (**Purge** suspend option).
PRIMARY		Invalid keyword for HRC Asynchronous volume pairs.
QUIESCE		Invalid keyword for HRC Asynchronous volume pairs.

* If the addressed device is the M-VOL, only HARC pairs in the same subsystem are suspended. Volume pairs whose M-VOLs are behind other MCUs are not affected.

Notes:

- If the first digit of the ***cmd_param*** is other than A, the subsystem interprets this command as pair suspension for HRC Synchronous or ShadowImage.
- The D and P in ***cmd_param*** stand for the Drain and Purge options, respectively. See section 5.4.1 for a detailed description of these HARC suspend options.
- When P (Purge) is specified, it is not possible to determine exactly which recordset will be settled before the addressed volume pair is suspended.
- Regardless of the number of volume pairs to be suspended, this command ends *before* the actual pair suspension is successfully completed. Confirmation by CQUERY or IEA494I console message is recommended after this command.

B.2.3 CDELPAIR

Table B.6 describes how to use the CDELPAIR command to delete HARC pairs and groups at the MCU. The syntax for the CDELPAIR command is:

CDELPAIR DEVN(X'*dev#*') PRIM(X'*ssid*' ***cmd_param*** X'*cca*') SEC(X'*ssid*' *serial#* X'*cca*')

Table B.6 Using CDELPAIR to Delete HARC Pairs/Groups at the MCU

Parameters	Contents	Description
cmd_param	AG000	Specifies that all pairs in the consistency group* should be deleted. All pending recordsets will be settled before deleting the volume pairs.
	AV000	Specifies that only the addressed pair should be deleted. All pending recordsets for the addressed volume will be settled before deleting the volume pair.

* Only HARC pairs in the same subsystem are deleted. Volume pairs whose M-VOLs are behind other MCUs are not affected.

Notes:

- If the first digit of the ***cmd_param*** is other than A, the subsystem interprets this command as pair deletion for HRC Synchronous or ShadowImage.
- The specified pair(s) will be deleted regardless of their pair status. Once the pair(s) is/are deleted, the volume(s) will not indicate their pair status before pair deletion. To delete HARC pairs with their update sequence consistency ensured:
  - Issue the CSUSPEND command with ***cmd_param*** of AGP00 or AGD00.
  - Issue CQUERY to confirm that the specified pairs have been successfully suspended with the consistency status of **Group**.
  - Issue the CDELPAIR command.
- Regardless of the number of volume pairs to be deleted, this command ends *before* the actual pair deletion is successfully completed. Confirmation by CQUERY or IEA494I console message is recommended after this command.

B.2.4 CRECOVER

Table B.7 describes how to use the CRECOVER command to delete HARC pairs and groups at the RCU. The syntax for the CRECOVER command is:

CRECOVER DEVN(X'*dev#*') PRIM(X'*ssid*' ***cmd_param*** X'*cca*') SEC(X'*ssid*' *serial#* X'*cca*')
[ID(*old_volser*[*new_volser*])]

Table B.7 Using CRECOVER to Delete HARC Pairs/Groups at the RCU

Parameters	Contents	Description
cmd_param	AC000	Specifies that all volume pairs (R-VOLs) in the consistency group whose consistency status is Suspended-Group should be deleted.
	AG000	Specifies that all volume pairs (R-VOLs) in the consistency group should be deleted regardless of pair status and consistency status. All pending recordsets will be settled before deleting the pairs.
	AV000	Specifies that the addressed volume pair (R-VOL) should be deleted regardless of pair status and consistency status. All pending recordsets for the addressed pair will be settled before deleting the pair.
[ID(*old_volser*[*new_volser*])]		HARC does not support this keyword. Depending on the timing, the write command to change the volume serial number may be rejected.

Notes:

- The addressed device must be the R-VOL.
- If the first digit of the ***cmd_param*** is other than A, the subsystem interprets this command as pair deletion for HRC Synchronous or ShadowImage.
- Regardless of the number of volume pairs to be deleted, this command ends *before* the actual pair deletion is successfully completed. Confirmation by CQUERY or IEA494I console message is recommended after this command.

B.2.5 CQUERY

The CQUERY command can be issued to a HARC pair to determine its detailed pair status as well as its HARC pair and group options. Figure B.1 shows the output of the CQUERY command with the VOLUME parameter issued to a HARC M-VOL.

```
*************** PPRC REMOTE COPY CQUERY - VOLUME *********************
*                                                 (PRIMARY)   (SECONDARY)*
*                                               SSID CCA    SSID CCA     *
*DEVICE   LEVEL        STATE     PATH STATUS SERIAL#     SERIAL#      *
*------ ---------  ----------  ---------- --------    ---------    *
* 0A32  PRIMARY..  PENDING...  ACTIVE..      7700 32       7740 12   *
*        CRIT(NO)                          A00S0G030982 000000030954 *
* PATHS SAID/DEST STATUS: DESCRIPTION                                 *
* ----- --------- ------  -------------------                       *
*   1    001D 0000 01     PATH ESTABLISHED...                       *
*        ---- ---- 00     NO PATH.............                      *
*        ---- ---- 00     NO PATH.............                      *
*        ---- ---- 00     NO PATH.............                      *
* IF STATE = PENDING/SUSPEND:  FIRST CYL OUT OF SYNC = 00117          *
*                                 LAST CYL OUT OF SYNC = 03338      *
*                                PERCENT OF COPY COMPLETE = 004%    *
***********************************************************************
```

Figure B.1 CQUERY Output Example: M-VOL/FORMAT/VOLUME

The CRIT field is not used for HARC (NO is always indicated).

The FIRST/LAST CYL OUT OF SYNC and PERCENT OF COPY COMPLETE fields indicate the first/last cylinder number and percentage of cylinders (including R-VOL cylinders) to be copied for pair resynchronization. See section 5.3 for a more detailed description.

The PATHS, SSID, DEST, STATUS, and DESCRIPTION fields show NO PATH for this volume pair instead of the actual path status. CQUERY with PATHS keyword provides the path status for this volume pair.

The MCU serial number field is used to display the following HARC information:

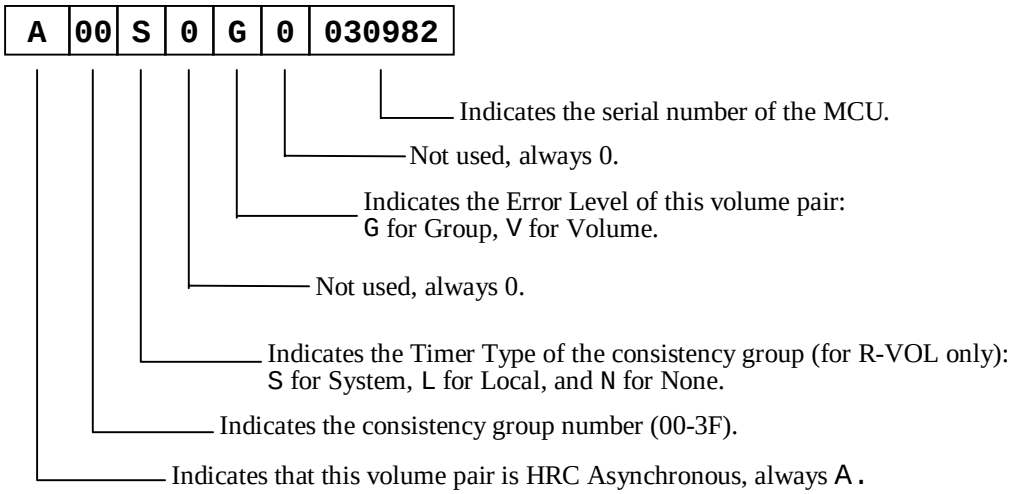


Figure B.2 shows the output of the CQUERY command with the VOLUME parameter issued to a HARC R-VOL.

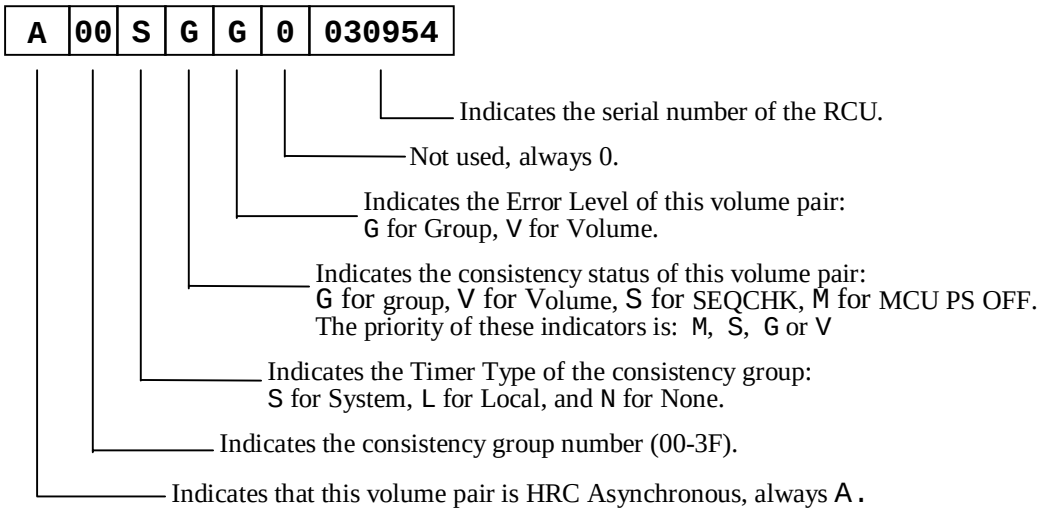
```
************* PPRC REMOTE COPY CQUERY - VOLUME ************************
*                                              (PRIMARY)   (SECONDARY)*
*                                              SSID CCA     SSID CCA  *
*DEVICE   LEVEL      STATE     PATH STATUS     SERIAL#       SERIAL#   *
*------ ---------  ----------  -----------  ---------     ---------   *
* OB12  SECONDARY  SUSPEND(5)   ACTIVE..      7700 32    7740 12      *
*       .........                          .............  A00SGG030954  *
* PATHS SAID/DEST STATUS: DESCRIPTION                                  *
* ----- --------- ------  ------------------                           *
*   0    ---- ----   00     NO PATH.............                      *
*        ---- ----   00     NO PATH.............                      *
*        ---- ----   00     NO PATH.............                      *
*        ---- ----   00     NO PATH.............                      *
* SECONDARY WAS SUSPENDED (YMD/GMT): 1998-10-17 14.18.12.242451        *
************************************************************************
```

Figure B.2 CQUERY Output Example: R-VOL/FORMAT/VOLUME

The SECONDARY WAS SUSPENDED (YMD/GMT) field displays the consistency time of this pair if the pair status is Suspended or Duplex. See section 2.4.2 for further information on the HARC consistency time.

If the timer type for the consistency group is System, the RCU indicates the content of the time-stamp given by the primary system with no modification.

The RCU serial number field is used to display the following HARC information:



B.3 CGROUP (FREEZE/RUN) Support

The HRC feature supports the CGROUP (FREEZE/RUN) TSO command for PPRC, which is also used in IBM's Geographically Dispersed Parallel Sysplex® (GDPS) environment. The CGROUP TSO command is used to control I/O operations for HRC Synchronous pairs on a specific MCU-RCU pair. The CGROUP command is supported for 9900 (and 7700E) subsystems functioning as HRC MCUs. The 9900/7700E provides all required host reporting for CGROUP operations (e.g., IEA494I with extended long busy (ELB) state), which is a key component of GDPS operations. For disaster recovery implementations, you must use 9900 subsystems at both sites, since the RCUs will become MCUs in the event of a disaster.

The CGROUP command has two parameters, FREEZE and RUN. The CGROUP/FREEZE command stops all host I/O operations to the specified HRC M-VOLs as well as all HRC update copy operations to their associated R-VOLs. The CGROUP/RUN command changes the pair status to *suspended* and allows the M-VOLs to start accepting host I/Os.

Caution: The 9900 subsystem executes the CGROUP command on HRC Synchronous pairs. HARC does not support the CGROUP TSO command. If CGROUP is issued to a HARC volume, the 9900 will reject the command. CGROUP (FREEZE/RUN) operations on HRC Synchronous pairs do not affect HARC pairs in any way.

B.3.1 Requirements

The CGROUP command can only be issued to an HRC Synchronous M-VOL or a simplex volume in the MCU. If CGROUP is issued to an HRC R-VOL, the RCU will reject the CGROUP command (F/M=0F, HRC error code=58). The CGROUP command must be issued to each logical CU image of the MCU, unless the 9900's mode 64 (see description below) is enabled.

The requirements for CGROUP (FREEZE/RUN) support are:

- **MCU**. The MCUs to which the CGROUP command will be issued must be 9900 subsystems (all-mainframe and multiplatform subsystems are both supported). For disaster recovery implementations, you must use 9900 subsystems at both sites, since the RCUs will become MCUs in the event of a disaster.
- **PPRC**. The host systems at the main and remote sites must have IBM PPRC support as well as the PPRC ERP PTF installed. ICKDSF does not support the CGROUP command.
- **SSIDs**. The MCUs to which the CGROUP command will be issued must have consecutive SSIDs. The Hitachi Data Systems representative configures the SSIDs on the 9900 SVP.

  CAUTION: MVS requires that the subsystem be offline during SSID changes. Reconfiguring SSIDs is therefore a disruptive event which must be carefully planned.

Requirements continue on the next page.

- **FREEZE Option**. The FREEZE option must be enabled on the MCUs to which the CGROUP command will be issued. If not enabled, the MCU will reject the CGROUP TSO command. The FREEZE option is enabled using the Remote Console PC (RCU Option panel). Enable the FREEZE option only after adding all MCU-RCU paths.
  Note: Mode 104 (see below) changes the default FREEZE option from *disabled* to *enabled*.

  The definition of the **LINK Parameter for the CESTPATH command** will be expanded to specify the FREEZE option on an **LCU pair basis**. The FREEZE option set by the CESTPATH command is effective until another CESTPATH command which specifies the same LCU pair but a different FREEZE Option is issued. The command syntax and parameter definitions are as follows:

  CESTPATH PRI*(ssid serial#)* SEC*(ssid serial#)* LINK*(ppppllcc, ppppllcc,…)*

  where:

  pppp = ESCON port ID of the primary CU (MCU) from which the HRC paths should be established and the FREEZE option for the LCU pair. Note that the first two digits (FREEZE option) must be the same in a series of link parameters.

