VSM5

Planning Guide

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Introducing ELS

E29151-03

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Notices

Alert Messages

Alert messages used within this document are presented as follows:

Note: A note provides emphasis or additional useful detail about a topic or procedure, and can either precede or follow the information it references.

CAUTION !

A caution directs urgent attention to an action or condition which could damage equipment or corrupt data or system software if the accompanying procedure is not completed or is performed incorrectly. A caution <u>always precedes</u> the information it references.

DANGER !!

A danger message directs urgent attention to an action or condition that has potential to create a hazardous situation or to cause immediate, severe, and possibly fatal injury or adverse long-term health effects if the accompanying procedure is not completed or is performed incorrectly. A danger message <u>always precedes</u> the information it references.

Class 1 Laser Product Notice

Laser transceivers are classified as Class 1 Laser Product, and have an output less than 70 microwatts and a wavelength of 850 nm. Oracle Class 1 Laser Products comply with EN 60 825-1(+A-11) and with sections 21 CFR 1040.10 and 1040.11 of the Food and Drug Administration (FDA) regulations. The following translations are provided to identify laser safety and classification:

Finnish: Luokan 1 laserlaite
French: appariel A laser de classe 1
Swedish: klasse 1 laser apparat

DANGER !!

Lasers and high-frequency signals used in optical fiber cables can cause eye injury if safety precautions are not followed. To prevent injury, observe these precautions: Never look directly into an optical fiber cable, laser transceiver, or connector; ensure that all transceiver optical ports are terminated with a cable or cover; and comply with all warning labels on fiber optic components.

Cabling Notice

Cables that connect peripherals to the VSM system must be shielded and grounded. Operation of peripheral equipment with cables that are not shielded and correctly grounded may result in interference to radio and TV reception.

Hazardous Materials Handling

Lead-acid battery packs and lithium-battery cards used in the VSM are classified as hazardous materials. Oracle personnel are required to comply with U.S. Department of Transportation (DOT), International Civil Aviation Organization (ICAO) and International Maritime Dangerous Goods (IMDG) Code requirements for shipping, recycling, and disposal of hazardous materials. If you have questions about these requirements, contact the Oracle Environmental Health and Safety (EHS) group.

Standards Conformance

This VSM5 system conforms to all necessary North American (U.S./Canada) and international standards for product safety, electromagnetic compatibility (EMC), body schemes, and binary multiples as defined below.

Product Safety Standards

This VSM5 system complies with the following product safety standards:

- Underwriters Laboratories (UL) – Listed by Underwriters Laboratories UL 1950, Information Technology Equipment, Third Edition
- Canadian Standards Association (CSA) – Certified to Canadian Standards Association, CAN/CSA C22.2 No. 950-95, Information Technology Equipment, Third Edition
- International Electrotechnical Commission (IEC) – Complies with IEC Publication 950, Safety Information Technology Equipment through TUV (Technischer Ueberwachungsverein)

Electromagnetic Compatibility

This VSM5 system complies with the following referenced standards for electromagnetic compatibility (EMC):

United States: Federal Communications Commission (FCC) – This equipment complies with FCC Title 47, Part 15 Subpart B, Unintentional Radiators Class A.

FCC Compliance Statement: This equipment has been tested and found to comply to the limits for Class A digital devices pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his or her own expense.

Canada: Canadian Department of Communications (CDC) – This equipment complies with Canadian EMC law CDC ICES-003.

European Union (CE Mark) – This equipment complies with Electromagnetic Compatibility Directive 89/336 (as amended).

Australia/New Zealand – This equipment complies with EMC Framework—AS/NZS 3548: 1995.

China – This equipment complies with CNS 13438.

Korea – This equipment complies with Korean EMC Law.

Japan: Voluntary Control Council for Interference (VCCI) – This equipment complies with VCCI (Japan) Class A (C15PR22).

VCCI Compliance Statement (Japanese translation):

この装置は、情報処理装置等電波障害自主規制協議会（ＶＣＣＩ）の基準に基づくクラスＡ情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。

VCCI Compliance Statement (English translation): This is a Class A product based on the Technical Requirement of the Voluntary Control Council for Interference (VCCI) by information technology equipment. In a domestic environment, this product may cause radio interference, in which case the user may be required to take corrective action.

Taiwan: Bureau of Commodity Inspection and Quarantine (BCIQ) – This equipment complies withBCIQ EMC Law—Taiwan: CNS13438.

The following warning label statement pertains to BSMI regulations in Taiwan, R.O.C.:

Taiwan Warning Label Statement (Taiwanese translation):

警告使用者: 這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

Taiwan Warning Label Statement (English translation): This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

CISPR 22 and EN55022 Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Safety / Fiber Optic / ESD Precautions

The following precautions must be followed during all phases of equipment installation, operation, and servicing. Equipment users are responsible for following warnings and cautions, and for taking other appropriate steps to assure safe equipment operation. Oracle assumes no liability for failure to comply with these requirements.

Safety Precautions

To prevent hazardous conditions and personal injury, follow these safety precautions:

Verify Proper Equipment Grounding

Ensure cabinet frames are properly connected to an electrical earth ground. AC power supplies require a three-conductor power cable. Source power cables must be plugged into approved three-contact electrical outlets. Power cable jacks and mating plugs must meet electrical code requirements for the intended area of use and also comply with International Electrotechnical Commission (IEC) safety standards.

Avoid Electric Shocks

Only qualified personnel may remove equipment covers for servicing. Before starting a service procedure, remove conductive metal objects from your person including rings, watches, necklaces, and badge chains. Use a conductive wrist strap and work mat grounded to a jack or unpainted metal surface on a cabinet frame. Never touch exposed connector pins or sockets, or leave ‘live’ cable ends exposed.

Use Only Approved Tools and Test Equipment

Use only approved tools and test equipment supplied in the standard CSE tool kit. Always ground test equipment to a grounding jack on the cabinet frame. Repair or replace any damaged tools or test equipment prior to use.

Be Aware of Your Operating Environment

Never operate electrical or electronic equipment in the presence of flammable gases or fumes, as these can create an explosion hazard.

Never Service or Adjust Equipment Alone

Never service or adjustment equipment unless another person capable of rendering first aid and resuscitation is present.

Do Not Substitute Parts or Modify Equipment

To assure equipment safety features are maintained, and to avoid introducing additional hazards, never install substitute parts or modify Oracle equipment without explicit permission from Oracle technical support personnel. Never remove, cut, or relocate raised-floor tiles without first receiving customer permission.

Provide Adequate Equipment Clearances

Make sure there is sufficient clearance around equipment to facilitate airflow and heat dissipation, and to maintain ambient system temperatures within recommended operating ranges. Provide clearances that allow cabinet doors to open at least 90 degrees, and to be easily removed for servicing equipment or in emergency situations.

Strictly Comply With Caution and Warning Messages

To prevent injury and equipment damage, comply with all caution and warning messages in this document. Also employ any and all other precautions which you deem necessary for safe operation of equipment in your specific operating environment.

Carefully Follow Procedural Steps

Always complete procedural steps in listed order. Performing steps out of order can expose you to potentially hazardous or lethal conditions.

Protect Yourself From Moving Parts

Restrict loose clothing and long hair to avoid becoming entangled in moving parts such as fans, impellers, and blowers.

Promptly Reinstall Covers and Doors

After completing service procedures, promptly reinstall cabinet covers, and close and lock cabinet doors to maintain proper cabinet airflow, prevent overheating, and restrict accessibility to energized FRUs.

Miscellaneous Safety Precautions

To prevent tipovers, never tilt a cabinet beyond a 15-degree angle (e.g., when ascending or descending ramps). Use caution when working near open floor tiles. Use good housekeeping practices to avoid fire hazards and to reduce the potential for mishaps.

Electrostatic Discharge Precautions

Electrostatic discharge (ESD)-sensitive components must always be handled under protected conditions, and ESD-preventive equipment must be used when servicing equipment. Employees who handles ESD-sensitive parts must be aware of the damage that ESD can cause, and must take the following precautions to prevent it.

Use ESD-Preventive Equipment

Always use Field Service Grounding Kit P/N 4711 when installing or servicing Oracle equipment. Always use a conductive wrist strap and antistatic work mat, and ensure those are grounded to a jack or unpainted metal on the cabinet frame when working.

Regularly Check and Clean ESD-Preventive Equipment

Regularly (at least monthly during frequent use) verify the resistance of wrist-strap grounding cords to be between 0.8M ohm (Ω) and 1.2M ohm (Ω), and work mat cords to be less than 1.2M ohm (Ω); replace damaged cords or any that do not meet these specifications. Regularly (at least monthly during frequent use) clean antistatic work mats; ACL Conductive Cleaner is preferred for this purpose since it leaves no residue, but isopropyl alcohol or a mild detergent and water solution can also be used.

Remove Conductive Personal Items

Before beginning service procedures inside a cabinet, remove all conductive metal objects from your person including rings, watches, necklaces, and badge chains.

Handle ESD-Sensitive Components Carefully

Keep circuit cards, ASICs, and other ESD-sensitive components away from ESD sources and extraneous electrical currents. Keep parts in ESD-protective packaging until installation, and store removed ESD-sensitive parts in protective packaging.

Fiber Optic Component Handling Precautions

To prevent damage to optical fiber cables and connectors, and to mitigate inherent hazards from laser-light emissions, always follow these general handling precautions:

Protect Your Eyes

Never aim the output of a laser, or of an optical fiber connected to a laser, directly into your eyes. Do not examine an optical connector on any cable that is still attached to its data transmission port, since laser light may be present in the cable. Before examining the end of an optical fiber, verify that no laser-light signals are present. Always cap unused data transmission ports on channel interface cards.

Handle Fiber Optic Components Gently

Handle fiber cables and connectors gently to prevent damage. Never grasp cables or connectors with pliers or grippers, or attach pulling devices to them. Never bend fiber cables (e.g., when routing along cable paths or guides) to a radius of <12 mm (<0.5 in.), and do not coil cables to <96 mm (<3.74 in.) in diameter. Use strain-relief mechanisms to prevent the weight of cables from damaging fibers. Protect cables from sharp edges or protrusions, heat sources, and other damaging conditions. Ensure that equipment openings and floor cutouts have protective edging at cable contact points.

Prevent Contamination of Cable Ends

Avoid touching the core of optical cables, as this can contaminate fibers and prevent light transmission. If a cable-end becomes contaminated, remove any loose debris using canned air or by gently tapping the connector, then clean the cable-end with an approved cleaning kit. Leave protective caps on cable-ends until cables are attached to a connector; after disconnecting cables, always reinstall clean protective caps.

Preface

Audience

This publication is intended for Oracle or customer personnel responsible for doing site planning for Oracle's StorageTek VSM5.

Notational and Typographic Conventions

The following notational and typographic conventions are used throughout this document to highlight special words, phrases, and actions.

Item	Example(s)	Description of Convention
Publications; course titles	*Installation and Service Guide*	Italic font
MS Windows or GUI screen titles	*Ethernet Setup* screen	Italic underlined font
Computer keyboard input keys	Press the [Enter] key.	Monospaced underlined font in square brackets [ ]
User-keyed non-variable inputs; system-generated outputs	**show systemstate**	Monospaced bold font
User-keyed variable inputs	**Name** = <*system name*>	Monospaced italic bold font in angled brackets < >
E-mail and IP addresses; URLs; file and folder names; active fields and icons in GUI windows	glsfs@Oracle.com; click Submit; www.support.storagetek.com; cli.exe file; 129.80.64 subnet	Monospaced underlined font
Emphasized text	Do not touch exposed wiring...	Underlined font
Physical VTSS labels for FRUs, LED indicators, ports, or switches	**POWER ON** indicator; **ETH0** port; **POWER ENABLE** switch	Bold caps font
Hypertext link (in PDF file) to a figure, table, procedure step, or section heading	See Figure 2-1 on page 2-27; Repeat Step 3; See "Assigning Passwords" on page 4-11.	Blue font (prints black in black and white photocopies)
Text references to numbered callouts in accompanying artwork	Pull the D-ring handle **[3]**.	Bold font in bold square brackets **[ ]**

1

Site Planning

This chapter provides information about activities designed to ensure the site is equipped to accommodate the power, safety, environmental, HVAC, and data handling requirements of VSM5 system equipment.

Key site readiness planning considerations include, but are not limited to:

- Site surveys to evaluate and eliminate or mitigate factors which could negatively affect delivery, installation, and operation of VSM5 system equipment.
- A plan for the layout and location of VSM5 system equipment and cabling that allows for efficient use and easy maintenance, plus adequate space and facilities for Oracle support personnel and their equipment.
- Facilities construction that provides an optimum operating environment for VSM5 system equipment and personnel, as well as safe flooring and protection from fire, flooding, contamination, and other potential hazards.
- Scheduling of key events and task completion dates for facilities upgrades, personnel training, and delivery, implementation, installation, testing, and certification activities.

Customers ultimately are responsible for ensuring that their site is physically prepared to receive and operate VSM5 system equipment, and that the site meets the minimum specifications for equipment operation as detailed in this guide.

Site Evaluation – External Considerations

Several months before delivery of VSM5 system equipment, a readiness planning team should identify and evaluate all external site factors that present existing or potential hazards, or which could adversely affect delivery, installation, or operation of the system. External factors that should be evaluated include:

- Reliability and quality of electrical power provided by the local utility, backup power generators, and uninterruptible power supplies (UPSs), etc.
- Proximity of high-frequency electromagnetic radiation sources (e.g., high-voltage power lines; television, radio, and radar transmitters)
- Proximity of natural or man-made floodplains and the resultant potential for flooding in the data center
- Potential effects of pollutants from nearby sources (e.g., industrial plants).

If any existing or potential negative factors are discovered, the site readiness planning team should take appropriate steps to eliminate or mitigate those factors before VSM5 system equipment is delivered. Oracle Global Services offers consultation services and other assistance to identify and resolve such issues. Contact your Oracle account representative for more information.

Site Evaluation – Internal Considerations

Several months before delivery of VSM5 system equipment, a readiness planning team should identify and evaluate all internal site factors that present existing or potential hazards, or which could adversely affect delivery, installation, or operation of the system. Internal factors that should be evaluated include:

- Structural dimensions, elevator capacities, floor-load ratings, ramp inclines, and other considerations when transferring equipment point-to-point between the delivery dock, staging area, and data center installation site
- Site power system(s) design and capacity
- VSM5 system equipment power system design and capacity
- Data center safety system design features and capabilities
- Data center environmental (HVAC) design features and capabilities
- Potential effects of corrosive materials, electrical interference, or excessive vibration from sources in close proximity to system equipment.