Value	Port ID	Freeze Option
X'0000'-X'001F'	Interface 1A-2R	Default
X'0100'-X'011F'	Interface 1A-2R	Enabled
X'0200'-X'021F'	Interface 1A-2R	Disabled

  ll = ESCON destination link address. The destination port number of ESCON director (ESCD) must be specified if the HRC link is connected through an ESCD dynamic connection. Otherwise, "00" must be specified.

  cc = LCU number of the secondary CU (RCU).

  The parameters may be described in the GDPS DASD configuration list. The required link parameter values must be written into the list or must be given to RCMF input.

- **Mode 49**. Mode 49 extends the range of the PPRC commands from 64 devices per SSID to 256 devices per SSID. Mode 49 requires consecutive SSIDs within each CU image of the MCU and RCU. Mode 49 enables the 9900 to process up to 256 M-VOLs (instead of just 64) for each PPRC command (including CGROUP, CESTPATH, CESTPAIR, CQUERY, etc.). When mode 49 is ON, PPRC commands should specify only the first SSID (LDEVs 00-3F) for the CU, and the 9900 will apply the command to all four SSIDs within the CU (LDEVs 00-FF). If mode 49 is ON and a PPRC command specifies one of the other SSIDs, the 9900 will return errors. When mode 49 is OFF, PPRC commands must specify each SSID separately.

  If mode 49 is desired, the Hitachi Data Systems representative enables mode 49 on each HRC MCU and RCU using the 9900 SVP. Consecutive SSIDs and mode 49 must be installed before any HRC pairs are established in a GDPS environment. If HRC pairs have already been established, you must delete all HRC pairs and logical paths (CDELPAIR, CDELPATH), change the SSIDs and mode 49 setting on the MCUs and RCUs, and then re-establish the paths and pairs (CESTPATH, CESTPAIR).

  Note: For operations in a GDPS environment, mode 49 must be ON.

- **Mode 59** (HXRC only). Mode 59 must be ON for HXRC (activates variable RECSET size to provide performance improvement). Please refer to the IBM XRC documentation for information on using XRC commands: *Planning for IBM Remote Copy* (SG24-2595), and *DFSMS MVS V1 Remote Copy Guide and Reference* (SC35-0169).
- **Mode 64** (optional). Mode 64 extends the range of the CGROUP command to the entire MCU instead of just one logical CU image. When mode 64 is enabled, one CGROUP command to any M-VOL or simplex volume in the MCU is executed across all MCU-RCU paths and on all HRC M-VOLs in the specified MCU, including all CU images (CU0-CU3). When mode 64 is disabled, you must issue a separate CGROUP command to an M-VOL (or simplex volume) in each logical CU image of the MCU. Although this mode can be enabled nondisruptively (i.e., existing HRC pairs do not have to be deleted), mode 64 should be enabled at the same time that mode 49 is enabled.

  Note: For operations in a GDPS environment, mode 64 must be OFF.
- **Mode 104**. Mode 104 changes the default FREEZE option to *enabled*. This mode should be enabled when CGROUP is being used in the GDPS environment. When mode 104 is enabled, the FREEZE option will remain enabled after the 9900 is powered off and then back on (e.g., due to some disaster). When mode 104 is not enabled, the FREEZE option will revert to the default value of *disabled* after the 9900 is powered off and back on.

  Note: For operations in a GDPS environment, mode 104 must be ON.

Note: For further information on 9900 SVP modes related to HRC (and HXRC) operations, please refer to Table 2.1 in section 2.1.1.

B.3.2 CGROUP (FREEZE/RUN) Command

The CGROUP TSO command specifies:

- the device (LDEV ID of HRC M-VOL or simplex volume) (DEVN parameter),
- the MCU (S/N and lowest SSID in CU image) (PRIM parameter), and
- the RCU (S/N and lowest SSID in CU image) (SEC parameter).

The CGROUP TSO command has the following two options:

- **FREEZE**. When CGROUP is issued with the FREEZE option, the MCU:
  - Blocks the logical path(s) between the specified MCU CU image and RCU CU image to stop all HRC update copy operations to the R-VOLs in the specified RCU.
  - Presents state change pending (SCP) with extended long busy status to host I/O requests, which causes the host to queue I/Os for the M-VOLs. SCP is indicated until the CGROUP/RUN command is issued or until the SCP delay time expires.

    Note: After all logical MCU-RCU paths are established, make sure to specify the desired SCP delay time (0-600 seconds) for the MCU using the RCU Option panel. To register the SCP delay time, select **OK** to close the RCU Option panel, even if you did not make any changes.

  Note: If the specified MCU does not have any HRC M-VOLs, the FREEZE command is executed without performing any operations (paths are not blocked, SCP is not indicated).
- **RUN**. When CGROUP is issued with the RUN option, the MCU:
  - Suspends all HRC pairs with M-VOLs on the specified MCU CU image.
  - Presents a state-change-interrupt (SCI) to the host(s), so that the host(s) re-issue the I/Os which were waiting while the M-VOLs were in the SCP state.
  - Changes the HRC M-VOL fence level to **Never** (PPRC CRIT=NO), so that the suspended M-VOLs accept host write I/O operations.

Table B.8 shows the HRC pair status for HRC M-VOLs and R-VOLs during CGROUP (FREEZE/RUN) operations.

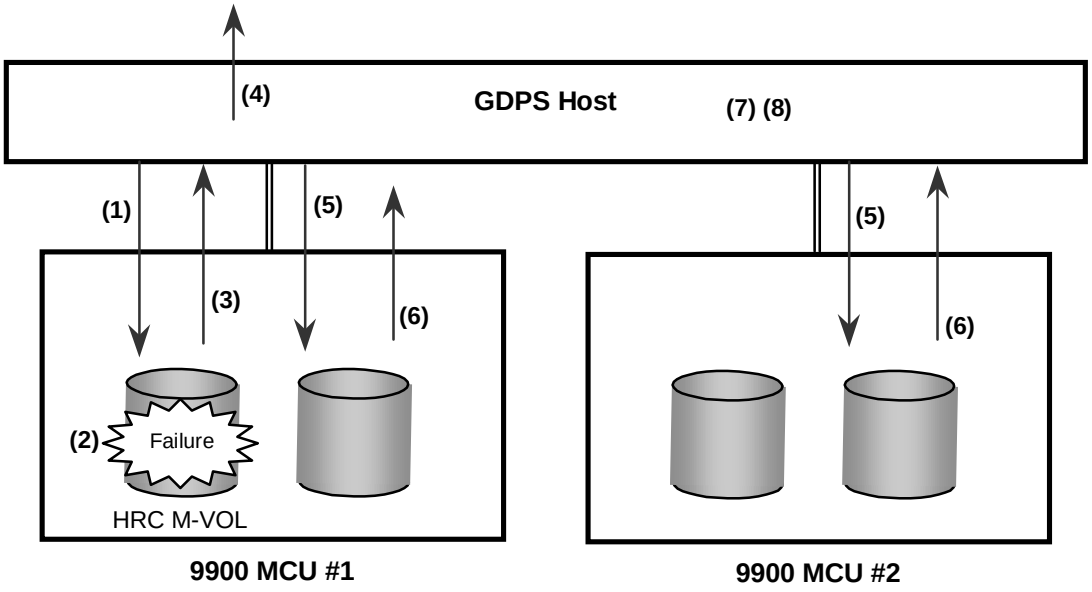
Table B.8 HRC Pair Status During CGROUP (FREEZE/RUN) Operations

	Before CGROUP (FREEZE/RUN)		After CGROUP/FREEZE		After CGROUP/RUN	
	M-VOL	R-VOL	M-VOL	R-VOL	M-VOL	R-VOL
HRC Pair Status	Simplex	---	Simplex	---	Simplex	---
	Pending	Pending	Pending	Pending	Suspended	Pending
	Duplex	Duplex	Duplex	Duplex	Suspended	Duplex
	Suspended	Suspended	Suspended	Suspended	Suspended	Suspended

B.3.3 Using the CGROUP Command

Figure B.3 shows a simplified operational example of the CGROUP (FREEZE/RUN) command implemented in a GDPS environment. The CGROUP (FREEZE/RUN) TSO command can be issued by the user or through automation (such as GDPS) to perform the following sequence of actions:

1. Suspend host updates to all HRC M-VOLs on the specified MCU.
2. Block the specified MCU-RCU path to stop HRC update copy operations to the R-VOLs.
3. Change all HRC M-VOLs on the specified MCU to suspended.
4. Resume host updates to the suspended M-VOLs.
5. The add RCU operation (CESTPATH) must be performed to re-establish the blocked logical paths. After the MCU-RCU path is re-established, the resume pair operation (CESTPAIR/RESYNC) must be performed to resume the suspended pairs.



(1) Read/write I/Os are issued from the host.
(2) A failure occurs on an HRC M-VOL, and the MCU suspends the pair.
(3) Suspend and extended long busy state are reported to the host.
(4) Host reports IEA494I with extended long busy state.
(5) CGROUP/FREEZE commands are issued to groups.
(6) SCP sense bytes are reported if an I/O is issued to a frozen volume.
(7) I/Os are queued at the host.
(8) Switch to remote (secondary) site.

Figure B.3 Overview of GDPS Operations

B.3.4 Using PPRC TSO Commands with CGROUP Support

CESTPATH. You can use the CESTPATH command to recover a blocked MCU-RCU path. Make sure to use the same parameters as when the path was established.

CESTPAIR. After you re-establish the MCU-RCU path that was blocked, you can use the CESTPAIR/RESYNC command to resume the HRC pairs suspended by the CGROUP/RUN command.

CDELPAIR. After you re-establish the MCU-RCU path that was blocked, you can use the CDELPAIR command to delete the HRC pairs suspended by the CGROUP/RUN command. If CDELPAIR is issued to an HRC pair whose MCU-RCU path is still blocked, the MCU rejects the command (F/M=0F, HRC error code=5A).

CRECOVER. You can use the CRECOVER command to change a suspended R-VOL to simplex. This command is issued to the R-VOL and does not affect the suspended M-VOL.

CQUERY/PATHS. Figure B.4 shows the output of the CQUERY command issued to an HRC MCU to which the CGROUP/FREEZE command has been issued. Figure B.5 shows the output of the CQUERY command issued to the HRC RCU which has a blocked path due to the CGROUP/FREEZE command.

CQUERY/VOLUME. Figure B.6 shows the output of the CQUERY command issued to an HRC M-VOL which has been suspended by the CGROUP/RUN command. As shown in Figure B.6, CQUERY issued to an M-VOL also indicates the status of the FREEZE option: CGRPLB(YES) = enabled, CGRPLB(NO) = disabled. Figure B.7 shows the output of the CQUERY command issued to an HRC R-VOL whose M-VOL has been suspended by the CGROUP/RUN command. The pair status and path status at the RCU are not changed.

```
*************** PPRC REMOTE COPY CQUERY - PATHS ********************
* PRIMARY UNIT: SERIAL#= 000000090217  SSID= 00F8                  *
*               FIRST        SECOND         THIRD         FOURTH    *
*             SECONDARY     SECONDARY     SECONDARY     SECONDARY   *
*SERIAL NO: 000000090217  ............  ............  ............ *
*     SSID:     00F8          0000          0000          0000      *
*    PATHS:      1             0             0             0        *
*           SAID DEST S*  SAID DEST S*  SAID DEST S*  SAID DEST S* *
*           --------- --  --------- --  --------- --  --------- -- *
*        1: 0020 FF04 10  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*        2: ---- ---- 00  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*        3: ---- ---- 00  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*        4: ---- ---- 00  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*                                                                   *
* S* = PATH STATUS:                                                 *
* 00=NO PATH          01=ESTABLISHED         02=INIT FAILED         *
* 03=TIME OUT         04=NO RESOURCES AT PRI 05=NO RESOURCES AT SEC*
* 06=SERIAL# MISMATCH 07=(RESERVED)          08=(RESERVED)          *
* 09=(RESERVED)       10=CONFIGURATION ERROR                        *
********************************************************************
```

Figure B.4 CQUERY Output Example: M-VOL/Paths/Format

```
*************** PPRC REMOTE COPY CQUERY - PATHS ********************
* PRIMARY UNIT: SERIAL#= ............  SSID= 0000                   *
*              FIRST        SECOND         THIRD          FOURTH    *
*            SECONDARY    SECONDARY      SECONDARY      SECONDARY   *
*SERIAL NO: 000000090217  ............  ............  ............ *
*     SSID:     00F8          0000           0000           0000     *
*    PATHS:       1             0              0              0       *
*           SAID DEST S*  SAID DEST S*  SAID DEST S*  SAID DEST S* *
*           --------- --  --------- --  --------- --  --------- -- *
*        1: 0020 FF04 10  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*        2: ---- ---- 00  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*        3: ---- ---- 00  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*        4: ---- ---- 00  ---- ---- 00  ---- ---- 00  ---- ---- 00 *
*                                                                   *
* S* = PATH STATUS:                                                 *
* 00=NO PATH          01=ESTABLISHED         02=INIT FAILED         *
* 03=TIME OUT         04=NO RESOURCES AT PRI 05=NO RESOURCES AT SEC*
* 06=SERIAL# MISMATCH 07=(RESERVED)          08=(RESERVED)          *
* 09=(RESERVED)       10=CONFIGURATION ERROR                        *
*******************************************************************
```

Figure B.5 CQUERY Output Example: R-VOL/Paths/Format

```
************** PPRC REMOTE COPY CQUERY - VOLUME ******************** HRC M-VOL is
*                                        (PRIMARY)   (SECONDARY) *  suspended by
*                                         SSID CCA    SSID CCA   *  CGROUP/RUN.
*DEVICE   LEVEL      STATE     PATH STATUS  SERIAL#     SERIAL#    *
*------ ---------  ----------  ----------- ---------    ---------  *  FREEZE option
* 0F80  PRIMARY..  SUSPEND(A)   INACTIVE    00F8 00      00F8 02   *  is enabled.
*       CRIT(NO).......      CGRPLB(YES) 000000090217 000000090217 *
* PATHS SAID/DEST STATUS: DESCRIPTION                               *  Logical path
* ----- --------- ------  ------------------                        *  is blocked by
*   1   0020 FF04   10    CONFIGURATION ERROR                       *  CGROUP/FREEZE.
*       ---- ----   00    NO PATH............                       *
*       ---- ----   00    NO PATH............                       *
*       ---- ----   00    NO PATH............                       *
*                            PERCENT OF COPY COMPLETE = 100%        *
*******************************************************************
```

Figure B.6 CQUERY Output Example: M-VOL/Volume/Format

```
************** PPRC REMOTE COPY CQUERY - VOLUME ******************** No change to
*                                        (PRIMARY)   (SECONDARY) *  R-VOL pair
*                                         SSID CCA    SSID CCA   *  status.
*DEVICE   LEVEL      STATE     PATH STATUS  SERIAL#     SERIAL#    *
*------ ---------  ----------  ----------- ---------    ---------  *  No change to
* 0F82  SECONDARY  DUPLEX...   ACTIVE.     00F8 00      00F8 02   *  path status.
*       ............          ........... ............ 000000090217*
* PATHS SAID/DEST STATUS: DESCRIPTION                               *
* ----- --------- ------  ------------------                        *
*   1   0020 FF04   10    CONFIGURATION ERROR                       *
*       ---- ----   00    NO PATH............                       *
*       ---- ----   00    NO PATH............                       *
*       ---- ----   00    NO PATH............                       *
*******************************************************************
```

Figure B.7 CQUERY Output Example: R-VOL/Volume/Format

B.4 IEA494I and IEA491E Console Messages

When an HRC pair is suspended, whether user-requested or due to failure, the MCU generates sense information to notify the host(s). If the PPRC ERP PTF is installed and **PPRC Support = Yes** is selected on the RCU option panel, this notification results in an IEA494I system console message as well as an IEA491E message. The IEA491E message indicates the reason for suspension. The IEA494I and IEA491E messages are generated by the S/390 host based upon SSBs (sense bytes) from the subsystem and not SIMs from the subsystem. Therefore, SIMs reported by the subsystem to the host are not used by the GDPS scripting.