If any existing or potential negative factors are discovered, the site readiness planning team should take appropriate steps to eliminate or mitigate those factors before VSM5 system equipment is delivered. Oracle Global Services offers consultation services and other assistance to identify and resolve such issues. Contact your Oracle account representative for more information.

Transferring Equipment Point-to-Point

Site conditions must be verified to ensure all VSM5 system equipment can be safely transported between the delivery dock, staging area, and data center without encountering dimensional restrictions, obstructions, or safety hazards, or exceeding rated capacities of lifting and loading equipment, flooring, or other infrastructure. Conditions that must to be verified are described below.

Structural Dimensions and Obstructions

Dimensions of elevators, doors, hallways, etc. must be sufficient to allow unimpeded transit of VSM5-VTSS cabinets (in shipping containers, where appropriate) from the delivery dock to the data center installation location. See <Arial 10-pt. blue>"VSM5-VTSS Physical Characteristics" on page 2-33 for VSM5 cabinet-dimension details.

Elevator Lifting Capacities

Any elevators that will be used to transfer VSM5 cabinets must have a certified load rating of at least 1000 kg (2200 lbs.). This provides adequate capacity to lift the heaviest packaged, fully-populated VSM5 cabinet (roughly 480 kg/1056 lbs. with 64 array drives), a pallet jack (allow 100 kg/220 lbs.), and two persons (allow 200 kg/440 lbs.). See <Arial 10-pt. blue>"VSM5-VTSS Physical Characteristics" on page 2-33 for additional cabinet-weight details.

Floor-Load Ratings

Solid floors, raised floors, and ramps located along the transfer path for VSM5-VTSS cabinets must be able to withstand concentrated and rolling loads generated by the weight of a populated cabinet, equipment used to lift a cabinet (e.g., a pallet jack), and personnel who are moving the cabinet from point to point.

Raised floor panels located along a transfer path must be able to resist a concentrated load of 454 kg (1000 lbs.) and a rolling load of 181 kg (400 lbs.) anywhere on the panel, with a maximum deflection of 2 mm (0.08 in.). Raised floor pedestals must be able to resist an axial load of 2268 kg (5000 lbs.). See "Floor Loading Requirements" on page 10 for additional floor-loading details.

When being moved from one location to another, a VSM5-VTSS cabinet generates roughly twice the floor load as in a static state. Using 19 mm (0.75 in.) plywood along a transfer path reduces the rolling load produced by a cabinet.

Ramp Inclines

To prevent VSM5-VTSS cabinets from tipping on ramps while being moved from point to point, the site engineer or facilities manager must verify the incline angle of all ramps in the transfer path. Inclines cannot exceed 10 degrees (176 mm/m; 2.12 in./ft.).

Data Center Safety

Safety must be a primary consideration in planning installation of VSM5 system equipment, and is reflected in such choices as where equipment will be located, the rating and capability of electrical, HVAC, and fire-prevention systems that support the operating environment, and the level of personnel training. Requirements of local authorities and insurance carriers will drive decisions as to what constitutes appropriate safety levels in a given environment.

Occupancy levels, property values, business interruption potential, and fire-protection system operating and maintenance costs should also be evaluated. The Standard for the Protection of Electronic Computer / Data Processing Equipment (NFPA 75), the National Electrical Code (NFPA 70), and local and national codes and regulations can be referenced to address these issues.

Emergency Power Control

The data center should be equipped with readily-accessible emergency power- off switches to allow immediate disconnection of electrical power from VSM5 system equipment. One switch should be installed near each principal exit door so the power-off system can be quickly activated in an emergency. Consult local and national codes to determine requirements for power disconnection systems.

Fire Prevention

The following fire-prevention guidelines should be considered in the construction, maintenance, and use of a data center:

- Store gases and other explosives away from the data center environment.
- Ensure data center walls, floors, and ceilings are fireproof and waterproof.
- Install smoke alarms and fire suppression systems as required by local or national codes, and perform all scheduled maintenance on the systems.

Note: Halon 1301 is the extinguishing agent most commonly used for data center fire suppression systems. The agent is stored as a liquid and is discharged as a colorless, odorless, electrically nonconductive vapor. It can be safely discharged in occupied areas without harm to personnel. Additionally, it leaves no residue, and has not been found to cause damage to computer storage media.

- Install only shatterproof windows, in code-compliant walls and doors.
- Install carbon dioxide fire extinguishers for electrical fires and pressurized water extinguishers for ordinary combustible materials.
- Provide flame-suppressant trash containers, and train personnel to discard combustible waste only into approved containers.
- Observe good housekeeping practices to prevent potential fire hazards.

Site Power Distribution Systems

The following elements of the site power distribution system should be evaluated when planning an installation of VSM5 system equipment.

System Design

A properly installed power distribution system is required to ensure safe operation of VSM5 system equipment. Power should be supplied from a feeder separate from one used for lighting, air conditioning, and other electrical systems.

A typical input power configuration, shown in FIGURE 1-1, is either a five-wire high-voltage or a four-wire low-voltage type, with three-phase service coming from a service entrance or separately derived source, and with overcurrent protection and suitable grounding. A three-phase, five-wire distribution system provides the greatest configuration flexibility, since it allows power to be provided to both three-phase and single-phase equipment.

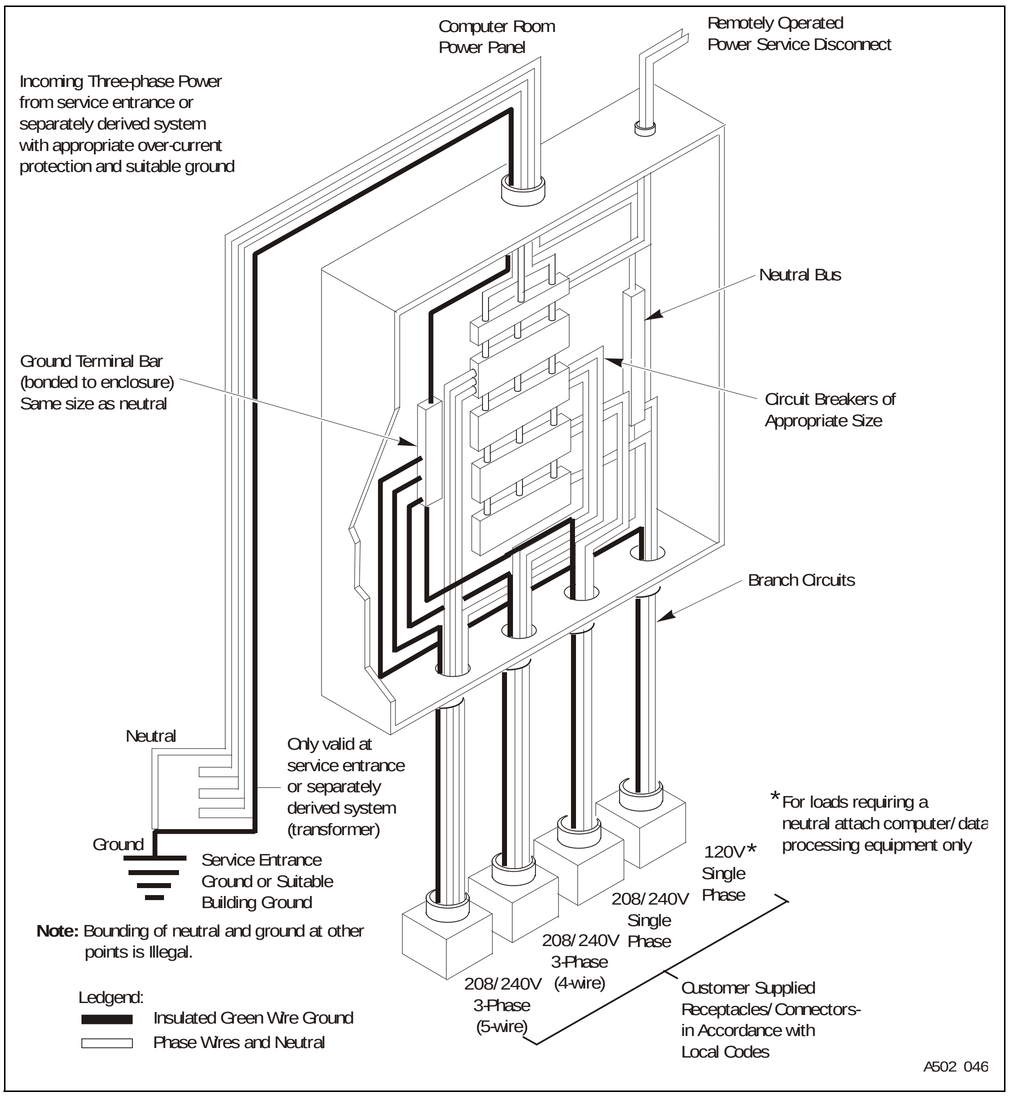


FIGURE 1-1 Site Electrical Power Distribution System

Equipment Grounding

For safety and ESD protection, VSM5 system equipment must be properly grounded. VSM5 cabinet power cables contain an insulated green/yellow grounding wire that connects the frame to the ground terminal at the AC source power outlet. A similar insulated green or green/yellow wire ground, of at least the same diameter as the phase wire, is required between the branch circuit panel and the power receptacle that attaches to each cabinet.

Source Power Input

Voltage and frequency ranges at the AC source power receptacle(s) that will supply power to VSM5 system equipment must be measured and verified to meet the specifications shown in TABLE 1-1.

TABLE 1-1 Source Power Requirements for VSM5 Equipmen

Source Power	Voltage Range	Frequency Range (Hz)
AC, single-phase, 3-wire	170-240	47-63

Dual Independent Source Power Supplies

VSM5 cabinets have a redundant power distribution architecture designed to prevent disruption of system operations from single-source power failures.

To enable this capability, the two VSM5 cabinet power-strip cables must be connected to separate, independent power sources that are unlikely to fail simultaneously (e.g., one to local utility power, the other to an uninterruptible power supply (UPS) system). Connecting both cabinet power-strip cables to the same power source will not enable this redundant power capability.

Transient Electrical Noise and Power Line Disturbances

Reliable AC source power free from interference or disturbance is required for optimum performance of VSM5 system equipment. Most utility companies provide power that can properly operate system equipment. However, equipment errors or failures can be caused when outside (radiated or conducted) transient electrical noise signals are superimposed on power provided to equipment.

Additionally, while VSM5 system equipment is designed to withstand most common types of power line disturbances with little or no effect on operations, extreme power disturbances such as lightning strikes can cause equipment power failures or errors if steps are not taken to mitigate such disturbances.

To mitigate the effects of outside electrical noise signals and power disturbances, data center source power panels should be equipped with a transient grounding plate similar to that shown in FIGURE 1-2.

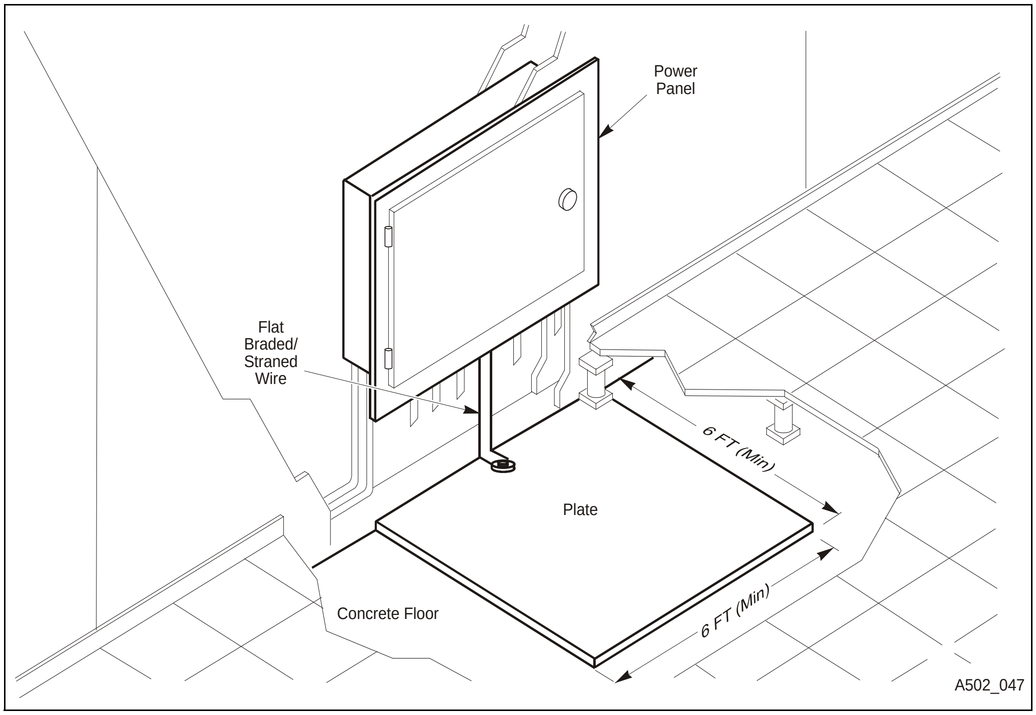


FIGURE 1-2 Transient Electrical Grounding Plate

Electrostatic Discharge

Electrostatic discharge (ESD; static electricity) is caused by movement of people, furniture, and equipment. ESD can damage circuit card components, alter information on magnetic media, and cause other equipment problems. The following steps are recommended to minimize ESD potential in the data center:

- Provide a conductive path from raised floors to ground.
- Use floor panels with nonconducting cores.
- Maintain humidity levels within recommended control parameters.
- Use grounded anti-static work mats and wrist straps to work on equipment.

HVAC Requirements

Cooling and air-handling systems must have sufficient capacity to remove heat generated by equipment and data center personnel. Raised-floor areas should have positive underfloor air pressure to facilitate airflow. If conditions change within a data center (e.g., when new equipment is added or existing equipment is rearranged), airflow checks should be done to verify sufficient airflow.

Environmental Requirements and Hazards

VSM5 system components are sensitive to corrosion, vibration, and electrical interference in enclosed environments such as data centers. Because of this sensitivity, equipment should not be located near areas where hazardous and/or corrosive materials are manufactured, used, or stored, or in areas with above-average electrical interference or vibration levels.

For best performance, equipment should be operated at nominal environmental conditions.If VSM5 system equipment must be located in or near adverse environments, additional environmental controls should be considered (and implemented where practicable) to mitigate those factors prior to installation of the equipment.