The IEA494I message is recommended as a trigger for automation over the IEA491E message. The IEA491E message is reported to only one host system, whereas the IEA494I message is reported to all attached MVS hosts each time the M-VOL pair status changes. GDPS uses the IEA494I message with extended long busy as a trigger for CGROUP (FREEZE/RUN).

Note: If **PPRC Support = No** is selected on the RCU Option panel, the host generates the system console message that includes the SIM instead of the IEA494I or IEA491E message.

B.4.1 IEA494I Message

Whenever an HRC pair status changes, with the exception of the HARC transition states *suspending* and *deleting*, the MCU reports state-change-interrupt (SCI) to all hosts. In response to the SCI, the IEA494I system console message is generated (if supported by the host). The 9900 reports SCI for both online and offline devices, but the host system does not generate console messages for offline devices. Therefore, the IEA494I message is never generated with an HRC R-VOL device address. Figure B.8 shows an example of an IEA494I message.

- The 9900 MCU reports SCI for all HARC pairs whose status has changed, regardless of the Group/Volume option of the suspend or delete pair operation (if the status change was user-requested).
- The 9900 MCU reports SCI for all HRC M-VOLs (synchronous only) which are in the SCP state due to the CGROUP/FREEZE command. As shown in Figure B.8, this IEA494I message indicates the extended long busy state.
- The 9900 MCU reports SCI for all HRC M-VOLs (synchronous only) which are suspended due to the CGROUP/RUN command. This IEA494I message indicates the extended long busy state.
- When the FREEZE option is enabled, the 9900 MCU reports SCI for an HRC pair which is suspended due to a failure. When the host supports GDPS, this IEA494I message with extended long busy triggers the CGROUP (FREEZE/RUN) command.

```
IEA494I OFC3,RDOFC3,PPRC PAIR SUSPENDING,SSID=OFCO,CCA=O3,EXTENDED LONG BUSY STATE
```

Figure B.8 Example of IEA494I Message with Extended Long Busy State

B.4.2 IEA491E Message

When an HRC pair is suspended due to a failure, the 9900 MCU reports SCI as well as unit check status and sense bytes with F/M = FB. In response to the F/M=FB sense bytes, the IEA491E system console message is generated (if supported by the host). Figure B.9 shows an example of an IEA491E message.

Note: If the host supports GDPS and the FREEZE option is enabled, the IEA494I system console message with extended long busy (which was generated in response to the SCI) triggers the CGROUP (FREEZE/RUN) command.

```
IEA491E DSLFCO,PPRC SUSPENDED, SECONDARY NOT READY, INTERVENTION_REQUIRED,
(PRI)SER=0113-90797,CCA=00 (SEC)SER=0113-90217,CCA=
```

Figure B.9 Example of IEA491E Message

B.5 9900 Response Characteristics to Failure Conditions

The 9900 subsystem supports the CGROUP command in the GDPS environment by performing PPRC-compatible actions and returning PPRC-compatible messages to failure conditions. Figure B.10 shows the failure conditions, and Table B.9 describes the response characteristics of the 9900 subsystem to these failure conditions.

Note: The **PPRC Support=Yes** option must be selected on the RCU option panel (see section 4.3.2). If not, the host processor generates the system console message that includes the SIM instead of the IEA494I or IEA491E message.

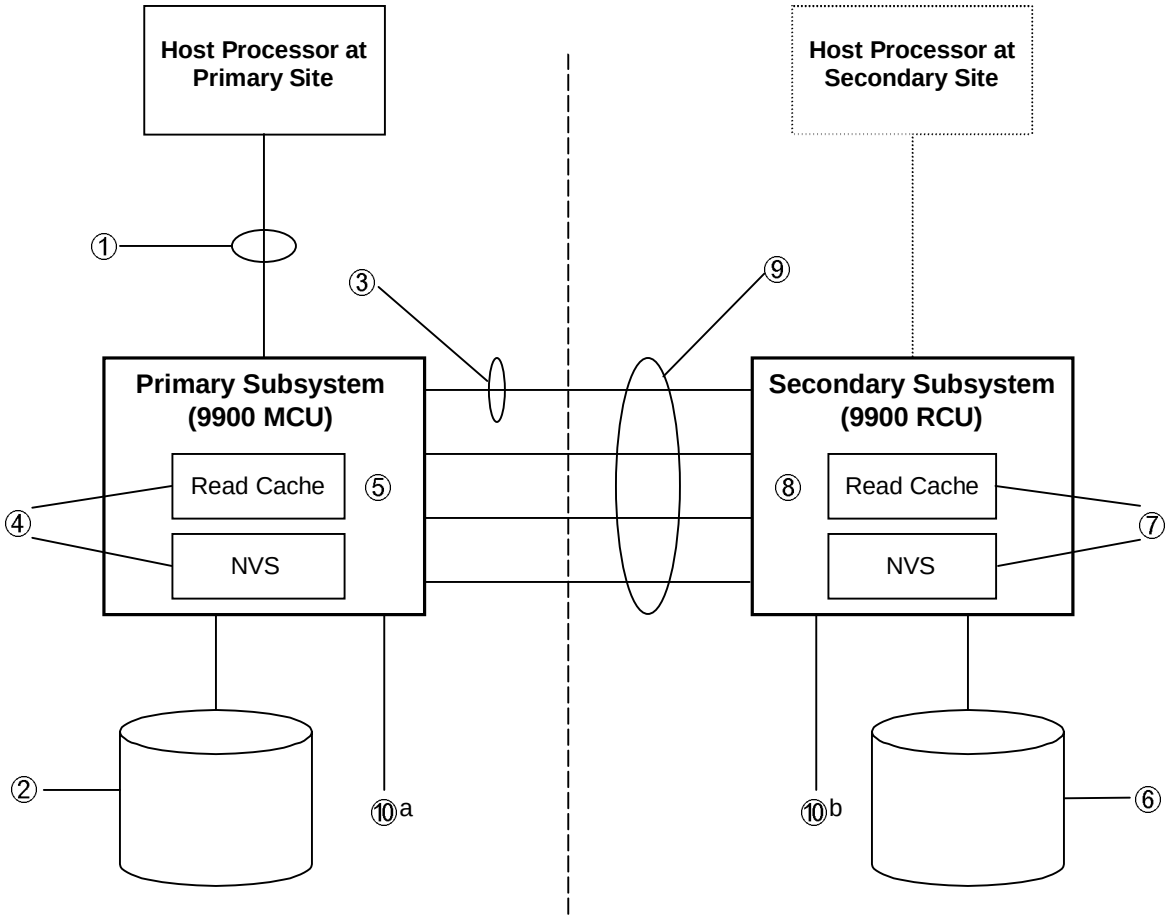


Figure B.10 Failure Conditions (described in Table B.9)

Table B.9 9900 Response Characteristics to Failure Conditions (continues on the next page)

Failure Condition	HRC Pairs Suspended?	Expected Messages	FREEZE Function
① Failure of all channel interfaces on the MCU	No	No IEA480, IEA491, or IEA494 messages are displayed.	Not activated
② Failure of a disk on the MCU			
(a) Failure of one physical device in a parity group	No	(1) IEA480 message (SIM for physical device blocked or port of physical device blocked) is displayed when the next I/O is issued to any logical volume in the parity group. (2) No IEA491 or IEA494 messages are displayed.	Not activated
(b) Failure of two physical devices in a parity group	No	(1) IEA480 message (SIM for LDEV blocked) is displayed when the next I/O is issued to any logical volume in the parity group. (2) No IEA491 or IEA494 messages are displayed.	Not activated
③ Failure of a link between the MCU and RCU	No	(1) IEA480 message (SIM for HRC path blocked) is reported when the next I/O to any device in this MCU is issued. (2) No IEA491 or IEA494 messages are displayed.	Not activated
④ Failure of NVS on the MCU; Failure of MCU read cache			
(a) One side of MCU cache blocked due to failure	No*	(1) IEA480 (SIM for cache blocked) is reported when the next I/O to any device in this MCU is issued. (2) No IEA491 or IEA494 messages are displayed.	Not activated
(b) One side of MCU cache blocked due to maintenance	No*	No IEA480, IEA491, or IEA494 messages are displayed.	Not activated
(c) One side of MCU cache blocked by SET CACHE OFF	No*	No IEA480, IEA491, or IEA494 messages are displayed.	Not activated
⑤ Both sides of MCU cache blocked due to failure	No	No IEA480, IEA491, or IEA494 messages are displayed. ***Note:*** The MCU returns CC=3 for all I/Os.	Not activated
⑥ Failure of a disk on the RCU			
(a) Failure of one physical device in a parity group	No	(1) The RCU reports IEA480 message (SIM for physical device blocked or port of physical device blocked) to either the MCU or the host processor (whichever issues the next I/O first) when the next I/O is issued to any logical volume in the parity group. If MCU receives the SIM, it passes the SIM to the attached host processor, and the IEA480 message is reported when the next I/O to this MCU is issued to any main (primary) volume paired with the logical volume in the parity group. (2) No IEA491 or IEA494 messages are displayed.	Not activated
(b) Failure of two physical devices in a parity group	Yes	(1) The RCU reports IEA480 message (SIM for LDEV blocked) to either the MCU or the host processor (whichever issues the next I/O first) when the next I/O is issued to any logical volume in the parity group. If MCU receives the SIM, it passes the SIM to the attached host processor, and the IEA480 message is reported when the next I/O to this MCU is issued to any main volume paired with the logical volume in the parity group. (2) One (or more) IEA494 messages showing EXTENDED LONG BUSY are displayed. (3) One (or more) IEA491 and IEA494 messages showing PAIR SUSPENDED are displayed.	Activated if the FREEZE option is **enabled** for the affected LCU pairs.

Table B.9 9900 Response Characteristics to Failure Conditions (continued)

Failure Condition	HRC Pairs Suspended?	Expected Messages	FREEZE Function
⑦ Failure of NVS on the RCU; Failure of RCU read cache			
(a) One side of RCU cache blocked due to failure	No	(1) The RCU reports IEA480 message (SIM for cache blocked) to either the MCU or the host processor (whichever issues the next I/O first). If MCU receives the SIM, it passes the SIM to the attached host processor. Therefore, IEA480 is reported when the next I/O to any device in this MCU issued. (2) No IEA491 or IEA494 messages are displayed.	Not activated
(b) One side of RCU cache blocked due to maintenance	No	No IEA480, IEA491, or IEA494 messages are displayed.	Not activated
(c) One side of RCU cache blocked by SET CACHE OFF	No	No IEA480, IEA491, or IEA494 messages are displayed.	Not activated
⑧ Both sides of RCU cache blocked due to failure	Yes	(1) No IEA480(SIM of cache blocked) is displayed. (2) One (or more) IEA494 messages showing EXTENDED LONG BUSY are displayed. (3) One (or more) IEA491 and IEA494 messages showing PAIR SUSPENDED are displayed. (4) If CGROUP FREEZE and RUN are issued, IEA494 messages showing PAIR SUSPENDED are displayed when the MCU accepts CGROUP-RUN. These messages are from the HRC pairs for which FREEZE option is enabled, and from main volumes which did not already report IEA491/IEA494 at (3).	Activated if the FREEZE option is **enabled** for the affected LCU pairs.
⑨ Failure of all links between the MCU and RCU	Yes	(1) IEA480 (SIM for HRC path blocked) message is reported when the next I/O to any device in this MCU is issued. (2) One (or more) IEA494 messages showing EXTENDED LONG BUSY are displayed. (3) One (or more) IEA491 and IEA494 messages showing PAIR SUSPENDED are displayed.	Activated if the FREEZE option is **enabled** for the affected LCU pairs.
⑩ Power failure			
(a) On the MCU	No	No IEA480, IEA491, or IEA494 messages are displayed.	Not activated
(b) On the RCU	Yes	(1) IEA480 (SIM of HRC path blocked) message is reported when the next I/O to any device in this MCU is issued. (2) One (or more) IEA494 messages showing EXTENDED LONG BUSY are displayed. (3) One (or more) IEA491 and IEA494 messages showing PAIR SUSPENDED are displayed.	Activated if the FREEZE option is **enabled** for the affected LCU pairs.

* ***Note:*** When one side of the MCU cache is blocked, *duplex* HRC pairs are not affected, but *pending duplex* HRC pairs are suspended. Suspending HRC pairs with *pending duplex* status provides additional protection in the unlikely event of a cache failure.

B.5.1 GDPS-HRC-HXRC Matrix

Table B.10 compares IBM 3990-6E GDPS support to Hitachi Lightning 9900™ and 7700E GDPS support, and also provides a comparison of HRC and HXRC to PPRC and XRC.

Note: The information shown in Table B.10 was current at the time of publication of this document but is expected to change over time. Please contact your Hitachi Data Systems account team for the latest GDPS-HRC-HXRC matrix information.

Table B.10 GDPS-HRC-HXRC Matrix (continues on the next page)

S/390 Feature	IBM 3990-6E	Hitachi Lightning 9900™	Hitachi Freedom Storage™ 7700E
GDPS			
Planned outage	Supported	Supported	Supported
Unplanned outage via IEA494I	Supported	Supported	Supported
IEA494I Long Busy message	Default time of 120 sec for FREEZE after IEA494I message is issued.	Default time for FREEZE is 120 sec, optional user-defined from 0 to 600 sec after IEA494I message is issued.	Default time for FREEZE is 120 sec, optional user-defined from 0 to 600 sec after IEA494I message is issued.
Peer-to-Peer Remote Copy	**PPRC**	**HRC, HARC**	**HRC, HRC-SSO, HARC**
Hardware based	3990-6 to 3990-6	9900/7700E to 9900/7700E. ***Note:*** 9900 is restricted to CPU 0-3 when attached to 7700E.	9900/7700E to 9900/7700E. ***Note:*** 9900 is restricted to CPU 0-3 when attached to 7700E.
Subsystem-subsystem interface	ESCON – max of 43 km Communication via channel extenders	ESCON – maximum of 43 km Communication via channel extenders CNT – Channelink or UltraNet InRange 9800MAX InRange 9801 – in certification	ESCON – maximum of 43 km Communication via channel extenders CNT – Channelink or UltraNet InRange 9800MAX InRange 9801 – in certification
Copy modes supported	Synchronous	Synchronous, asynchronous ***Note:*** The default for IBM software commands is synchronous.	Synchronous, semi-synchronous, asynchronous ***Note:*** Semi-synchronous can only be specified by 7700E Remote Console PC (or SVP). The default for IBM software commands is synchronous.
Dual Copy combination support	Yes	No, Dual Copy not supported by subsystem.	No, Dual Copy not supported by subsystem.
TSO command Support	Yes	Yes. ***Note:*** Some additional options only available via Remote Console PC (or SVP).	Yes. ***Note:*** Some additional options only available via Remote Console PC (or SVP).
ICKDSF command support	Yes	Yes. ***Note:*** Some additional options only available via Remote Console PC (or SVP).	Yes. ***Note:*** Some additional options only available via Remote Console PC (or SVP).
P/DAS support	Yes	Yes	Yes
Maximum pairs	64	4,096	1,024
Maximum paths between subsystems	4	4 per logical control unit, 64 total	4 per logical control unit, 16 total

Table B.10 GDPS-HRC-HXRC Matrix (continued)

Peer-to-Peer Remote Copy (continued)	PPRC	HRC, HARC	HRC, HRC-SSO, HARC
Number of copy operations on initial copy	4	1 to 4, default is 4 per LCU. ***Note:*** Requires Remote Console PC (or SVP) to change default.	1 to 4, default is 4 per LCU. ***Note:*** Requires Remote Console PC (or SVP) to change default.
Dedicated interface between subsystems	No	Yes, requires main subsystem port to be set to LCP by Remote Console PC (or SVP) or automatically in response to establish and delete path commands.	Yes, requires main subsystem port to be set to LCP by Remote Console PC (or SVP) or automatically in response to establish and delete path commands.
PACE parameter initial copy option	1-255, default is 15 (setting of 1 copies a maximum of 3 tracks at a time, 2-255 copies a maximum of 15 tracks at a time)	3 or 15, default = 15 tracks	3 or 15, default = 15 tracks
CRITICAL pair error options (Fence Level parameter)	Yes No – Default Path	R-VOL Data Never – Default R-VOL Status	R-VOL Data Never – Default R-VOL Status
CGROUP	FREEZE/RUN by logical controller SSID pair	FREEZE/RUN by logical controller SSID pair, or optionally by entire subsystem using mode 64.	FREEZE/RUN by logical controller SSID pair, or optionally by entire subsystem using mode 64.
CQUERY	Supported	Supported, but requires mode 49 be ON to enable reporting of all 256 LDEVs in each logical control unit.	Supported, but requires mode 49 be ON to enable reporting of all 256 LDEVs in each logical control unit.
HRC-Unique Features (specified via Remote Console PC or SVP)			
RCU Options			
Minimum paths	Not supported	Default = 1. ***Note:*** If the minimum number of MCU-RCU active paths falls below this value, all pairs will be suspended based on the Fence Level option in effect.	Default = 1. ***Note:*** If the minimum number of MCU-RCU active paths falls below this value, all pairs will be suspended based on the Fence Level option in effect.
PPRC support by host	Host must support PPRC	Default = YES - PPRC supported, optional capability to allow host support for non PPRC capable operating systems.	Default = YES - PPRC supported, optional capability to allow host support for non PPRC capable operating systems.
RCU-to-MCU SIM reporting	Not supported per IBM doc *Planning for IBM Remote Copy* (SG24-2594-009 p.184)	To any host or only to RCU host	To any host or only to RCU host
RCU to MCU service SIM reporting	Not supported per IBM doc *Planning for IBM Remote Copy* (SG24-2594-009 p.184)	Default = Not report; Tables D.1 and D.2 list HRC service SIMs. Designed for non-MVS operating systems which do not support SIM reporting.	Default = Not report; Tables D.1 and D.2 list HRC service SIMs. Designed for non-MVS operating systems which do not support SIM reporting.
Pair Options			
Cache fast write data	Not supported	Optional to R-VOL, default = M-VOL	Optional to R-VOL, default = M-VOL

Table B.10 GDPS-HRC-HXRC Matrix (continued)

Extended Remote Copy	XRC	HXRC	HXRC
SMS 1.3 - SDM ver. 1	Not supported	Not supported	Not supported
SMS 1.3 + PTFs - SDM ver. 2	Supported	Supported	Supported
SMS 1.4 – SDM ver. 2	Supported	Supported	Supported
SMS 1.4+ PTFs – SDM ver. 2	Supported	Supported	Supported
SMS 1.5 – SDM ver. 2	Supported	Not supported, in QA test	Not supported, in QA test
Max. sessions	4 per subsystem	4 per CU image, 64 total	4 per CU image, 16 total
Max. volumes	256 per subsystem	256 per CU image, 4096 total	256 per CU image, 1024 total
Utility volumes with Multi Reader Support #OW30183	Multiple supported	Multiple supported	Multiple supported
SIM/error messages	Per IBM doc	Per IBM doc	Per IBM doc
Primary subsystem interface	Parallel or ESCON	ESCON only	ESCON only
Secondary subsystem interface	Parallel or ESCON	Parallel or ESCON	Parallel or ESCON
Channel extender support	Yes	CNT – Channelink or UltraNet	CNT – Channelink or UltraNet
Maximum sidefile size	50%	50% available cache	50% available cache
Sidefile puncture %	60%	60%. ***Note:*** Retries issued at 40% utilization, host interface blocked at 50% utilization.	60%. ***Note:*** Retries issued at 40% utilization, host interface blocked at 50% utilization.

Appendix C Pinned Track Recovery for HRC Volumes

If a pinned track occurs on an HRC M-VOL or R-VOL, the MCU will suspend the pair (SIM reference code = DB1x). Use the following procedure to ensure full data integrity of the volume pair while recovering the pinned track:

1. Connect to the MCU of the suspended pair, and select the correct CU image.
2. Delete the volume pair.
3. If the volume is offline (e.g., R-VOL has pinned track), vary the volume online.
4. Perform your usual procedure for recovering data from a pinned track. Refer to the pinned track recovery procedures for your operating system. Please contact your Hitachi Data Systems Support Center to inform them of the pinned track.
5. If the volume was previously offline (e.g., R-VOL), make sure to vary the volume offline again.
6. Restart the volume pair using the Add Pair panel, making sure to use the Entire Volume initial copy option.

Appendix D SIM Reporting

The Hitachi Lightning 9900™ subsystem reports a service information message (SIM) to the host when it is necessary to notify the user of a possible service requirement for the subsystem. The SIMs are classified according to severity for reporting and logging purposes: service, moderate, serious, or acute. The SVP reports all SIMs related to HRC operations, and all SIMs are stored on the SVP for use by Hitachi Data Systems personnel. The SIMs reported to the S/390® host are logged in the SYS1.LOGREC dataset of the host operating system. Each time a SIM is generated, the amber **Message** LED on the 9900 control panel (under the **Ready** and **Alarm** LEDs) turns on as an additional alert for the user. The 9900 subsystem also reports SIMs to the Remote Console PC to provide an additional source of notification for the user.
Note: For further information on SIM reporting, please refer to the *Hitachi Lightning 9900™ User and Reference Guide* (MK-90RD008).

During HRC operations, the MCU and RCU will generate a service SIM each time the pair status of the M-VOL or R-VOL changes for any reason, including normal status transitions (e.g., *pending duplex* to *duplex*). For HARC transition states (*suspending* and *deleting*), a SIM is generated when the status changes to the transition state, and again when the transition is complete. SIMs generated by the MCU will include the M-VOL device ID (byte 13), and SIMs generated by the RCU will include the R-VOL device ID (byte 13). The RCU Option panel (see section 4.3.2) allows you to configure each MCU to report or not report service-level SIMs to the attached host(s).

Figure D.1 shows a typical 32-byte SIM from the 9900 subsystem. SIMs are displayed on the host console by reference code (RC) and severity. The six-digit RC (composed of bytes 22, 23, and 13) identifies the possible error and determines the severity. The SIM type (byte 28) indicates the component which experienced the error. When byte 22 = 21, the SIM is a control unit SIM. When byte 22 = Dx, the SIM is a device SIM. When byte 22 = (D5-D7, DB), the specified pair is HARC. When byte 22 = (D8 - DC), the pair is HRC Synchronous. The SIM reference codes DB6x, DB7x, and DB8x indicate a HARC pair suspended by the RCU.

Table D.1 lists and describes the control unit SIMs (byte 28 = F1) related to HRC operations. Table D.2 lists and describes the device SIMs (byte 28 = FE) related to HRC operations. Tables D.1 and D.2 also specify the severity, host reporting, and SVP log file for each SIM.

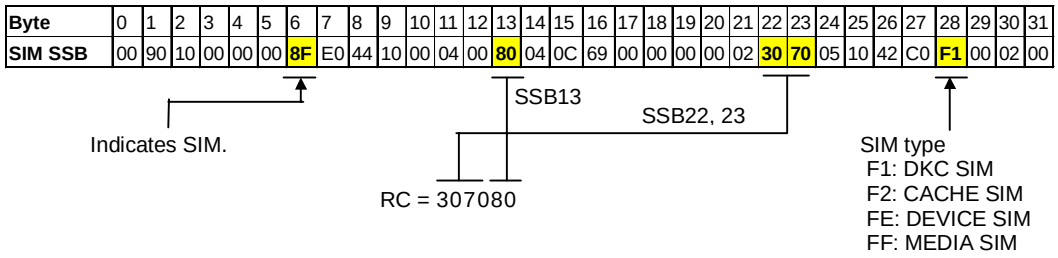


Figure D.1 Typical 9900 SIM Showing Reference Code and SIM Type

Note: The SIM information for the 9900 subsystem changes as new features and functions are added and supported. Please contact your Hitachi Data Systems account team or the Hitachi Data Systems Support Center for the latest SIM information for the 9900 subsystem.

Table D.1 HRC Control Unit SIMs

Ref. Code 22	Ref. Code 23	Severity	Description	Reported to Host	SVP Log File
21	80	Moderate	The logical path(s) on the remote copy connection(s) was logically blocked due to an error condition.	Yes Repeat	SIM Log
21	81	Service	The logical path on the remote copy connection has recovered from the blocked condition.	Yes* Once	SSB Log

* This SIM is not reported to the host system when the **Service SIM=Not Report** RCU option is selected.