Floor Construction Requirements

VSM5 system equipment is designed for use on either raised or solid floors. Carpeted surfaces are <u>not</u> recommended since these retain dust and contribute to the buildup of potentially damaging electrostatic charges. A raised floor is preferable to a solid floor since it permits power and data cables to be located safely away from floor traffic and other potential floor-level hazards.

Floor Loading Requirements

DANGER !!

Exceeding recommended raised-floor loads can cause a floor collapse, which could result in severe injury or death, equipment damage, and infrastructure damage. It is advisable to have a structural engineer perform a floor-load analysis before beginning installation of VSM5 system equipment.

CAUTION !

When being moved, a VSM5 cabinet creates almost twice the floor load as when static. To reduce floor load and stress, and the potential for damage or injury when moving a VSM5 (e.g., during installation), consider using 19 mm/ 0.75 in. plywood on the floor along the path where the cabinet will be moved.

Flooring with an overall (superimposed) load rating of 490 kg/m^2 (100 lbs./ft^2) is recommended. If floors do not meet this rating, a site engineer or facilities manager must consult the floor manufacturer or a structural engineer to calculate actual loads and determine if the weight of a particular VSM5 system configuration can be safely supported.

When being moved from one location to another, a VSM5-VTSS system cabinet generates roughly twice the floor load as in a static state. Using 19 mm (0.75 in.) plywood along a transfer path reduces the rolling load produced by a cabinet.

Floor Loading Specifications and References

TABLE 1-2 VSM5 Floor Loading Specifications

Basic Floor Load*	Maximum Superimposed Floor Load #
730 kg/m^2 (149 lbs./ft^2)	**485 kg/m^2 (99 lbs./ft^2)**

Note –

- * Load over footprint surface area (7093.7 cm^2/1099.5 in^2) of an unpackaged VSM5 cabinet, with a maximum weight of 445 kg/982 lbs., i.e., a VSM5 with 64 array disk drives.
- # Assumes minimum Z+Z axis dimension of 185.3 cm/73.0 in. (i.e., cabinet depth 77.1 cm/30.4 in. + front service clearance of 54.1 cm/21.3 in. + rear service clearance of 54.1 cm/21.3 in.), minimum X+X axis dimension of 104.9 cm/41.2 in. (i.e., cabinet width 92.1 cm/36.3 in. + left clearance of 6.4 cm/2.5 in. + right clearance of 6.4 cm/2.5 in.).

TABLE 1-3 VSM5 Cabinet Superimposed Floor Loading Example

Total Front + Rear Service Clearance (Z+Z) / 2	Total Left + Right Side Clearance (X+X) / 2				
	7.6 cm (3.0 in.)	61.0 cm (24.0 in.)	91.4 cm (36.0 in.)	121.9 cm (48.0 in.)	152.4 cm (60.0 in.)
55.9 cm (22.0 in)	443 kg/m^2 (91 lb./ft^2)	340 k.g/m^2 (70 lb/ft^2)	308 kg/m^2 (63 lb./ft^2)	285 kg/m^2 (58 lb./ft^2)	268 kg/m^2 (55 lb./ft^2)
96.5 cm (38.0 in)	374 kg/m^2 (77 lb./ft^2)	295 k.g/m^2 (60 lb/ft^2)	270 kg/m^2 (55 lb./ft^2)	252 kg/m^2 (52 lb./ft^2)	239 kg/m^2 (49 lb./ft^2)
116.8 cm (46.0 in)	350 kg/m^2 (72 lb./ft^2)	279 kg/m^2 (57 lb./ft^2)	257 kg/m^2 (53 lb./ft^2)	241 kg/m^2 (49 lb./ft^2)	229 kg/m^2 (47 lb./ft^2)
137.2 cm (54.0 in)	331 kg/m^2 (68 lb./ft^2)	267 kg/m^2 (55 lb./ft^2)	247 kg/m^2 (51 lb./ft^2)	232 kg/m^2 (48 lb./ft^2)	222 kg/m^2 (45 lb./ft^2)
157.5 cm (62.0 in)	315 kg/m^2 (64 lb./ft^2)	256 kg/m^2 (52 lb./ft^2)	238 kg/m^2 (49 lb./ft^2)	225 kg/m^2 (46 lb./ft^2)	215 kg/m^2 (44 lb./ft^2)

Note –

- See TABLE 1-2 on page 11 for the location and load of each VSM5 cabinet support point.
- Values assume 15 lb./ft^2 (73 kg/m^2) superimposed dead load over entire area for raised floor, cables, etc., and 15 lb./ft^2 (73 kg/m^2) live load for personnel and equipment in clearance areas between units.
- Loading of adjacent floor areas must be considered when evaluating overall floor capacity.
- To evaluate floor loading for other possible configurations, consult a structural engineer.

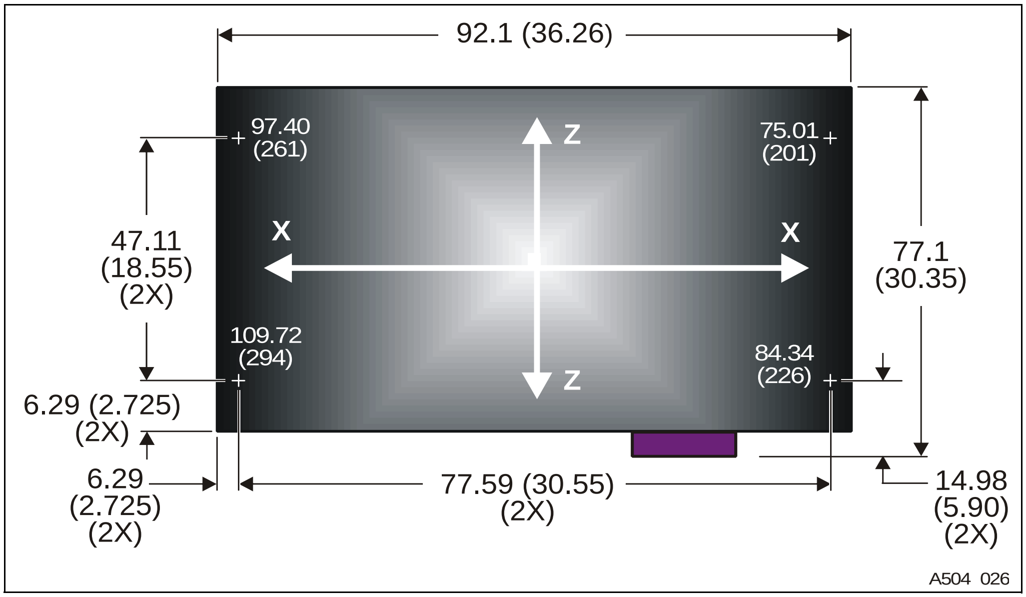


FIGURE 1-3 VSM5 Cabinet Weight Distribution and Leveler Locations

Raised-Floor Lateral Stability Ratings

In areas of high earthquake activity, the lateral stability of raised floors must be considered. Raised floors where VSM5 system equipment is installed must be able to resist the horizontal-stress levels shown in TABLE 1-4.

TABLE 1-4 Raised Flooring Horizontal Force Chart

Seismic Risk Zone	Horizontal Force (V) Applied at Top of Pedestal
1	13.5 kg / 29.7 lbs
2A	20.2 kg / 44.6 lbs
2B	26.9 kg / 59.4 lbs
3	40.4 kg / 89.1 lbs
4	53.9 kg / 118.8 lbs

Note: **Note**: Horizontal forces are based on the 1991 Uniform Building Code (UBC) Sections 2336 and 2337, and assume minimum operating clearances for multiple VSM5 cabinets. Installations in areas not covered by the UBC should be engineered to meet seismic code provisions of the local jurisdiction.

Raised-Floor Panel Ratings

Raised floor panels must be able to resist a concentrated load of 454 kg (1000 lbs.) and a rolling load of 181 kg (400 lbs.) anywhere on the panel with a maximum deflection of 2 mm (0.08 in.). Perforated floor panels are not required for VSM5 system equipment, but if used must comply with the same ratings.

Raised-Floor Pedestal Ratings

Raised floor pedestals must be able to resist an axial load of 2268 kg (5000 lbs.). Where floor panels are cut to provide service access, additional pedestals may be required to maintain the loading capacity of the floor panel.

Physical Space Requirements

Floor space and layout requirements can differ for each VSM5 system configuration. FIGURE 1-4 shows dimensions and recommended service clearances for a VSM5-VTSS cabinet. Considerations for floor space layout may include, but are not limited to: available space; required service clearances; intended equipment applications; equipment priority assignments; equipment visibility from the host console; operator convenience; cable lengths; and future expansion plans.

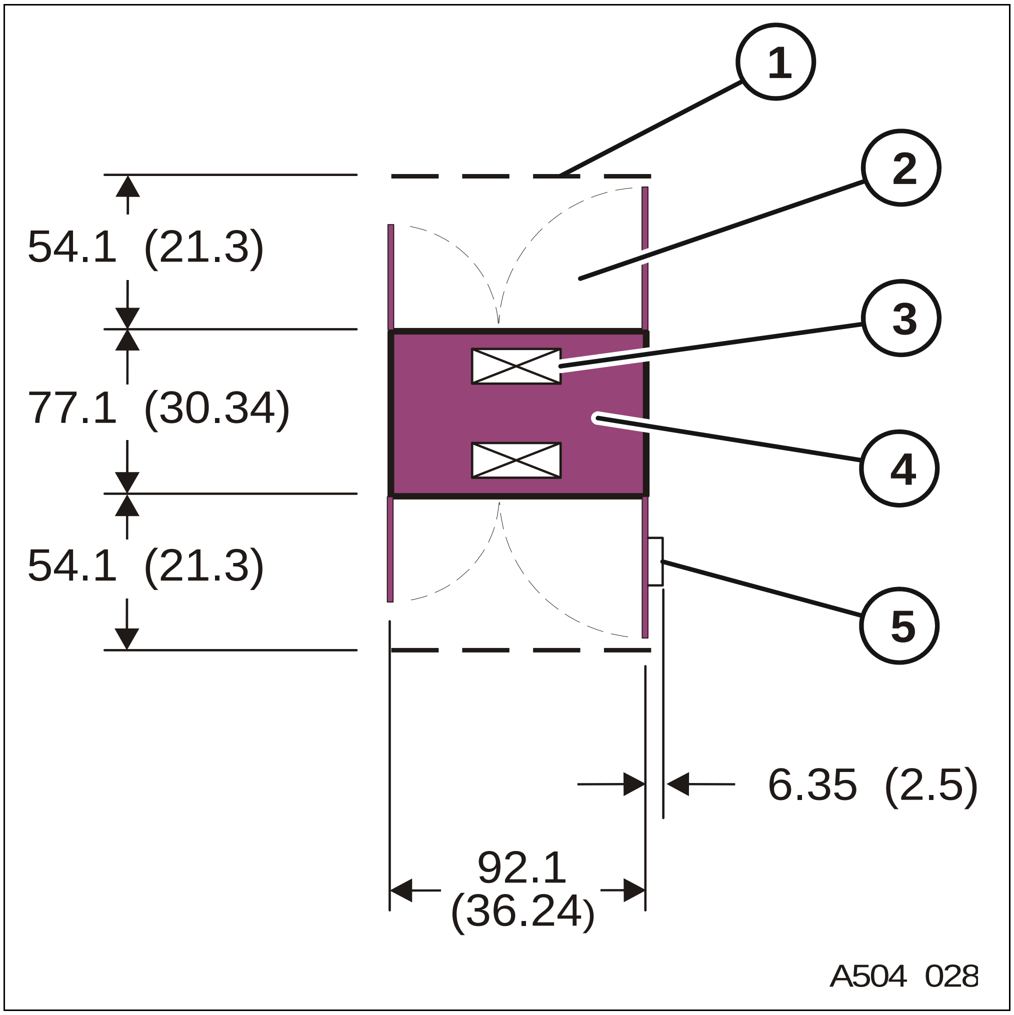


FIGURE 1-4 VSM5 Cabinet Dimensions for Physical Space Planning

Legend:

1. Boundary of recommended service access area
2. Open radius of front and rear doors (4 total)
3. Cabinet
4. Openings for entry / exit of data and power cables
5. Front cover bezel (additional 6.35 cm (2.5 inches) right-side clearance required to open door 90 degrees)

Note –

- Metric dimensions are shown first (in centimeters), followed by English dimensions (in inches).
- Front and rear doors are shown in the open position to indicated dimensions required for service access.
- The VSM5 does not require or provide side access; side covers are permanently attached and should not be removed under normal circumstances

2

VSM5 Planning

This chapter provides information about VSM5 planning topics.

Note – Contact your Oracle representative for additional assistance in planning your specific VSM5 configuration.

VSM5 Models

VSM5 Legacy Models

TABLE 2-5 VSM5-VTSS Model Numbers / Configurations / Capacities

Base Model Number	Disk Arrays Configuration	Data Drives* Total Capacity	Capacity Feature Code	PCap Capacity#	Published Effective 4:1 Capacity	Actual Effective 4:1 Capacity‡	PCap Utiliza-tion#
VSMB-465	**2 x 13 + 2 + 1 (32 drives*)**	3737.6 GB (1:1 uncompressed) --------- 14,950.4 GB (4:1 compression)	Base model	330GB	1250GB	1320GB	8.8%
			VC15	660GB	2500GB	2640GB	17.7%
			VC16	1320GB	5000GB	5280GB	35.3%
			VC21	1970GB	7500GB	7880GB	52.7%
			VC18	2890GB	11,000GB	11,560GB	77.3%
			VC19	3551GB	14,000GB	14,203GB	95.0%
VSMC-465	**3 x 13 + 2 + 1 (48 drives*)**	5606.4 GB (1:1 uncompressed) --------- 22,425.5 GB (4:1 compression)	Base model	4200GB	16,000GB	16,800GB	74.9%
			VC22	4730GB	18,000GB	18,920GB	84.4%
			VC23	5326GB	21,000GB	21,304GB	95.0%
VSMD-465	**4 x 13 + 2 + 1 (64 drives*)**	7475.2 GB (1:1 uncompressed) --------- 29,900.7 GB (4:1 compression)	Base model	6040GB	23,000GB	24,160GB	80.8%
			VC24	6570GB	25,000GB	26,280GB	87.9%
			VC25	7101GB	28,000GB	28,406GB	95.0%

Note –

- Abbreviations key: GB = gigabyte(s) (10^9 bytes); PCap = Physical Capacity Control feature
- * 32-drive configuration = 26 data drives, 4 parity drives, 2 spare drives, 30 read actuators, and 13 write actuators; 48-drive configuration = 39 data drives, 6 parity drives, 3 spare drives, 45 read actuators, and 13 write actuators; 64-drive configuration = 52 data drives, 8 parity drives, 4 spare drives, 60 read actuators, and 13 write actuators.
- # PCAP utilization is the sum of PCap capacity divided by the uncompressed capacity of all data drives in a base model. Example: Model VSMB-465 with capacity feature VC15 has a PCap capacity of 660GB and a data drive capacity of 3737.6GB (13 drives), or a 17.7% utilization rate. PCap utilization is capped to a maximum of 95% to ensure at least 5% of data drive space is available for free space collection.
- ‡ Actual effective 4:1 capacity = PCap capacity with 4:1 compression, based on number of data drives per array (13) x number of arrays (2, 3, or 4) x base capacity per drive (143.75GB).