Table D.2 HRC Device SIMs

Ref. Code 22	Ref. Code 23	Severity	Description	Reported to Host	Generated by	Log File
D0	0x	Service	HRC started the initial copy for this volume, or was out of sync for this volume.	Yes[1] Once	MCU	SSB Log
D0 D8	1x	Service	HRC completed the initial copy for this volume.	Yes[1] Once	MCU	SSB Log
D0	2x	Service	HRC for this volume was deleted as requested by the Remote Console PC, SVP, or host.	Yes[1] Once	MCU	SSB Log
D0	3x	Service	The MCU changed the volume pair status as requested by the Remote Console PC, SVP, or host.	Yes[1] Once	MCU	SSB Log
D1	sx	Service	Status of the R-VOL has changed as requested by the MCU. The third digit of the reference code "s" indicates change of states as follows: 0 : from simplex to pending 1 : from simplex to duplex 2 : from pending to duplex 3 : from pending to suspended 4 : from dup;ex to suspended 5 : from duplex to simplex 6 : from pending to simplex 7 : from suspended to simplex 8 : from suspended to pending.	Yes[1] Once	RCU	SSB Log
D2	0x	Service	The RCU changed the R-VOL status to *suspended* as requested by Remote Console PC, SVP, or host.	No	RCU	SSB Log
D2	1x	Service	The R-VOL status changed from *suspended* to *simplex* as requested by Remote Console PC, SVP, or host.	No	RCU	SSB Log
D2	2x	Service	The R-VOL status has changed from *duplex* to *simplex*.	No	RCU	SSB Log
D2	3x	Service	The HRC R-VOL status has changed from *pending duplex* to *simplex*.	No	RCU	SSB Log
D4	0x	Serious	HRC for this volume was suspended due to a failure on the remote copy connection.	Yes[2] Repeat	MCU	SIM Log

Table D.2 HRC Device SIMs (continued)

Ref. Code 22	23	Severity	Description	Reported to Host	Generated by	Log File
D4	1x	Serious	HRC for this volume was suspended due to a failure on the M-VOL or remote copy.	Yes[2] Repeat	MCU	SIM Log
D4	2x	Serious	HRC for this volume was suspended due to a failure on the R-VOL.	Yes[2] Repeat	MCU	SIM Log
D4	3x	Serious	HRC for this volume was suspended because DFW to the R-VOL was blocked.	Yes[2] Repeat	MCU	SIM Log
D4	4x	Serious	HRC for this volume was suspended due to an internal error condition detected by the RCU.	Yes[2] Repeat	MCU	SIM Log
D4	5x	Serious	HRC for this volume was suspended because the operator deleted the volume pair from the RCU.	Yes[2] Repeat	MCU	SIM Log
D4	Cx	Service	The MCU detected a service-level SIM at the RCU.	Yes[1] Once	RCU	SSB Log
D4	Dx	Moderate	The MCU detected a moderate-level SIM at the RCU.	Yes[1] Repeat	RCU	SIM Log
D4	Ex	Serious	The MCU detected an acute- or serious-level SIM at the RCU.	Yes[1] Repeat	RCU	SIM Log
D4	Fx	Serious	The status of the M-VOL is not consistent with the status of the R-VOL.	Yes[2] Repeat	MCU	SIM Log
D5	0x	Service	HRC started the initial copy for this volume, or was out of sync for this volume.	Yes[1] Once	MCU	SSB Log
D5	1x	Service	HRC completed the initial copy fo this volume.	Yes[1] Once	MCU	SSB Log
D5	2x	Service	The volume pair accepted Delete Pair operation.	Yes[1] Once	MCU	SSB Log
D5	3x	Service	The volume pair accepted Suspend Pair operation.	Yes[1] Once	MCU	SSB Log
D5	4x	Service	Delete Pair operation for this volume pair has completed.	Yes[1] Once	MCU	SSB Log
D5	5x	Service	Suspend Pair operation for this volume pair has completed	Yes[1] Once	MCU	SSB Log
D6	sx	Service	The R-VOL status has changed as requested by the MCU. The third digit of the reference code "s" indicates change of states as follows: 0: from simplex to pending 1: from simplex to duplex 2: from pending to duplex 3: from pending to suspended 4: from duplex to suspended 5: from duplex to simplex 6: from pending to simplex 7: from suspended to simplex 8: from suspended to pending	Yes[1] Once	RCU	SSB Log

Table D.2 HRC Device SIMs (continued)

Ref. Code 22	23	Severity	Description	Reported to Host	Generated by	Log File
D7	sx	Service	The R-VOL has accepted/completed state change as requested by operation. The third digit of the reference code "s" indicates the events as follows: 0: Accepted Suspend Pair operation. 1: Accepted Delete Pair operation. R-VOL is suspended. 2: Accepted Delete Pair operation. R-VOL is duplex. 3: Accepted Delete Pair operation. R-VOL is pending. 4: Completed Suspend Pair operation. 5: Completed Delete Pair operation.	No	RCU	SSB Log
DB	0x	Serious	The volume pair was suspended due to a failure on the remote copy connections.	Yes[2] Repeat	MCU	SIM log
DB	1x	Serious	The volume pair was suspended due to a failure on the M-VOL or remote copy.	Yes[2] Repeat	MCU	SIM log
DB	2x	Serious	The volume pair was suspended due to a failure on the R-VOL.	Yes[2] Repeat	MCU	SIM log
DB	3x	Serious	The volume pair was suspended because DFW to the R-VOL was blocked.	Yes[2] Repeat	MCU	SIM log
DB	4x	Serious	The M-VOL has changed to suspended state due to an inaternal error condition detected by the RCU.	Yes[2] Repeat	MCU	SIM log
DB	5x	Serious	The M-VOL has changed to suspended state because the operator deleted the volume pair from the RCU.	Yes[2] Repeat	MCU	SIM log
DB	6x	Serious	The RCU has suspended all R-VOLs in the consistency group due to time out failure defined by the maximum copy delay time.	Yes[2] Repeat	RCU	SIM log
DB	7x	Serious	The RCU has suspended all R-VOLs in the consistency group due to the internal logic error.	Yes[2] Repeat	RCU	SIM log
DB	8x	Service	The R-VOL was suspended due to MCU power-off event.	Yes[1] Once	RCU	SSB Log
DB	Fx	Serious	The status of the M-VOL is not consistent with the status of the R-VOL.	Yes[2] Repeat	MCU	SIM log

Notes:

1. These SIMs are reported to the host only if the **Service SIM=Report** and **PPRC Support=No** RCU options are both selected.
2. These SIMs are reported to the host system only if the **PPRC Support=No** RCU option is selected.

Appendix E HRC Scripting

E.1 Overview of HRC Scripting

An added benefit of the HRC feature is its support for scripting HRC operations. This capability provides the user with additional flexibility in managing their HRC environment. An HRC script file contains a list of macros (commands) which describes a series of HRC pair operations. The HRC scripting macros are defined in a text file, and the HRC remote console software reads the text file and executes the specified HRC pair operations.

Note: This appendix assumes that the user is familiar with batch files and does not provide instructions for writing or editing batch files. The macro commands and parameters listed in this appendix are the only commands recognized by the HRC scripting function.

WARNING: The user is responsible for testing the HRC scripting function before running any HRC scripts. If an HRC script is run without prior testing and the script ends abnormally, data loss could occur. Before testing an HRC script, back up the data and vary the volumes offline. If the volumes must remain online, back up the data and confirm that the target volume pair defined in the HRC script is correct. The results of an HRC script can be confirmed by checking the latest HRC pair status update (**Last Updated** field on HRC Pair Status panel).

Table E.1 lists the HRC pair macro commands. Table E.2 lists the internal macro commands for HRC scripting. The following HRC operations cannot be performed using HRC scripting and must be performed using the Remote Console PC:

- Configure ports (LCP↔RCP) (section 4.2.3)
- Monitor remote copy activity (section 4.2.4)
- Clear remote copy SIMs (section 4.2.5)
- Add/delete RCU (section 4.3.1)
- Change RCU options (section 4.3.2)
- Add/delete path/SSID (sections 4.3.4, 4.3.5)
- View RCU status (section 4.3.6)
- Change async options (section 4.4.1)
- Add/delete group (section 4.4.2)
- Change group options (section 4.4.3)
- View group status (section 4.4.4)

Table E.1 Functional Macro Commands for HRC Scripting

HRC Scripting Macro	Description
CreateHrcPair	Registers an HRC pair or pairs. (StartHrcPair is used to start the initial copy operation.)
SuspendHrcPair	Suspends an HRC pair or pairs.
DeleteHrcPair	Deletes an HRC pair or HRC pairs.
ResumeHrcPair	Resumes an HRC pair or HRC pairs.
ChangeHrcOption	Changes the pair options for an HRC pair or HRC pairs.
StartHrcPair	Starts remote copy operations for the new pairs and/or resumed pairs specified in the preceding scripting commands.
GetHrcStatus	Displays the status of an HRC pair or HRC pairs.
SelectHrcDevice	Searches HRC paired devices.

Table E.2 Internal Macro Commands for HRC Scripting

Type	Macro	Description
For lists	SetList	Set (define) a list of items.
	AddList	Add items to a list.
For non-lists	Start	Declares the beginning of a script.
	End	Declares the end of a script.
	Delay	Suspends script execution for the specified length of time.
	If	Executes a script conditionally.
	EndIf	Terminates a script conditionally.
	MakeString	Makes strings; converts numeric value to character string.
	Message	Displays a message window with buttons (OK, Yes/No).

E.2 Syntax for Scripting

E.2.1 Syntax Overview

An HRC script file can be written using any text editor (e.g., WordPad, NotePad). A script file consists of an unlimited number of statements which consist of macros (i.e., commands), work variables, and comments (see sections E.3 and E.4). The first executable statement in an HRC script file must be the HRC Start macro, and the last statement must be the HRC End macro. Each line in an HRC script file cannot exceed 240 bytes. A leading blank is ignored, and a leading tab character (0x09) is converted to a space (0x20). A tab character (0x09) within a string is not converted to a space.

Each script file should contain all five script statements (see Tables E.3 and E.4):

- A comment statement, including a short preface for the script: purpose, author, usage, description, operation, creation date, update date, and any reminder notes to the author. The comment statement is a non-execution statement. A comment statement begins with "//"and contains text (any character string) without any commands. Do not use the "//" symbol anywhere else in a script file, only at the beginning of a comment statement.
- A macro statement (sections E.3 and E.4). The macro statement is an execution statement. Only one macro instruction can be set per line, and a macro can span more than one line.
- A work variable statement (section E.5). The work variable statement is also an execution statement. Only one work variable statement can be set per line, and a work variable statement cannot span more than one line.
- A blank statement (Table E.3). The blank statement is a non-execution statement.
- An empty statement (Table E.3). The empty statement is a non-execution statement.

Table E.3 Syntax Description

Statement Name	Description
Blank statement	Space or Tab with a return
Comment statement	One line beginning with //
Empty statement	Return only
Execution statement	Work variable statement (non-list type work variable = constant)
Macro statement	Macro name [parameter list] (Refer to sections E.3 and E.4 for macro information.)

Table E.4 Script Components

Component Name	Description
Macro name	Either an internal macro or a functional macro.
Parameter list	Parameter identification name (defined in each macro format) = non-list type expression.
Expression	List, constant, and work variable.
List	In a list description, a constant is enclosed in braces "{}". A comma "," is inserted between constants. For example {1, 2, 3, 4}, or {"ABC", "qtw" }. Lists and work variables cannot be described in a list.
Constant	String or a numeric value.
String	The string covers the following lists. (Enclose a list with a double-quotation mark (""). Letters (uppercase and lowercase), numbers, symbols ▪ Numeric list: List that consists of (0, 1, 2, 3, 4, 5, 6, 7, 8, 9) ▪ Hexadecimal number list: List that begins with 0x/0X of (A, B, C, D, E, F, a, b, c, d, e, f)
Reserved variables	Reserved variables can only be referenced in a script. Setting a value is not possible.

E.2.2 Script File Requirements

Table E.5 lists the requirements for the components of a script file.

Table E.5 Script File Requirements

Item	Requirement
Maximum length of one line of a script	240 bytes
Maximum number of items of one list type identification name	4096
Maximum length of one item of a list type work variable string	16 bytes
Maximum length of one item of a non-list type string	150 bytes
Maximum number of items of macro trace storage	1,000
Maximum number of items of error trace	1,000

E.2.3 Script Symbols

Symbols can be used in a script to enhance or limit the power of each script command. Table E.6 lists and describes the symbols that can be used in a script.

Table E.6 Script Symbols

Symbol	Use
Quotation mark	Used to define the character constant by enclosing with it quotation marks.
Space	Used to delimit the before and after phrases.
Comma	Used to delimit the before and after phrases. This symbol must be placed by following each macro description rule.
Brace	Used to describe a list.
Parenthesis	Only used to describe a condition in the If statement.
Exclamation mark	Used as an operator in the If statement by placing the equal sign next to it. This symbol is not useful when used alone.
Unequal sign	Used as an operator in the If statement when used alone. When the equal sign follows, nothing changes.
Equal sign	Used as a substitute sign when used alone. When the equal sign follows, it becomes an operator in the If statement.

Note: The before and after phrases are split by the above symbols. Each symbol is recognized as a single word.

E.3 Operation Macro Commands

The functional macros are the script equivalents of the following HRC pair operations:

- Create HRC pairs (see section E.3.1),
- Delete HRC pairs (see section E.3.2),
- Suspend HRC pairs (see section E.3.3),
- Resume HRC pairs (see section E.3.4),
- Change HRC pair options (see section E.3.5),
- Start HRC pairs (see section E.3.6),
- Get HRC pair status (see section E.3.7), and
- Select HRC pair devices (see section E.3.8).

E.3.1 Create HRC Pairs

The CreateHrcPair command allows you to establish new HRC volume pairs. ***Note:*** The CreateHrcPair command only creates the pair. You must run the StartHrcPair command after establishing the pair to start the remote copy process.

The CreateHrcPair parameters are:

- M-VOL device list (numeric): C x 0x100 + VV, where C=CU#, VV=vol# within CU.
- Serial number list (string): RCU serial number (serial number is five digits decimal 0-9). Do not specify more than 12 RCUs.
- SSID number list (numeric): RCU SSID (four digits hexadecimal 0-F).
- R-VOL device list (numeric): C x 0x100 + VV, where C=CU#, VV=vol# within CU.
- Initial copy pace list (string): "CP_MIDDLE" (0x01) = 3 tracks; "CP_FAST" (0x02) = 15 tracks; default = CP_FAST.
- Initial copy mode list (string): "E" (0x00) = entire; "N" (0x01) = none; default = E.
- Sync level list (string): "S0" or "Synchronous0" (0x00) = sync, "S2" or "Synchronous2" (0x02) = async; default = S0. S0 and S2 cannot be specified at the same time.
- CT group list (numeric): consistency group number (0x00 - 0x3F). For async pairs you must specify this parameter. For sync pairs you must omit this parameter.
- Priority list (numeric): priority of initial copy operation (1-256); default = 32.
- Fence level list (string): "N" or "Never" = (0x00); "S" or "Status" = (0x02); "D" or "Data" = (0x01); default = "Never". For async pairs you must either specify N (never) or omit this parameter.
- CFW flag list (numeric): 0 = copy CFW data to R-VOL; 1 = only M-VOL; default = 1.
- DFW flag list (numeric): 0 = DFW not required; 1 = DFW required; default = 0. Must be omitted for async pairs.
- Error level list (string): "G" (0x00) = group; "V" (0x01) = volume; default = G. For sync pairs you must omit this parameter.
- Time-Saving Mode flag: "Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure E.1 shows an example of the HRC pair macro command needed to create the specified HRC pairs with the parameters listed in Table E.7.

Caution: When using the CreateHrcPair command to create more than one HRC pair, make sure to keep each line within the maximum line length (240 bytes). Refer to section E.2.2 for script command restrictions and parameters.