New VSM5 Models

The VSM5 provides new models that offer the capacities shown in <Z_Xref>TABLE 2-6.

TABLE 2-6 VSM5 New Model Capacities

Drive Capacity	1-Array TBE	2-Arrays TBE	3-Arrays TBE	4-Arrays TBE	VSM Model	Product Family ID
450GB		45			VSM5-45TB-IFF3	580
450GB			68		VSM5-68TB-IFF3	580
450GB				90	VSM5-90TB-IFF3	580
146GB		7.5/11/14			VSM5-1.25TB-IFF3	567
146GB			16/18/21		VSM5-16TB-IFF3	567
146GB				23/25/28	VSM5-23TB-IFF3	567
146GB	.8/1.25				VSM5E -.8TB	567

Note –

- TBE =The approximate maximum effective capacity in Terabytes (TB).
- Models VSM5-45TB-IFF3, VSM5-68TB-IFF3, and VSM5-90TB-IFF3 require PTF L1H14UN (SES7000).

  These models can contain a maximum of 500,000 VTVs
- VSM5 new models require the following VTSS microcode:
  - **For Models VSM5-45TB-IFF3, VSM5-68TB-IFF3, and VSM5-90TB-IFF3 only**, VTSS microcode level H02.07.
  - **For all other Models**, VTSS microcode level D02.07.
  - Models VSM5-1.25TB-IFF3, VSM5-16TB-IFF3, and VSM5-23TB-IFF3 support ESCON channel cards. For more information, see "VSM5 ESCON/FICON Configurations" on page 403.

VSM5 Environmental Requirements

TABLE 2-7 VSM5 Environmental Requirements

Environmental Factor	Shipping Environment Limits*	Storage Environment Limits#	Operating Environment Limits
Temperature	-40^{o}C to +60^{o}C (-40^{o} F to +140^{o} F)	10^{o}C to 40 C (50^{o} F to 104^{o} F)	16^{o}C to 32^{o}C (60^{o} F to 90^{o} F)
Thermal Change (maximum rate/hr)	15 C (27^{o} F)	15^{o}C (27^{o} F)	5^{o}C (9^{o} F)
Humidity‡	10% to 80%	10% to 80%	20% to 80%
Altitude	0m to 15,240m (0 ft. to 50,000 ft.)	0m to 3050m (0 ft. to 10,000 ft.)	0m to 2439m (0 ft. to 8000 ft.) except in China markets where regulations may limit installations to a maximum altitude of 2km.

Note –

- Abbreviations key: C = Centigrade; F = Fahrenheit; ft. = foot / feet; m = meter(s)
- * The shipping environment must not exceed the storage environment limits longer than 10 days.
- # The storage environment must not exceed the operating environment limits longer than 60 days.
- ‡ Humidity specifications exclude conditions that may cause condensation on disk drives.

VSM5 Physical Characteristics

TABLE 2-8 VSM5 Physical Characteristics

Physical Attribute	Specification
Height	154.94cm (61.0 in.)
Width (with both side covers attached)	92.1cm (36.24 in.)
Depth (with front and rear doors attached)	77.1cm (30.34 in.)
Maximum Weight (with 64 array drives)	445kg (982 lbs.)
Footprint	7093.7cm^2 (1099.5 in^2)
Recommended Service Clearance, Front/Rear (door swing radius)	54.1cm (21.3 in.)
Recommended Left/Right Side Clearance (optional)	6.4cm (2.5 in.)

VSM5 ESCON/FICON Card Configuration Options

TABLE 2-9 and TABLE 2-10 show the ESCON/FICON Card configuration options for the VSM5E and VSM5, respectively. Each line of the tables shows a supported slot combination. For example, as shown in TABLE 2-9, a VSM5E can have either VCF (FICON) cards in Slots 00, 02, 10, and 11, or ICE (ESCON) cards in Slots 00, 02, 10, and 11.

TABLE 2-9 VSM5E Card Configuration Options

	Cluster 0				**Cluster 1**			
Card Slot	00	01	02	03	10	11	12	13
Card Type	VCF		VCF		VCF		VCF	
	ICE		ICE		ICE		ICE	

TABLE 2-10 VSM5 Card Configuration Options

	Cluster 0				**Cluster 1**			
Card Slot	00	01	02	03	10	11	12	13
Card Type	VCF		VCF		VCF		VCF	
	VCF	VCF	VCF		VCF	VCF	VCF	
	VCF	VCF	VCF	VCF	VCF	VCF	VCF	VCF
	ICE	VCF	VCF	ICE	ICE	VCF	VCF	ICE
	ICE	ICE	ICE	ICE	ICE	ICE	ICE	ICE

Planning for FICON Attachment

Prerequisites for FICON Connectivity

Note – VTCS 5.1 code or later and VTSS code D01.01.00.17 or higher are required prerequisites for enabling front-end FICON connectivity between a VTSS and mainframe (host) CPU or FICON director. VTCS 6.0 code or higher and VTSS code D01.02.00.00 or higher are required prerequisites for enabling back-end FICON connectivity between a VTSS and RTDs or cluster-links (Clinks).

In a VSM5, front-end channel transfers are never synchronized with back-end array transfers. As such, timing problems associated with channel extenders for traditional disk storage systems do not apply to the VSM5.

A VSM5 must be ordered with minimum of 4 VCF3 cards for front-end FICON connections. The field upgrade procedure is disruptive, i.e., the VSM5 must be powered down and host interfaces must be reconfigured after installing the VCF3 cards and 32-Port FICON option. Whether FICON connectivity is provided through a factory-ordered unit or a field upgrade, the 32-Port FICON option must be installed.

Prerequisites for front-end FICON connectivity to hosts and FICON directors are:

- Two VCF3 card pairs (four cards total)
- VTCS code level 5.1 or higher
- VSM5 code level D01.01.00.17 or higher.

Prerequisites for back-end FICON connectivity to real tape drives (RTDs) and cluster-links (Clinks) are:

- One or more VCF2 card pairs in place of a like number of ICE3 card pairs
- VTCS code level 6.0 or higher
- VSM5 code level D01.02.00 or higher.

Additional Prerequisites for FICON RTDs

Additional prerequisites applicable only for back-end FICON connectivity to RTDs are:

- Minimum tape drive microcode levels
  - 9840B tape drives = 1.35.304 or higher
  - 9940B tape drives = 1.35.404 or higher
  - 9940C tape drives = 1.35.504 or higher
  - T10000 tape drives = 1.35.604 or higher
- 3490 Emulation Mode – All RTDs must use 3490 Emulation Mode, which is selected at the T9X40 Emulation Mode submenu.
- Receive Buffer Frame Size – All RTDs must have their receive buffer frame size set to 2048 MB, which is selected at the T9X40 Port A/B Maximum Data Size submenu.

See Chapter 5 of the *T9X40 Service Reference Manual*, P/N 95740, for details on how to verify code levels and set the parameters listed above.

Native FICON Attachment

Native FICON attachment refers to a FICON CPU channel connected to a FICON control unit interface, which may pass through a FICON director (switch). Since the connection is all-FICON, all channels can provide the increased performance of FICON if the attached devices are capable of FICON speeds.

Figure 2-5 illustrates the two attachment modes for native FICON: direct and switched. Direct (point-to-point) attachment consists of a CPU FICON channel that connects directly to a FICON control unit interface, without any intervening directors (switches).

Switched attachment is similar to direct attachment except that the FICON path passes through a FICON switch, similar to an ESCON director. Adding a FICON director/switch provides increased flexibility and connectivity similar to what ESCON directors provide, but with the benefits and features of FICON.

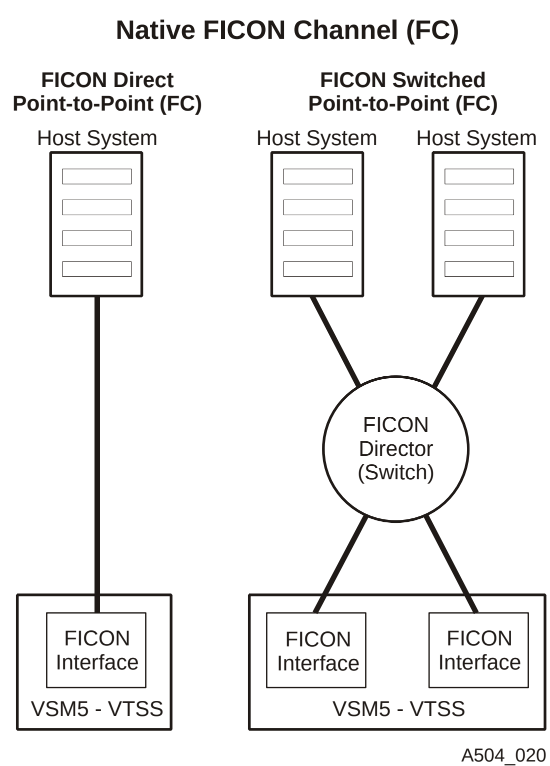


FIGURE 2-5 Native FICON Attachment Options

FICON Data Transfer Rates

The fastest native FICON channels are rated at 200 MB/sec., but actually can achieve a maximum data rate of only 170 MB/sec. under optimum conditions. In actual practice, FICON typically operates at 40-60 MB/sec. using the 32 KB block size commonly found in tape workloads.

VCF3 cards support 2 Gb link speeds; actual throughput speed is determined by many factors including block size, microcode level, etc.

FICON Cabling — Short-Wave vs. Long-Wave Connections

Currently, FICON channels send data via fiber-optic cables only; copper-wire cables are not supported. Fiber-optic data communication cables are either single-mode or multi-mode, as summarized in Table , and have these characteristics:

- Single-mode cables have a smaller core size than multi-mode, typically 8.5 or 9 microns, and use long wavelengths to transmit data over greater distances (up to 10 km; 20 km with an RPQ)[1]
- Multi-mode cables have a larger core size than single-mode cables, typically 50 or 62.5 microns, and use short wavelengths, which limits transmission range to distances less than 500 m (1640 ft.). Multi-mode cables are more economical when long transmission distances are not a requirement.

VCF2 (FICON) cards support both short- and long-wave connections through different SFP connectors, which can be intermixed on individual cards. By default, VCF2 cards ship with long-wave (LX) SFP connectors; an orderable option allows field upgrades to short-wave (SX) connections.

LC Fibre connectors are used on both short- and long-wave SFPs, which requires use of LC-LC or LC-SC cables for all VSM5-to-host connections.

TABLE 2-11 Single-Mode vs. Multi-Mode FICON Cabling

Mode Type	Core Size	Wavelength	Color	Max. Transmission Distance	Relative Cost
Single-mode (SM)	8.5 to 9 microns	Long (LX)	Yellow	10 km (6.2 mi.) 20 km (12.4 mi.) with RPQ 100 km (62 mi.) with repeaters	More
Multi-mode (MM)	50 to 62.5 microns	Short (SX)	Orange	50 micron: ≤ 500 m (1640 ft.) 62.5 micron: ≤ 175 m (574 ft.)*	Less
Note – * Requires mode-conditioner patch (MCP) cables, used in pairs. Data rates >100 MB/sec. are not supported when MCP cables are used.					

1. RPQ is not available with FICON channels rated at 200 MB/sec.

VCF3 (FICON) Card Configuration Examples

Note – VCF3 (FICON) cards must be installed and removed in pairs. A minimum VSM5 configuration requires four VCF3 cards. Cards must be removed in the reverse order they were installed. Although there is no mechanism to restrict or support which slots VCF cards are placed in, configurations other than those shown in Figure 2-6 through Figure 2-8 will not be supported.

As shown in Figure 2-6, the required minimum configuration of four VCF cards provides eight physical FICON ports, and each port supports 64 host paths (512 paths total). The first four VCF3 cards must be installed in slots VCF00, VCF02, VCF10, and VCF12.

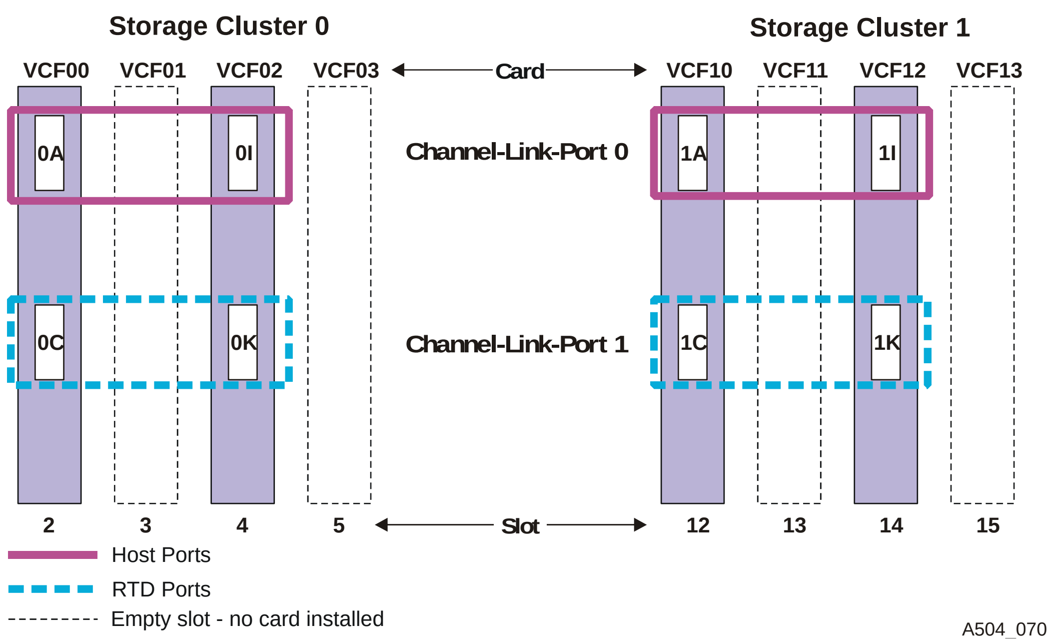


FIGURE 2-6 FICON Channel Card Configuration – 4 VCF Cards

As shown in Figure 2-7, six VCF cards provide 12 physical FICON ports, and each port supports 64 host paths (768 paths total). Cards must be installed in the slots shown (i.e., the third VCF3 card pair must be installed in slots VCF01 and VCF11).

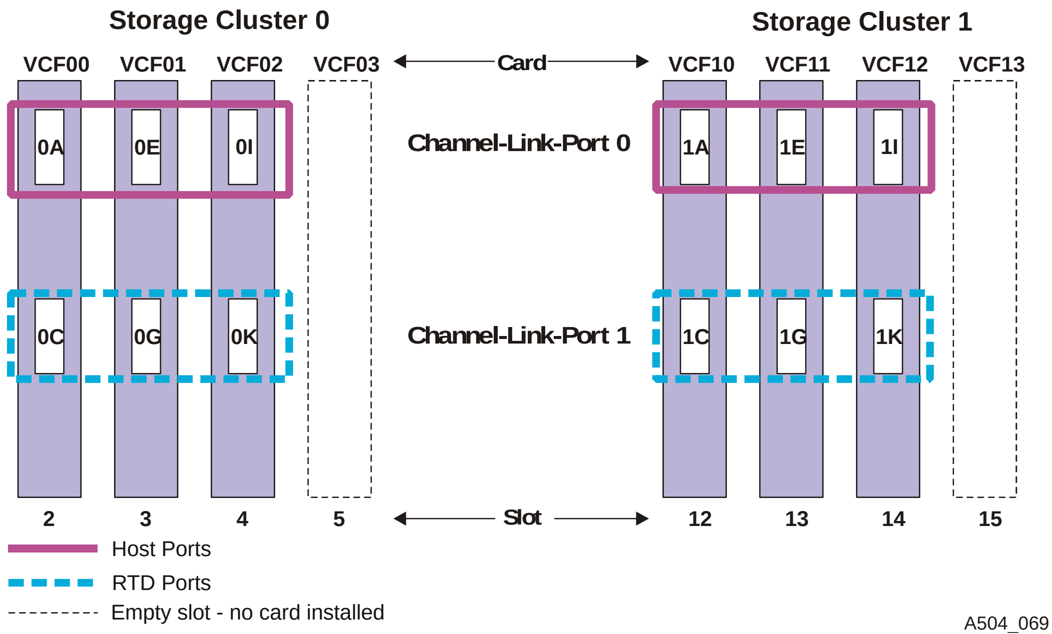


FIGURE 2-7 FICON Channel Card Configuration – 6 VCF Cards

As shown in Figure 2-8, eight VCF cards provide 16 physical FICON ports, and each port supports 64 host paths (1024 paths total). Cards must be installed in the slots shown (i.e., the third VCF3 card pair must be installed in slots VCF03 and VCF13).

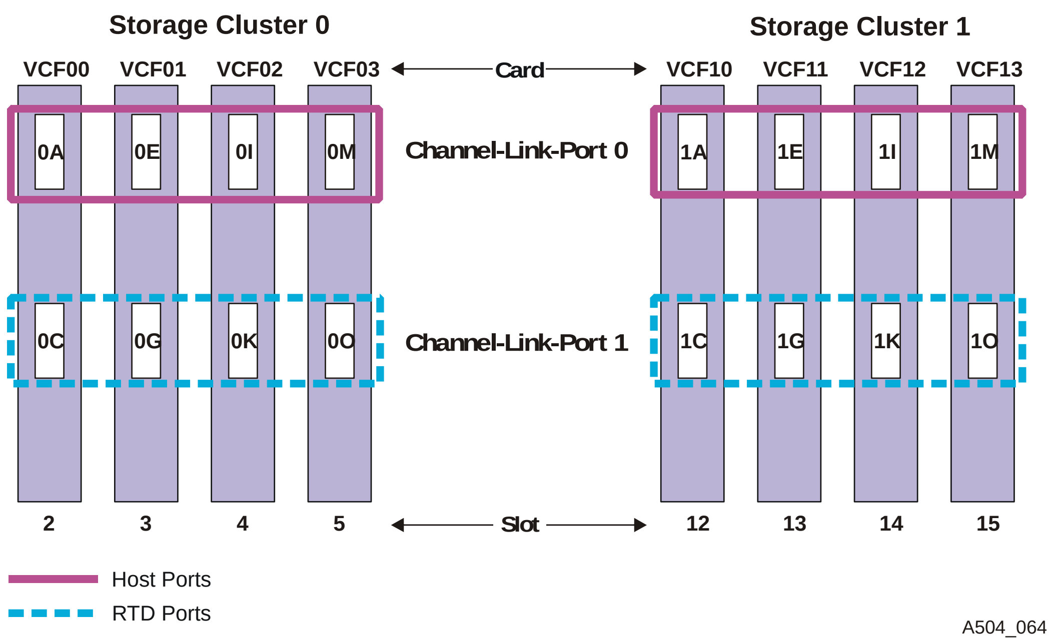


FIGURE 2-8 FICON Channel Card Configuration – 8 VCF Cards

Fibre Channel Cables — Available Lengths

TABLE 2-12 Fibre Channel Cables – Available Lengths

Description / Length	Part Number
LC-LC, 9/125, Duplex, Plenum, 10 meter (32.8 ft.), RoHS-5	10800330
LC-LC, 9/125, Duplex, Riser, 10 meter (32.8 ft.), RoHS-5	10800331
LC-LC, 9/125, Duplex, Plenum, 50 meter (164 ft.), RoHS-5	10800332
LC-LC, 9/125, Duplex, Riser, 50 meter (164 ft.), RoHS-5	10800333
LC-LC, 9/125, Duplex, Plenum, 100 meter (328 ft.), RoHS-5	10800305
LC-LC, 9/125, Duplex, Riser, 100 meter (328 ft.), RoHS-5	10800306
LC-SC, 9/125, Duplex, Plenum, 10 meter (32.8 ft.), RoHS-5	10800334
LC-SC, 9/125, Duplex, Riser, 10 meter (32.8 ft.), RoHS-5	10800335
LC-SC, 9/125, Duplex, Plenum, 50 meter (164 ft.), RoHS-5	10800336
LC-SC, 9/125, Duplex, Riser, 50 meter (164 ft.), RoHS-5	10800337
LC-SC, 9/125, Duplex, Plenum, 100 meter (328 ft.), RoHS-5	10800303
LC-SC, 9/125, Duplex, Riser, 100 meter (328 ft.), RoHS-5	10800304
SC-SC, 50/125, Duplex, Plenum, 10 meter (32.8 ft.), RoHS-5	10800294
SC-SC, 50/125, Duplex, Riser, 10 meter (32.8 ft.), RoHS-5	10800297
SC-SC, 50/125, Duplex, Plenum, 50 meter (164 ft.), RoHS-5	10800295
SC-SC, 50/125, Duplex, Riser, 50 meter (164 ft.), RoHS-5	10800298
SC-SC, 50/125, Duplex, Plenum, 100 meter (328 ft.), RoHS-5	10800296
SC-SC, 50/125, Duplex, Riser, 100 meter (328 ft.), RoHS-5	10800299

Note –

- Order plenum-rated cables for sites where cables will be routed through HVAC ductwork. Plenum cables have fire-retardant coating to prevent release of toxic gases and smoke in case of fire, so cost more than riser cables.
- Order riser cables for sites where cables will be installed in vertical riser shafts. Riser cables cannot be used in plenum areas unless specifically permitted by local codes. Riser cables provided by Oracle are compliant with the standard flame spread test requirements outlined in UL specification 1666.
- When ordering cables, add a ‘service loop’ of at least 4.6 m (15 ft.) of extra cable at each end of the measured VTSS-to-host length to allow the VTSS to be moved as needed for servicing, room reconfigurations, etc. Store extra cabling either on the floor beneath the VTSS or inside the VTSS, but not in an under-floor cable trough. If in doubt as to where locate the loop, contact the data center manager or Oracle Technical Support.

AC Source Power Specifications and Connectors

TABLE 2-13 VSM5-VTSS AC Source Power Specifications and Connectors

AC Source Power Requirement	Power Specification
Power and Frequency	Single-phase 170-240 VAC 30A @ 47-63 Hz
Heat Dissipation	4.77 minimum kBTU/hr — 7.64 maximum kBTU/hr
kVA	1.42 minimum kVA — 2.29 maximum kVA
Connector Type or Location	Connector Specification
Oracle-supplied VTSS power cables (from VTSS power strips to AC source connector)	RussellStoll RS3750DP* (North America only) No connector (all sites outside North America)
Customer-supplied wall receptacles or connector cables (from AC source connector to VTSS power strips)	RussellStoll RS 9R33u0W (rigid mount) RussellStoll RS 9C33U0 (flexible mount)

Note –

- Abbreviations key: AC = alternating current; Hz = hertz; kVA = kilovolt-amperes; V = volt(s)
- * There is no equivalent Hubbell connector.

DC Power Supply Voltage Ripple Specifications

TABLE 2-14 VSM5-VTSS DC Power Supply Voltage Ripple

DC Power Supply Type	**Output Voltage**	**Maximum Ripple (mV peak-to-peak)**
Logic Power Supply	5.1	50
Array Power Supplies	5.1 12 (logic)	50 240

Power Requirements

TABLE 2-15 VSM5-VTSS Power Requirements — Single AC Source Power Cable Operation

Number of 16-Drive Arrays	AC Source Voltage In	AC Source Amps (Current) In	kVA	kW	Power Factor	kBTUs Per Hour
2	264V	10.1A	2.7	2.5	0.95	8.6
	208V	12.4A	2.6	2.5	0.98	8.6
	180V	16.2A	2.9	2.9	0.99	9.9
3	264V	13.0A	3.4	3.3	0.95	11.1
	208V	16.0A	3.3	3.3	0.98	11.1
	180V	18.3A	3.3	3.3	0.99	11.1
4	264V	14.5A	3.8	3.6	0.95	12.4
	208V	17.8A	3.7	3.6	0.98	12.4
	180V	20.3A	3.7	3.6	0.99	12.4

Note –

- Abbreviations key: A = ampere(s); AC = alternating current; kBTUs = thousand British Thermal Units; kVA = kilovolt-amperes; kW = kilowatts

TABLE 2-16 VSM5-VTSS Power Requirements — Dual AC Source Power Cable Operation

Number of 16-Drive Arrays	AC Source Voltage In	AC Source Amps (Current) In*	kVA	kW	Power Factor	kBTUs Per Hour
2	264V	5.6A	3.0	2.8	0.95	9.6
	208V	6.9A	2.9	2.8	0.98	9.6
	180V	7.9A	2.8	2.8	0.99	9.6
3	264V	6.3A	3.3	3.1	0.95	10.7
	208V	7.7A	3.2	3.1	0.98	10.7
	180V	8.8A	3.2	3.1	0.99	10.7
4	264V	6.9A	3.7	3.5	0.95	11.9
	208V	8.5A	3.5	3.5	0.98	11.9
	180V	9.8A	3.5	3.5	0.99	11.9

Notes:

- * Values are for each line cord; multiply this value by two to obtain the total current for both line cords.
- Abbreviations key: A = ampere(s); AC = alternating current; kBTUs = thousand British Thermal Units; kVA = kilovolt-amperes; kW = kilowatts

A

FICON Channel Extension Guidelines

This appendix provides information about FICON channel extensions for the VSM system.

Note – Always consult your selected vendor's release documentation for their extension products, and guidelines for proper application of those products.

Definition of Terms

The following terms are used in this appendix:

- Front-end – any equipment between a host and a VTSS
- Back-end – any equipment between a VTSS and RTD
- Channel extension – a configuration of equipment that exceeds the maximum distance allowed by native FICON protocol, implemented by adding a pair of channel extenders.
- Channel extender – a piece of equipment that can lengthen the maximum distance allowed between two pieces of FICON-capable equipment. Channel extenders are used in pairs, usually with a WAN network between them. Some channel extenders have
FICON director/switch capabilities, and hence are also labeled as FICON switches.
- FICON director or FICON switch – a piece of equipment that is capable of acting like an electronic 'patch panel'. Directors are used to reduce the number of cables required to achieve connectivity between multiple pieces of equipment. Note that some vendors sell FICON directors/switches that also can function as channel extenders (when appropriate cards have been added).
- Cascading switches – a hardware configuration which includes at least one FICON director/switch connected to another FICON director/switch. In the IBM native FICON protocol, cascading can involve no more than two switches; however, most switch vendors allow more than two switches in a cascaded configuration.
- ISL – inter-switch sink; a link between two switches. ISLs can be channel-extended.
- Direct attach – any connection between two pieces of equipment that does not go through a FICON director/switch. The connection could, however, still include channel extenders (which are invisible to the FICON protocol).
- RTD – Real Tape Drive; a physical tape drive linked to a VTSS box, as opposed to a host. Note that if a FICON director/switch is used between the tape drive and VTSS, the drive could function as a RTD at one point in time, and as a conventional tape drive at another time; this would require varying the drive offline from VTCS and online to MVS.
- Conventional tape drive – a tape drive linked to a host, as opposed to a VTSS box. Note that if a FICON director/switch is used between the tape drive and VTSS, the drive could function as a conventional tape drive at one point in time, and as a RTD at another time; this would require varying the drive offline from MVS and online to VTCS.
- Cluster – a pair of VTSS boxes connected by one or more CLINKs. Depending on the direction of the CLINKs, a cluster can be uni-directional or bi-directional. Clustering is used to provide hardware fallback in case one of the VTSS boxes becomes inoperative. VTVs can be replicated between the two VTSS boxes in normal mode (over the CLINKs), allowing one box to take over from the other in case of an outage.

- CLINK – Cluster LINK; a connection between two VTSS boxes in a cluster. Each CLINK allows data to flow in only one direction. For bi-directional clustering, at least one CLINK in each direction must be used. A CLINK connection between two VTSS boxes can include FICON directors/switches and channel extenders.
- VTD – Virtual Tape Drive; a virtual (as opposed to physical) tape drive that exists within a VTSS, as defined by the VTCS (Virtual Tape Control System) host software. A VTD is a transport in a VTSS that emulates a physical 3490E tape drive to a MVS system. Data that are 'written' to a VTD actually are written to the disk buffer (VTSS). A VTSS has 64 VTDs that perform virtual mounts of VTVs.