Table E.7 Example of CreateHrcPair Parameters

Parameter	Value		Parameter	Value
M-VOL	_ilDevA		CT group	[omit – N/A]
Serial number (RCU)	_slWorkA		Priority	_ilWorkA
SSID (RCU)	11		Fence level	Never
R-VOL	_ilDevB		CFW flag	0
Initial copy pace	_slWorkB		DFW flag	1
Initial copy mode	E		Error level	[omit – N/A]
Sync level	S0, S0, S0		Time-Saving Mode	[omit – default]

```
:
:
CreateHrcPair $Dev=_ilDevA,$RcuSn=_slWorkA,$RcuSsid=11,$Rdev=_ilDevB,$CopyPace=_slWorkB,
$CopyMode="E",$Sync={"S0","S0","S0"},$Priority=_ilWorkA,$Fence="N",$OptCfw=0,$OptSusDfwBlk=1
:
:
…
   …
StartHrcPair
```

Figure E.1 Example of CreateHrcPair Command

E.3.2 Delete HRC Pairs

The DeleteHrcPair command allows you to delete HRC pairs. The DeleteHrcPair parameters include:

- Device list (numeric): C x 0x100 + VV, where C=CU#, VV=vol# within the CU.
- Delete mode list (numeric): 0 (0x00) = normal, 1 (0x01) = delete by force; default = 0. You must specify 0 (normal) when deleting two or more async pairs.
- Delete range list (string): "G" or "Group" = group; "V" or "Volume" = volume; "C" or "C/T" = consistency time. For sync pairs you must omit this parameter.
  - When two or more volumes are specified, the default = V. If you want to delete two or more specific async pairs, you can specify V or omit this parameter.
  - When one volume is specified, the default = G under these conditions:
    Volume is an M-VOL and delete mode = 0 (normal) (any pair status); or
    Volume is an R-VOL, delete mode = 0, and pair status = suspending or deleting.
    If you want to delete an entire group by force (delete mode = 1), you must specify G.
  - When one volume is specified, the default = C/T under these conditions:
    Volume is an R-VOL, delete mode = 0, and pair status is not suspending or deleting.
- Time-Saving Mode flag: "Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure E.2 provides an example of the HRC pair macro command needed to delete the specified HRC pair with delete mode = normal.

```
MakeString $D=_sMsgE,$Fmt="RMS=(x%x %d %d). ",$Item=_Result,_MsgResult,_SelectResult
GetHrcStatus $Dev=_iNumA
MakeString $D=_sMsgA,$Fmt="%s  RCU=(S/N=%s, SSID=x%x)  Mode=%s  Mvol=%x
Rvol=%x",$Item=_sMsgF,_HrcStatus_Sn,_HrcStatus_Ssid,_HrcStatus_CopyType,_HrcStatus_DeviceM,_HrcStatus_DeviceR
MakeString $D=_sMsgA,$Fmt="%s  Status=(%s, %d%)  Fence=%s  %s  Continue with
CreateHrcPair?",$Item=_sMsgA,_HrcStatus_PairStatus,_HrcStatus_CopyRatio,_HrcStatus_Fence,_sMsgE
Message $Msg=_sMsgA,$OptMsg=0x0004
:
DeleteHrcPair $Dev=18,$DelMode=0
:
:
```

Figure E.2 Example of DeleteHrcPair Command

E.3.3 Suspend HRC Pairs

The SuspendHrcPair command allows you to suspend HRC pairs. The SuspendHrcPair parameters include:

- Device list (numeric): C x 0x100 + VV, where C=CU#, VV=vol# within the CU.
- Suspend mode list (string): "M" or "M-Vol" (0x00) = M-VOL failure, "R" or "R-Vol" (0x01) = R-VOL; default = R-VOL. You must specify R or omit this parameter when suspending async pairs.
- Flag list (numeric): suspend report flag: 0 = reports; 1 = no reports; default = 1.
- Suspend range list (string): "G" or "Group" (0x04) = group; "V" or "Volume" (0x00) = volume. For sync pairs you must omit this parameter.
  - When one volume is specified, the default = G. If you want to suspend only one async pair, you must specify V.
  - When two or more volumes are specified, the default = V. When two or more volumes are specified, you must either specify V or omit this parameter.
- Pending data flag list (string): "D" or "Drain" (0x00) = drain; "P" or "Purge" (0x08) = purge; default = D. For sync pairs you must omit this parameter.
- Time-Saving Mode flag: "Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure E.3 provides an example of the HRC pair macro command needed to suspend the specified HRC pair with suspend mode = R-VOL and the default flag of no reports.

```
:
:
MakeString $D=_sMsgE,$Fmt="RMS=(x%x %d %d). ",$Item=_Result,_MsgResult,_SelectResult
GetHrcStatus $Dev=_iNumA
MakeString $D=_sMsgA,$Fmt="%s  RCU=(S/N=%s, SSID=x%x)  Mode=%s  Mvol=%x
Rvol=%x",$Item=_sMsgF,_HrcStatus_Sn,_HrcStatus_Ssid,_HrcStatus_CopyType,_HrcStatus_DeviceM,_HrcStatus_DeviceR
MakeString $D=_sMsgA,$Fmt="%s  Status=(%s, %d%)  Fence=%s  %s  Continue with
ResumeHrcPair?",$Item=_sMsgA,_HrcStatus_PairStatus,_HrcStatus_CopyRatio,_HrcStatus_Fence,_sMsgE
Message $Msg=_sMsgA,$OptMsg=0x0004
:
:
SuspendHrcPair $Dev=18,$SusMode="R"
```

Figure E.3 Example of SuspendHrcPair Command

E.3.4 Resume HRC Pairs

The ResumeHrcPair command allows you to resume HRC pairs. The ResumeHrcPair parameters include:

- M-VOL device list (numeric): C x 0x100 + VV, where C=CU#, VV=vol# within CU.
- Priority list (numeric): priority of initial copy operation (numeric 1-256); default = 32.
- Fence level list (string): "N" or "Never" (0x00) = never; "S" or "Status" (0x02) = status; "D" or "Data" (0x01) = data; default = current value. For async pairs you must either specify N (never) or omit this parameter.
- Sync level list (string): "S0" or "Synchronous0" (0x00) = sync, "S2" or "Synchronous2" (0x02) = async; default = current value.
- Error level list (string): "G" or "Group" (0x00) = group; "V" or "Volume" (0x01) = volume; default = current value. For sync pairs you must omit this parameter.
- Resume range list (string): "G" (0x00) = group; "V" (0x01) = volume. For sync pairs you must omit this parameter.
  - When one volume is specified, the default = G. If you want to resume only one async pair, you must specify V.
  - When two or more volumes are specified, the default = V. When two or more volumes are specified, you must either specify V or omit this parameter.
- Time-Saving Mode flag: "Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure E.4 provides an example of the HRC pair macro command needed to resume the specified HRC pair in synchronous mode with fence level = never and priority = 1. ***Note:*** After resuming pairs, you must run the StartHrcPair command to begin remote copy activity.

```
:
MakeString $D=_sMsgE,$Fmt="RMS=(x%x %d %d). ",$Item=_Result,_MsgResult,_SelectResult
GetHrcStatus $Dev=_iNumA
MakeString $D=_sMsgA,$Fmt="%s  RCU=(S/N=%s, SSID=x%x)  Mode=%s  Mvol=%x
Rvol=%x",$Item=_sMsgF,_HrcStatus_Sn,_HrcStatus_Ssid,_HrcStatus_CopyType,_HrcStatus_DeviceM,_HrcStatus_DeviceR
MakeString $D=_sMsgA,$Fmt="%s  Status=(%s, %d%)  Fence=%s  %s  Continue with DeleteHrcPair
?",$Item=_sMsgA,_HrcStatus_PairStatus,_HrcStatus_CopyRatio,_HrcStatus_Fence,_sMsgE
Message $Msg=_sMsgA,$OptMsg=0x0004
:
ResumeHrcPair $Dev=25,$Priority=1,$Fence="N",$Sync="Synchronous0"
StartHrcPair
```

Figure E.4 Example of ResumeHrcPair Command

E.3.5 Change HRC Pair Options

The ChangeHrcOption command allows you to change the pair options for HRC pairs. The ChangeHrcOption parameters include:

- M-VOL device list (numeric): C x 0x100 + VV, where C=CU#, VV=vol# within CU.
- Fence level list (string): "N" or "Never" (0x00) = never, "S" or "Status" (0x02) = status; "D" or "Data" (0x01) = data; default = current value. For async pairs you must either specify N or omit this parameter.
- CFW flag list (numeric): 0 = copy CFW data to R-VOL; 1 = only M-VOL; default = current value.
- DFW flag list (numeric): 0 = DFW not required; 1 = DFW required; default = current value. For async pairs you must omit this parameter.
- Error level list (string): "G" (0x00) = group; "V" (0x01) = volume; default = current value. For sync pairs you must omit this parameter.
- Time-Saving Mode flag: "Yes" = The **Use Time-Saving Mode** option is enabled; "No" = The **Use Time-Saving Mode** option is disabled; default = "Yes". This parameter is a non-list type and only one value can be specified.

Figure E.5 provides an example of the HRC pair macro command needed to change the pair options for the HRC pair with LDEV ID 0x4a as follows: set fence level option to **Never**, set CFW option to M-VOL only, and set DFW to required.

```
MakeString $D=_sMsgE,$Fmt="RMS=(x%x %d %d). ",$Item=_Result,_MsgResult,_SelectResult
GetHrcStatus $Dev=_iNumA
MakeString $D=_sMsgA,$Fmt="%s  RCU=(S/N=%s, SSID=x%x)  Mode=%s  Mvol=%x
Rvol=%x",$Item=_sMsgF,_HrcStatus_Sn,_HrcStatus_Ssid,_HrcStatus_CopyType,_HrcStatus_DeviceM,_HrcStatus_DeviceR
MakeString $D=_sMsgA,$Fmt="%s  Status=(%s, %d%)  Fence=%s  %s  Continue with
SuspendHrcPair?",$Item=_sMsgA,_HrcStatus_PairStatus,_HrcStatus_CopyRatio,_HrcStatus_Fence,_sMsgE
Message $Msg=_sMsgA,$OptMsg=0x0004
:
:
ChangeHrcOption $LDEV=0x4a,$Fence="Never",$OptCfw=1,$OptSusDfwBlk=1
```

Figure E.5 Example of ChangeHrcOption Command

E.3.6 Starting an HRC Pair

The StartHrcPair command allows you to start the remote copy process for all new and resumed HRC pairs (CreateHrcPair and ResumeHrcPair script file commands). The StartHrcPair command does not have any arguments or parameters. After you have created and/or resumed all desired HRC pairs, add the StartHrcPair command to the script to begin remote copy activity for all preceding new and resumed pairs. Figure E.6 provides an example of the StartHrcPair command as it appears within a script file.

```
MakeString $D=_sMsgE,$Fmt="RMS=(x%x %d %d). ",$Item=_Result,_MsgResult,_SelectResult
GetHrcStatus $Dev=_iNumA
MakeString $D=_sMsgA,$Fmt="%s  RCU=(S/N=%s, SSID=x%x)  Mode=%s  Mvol=%x
Rvol=%x",$Item=_sMsgF,_HrcStatus_Sn,_HrcStatus_Ssid,_HrcStatus_CopyType,_HrcStatus_DeviceM,_HrcStatus_DeviceR
MakeString $D=_sMsgA,$Fmt="%s  Status=(%s, %d%)  Fence=%s  %s  Continue with
GetHrcStatus?",$Item=_sMsgA,_HrcStatus_PairStatus,_HrcStatus_CopyRatio,_HrcStatus_Fence,_sMsgE
Message $Msg=_sMsgA,$OptMsg=0x0004
:
:
StartHrcPair
```

Figure E.6 Example of StartHrcPair Command

E.3.7 Getting HRC Pair Status

The GetHrcStatus macro command allows you to obtain the status of a specific HRC pair. The GetHrcStatus argument is:

- Device (numeric constant, non-list-type and numeric-type work variable): VOL = C x 0x100 + VV, where C=CU#, VV=vol# within the CU.

The GetHrcStatus command obtains the status of the pair from the 9900 subsystem and displays the status as a reserved variable "_HrcStatus" (see Table E.15). Figure E.7 provides an example of the GetHrcStatus command for the HRC pair with LDEV ID 0x4a.

```
GetHrcStatus $Dev=0x4a
_sMsgB=_HrcStatus_Fence
_sMsgC=_HrcStatus_Sync
_sMsgD=_HrcStatus_Sn
_iNumB=_HrcStatus_Ssid
_iNumC=_HrcStatus_DeviceR
MakeString $D=_sMsgE,$Fmt="RMS=(x%x %d %d). ",$Item=_Result,_MsgResult,_SelectResult
MakeString $D=_sMsgA,$Fmt="%s  RCU=(S/N=%s, SSID=x%x)  Mode=%s  Mvol=%x
Rvol=%x",$Item=_sMsgF,_HrcStatus_Sn,_HrcStatus_Ssid,_HrcStatus_CopyType,_HrcStatus_DeviceM,_HrcStatus_DeviceR
MakeString $D=_sMsgA,$Fmt="%s  Status=(%s, %d%)  Fence=%s  %s  Continue with
ChangeHrcOption?",$Item=_sMsgA,_HrcStatus_PairStatus,_HrcStatus_CopyRatio,_HrcStatus_Fence,_sMsgE
Message $Msg=_sMsgA,$OptMsg=0x0004
```

Figure E.7 Example of GetHrcStatus Command

E.3.8 Selecting the HRC Pair Device

The SelectHrcDevice command allows you to search for HRC pairs whose status matches the specified parameters. The SelectHrcDevice argument is:

- Output list (list-type and numeric work variable)

The SelectHrcDevice parameters include:

- Device list (numeric): list of devices to be searched: C x 0x100 + VV, where C=CU#, VV=vol# within CU. Default = all possible target devices that can be specified.
- Serial number list (string): RCU serial number. Default = not specific.
- SSID number list (numeric): RCU SSID. Default = not specific.
- Fence level list (string): "N" or "Never" (0x00) = never; "S" or "Status" (0x02) = status; "D" or "Data" (0x01) = data. Default = not specific.
- Sync level list (string): "S0" or "Synchronous0" (0x00) = sync, "S2" or "Synchronous2" (0x02) = async. Default = not specific.
- Pair status list (string): "Simplex", "Pending", "Duplex", "Suspended0" (suspended during initial copy), "Suspended1" (suspended after initial copy), "Suspended" (all suspend types), "Suspending", "Deleting", "Undefined". Default = not specific.
- Device attribute list (string): "M" or "M-Vol", "R" or "R-Vol". Default = not specific.
- Error level list (string): "G" or "Group"; "V" or "Volume". Default = not specific.
- CT group list (numeric): consistency group number (0x00 - 0x3F). Default = not specific.
- SEQCHK flag list (string): "Yes" = SEQCHK on; "No" = SEQCHK off. Default = not specific.

Figure E.8 provides an example of the SelectHrcDevice command to find the HRC pairs with the parameters listed in Table E.8.

Table E.8 Select HRC Device Parameters

Parameter	Value
Output list	_ilDevA
Device list	_ilDevB
RCU serial number	_slWorkA
RCU SSID	_ilWorkA
Fence level	N
Copy mode	S0, S0, S0
Pair status	Suspended0
Device attribute	M

```
GetHrcStatus $Dev=_iNumA
_sMsgB=_HrcStatus_Fence
_sMsgC=_HrcStatus_Sync
_sMsgD=_HrcStatus_Sn
_iNumB=_HrcStatus_Ssid
_iNumC=_HrcStatus_DeviceR
MakeString $D=_sMsgE,$Fmt="RMS=(x%x %d %d). ",$Item=_Result,_MsgResult,_SelectResult
SelectHrcDevice $DevList=_ilDevA,$Dev=_ilDevB,$RcuSn=_slWorkA,$RcuSsid=_ilWorkA,$Fence="N",
$Sync={"S0","S0","S0"},$PairStatus="Suspended0",$DevAttr="M"
```

Figure E.8 Example of SelectHrcDevice Command

E.4 Internal Macro Commands

The internal macro commands are the connection agents that allow you to connect the functional macros together and produce a complete and functioning script. The internal macros are divided into two groups as shown in Table E.9: list types and non-list types.

Table E.9 Internal Macro Commands

Type	Macro	Description
For lists	SetList	Set (define) a list of items.
	AddList	Add items to a list.
For non-lists	Start	Declares the beginning of a script.
	End	Declares the end of a script.
	Delay	Suspends script execution for the specified length of time.
	If	Executes a script conditionally.
	EndIf	Terminates a script conditionally.
	MakeString	Makes strings; converts numeric value to character string.
	Message	Displays a message window with buttons (OK, Yes/No).

The **Start** and **End** commands are used together to begin and end the functions of a script. Every script must have a **Start** and **End** command. The **If/EndIf** commands are also used concurrently to string two or more functional commands together. The **If/EndIf** commands must be used together. For every **If** command in a script there must be an **EndIf** command. The **Delay** command allows you to delay a script for up to an hour, while the **Message** command allows you to create graphic user interface (GUI) messages to the user. The **MakeString** command allows you to assign several values to a string statement, or the **MakeString** command can convert numeric values to sting values. The **SetList** command allows you to create a list (e.g., all the searchable ports in the 9900, all the searchable LDEVs in the 9900) and the **AddList** command allows you to expand the parameters of a list created with the **SetList** command.

E.4.1 Internal Macro Command Definitions

AddList

The **AddList** command allows you to add a specified value to a specific list type. If you add a value to a list that exceeds the maximum number of items for that output list, the excess values will be ignored. The format for the **AddList** command is: **AddList $D=** the output list to which you want to add a value **,$S=** the expressions or values to be added to the output list with a numeric range of 0x0000 to 0xffff. For example, to add these values (0, 1, 2, 3, 0x1e, and 0x1f) to the Dev (Device) B list, the **AddList** command would be:

```
AddList $D=_ilDevB
      ,$S={0,1,2,3,0x1e,0x1f}
```

Delay

The **Delay** command allows you to delay a script for a specified length of time. The script delay time is set in seconds (0 - 3600). The format for the **Delay** command is: **Delay $Time=** the length of time you want to delay the script. For example, to delay a script by 60 seconds, the **Delay** command would be:
Delay $Time=60

End

The **End** command allows you to declare the end of a script. The **End** command also terminates the execution of a script. At least one **End** statement must be described in the trailing line of the script statement. The format for the **End** statement is: **End**

If / EndIf

The **If/EndIf** statements are used together to allow you to verify the conditions of an expression. If the **If/EndIf** statement is successfully completed, succeeding statements will be processed. If the **If/EndIf** statement is not successfully completed, the script will abort and the succeeding statements will not be completed. When **If/EndIf** statements are used, several conditions must be met. You must end an **If** statement with an **EndIf** statement. The execution statement cannot be defined on the same line as the **If** statement. The **If** statement must contain one conditional decision statement within parentheses. The string values must be compared as ASCII character codes (see Table E.10). The format for an **If/EndIf** statement is:

If expression one compared with expression two (see Table E.11 for comparison expressions) macro statement, either internal or functional
EndIf

For example, to start an HRC pair only if the pair was created successfully (result value of CreateHrcPair command is not 0), use the following **If/EndIf** command:

If (_Result!=0)
StartHrcPair
EndIf

Table E.10 ASCII Character Codes

Character	Code
0	0x30
1	0x31
9	0x39
A	0x41
Z	0x5a
a	0x61
z	0x7a

Table E.11 If/EndIf Comparison Symbols

Symbol	Meaning
= =	Expression 1 is equal to Expression 2.
<	Expression 1 is less than Expression 2.
<=	Expression 1 is less than or equal to Exp 2.
>	Expression 1 is greater than Expression 2.
>=	Expression 1 is greater than or equal to Exp 2.
!=	Expression 1 is not equal to Expression 2.

MakeString

The **MakeString** command allows you to edit a string and/or convert numeric values to string characters. When using the **MakeString** statement several conditions must be met. For each format control string statement there must be an $Item statement. The format control string of expression 1 must be enclosed in quotation marks (“”). If you set a value exceeding the maximum length of a string, the extraneous portion of the value will be not set. Table E.12 defines the two expression statement in the **MakeString** command. The format for the **MakeString** command is:
MakeString $D=** output buffer **,$Fmt= expression 1**,$Item=** expression 2

Table E.12 MakeString Expression Definitions

Expression 1	Expression 2
Expression 1 is one of three format control strings ($Fmt): **%d** Converts a 16-bit numeric expression to a decimal number (0 - 65535). **%x** Converts a 16-bit numeric expression to a hexadecimal number (0 - 0xffff). **%s** Sets a string as it is.	Expression 2 is any expression not containing a list reserved variable (must be constant or work variable).

For example, to create a **MakeString** statement that will convert the 16-bit numeric expression to a hexadecimal number (0 - 0xffff) and set the string as it is, with an output buffer of _sMsg, the command would be:

MakeString $D=_sMsgB
,$Fmt=”EndCode=(0x%x):%s”
,$Item=_Result,_sMsgA

For the **MakeString** command listed above: _sMsgB = “EndCode=(0x110f):Error Occurred”.

Message

The **Message** command allows you to display GUI messages along with user option buttons. The format for the **Message** command is:
Message $Msg=** String or work variable message **,$OptMsg= message option (0x0000 = OK button, 0x0004 = Yes/No buttons). For example, to display a message saying “Do you want to end?” with the Yes and No user option buttons the command would be:

Message $Msg=”Do you want to end?”,$OptMsg=0x0004

SetList

The **SetList** command allows you to assign specific items to a list. The format of the **SetList** command is: **SetList $D=** output list**,$S=**expression(attribute of the items to be assigned to the list with a numeric range of 0x0000 to 0xffff). For example, to set 0, 1, 2, 0x1e, and 0x1f to be displayed in the Dev (Device) B list the command would be:

SetList $D=ilDevB,$S={0,1,2,0x1e,0x1f}

Start

The **Start** command allows you to declare the beginning of a script and check to verify that the controller name matched the connected controller. When using the **Start** command, several conditions must be met. The **Start** command must be described on the first line of the script. The **Start** statement cannot include a comment statement, an empty statement or a blank statement. The **Start** statement must appear at the beginning of every script. If the controller name does not match the connected controller, an error will occur and the script will be aborted. The format of the **Start** command is: **Start $Script="HRCHODM",$Svr=** controller name. For example, to start an HRC script for a controller named Training 9900 the command would be:

Start $Script="HRCHODM",$Svr="Training 9900"

E.5 Work Variables

There are two types of work variables: list type, and non-list type. All work variables are initialized before a script is executed.

- Numeric work variables may have a value between 0x0000 and 0xffff. Numeric work variables are initialized with 0.
- A non-list string work variable may have a string with length up to 150 bytes. A list string work variable may have strings with length up to 16 bytes each. String work variables are initialized with a null string whose length is 0.
- A list work variable may have up to 1024 items. A non-list work variable is a constant. List work variables are initialized as empty (no items).

The work variable is part of an execution statement in an HRC script. Table E.13 provides a description and the storage type of each work variable statement for list and non-list types.

Table E.13 Work Variables

	Variable	Type	Description and Storage Type
List Type	_ilDEV	Numeric	Stores the device number list. Expression: _ilDevA, _ilDevB, _ilDevC
	_ilPriority	Numeric	Stores the priority number list. Expression: _ilPriorityA, _ilPriorityB, _ilPriorityC
	_ilWork	Numeric	Stores any 16-bit numeric values. Expression: _ilWorkA, _ilWorkB, _ilWorkC _ilWorkD, _ilWorkE, _ilWorkF
	_slWork	String	Stores any strings. Expression: _slWorkA, _slWorkB, _slWorkC, _slWorkD, _slWorkE, _slWorkF
Non-List Type	_iNum	Numeric	Stores any 16-bit numeric value. Expression: _iNumA, _iNumB, _iNumC, _iNumD, _iNumE, _iNumF
	_sMsg	String	Stores any string. Expression: _sMsgA, _sMsgB, _sMsgC, _sMsgD, _sMsgE, _sMsgF

E.6 Reserved Variables

Reserved variables include result variables (i.e., result of macro execution) and status variables (i.e., HRC pair status of specified volume). The reserved variables are for reference use only.

E.6.1 Reserved Result Variables

When an HRC functional macro is executed (e.g., CreateHrcPair), a result value (_Result) is issued. Figure E.9 illustrates the result statement format, and Table E.14 lists and defines the valid result values. When a new macro is initiated, the result value automatically resets to 0x0000. The functional macro executes on the specified number of devices. If the macro does not satisfy the execution condition, a conditional error occurs. If a conditional error is found, the result value is OR'ed with 0x1000, and the macro is logged in the error and macro trace files (see section 4.6). If the return value of the API (application program interface) is not 0, an API error occurs. If an API error occurs, the result value is OR'ed with 0x0100, and the macro is logged in the error and macro trace files.

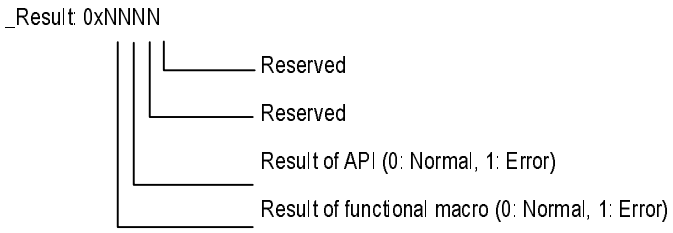


Figure E.9 Result Statement Format

Table E.14 Reserved Result Variables

Variable	Type	Description
_Result	Numeric	Stores the execution results of a macro. 0 = normal end. Other values depend on the macro.
_MsgResult	Numeric	Stores the execution results of a Message (internal) macro. 1 = OK, 6 = Yes, 7 = No.
_SelectResult	Numeric	Stores the number of devices found by SelectHrcDevice macro. 0 = no devices found.

E.6.2 Reserved Status Variables

When a GetHrcStatus command is issued, the Remote Console PC obtains the status of the specified HRC pair(s) from the 9900 subsystem. The results of this query are displayed in the reserved status variables. Table E.15 lists and describes the valid reserved status variables.

Table E.15 Reserved Status Variables

Variable	Type	Description
_HrcStatus _CopyType	String	Stores the copy type: "RDC" = HRC mode ; "RMC' = HODM mode; "---" = other than the above modes.
_HrcStatus _DeviceAttr	String	Stores the device attribute: "M-Vol" = M-VOL "R-Vol" = R-VOL "---" = other than the above modes.
_HrcStatus _DeviceM	Numeric	Stores the M-VOL device number.
_HrcStatus _DeviceR	Numeric	Stores the R-VOL device number.
_HrcStatus _Sn	String	Stores the serial number of the controller for the remote copy pairs.
_HrcStatus _Ssid	Numeric	Stores the storage subsystem ID (SSID) of the controller for the remote copy pairs.
_HrcStatus _PairStatus	String	Stores the copy pair status: "Simplex" = simplex; "Duplex" = duplex; "Pending" = initial copy in progress; "Suspended0" = copy abort in initial copy; "Suspended1" = copy abort other than initial copy; "Suspending" = HARC suspend in progress; "Deleting" = HARC delete in progress; "Undefined" = undefined.
_HrcStatus _Fence	String	Stores the M-VOL fence level: "Never" = no fence; "Status" = fence due to an R-VOL status change failure; "Data" = fence due to a data error; "Undefined" = undefined.
_HrcStatus _Sync	String	Stores the synchronous level: "Synchronous0" = sync; "Synchronous2" = async; "Undefined" = undefined.
_HrcStatus _TimeOfUpdate	String	Stores the pair status update time: "MM/DD/YYYY hh:mm:ss" = MM: month, DD: day, YYYY: year, hh: hour, mm: minute, ss: second.
_HrcStatus _TimeOfEstablish	String	Stores the pair creation update time: "MM/DD/YYYY hh:mm:ss" = MM: month, DD: day, YYYY: year, hh: hour, mm: minute, ss: second.
_HrcStatus _CopyRatio	Numeric	Stores the copy progress ratio (0 – 100).
_HrcStatus _InternalStatus	Numeric	Stores the internal status code.
_HrcStatusTypeOfCT	String	Stores the timer type of the consistency group: "System" = system timer; "Local" = local (SVP) timer; "None" = no timer; "Undefined" = undefined.
_HrcStatus_CTG	Numeric	Stores the consistency group number: 0x00-0x3F.
_HrcStatus_SuspendBy	String	Stores the async suspension status: "Group" = consistency time of suspended volume matches consistency time of group; "Volume" = consistency time of suspended volume does not match the group consistency time; "Undefined" = undefined.
_HrcStatus_ErrLv	String	Stores the error level (async) pair option: "Group" = all volumes in the group will be suspended if this volume is suspended; "Volume" = this volume will be suspended individually; "Undefined" = undefined.