General Channel Extension Considerations

Understand Channel Extension Performance Limitations

Channel extension usually involves using a WAN (wide-area network), which possibly operates at slower-than-FICON speeds. At the very least, the addition of channel extenders will cause additional overhead, and will slow down tape I/O processing.

Channel Extenders Are Invisible to Other Devices

By its nature, channel extension must look to end devices (hosts, switches, VTSSs, and/or RTDs) as if those were connected to each other without channel extenders; hence, channel extenders are invisible to FICON devices. Neither software on the host (HSC/VTCS) nor microcode in a VTSS or RTD can sense the existence of a channel extender.

Channel Extenders Can Cause Timing Problems

Since channel extenders can cause delays, adding channel extenders to a configuration that works may cause I/O timeouts or other I/O problems. If channel extenders are used for both tape and disk I/O, the disk I/O can cause further delays for tape I/O, for example.

Channel Extenders Can Insert Fake I/O Errors

Some channel extension products attempt to streamline tape I/O in various ways, including simulating responses from tape drives or VTSSs. On occasion, a channel extender will encounter a problem, which must be reported back to the issuer of the tape I/O. Since a channel extender is invisible to end devices, it has no way to report errors itself; instead, a channel extender will report a fake I/O error coming from a RTD or VTSS, when the channel extender was actually the source of the problem. These types of errors can be very difficult to diagnose, and may require personnel from multiple vendors for resolution.

Avoid RECLAIMs and DRAINs on Channel-Extended RTDs

Most current channel extension products will attempt to streamline tape <u>write</u> I/O but not <u>read</u> I/O. This means users should avoid long operations that require large amounts of read I/O over channel extenders. There are many different back-end and front-end scenarios to consider, but one that should definitely be avoided is doing DRAIN and RECLAIM operations over channel extenders. DRAINs and RECLAIMs tend to perform many tape read I/Os on input MVC cartridges (as well as tape wirtes to output MVC cartridges).

Avoid RECALLs on Channel-Extended RTDs

Most current channel extension products will attempt to streamline tape <u>write</u> I/O but not <u>read</u> I/O. This means users should avoid long operations that require large amounts of read I/O over channel extenders. RECALL operations cause data to be copied from a MVC cartridge mounted on a RTD back into a VTSS box. If the path between a VTSS and RTD includes channel extenders, such a recall may be very slow. Automatic recalls (which are triggered by a job on the mainframe needing data not available in a VTSS) especially can hold up critical work on the mainframe.

Avoid Syncsort Apps That Use Long Chains on Channel-Extended VTDs

Some Syncsort applications that use long chains (specifically when using sort work files allocated to virtual tape) will not run when using channel extenders between the host and the VTSS (i.e., a remote VTSS), due to protocol timeouts that can occur from WAN delays. The application should be evaluated, and dedicated conventional tape drives should be considered for Syncsort applications. If VSM is required, consider running the Syncsort application on local VTSS, rather than a remote (channel-extended) VTSS. Alternatively, if possible, the best option is to configure shorter chains.

FICON Topologies

See "Placement of Extension Equipment" below to determine proper placement of extension equipment for the following FICON topologies:

1. Host-to-VTSS (front-end link to VTDs)
   a. direct-attach connection
   b. single FICON director/switch connection
   c. cascaded directors/switches connection
2. VTSS-to-RTD (back-end link to RTDs)
   a. direct-attach connection
   b. single FICON director/switch connection
   c. cascaded directors/switches connection
3. VTSS-to-VTSS (CLINKs)
   a. direct-attach connection
   b. single FICON director/switch connection
   c. cascaded directors/switches connection
4. Host-to-conventional tape drive (no VTSS nor VSM involved)
   a. direct-attach connection
   b. single FICON director/switch connection
   c. cascaded directors/switches connection

Placement of Extension Equipment

VSM allows many different ways of connecting hosts with VTSS boxes and RTDs, with or without FICON directors/switches. The number of combinatons and permutations is too large to list here. Use the sample configurations shown on the following pages as a guideline for where to place channel extension equipment.

Interoperability Testing

Supported directors and configurations for VSM5 systems with channel extensions are listed in the Interop Tool on the Sun Sales Support website at https://extranet.stortek.com/interop/interop.

The Interop Tool provides connectivity information for all currently supported products sold through Sun, regardless of whether the product is Sun branded or third-party branded. While the tool does validate compatibility, it does not validate the final configuration, the system, or whether the configuration will perform in the end user’s environment. Consult with Sun support personnel to validate all configurations before ordering equipment.

FICON Channel Extension – Sample Configurations

FIGURE A-9 Host-to-VTSS Channel Extension – Direct Attachment

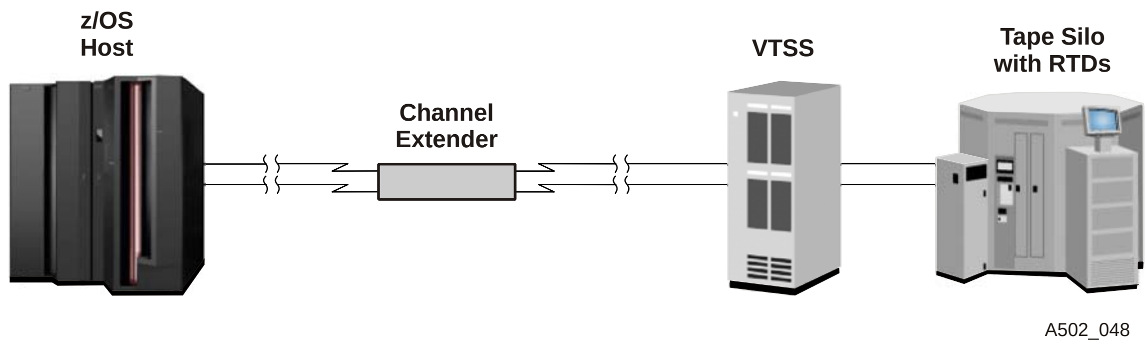


FIGURE A-10 Host-to-VTSS Channel Extension – Behind Single FICON Switch / Director

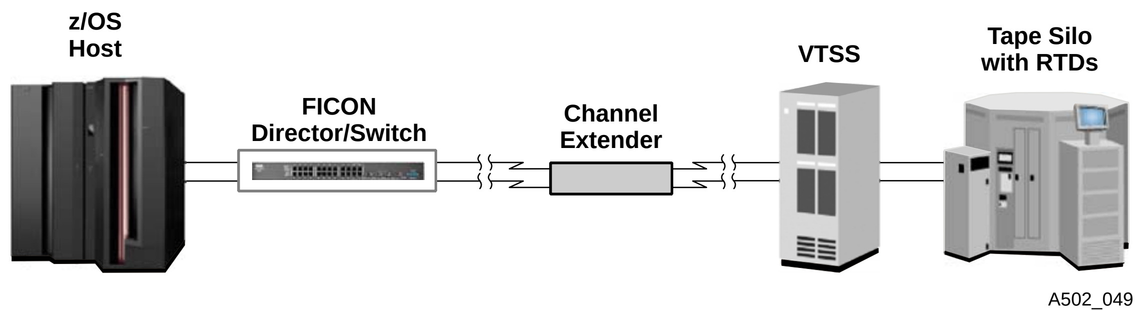


FIGURE A-11 Host-to-VTSS Channel Extension – Between Cascaded FICON Switches / Directors

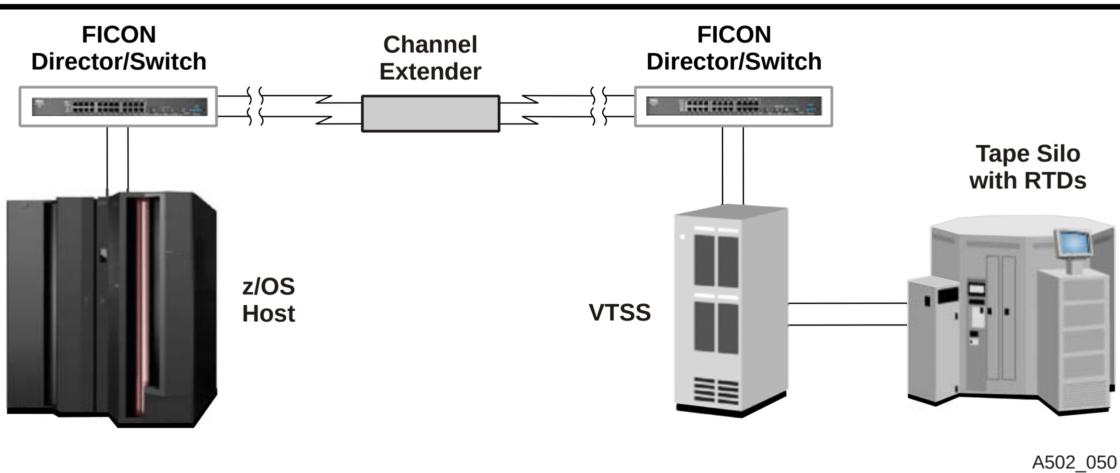


FIGURE A-12 VTSS-to-RTD Channel Extension – Direct Attachment

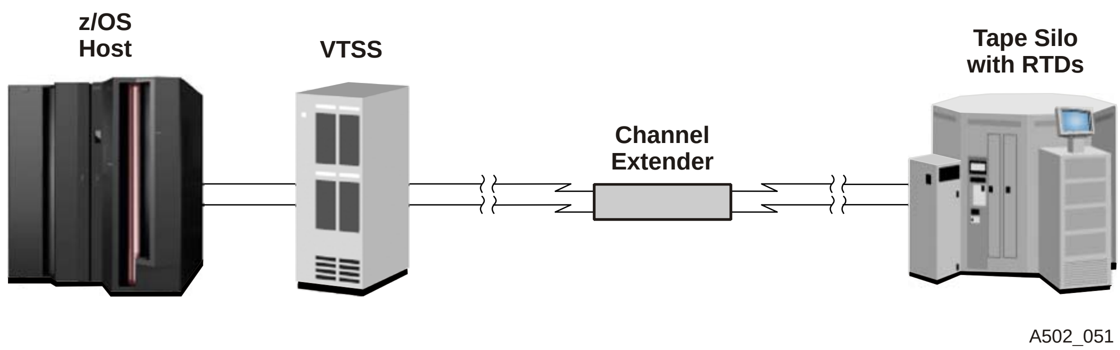


FIGURE A-13 VTSS-to-RTD Channel Extension – Between Cascaded FICON Switches / Directors

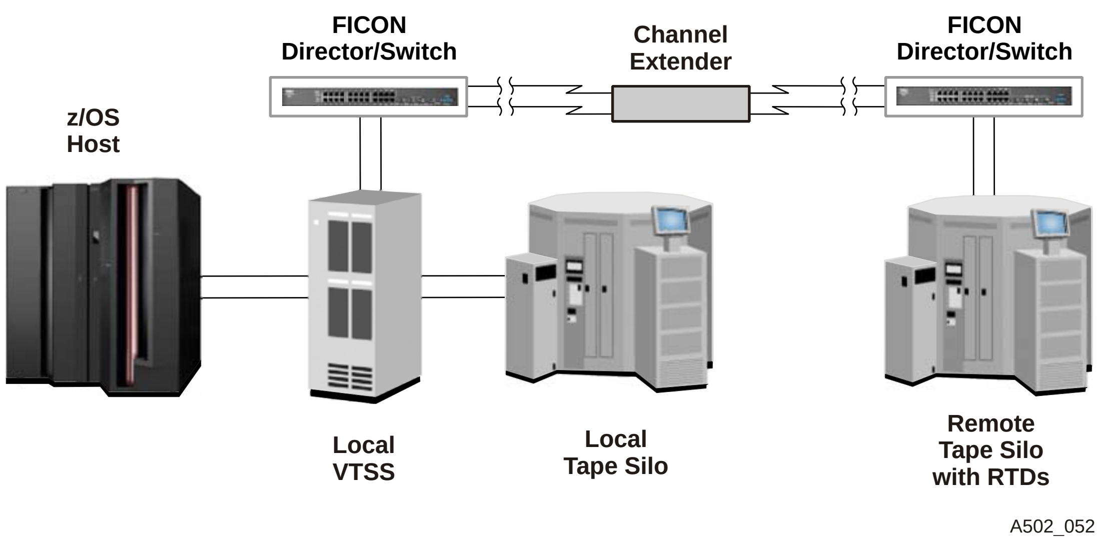
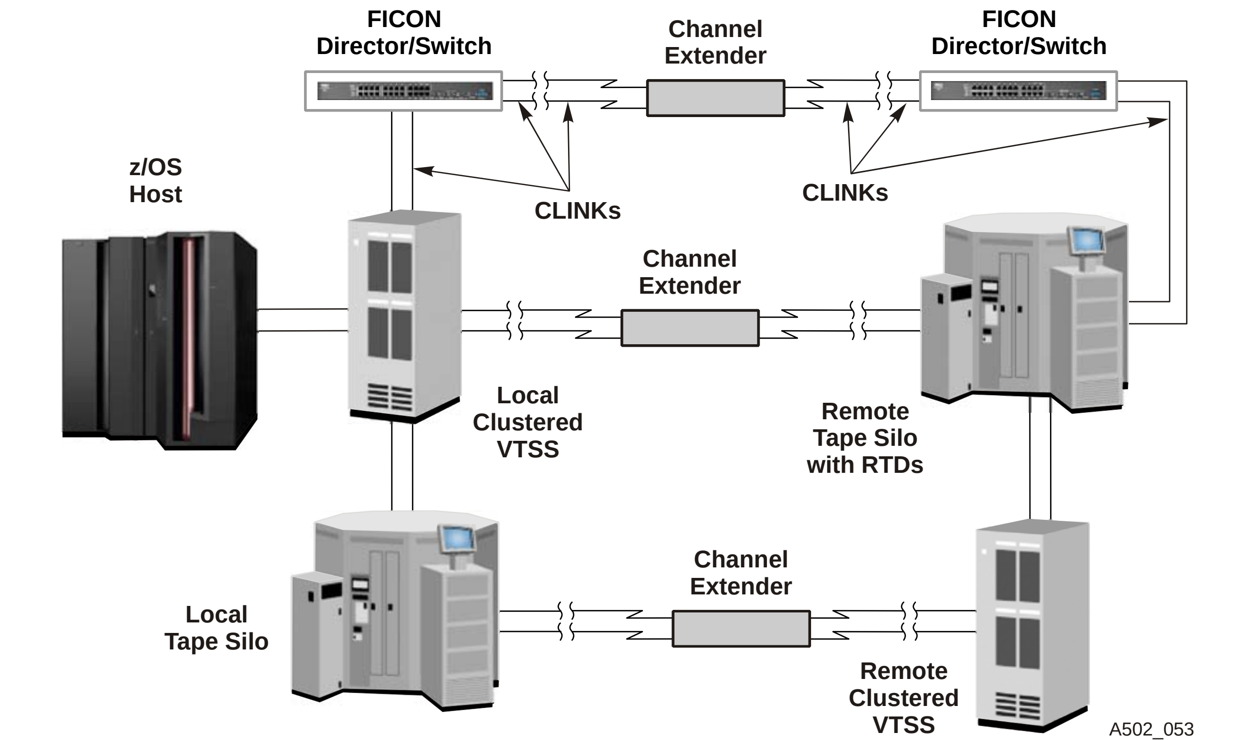


FIGURE A-14 VTSS-to-VTSS Channel Extension – Between Cascaded FICON Switches / Directors



McData/CNT Channel Extension Interoperability

The following interoperability and configuration information and guidelines apply when using McData/CNT USD-X and Edge3000 channel extenders with a VSM-VTSS.