E.7 Optional Script Parameters

The parameters outlined in Table E.16 are optional parameters that can be added to an HRC script at the script creator's discretion. If any of these parameters are included in a script, the 9900 subsystem will perform a syntactical check of the script to ensure that the syntax requirements for the parameter have been met. If no optional parameters are included, the 9900 will not check any part of the script. The 9900 will run the script commands based only on what has been specified in the text of the script. Table E.16 lists the optional script parameters in the order that the 9900 subsystem will execute them, and describes the syntax requirements that will be evaluated.

Table E.16 Syntax Requirements for Optional Parameters (continues on the next page)

Parameter	Syntax Requirements
Length	Check that each line does not exceed the maximum length for a script statement.
Phrases in a script statement	A phrase is enclosed by the quotation symbols. Use of the parentheses is correct, and the number of parentheses is exact. A statement does not terminate with an equal sign. The parameter identification name (phrase beginning with "$") is always defined. The work variable and reserved variable (phrase beginning with "_") are always defined.
Script statement	The first line begins with (Start) as an execution statement. The lead of one line in the execution statement always begins with a macro name or an identification name for non-list type work variable.
Substitute statement	The number of phrases is correct. The equal sign is described exactly between the right side and the left side. The right side of the substitute statement is correct.
SetList, AddList	The number of phrases is not less than the minimum count. Duplicate parameter identification names are not specified. The required parameter identification name is defined. The equal sign is described between the right side and $D. Specifying the right side is correct. The equal sign is described between the right side and $S. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). An illegal phrase is not included in any statement.

Table E.16 Syntax Requirements for Optional Parameters (continued)

Parameter	Syntax Requirements
Start	The number of phrases is not fewer than the minimum count. Duplicate parameter identification names are not specified. The required parameter identification name is defined. The equal sign is described between the right side and $Script. Specifying the right side is correct. The equal sign is described between the right side and $Svr. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). An illegal phrase is not included in one statement.
End	Check that the number of phrases matches.
Delay	The number of phrases matches. The required parameter identification name is defined. The equal sign is described between the right side and $Time. Specifying the right side is correct.
If	The number of phrases matches. The parentheses are described in the correct location. Expressions 1 and 2 are correctly described. The attribute of expressions 1 and 2 matches. Specifying the right side is correct. The comparison operator is correctly described.
EndIf	The number of phrases matches. The macro is describe with the related If statement.
MakeString	Duplicate parameter identification names are not specified. The required parameter identification name is defined. The equal sign is described between the right side and one of $D, $Fmt and $Item. Specifying the right side is correct. The items are split by a comma (,) if multiple items are specified in $Item. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). The matching between the specification of the control string and the description of the item is correct. An illegal phrase is not included in any statement.

Table E.16 Syntax Requirements for Optional Parameters (continued)

Parameter	Syntax Requirements
Message	The number of phrases is not less than the minimum count. Duplicate parameter identification names are not specified. The required parameter for the identification name is defined. The equal sign is described between the right side and $Msg. Specifying the right side is correct. The equal sign is described between the right side and $OptMsg. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameter identification names are delimited by a comma (,). An illegal phrase is not included in one statement.
Functional macro (except for StartHrcPair)	The number of phrases is not less than the minimum count. Duplicate parameter identification name is prohibited. The required parameter for the identification name is defined. The equal sign is described between the right side and the parameter identification name. Specifying the right side is correct. The parameter identification name is described immediately after the macro. The parameters for the identification names are delimited by a comma (,). An illegal phrase is not included in any statement.
StartHrcPair	Check that the number of phrases matches.
Entire check	Check that the (If) has a matching (EndIf). Check that the last line in the execution statement terminates at (END.)

E.8 Error Reporting

The scripting error codes are slightly different than the general HRC error codes. Figure E.10 shows the format of the scripting error codes. Table E.17 describes the HRC scripting error messages. Table E.18 lists the scripting error codes. In Table E.18 the message ID is the four-digit number displayed on the HRC error message. The internal code is the four-digit number displayed in the fifth column of the error trace file (refer to section 4.6). Refer to Chapter 7 for additional HRC troubleshooting information.

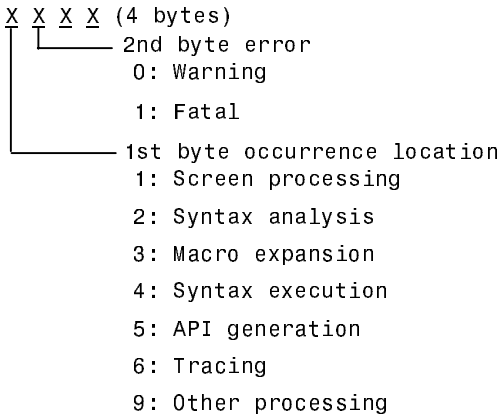


Figure E.10 Scripting Error Code Format

Table E.17 Error Messages

Error Message	Conditions to Verify	Corrective Action
Syntax error	The syntax validity of the HRC script is checked at the start of execution. An error message will be displayed if failed.	Use the scripting error code to determine which line contains the syntax error (see Table E.18), and fix the syntax error.
Parameter error	The parameter validity of the HRC script is checked on executing each instruction. An error message will be displayed if failed.	Use the scripting error code to determine which line contains the parameter error (see Table E.18), and fix the parameter error.
Rejection	The result of the execution is checked on each target device. If failed, the last error status is displayed and error flag is set in the reserved variable _Result. Also HRC script continues to be executed.	If you want to terminate the script or display a message of error occurrence and indication following steps, check that _Result is not 0 in HRC script.
Skip if not executable	The condition of each target device is checked to be executable status. For example, the M-VOL status must be *simplex* to create an HRC pair. If failed, error flag is set in the reserved variable _Result. Also HRC script continues to be executed.	If you want to terminate the script or display a message of error occurrence and indication following steps, check that _Result is not 0 in HRC script.

Table E.18 HRC Scripting Error Codes (continues on the next page)

Message ID	Internal Code	Error Message	Error Description
2338	--	Normal End.	The script execution has completed successfully.
2339	1102	Cannot open a file by 'Memo' command.	The 'Memo' command cannot start the Write application. The Write.exe file may be absent from the Windows directory.
2340	1103, 1104	Invalid command line parameter.	An error is found in the startup parameter of the script monitor. The installation process may not have been complete.
2341	1f01, 1f02	File I/O error (parameter).	The parameter file cannot be opened. The installation process may not have been complete.
2341	2f01, 2f02	File I/O error (script).	The specified file may be corrupt.
2341	2f03~ 2f05, 4101, 4102	File I/O error (temporary).	The work middle file is abnormal. The disk capacity maybe insufficient or the file may be corrupt.
2341	6101~ 6105	File I/O error (trace).	The macro trace file cannot be opened. The disk capacity may be insufficient or the file may be corrupt.
2341	6111~ 6115	File I/O error (trace).	The error trace file cannot be opened. The disk capacity may be insufficient or the file may be corrupt.
2342	2101	Too long line. Line = nnnn	A script line exceeds the maximum character length (240), where nnnn is the script line number.
2343	2201, 2203	Illegal 'If' and 'EndIf' pair. Line = nnnn	'If' and 'EndIf' script commands do not match, in script line nnnn
2344	2202	'End' is required. Line = nnnn	'End' does not exist at the end of the script line nnnn.
2345	2204	'Start' is required. Line = nnnn	The script line nnnn does not begin with 'Start.'
2346	2205	Illegal word is found. Line = nnnn	An illegal word was found in script line nnnn.
2347	2206	List type variable is unexpected. Line = nnnn	The list type variable is incorrect in script line nnnn.
2348	2207	Illegal quotation. Line = nnnn	A quotation mark is not found at the end of a string in script line nnnn.
2349	2208	Required value is not found. Line = nnnn	The end of line nnnn is "=".
2350	2209, 220a	Illegal '('and')' pair. Line = nnnn	The parentheses are not matched in script line nnnn.

Table E.18 HRC Scripting Error Codes (continued)

Message ID	Internal Code	Error Message	Error Description
2351	220b, 2303	Syntax error. Line = nnnn	An illegal word is included in script line nnnn.
2351	27xx	Syntax error. Line = nnnn	The parameter setting for script line nnnn is invalid.
2351	29xx	Syntax error. Line = nnnn	The macro description for script line nnnn is invalid.
2351	2axx	Syntax error. Line = nnnn	An invalid comma is used in script line nnnn.
2352	220e	Illegal expression. Line = nnnn	An unavailable operator is defined in the if statement of script line nnnn.
2353	220f	Illegal parameter. Line = nnnn	The list of the format control string and the value of the expression specified by $Item do not match in the Make String command. Or, the format control string and the expression do not match the attributes in script line nnnn.
2353	24xx	Illegal parameter. Line = nnnn	The parameters of script line nnnn are invalid.
2354	2301	Unknown parameter. Line = nnnn	An undefined parameter is used in script line nnnn.
2355	2355	Unknown identifier. Line = nnnn	An undefined word is used to define the parameters in script line nnnn.
2356	25xx	Same parameter appears again. Line = nnnn	A duplicate parameter was found in script line nnnn.
2357	26xx	Required parameter is not found. Line = nnnn	A required parameter for script line nnnn was not found.
2358	28xx	Value type mismatch. Line = nnnn	The values on the left and right side of script line nnnn are not compatible.
2359	1001, 4111, 4112	Internal error.	An internal program error has occurred. The program installation may not have been complete.
2360	4181	Mismatch script type.	The script types specified by the Start macro and by the execution environment file are different.
2361	4182	Mismatch controller name.	The device names specified by the Start macro and by the execution environment file are different.
2362	5101	Parameter value error ($Dev).	A functional macro parameter error was found. Check the setting value in the $Dev parameter.
2362	5102	Parameter value error ($Priority).	A functional macro parameter error was found in setting $Priority.
2362	5103	Parameter value error ($Fence).	A functional macro parameter error was found in setting $Fence.

Table E.18 HRC Scripting Error Codes (continued)

Message ID	Internal Code	Error Message	Error Description
2362	5104	Parameter value error ($Sync).	A functional macro parameter error was found in setting $Sync.
2362	5105	Parameter value error ($SusMode).	A functional macro parameter error was found in setting $SusMode.
2362	5106	Parameter value error ($SusReport).	A functional macro parameter error was found in setting $SusReport.
2362	5107	Parameter value error ($DelMode).	A functional macro parameter error is found in the setting $DelMode.
2362	5108	Parameter value error ($OptCfw).	A functional macro parameter error is found in setting $0ptCfw.
2362	5109	Parameter value error ($OptSusDfwBlk).	A functional macro parameter error is found in setting $0ptSusDfwblk.
2362	5110	Parameter value error ($RcuSn).	A functional macro parameter error was found in setting $RcuSn.
2362	5111	Parameter value error ($RcuSsid).	A functional macro parameter error was found in the setting $RcuSsid.
2362	5112	Parameter value error ($Rdev).	A functional macro parameter error was found in the setting $Rdev.
2362	5113	Parameter value error ($CopyPace).	A functional macro parameter error was found in the setting $CopyPace.
2362	5114	Parameter value error ($CopyMode).	A functional macro parameter error was found in the setting $CopyMode.
2362	5115	Parameter value error ($PairStatus).	A functional macro parameter error was found in the setting $PairStatus.
2362	5116	Parameter value error ($DevAttr).	A functional macro parameter error was found in the setting $DevAttr.
2362	5117	Parameter value error ($DevAttr).	A functional macro parameter error was found in the setting $DevAttr.
2362	5118	Parameter value error ($DevAttr).	A functional macro parameter error was found in the setting $DevAttr.
2362	5121	Parameter value error ($RcuSn!=$Dev).	A functional macro parameter error was found in the $RcuSn!=$Dev setting.
2362	5122	Parameter value error ($RcuSsid!=$Dev).	A functional macro parameter error was found in the $RcuSsid!=$Dev settings.
2362	5123	Parameter value error ($Rdev!=$Dev).	A functional macro parameter error was found in the $Rdev!=$Dev settings.
2362	5124	Parameter value error ($CopyMode!=$Sync).	A functional macro parameter error is found in the $CopyMode!=$Sync settings.

Table E.18 HRC Scripting Error Codes (continued)

Message ID	Internal Code	Error Message	Error Description
2362	5132	Parameter value error ($CTG). Error Code = eeee	A functional macro parameter error is found. Set the correct CT group number in the $CTG parameter.
2362	5133	Parameter value error ($OptErrLv). Error Code = eeee	A functional macro parameter error is found. Set the correct error level in the $OptErrLv parameter.
2362	5134	Parameter value error ($SusRange). Error Code = eeee	A functional macro parameter error is found. Set the correct suspend range in the $SusRange parameter.
2362	5135	Parameter value error ($PendData). Error Code = eeee	A functional macro parameter error is found. Set the correct peding data flag in the $PendData parameter.
2362	5136	Parameter value error ($DelRange). Error Code = eeee	A functional macro parameter error is found. Set the correct delete range in the $DelRange parameter.
2362	5137	Parameter value error ($OptRsmRange). Error Code = eeee	A functional macro parameter error is found. Set the correct resume range in the $OptRsmRange parameter.
2362	5138	Parameter value error ($Seqchk). Error Code = eeee	A functional macro parameter error is found. Set the correct SEQCHK flag in the $Seqchk parameter.
2362	5139	Parameter value error ($TimeSave). Error Code = eeee	A functional macro parameter error is found. Set the correct time-saving mode flag in the $TimeSave parameter.
2995	5201	Illegal combination ($Sync and $OptSusDfwBlk). Error Code = eeee	A functional macro parameter combination error is found. ($Sync and $OptSusDfwBlk.)
2995	5203	Illegal combination ($Sync and $CTG). Error Code = eeee	A functional macro parameter combination error is found. ($Sync and $CTG.)
2995	5204	Illegal combination ($Sync and $OptErrLv). Error Code = eeee	A functional macro parameter combination error is found. ($Sync and $OptErrLv.)
2996	5301	$CTG not found. Error Code = eeee	$CTG is not described when asynchronous copy pair creation.

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