Set Buffer-to-Buffer Credits at Director Ports

In FICON fabric topology, configure buffer-to-buffer (BB) credits on all director ports that are part of all channel-extended end-to-end paths to 'extended distance', i.e., ≥ 60 BB credits. This includes host ports, CU ports, and ISL[2] ports that carry I/O on a channel-extended path, regardless of which link is physically extended. For example, consider a single director configuration with three CHPIDs configured to perform I/O with two CU ports, where one CU port is channel-extended. In this case, four director ports should have their BB credits set to 'extended distance': Each of the three F_Ports attached to the three hosts, and the F_Port attached to the extension equipment that extends to the CU port.

Set Extension-Attached Director Ports to Fixed Speeds

When channel extension is added to a FICON link, the result is two FICON links which are coupled by the two channel extension chassis through a WAN. The link speed setting on at least one side of the pair of FICON links must be set to a fixed speed to avoid exposure to an issue where the link may not initialize once a fibre/SFP[3] cable is attached, or where the link may not reinitialize after a loss of synchronization during operations.

The FICON directors on the supported list provide a port configuration option for link speed. The VSM port runs in auto-speed mode (currently unconfigurable). The recommendation is to set all FICON director ports attached to extension equipment to a fixed speed, and to set the attached extension ports to a fixed speed, as follows:

- Set the FICON director port to '1Gbps-ONLY' for attachment to the USD-X channel extender. Also set the speed of the attached USDX port to '1Gbps-ONLY'.
- Set the FICON director port to '2Gbps-ONLY' for attachment to the Edge3000 channel extender. Also set the speed of the attached Edge3000 port to '2Gbps-Only'.

> **Note –** Setting the FICON director port to '1Gbps-ONLY' for the Edge3000 channel extender attachment is also valid when the WAN link in 1Gbps Ethernet. In this configuration, also set the attached Edge3000 port to '1Gbps-ONLY'.

Set Extension Ports to Fixed Speeds When Extending a VTSS-to-VTSS Channel Link (CLINK) or a VTSS-to-RTD Link

When channel extension is added to a FICON link, the result is two FICON links which are coupled by the two channel extension chassis through a WAN. The link speed setting on at least one side of the pair of FICON links must be set to a fixed speed to avoid

2. Inter-switch link; the fibre channel link providing connectivity between two switches
3. Short form factor pluggable connectors

exposure to an issue where the link may not initialize once a fibre/SFP cable is attached, or where the link may not reinitialize after a loss of synchronization during operations.

McData channel extension equipment on the supported list provides a port configuration option for link speed, which defaults to auto-speed. McData service personnel may perform this configuration change to a fixed speed.

The recommendation is to set a least one attached extension port per extended link to a fixed speed, as follows:

- Set the speed of the attached USD-X chanel extender port to '1Gbps-Only'.
- Set the speed of the attached Edge3000 channel extender port to '2Gbps-Only'.

> **Note –** Setting the attached Edge3000 port to '1Gbps-Only' is also valid when the WAN link in 1Gbps Ethernet.

ISL Failover Is Supported Only in Shuttle Mode

McData does not support ISL failover when the extension equipment is configured for FICON emulation. If extension equipment is configured in FICON shuttle mode, then ISL failover can be used. Due to distance limitations, shuttle mode is seldom used.

Avoiding Host Protocol Timeouts

Host protocol timeouts may occur due to WAN delays that increase the time for the VTSS to process multiple outstanding 'CU busy' signals. To avoid these timeouts:

- Vary on no more than 16 devices over a channel-extended path to a single VTSS port
- Configure the USD-X or Edge3000 channel extender to support 32 simultaneous emulations by setting the number of emulation control blocks (ECBs) to 32.

Performance Considerations

Consult McData recommendations regarding performance considerations and modes of operation (i.e., emulation versus shuttle). McData channel extenders emulate write commands, and use shuttle mode (WAN 'pass-through') for read commands. When planning for channel extension, consider the job mix (specifically, the read workload) in combination with performance requirements, as performance may be significantly affected with the shuttle mode over certain distances.

Cisco Systems Channel Extension Interoperability

The following interoperability and configuration information and guidelines apply when using Cisco Systems channel extension equipment with a VSM-VTSS.

Note – This qualification is for distances up to 200km without any performance penalty. Cisco is planning a performance improvement beyond the current 200km limit, which will be tested by Sun once that code level is delivered. No timeline has been established for completion of the >200km distance qualification.

Note – These guidelines apply to VSM4-VTSS models VSMA-734, VSMB-734, VSMC-734, and VSMD-734. Tests are pending to ensure the guidelines are applicable for model VSME-734 (VSM4 ‘lite’), and for VSM5-VTSS models VSMB-465, VSMC-465, and VSMD-465.

- Supported Cisco channel extenders:
  - MDS 9506 (up to 200km)
  - MDS 9509 (up to 200km)
- Mandatory code base levels:
  - MDS 9506/9509 – 2.1.2b
  - VSM4 – D01.02.02.04 or higher

Customers should consult fabric vendor guidelines and DWDM[4] vendor guidelines to assure valid configurations (i.e., distances, fibre and SFP cable types, settings, etc.).

4. Dense wavelength division multiplexer, e.g. the McData FSP 2000

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B

Controlling Contaminants

Environmental Contaminants

Control over contaminant levels in a computer room is extremely important because tape libraries, tape drives, and tape media are subject to damage from airborne particulates. Most particles smaller than ten microns are not visible to the naked eye under most conditions, but these particles can be the most damaging. As a result, the operating environment must adhere to the following requirements:

- ISO 14644-1 Class 8 Environment.
- The total mass of airborne particulates must be less than or equal to 200 micrograms per cubic meter.
- Severity level G1 per ANSI/ISA 71.04-1985.

Oracle currently requires the ISO 14644-1 standard approved in 1999, but will require any updated standards for ISO 14644-1 as they are approved by the ISO governing body. The ISO 14644-1 standard primarily focuses on the quantity and size of particulates as well as the proper measurement methodology, but does not address the overall mass of the particulates. As a result, the requirement for total mass limitations is also necessary as a computer room or data center could meet the ISO 14644-1 specification, but still damage equipment because of the specific type of particulates in the room. In addition, the ANSI/ISA 71.04-1985 specification addresses gaseous contaminations as some airborne chemicals are more hazardous. All three requirements are consistent with the requirements set by other major tape storage vendors.

Required Air Quality Levels

Particles, gasses and other contaminants may impact the sustained operations of computer hardware. Effects can range from intermittent interference to actual component failures. The computer room must be designed to achieve a high level of cleanliness. Airborne dusts, gasses and vapors must be maintained within defined limits to help minimize their potential impact on the hardware.

Airborne particulate levels must be maintained within the limits of *ISO 14644-1 Class 8 Environment*. This standard defines air quality classes for clean zones based on airborne particulate concentrations. This standard has an order of magnitude less particles than standard air in an office environment. Particles ten microns or smaller are harmful to most data processing hardware because they tend to exist in large numbers, and can easily circumvent many sensitive components' internal air filtration systems. When computer hardware is exposed to these submicron particles in great numbers they endanger system reliability by posing a threat to moving parts, sensitive contacts and component corrosion.

Excessive concentrations of certain gasses can also accelerate corrosion and cause failure in electronic components. Gaseous contaminants are a particular concern in a computer room both because of the sensitivity of the hardware, and because a proper computer room environment is almost entirely recirculating. Any contaminant threat in the room is compounded by the cyclical nature of the airflow patterns. Levels of exposure that might not be concerning in a well ventilated site repeatedly attack the hardware in a room with recirculating air. The isolation that prevents exposure of the computer room environment to outside influences can also multiply any detrimental influences left unaddressed in the room.

Gasses that are particularly dangerous to electronic components include chlorine compounds, ammonia and its derivatives, oxides of sulfur and petrol hydrocarbons. In the absence of appropriate hardware exposure limits, health exposure limits must be used.

While the following sections will describe some best practices for maintaining an ISO 14644-1 Class 8 Environment in detail, there are some basic precautions that must be adhered to:

- Do not allow food or drink into the area.
- Cardboard, wood, or packing materials must not be stored in the data center clean area.
- Identify a separate area for unpacking new equipment from crates and boxes.
- Do not allow construction or drilling in the data center without first isolating sensitive equipment and any air targeted specifically for the equipment. Construction generates a high level of particulates that exceed ISO 14644-1 Class 8 criteria in a localized area. Dry wall and gypsum are especially damaging to storage equipment.

Contaminant Properties and Sources

Contaminants in the room can take many forms, and can come from numerous sources. Any mechanical process in the room can produce dangerous contaminants or agitate settled contaminants. A particle must meet two basic criteria to be considered a contaminant:

- It must have the physical properties that could potentially cause damage to the hardware.
- It must be able to migrate to areas where it can cause the physical damage.

The only differences between a potential contaminant and an actual contaminant are time and location. Particulate matter is most likely to migrate to areas where it can do damage if it is airborne. For this reason, airborne particulate concentration is a useful measurement in determining the quality of the computer room environment. Depending on local conditions, particles as big as 1,000 microns can become airborne, but their active life is very short, and they are arrested by most filtration devices.

Submicron particulates are much more dangerous to sensitive computer hardware, because they remain airborne for a much longer period of time, and they are more apt to bypass filters.

Operator Activity

Human movement within the computer space is probably the single greatest source of contamination in an otherwise clean computer room. Normal movement can dislodge tissue fragments, such as dander or hair, or fabric fibers from clothing. The opening and closing of drawers or hardware panels or any metal-on-metal activity can produce metal filings. Simply walking across the floor can agitate settled contamination making it airborne and potentially dangerous.

Hardware Movement

Hardware installation or reconfiguration involves a great deal of subfloor activity, and settled contaminants can very easily be disturbed, forcing them to become airborne in the supply air stream to the room's hardware. This is particularly dangerous if the subfloor deck is unsealed. Unsealed concrete sheds fine dust particles into the airstream, and is susceptible to efflorescence -- mineral salts brought to the surface of the deck through evaporation or hydrostatic pressure.

Outside Air

Inadequately filtered air from outside the controlled environment can introduce innumerable contaminants. Post-filtration contamination in duct work can be dislodged by air flow, and introduced into the hardware environment. This is particularly important in a downward-flow air conditioning system in which the sub-floor void is used as a supply air duct. If the structural deck is contaminated, or if the concrete slab is not sealed, fine particulate matter (such as concrete dust or efflorescence) can be carried directly to the room's hardware.

Stored Items

Storage and handling of unused hardware or supplies can also be a source of contamination. Corrugated cardboard boxes or wooden skids shed fibers when moved or handled. Stored items are not only contamination sources; their handling in the computer room controlled areas can agitate settled contamination already in the room.

Outside Influences

A negatively pressurized environment can allow contaminants from adjoining office areas or the exterior of the building to infiltrate the computer room environment through gaps in the doors or penetrations in the walls. Ammonia and phosphates are often associated with agricultural processes, and numerous chemical agents can be produced in manufacturing areas. If such industries are present in the vicinity of the data center facility, chemical filtration may be necessary. Potential impact from automobile emissions, dusts from local quarries or masonry fabrication facilities or sea mists should also be assessed if relevant.

Cleaning Activity

Inappropriate cleaning practices can also degrade the environment. Many chemicals used in normal or "office" cleaning applications can damage sensitive computer equipment. Potentially hazardous chemicals outlined in the "Cleaning Procedures and Equipment" section should be avoided. Out-gassing from these products or direct contact with hardware components can cause failure. Certain biocide treatments used in building air handlers are also inappropriate for use in computer rooms either because they contain chemicals, that can degrade components, or because they are not designed to be used in the airstream of a re-circulating air system. The use of push mops or inadequately filtered vacuums can also stimulate contamination.

It is essential that steps be taken to prevent air contaminants, such as metal particles, atmospheric dust, solvent vapors, corrosive gasses, soot, airborne fibers or salts from entering or being generated within the computer room environment. In the absence of hardware exposure limits, applicable human exposure limits from OSHA, NIOSH or the ACGIH should be used.

Contaminant Effects

Destructive interactions between airborne particulate and electronic instrumentation can occur in numerous ways. The means of interference depends on the time and location of the critical incident, the physical properties of the contaminant and the environment in which the component is placed.

Physical Interference

Hard particles with a tensile strength at least 10% greater than that of the component material can remove material from the surface of the component by grinding action or embedding. Soft particles will not damage the surface of the component, but can collect in patches that can interfere with proper functioning. If these particles are tacky they can collect other particulate matter. Even very small particles can have an impact if they collect on a tacky surface, or agglomerate as the result of electrostatic charge build-up.

Corrosive Failure

Corrosive failure or contact intermittence due to the intrinsic composition of the particles or due to absorption of water vapor and gaseous contaminants by the particles can also cause failures. The chemical composition of the contaminant can be very important. Salts, for instance, can grow in size by absorbing water vapor from the air (nucleating). If a mineral salts deposit exists in a sensitive location, and the environment is sufficiently moist, it can grow to a size where it can physically interfere with a mechanism, or can cause damage by forming salt solutions.

Shorts

Conductive pathways can arise through the accumulation of particles on circuit boards or other components. Many types of particulate are not inherently conductive, but can absorb significant quantities of water in high-moisture environments. Problems caused by electrically conductive particles can range from intermittent malfunctioning to actual damage to components and operational failures.

Thermal Failure

Premature clogging of filtered devices will cause a restriction in air flow that could induce internal overheating and head crashes. Heavy layers of accumulated dust on hardware components can also form an insulative layer that can lead to heat-related failures.

Room Conditions

All surfaces within the controlled zone of the data center should be maintained at a high level of cleanliness. All surfaces should be periodically cleaned by trained professionals on a regular basis, as outlined in the "Cleaning Procedures and Equipment" section. Particular attention should be paid to the areas beneath the hardware, and the access floor grid. Contaminants near the air intakes of the hardware can more easily be transferred to areas where they can do damage. Particulate accumulations on the access floor grid can be forced airborne when floor tiles are lifted to gain access to the sub-floor.

The subfloor void in a downward-flow air conditioning system acts as the supply air plenum. This area is pressurized by the air conditioners, and the conditioned air is then introduced into the hardware spaces through perforated floor panels. Thus, all air traveling from the air conditioners to the hardware must first pass through the subfloor void. Inappropriate conditions in the supply air plenum can have a dramatic effect on conditions in the hardware areas.

The subfloor void in a data center is often viewed solely as a convenient place to run cables and pipes. It is important to remember that this is also a duct, and that conditions below the false floor must be maintained at a high level of cleanliness. Contaminant sources can include degrading building materials, operator activity or infiltration from outside the controlled zone. Often particulate deposits are formed where cables or other subfloor items form air dams that allow particulate to settle and accumulate. When these items are moved, the particulate is re-introduced into the supply airstream, where it can be carried directly to hardware.

Damaged or inappropriately protected building materials are often sources of subfloor contamination. Unprotected concrete, masonry block, plaster or gypsum wall-board will deteriorate over time, shedding fine particulate into the air. Corrosion on post-filtration air conditioner surfaces or subfloor items can also be a concern. The subfloor void must be thoroughly and appropriately decontaminated on a regular basis to address these contaminants. Only vacuums equipped with High Efficiency Particulate Air (HEPA) filtration should be used in any decontamination procedure. Inadequately filtered vacuums will not arrest fine particles, passing them through the unit at high speeds, and forcing them airborne.

Unsealed concrete, masonry or other similar materials are subject to continued degradation. The sealants and hardeners normally used during construction are often designed to protect the deck against heavy traffic, or to prepare the deck for the application of flooring materials, and are not meant for the interior surfaces of a supply air plenum. While regular decontaminations will help address loose particulate, the surfaces will still be subject to deterioration over time, or as subfloor activity causes wear. Ideally all of the subfloor surfaces will be appropriately sealed at the time of construction. If this is not the case, special precautions will be necessary to address the surfaces in an on-line room.

It is extremely important that only appropriate materials and methodology are used in the encapsulation process. Inappropriate sealants or procedures can actually degrade the conditions they are meant to improve, impacting hardware operations and reliability. The following precautions should be taken when encapsulating the supply air plenum in an on-line room:

- Manually apply the encapsulant. Spray applications are totally inappropriate in an on-line data center. The spraying process forces the sealant airborne in the supply airstream, and is more likely to encapsulate cables to the deck.
- Use a pigmented encapsulant. The pigmentation makes the encapsulant visible in application, ensuring thorough coverage, and helps in identifying areas that are damaged or exposed over time.
- It must have a high flexibility and low porosity to effectively cover the irregular textures of the subject area, and to minimize moisture migration and water damage.
- The encapsulant must not out-gas any harmful contaminants. Many encapsulants commonly used in industry are highly ammoniated or contain other chemicals that can be harmful to hardware. It is very unlikely that this out-gassing could cause immediate, catastrophic failure, but these chemicals will often contribute to corrosion of contacts, heads or other components.

Effectively encapsulating a subfloor deck in an on-line computer room is a very sensitive and difficult task, but it can be conducted safely if appropriate procedures and materials are used. Avoid using the ceiling void as an open supply or return for the building air system. This area is typically very dirty and difficult to clean. Often the structural surfaces are coated with fibrous fire-proofing, and the ceiling tiles and insulation are also subject to shedding. Even before filtration, this is an unnecessary exposure that can adversely affect environmental conditions in the room. It is also important that the ceiling void does not become pressurized, as this will force dirty air into the computer room. Columns or cable chases with penetrations in both the subfloor and ceiling void can lead to ceiling void pressurization.

Exposure Points

All potential exposure points in the data center should be addressed to minimize potential influences from outside the controlled zone. Positive pressurization of the computer rooms will help limit contaminant infiltration, but it is also important to minimize any breaches in the room perimeter. To ensure the environment is maintained correctly, the following should be considered:

- All doors should fit snugly in their frames.
- Gaskets and sweeps can be used to address any gaps.

- Automatic doors should be avoided in areas where they can be accidentally triggered. An alternate means of control would be to remotely locate a door trigger so that personnel pushing carts can open the doors easily. In highly sensitive areas, or where the data center is exposed to undesirable conditions, it may be advisable to design and install personnel traps. Double sets of doors with a buffer between can help limit direct exposure to outside conditions.
- Seal all penetrations between the data center and adjacent areas.
- Avoid sharing a computer room ceiling or subfloor plenum with loosely controlled adjacent areas.

Filtration

Filtration is an effective means of addressing airborne particulate in a controlled environment. It is important that all air handlers serving the data center are adequately filtered to ensure appropriate conditions are maintained within the room. In-room process cooling is the recommended method of controlling the room environment. The in-room process coolers re-circulate room air. Air from the hardware areas is passed through the units where it is filtered and cooled, and then introduced into the subfloor plenum. The plenum is pressurized, and the conditioned air is forced into the room, through perforated tiles, which then travels back to the air conditioner for reconditioning. The airflow patterns and design associated with a typical computer room air handler have a much higher rate of air change than typical comfort cooling air conditioners so air is filtered much more often than in an office environment. Proper filtration can capture a great deal of particulates. The filters installed in the in-room, re-circulating air conditioners should have a minimum efficiency of 40% (Atmospheric Dust-Spot Efficiency, ASHRAE Standard 52.1). Low-grade pre-filters should be installed to help prolong the life of the more expensive primary filters.

Any air being introduced into the computer room controlled zone, for ventilation or positive pressurization, should first pass through high efficiency filtration. Ideally, air from sources outside the building should be filtered using High Efficiency Particulate Air (HEPA) filtration rated at 99.97% efficiency (DOP Efficiency MILSTD-282) or greater. The expensive high efficiency filters should be protected by multiple layers of pre-filters that are changed on a more frequent basis. Low-grade pre-filters, 20% ASHRAE atmospheric dust-spot efficiency, should be the primary line of defense. The next filter bank should consist of pleated or bag type filters with efficiencies between 60% and 80% ASHRAE atmospheric dust-spot efficiency.

ASHRAE 52-76	**Fractional Efficiencies %**		
Dust spot efficiency %	**3.0 micron**	**1.0 micron**	**0.3 micron**
25-30	80	20	<5
60-65	93	50	20
80-85	99	90	50
90	>99	92	60
DOP 95	--	>99	95

Low efficiency filters are almost totally ineffective at removing sub-micron particulates from the air. It is also important that the filters used are properly sized for the air handlers. Gaps around the filter panels can allow air to bypass the filter as it passes through the air conditioner. Any gaps or openings should be filled using appropriate materials, such as stainless steel panels or custom filter assemblies.

Positive Pressurization and Ventilation

A designed introduction of air from outside the computer room system will be necessary in order to accommodate positive pressurization and ventilation requirements. The data center should be designed to achieve positive pressurization in relation to more loosely controlled surrounding areas. Positive pressurization of the more sensitive areas is an effective means of controlling contaminant infiltration through any minor breaches in the room perimeter. Positive pressure systems are designed to apply outward air forces to doorways and other access points within the data processing center in order to minimize contaminant infiltration of the computer room. Only a minimal amount of air should be introduced into the controlled environment. In data centers with multiple rooms, the most sensitive areas should be the most highly pressurized. It is, however, extremely important that the air being used to positively pressurize the room does not adversely affect the environmental conditions in the room. It is essential that any air introduction from outside the computer room is adequately filtered and conditioned to ensure that it is within acceptable parameters. These parameters can be looser than the goal conditions for the room since the air introduction should be minimal. A precise determination of acceptable limits should be based on the amount of air being introduced and the potential impact on the environment of the data center.

Because a closed-loop, re-circulating air conditioning system is used in most data centers, it will be necessary to introduce a minimal amount of air to meet the ventilation requirements of the room occupants. Data center areas normally have a very low human population density; thus the air required for ventilation will be minimal. In most cases, the air needed to achieve positive pressurization will likely exceed that needed to accommodate the room occupants. Normally, outside air quantities of less than 5% make-up air should be sufficient (ASHRAE Handbook: Applications, Chapter 17). A volume of 15 CFM outside air per occupant or workstation should sufficiently accommodate the ventilation needs of the room.

Cleaning Procedures and Equipment

Even a perfectly designed data center requires continued maintenance. Data centers containing design flaws or compromises may require extensive efforts to maintain conditions within desired limits. Hardware performance is an important factor contributing to the need for a high level of cleanliness in the data center.

Operator awareness is another consideration. Maintaining a fairly high level of cleanliness will raise the level of occupant awareness with respect to special requirements and restrictions while in the data center. Occupants or visitors to the data center will hold the controlled environment in high regard and are more likely to act appropriately. Any environment that is maintained to a fairly high level of cleanliness and is kept in a neat and well organized fashion will also command respect from the room's inhabitants and visitors. When potential clients visit the room they will interpret the overall appearance of the room as a reflection of an overall commitment to excellence and quality. An effective cleaning schedule must consist of specially designed short-term and long-term actions. These can be summarized as follows:

Frequency	Task
Daily Actions	Rubbish removal
Weekly Actions	Access floor maintenance (vacuum and damp mop)
Quarterly Actions	Hardware decontamination
	Room surface decontamination
Bi-Annual Actions	Subfloor void decontamination
	Air conditioner decontamination (as necessary)

Daily Tasks

This statement of work focuses on the removal of each day's discarded trash and rubbish from the room. In addition, daily floor vacuuming may be required in Print Rooms or rooms with a considerable amount of operator activity.

Weekly Tasks

This statement of work focuses on the maintenance of the access floor system. During the week, the access floor becomes soiled with dust accumulations and blemishes. The entire access floor should be vacuumed and damp mopped. All vacuums used in the data center, for any purpose, should be equipped with High Efficiency Particulate Air (HEPA) filtration. Inadequately filtered equipment cannot arrest smaller particles, but rather simply agitates them, degrading the environment they were meant to improve. It is also important that mop-heads and dust wipes are of appropriate non-shedding designs.

Cleaning solutions used within the data center must not pose a threat to the hardware. Solutions that could potentially damage hardware include products that are:

- Ammoniated
- Chlorine-based
- Phosphate-based
- Bleach enriched
- Petro-chemical based
- Floor strippers or re-conditioners.

It is also important that the recommended concentrations are used, as even an appropriate agent in an inappropriate concentration can be potentially damaging. The solution should be maintained in good condition throughout the project, and excessive applications should be avoided.

Quarterly Tasks

The quarterly statement of work involves a much more detailed and comprehensive decontamination schedule and should only be conducted by experienced computer room contamination-control professionals. These actions should be performed three to four times per year, based on the levels of activity and contamination present. All room surfaces should be thoroughly decontaminated including cupboards, ledges, racks, shelves and support equipment. High ledges and light fixtures and generally accessible areas should be treated or vacuumed as appropriate. Vertical surfaces including windows, glass partitions, doors, etc. should be thoroughly treated. Special dust cloths that are impregnated with a particle absorbent material are to be used in the surface decontamination process. Do not use generic dust rags or fabric cloths to perform these activities. Do not use any chemicals, waxes or solvents during these activities.

Settled contamination should be removed from all exterior hardware surfaces including horizontal and vertical surfaces. The unit's air inlet and outlet grilles should be treated as well. Do not wipe the unit's control surfaces as these areas can be decontaminated by the use of lightly compressed air. Special care should also be taken when cleaning keyboards and life-safety controls. Specially treated dust wipes should be used to treat all hardware surfaces. Monitors should be treated with optical cleansers and static-free cloths. No Electro-Static Discharge (ESD) dissipative chemicals should be used on the computer hardware, since these agents are caustic and harmful to most sensitive hardware. The computer hardware is sufficiently designed to permit electrostatic dissipation thus no further treatments are required. After all of the hardware and room surfaces have been thoroughly decontaminated, the access floor should be HEPA vacuumed and damp mopped as detailed in the Weekly Actions.

Biennial Tasks

The subfloor void should be decontaminated every 18 months to 24 months based on the conditions of the plenum surfaces and the degree of contaminant accumulation. Over the course of the year, the subfloor void undergoes a considerable amount of activity that creates new contamination accumulations. Although the weekly above floor cleaning activities will greatly reduce the subfloor dust accumulations, a certain amount of surface dirt will migrate into the subfloor void. It is important to maintain the subfloor to a high degree of cleanliness since this area acts as the hardware's supply air plenum. It is best to perform the subfloor decontamination treatment in a short time frame to reduce cross contamination. The personnel performing this operation should be fully trained to assess cable connectivity and priority. Each exposed area of the subfloor void should be individually inspected and assessed for possible cable handling and movement. All twist-in and plug-in connections should be checked and fully engaged before cable movement. All subfloor activities must be conducted with proper consideration for air distribution and floor loading. In an effort to maintain access floor integrity and proper psychrometric conditions, the number of floor tiles removed from the floor system should be carefully managed. In most cases, each work crew should have no more than 24 square feet (six tiles) of open access flooring at any one time. The access floor's supporting grid system should also be thoroughly decontaminated, first by vacuuming the loose debris and then by damp-sponging the accumulated residue. Rubber gaskets, if present, as the metal framework that makes up the grid system should be removed from the grid work and cleaned with a damp sponge as well. Any unusual conditions, such as damaged floor suspension, floor tiles, cables and surfaces, within the floor void should be noted and reported.

Activity and Processes

Isolation of the data center is an integral factor in maintaining appropriate conditions. All unnecessary activity should be avoided in the data center, and access should be limited to necessary personnel only. Periodic activity, such as tours, should be limited, and traffic should be restricted to away from the hardware so as to avoid accidental contact. All personnel working in the room, including temporary employees and janitorial personnel, should be trained in the most basic sensitivities of the hardware so as to avoid unnecessary exposure. The controlled areas of the data center should be thoroughly isolated from contaminant producing activities. Ideally, print rooms, check sorting rooms, command centers or other areas with high levels of mechanical or human activity should have no direct exposure to the data center. Paths to and from these areas should not necessitate traffic through the main data center areas.