

Power Systems

*Disk drives or solid-state drives for the  
5105-22E, 9008-22L, 9009-22A,  
9009-22G, 9223-22H, or 9223-22S*



**Note**

Before using this information and the product it supports, read the information in [“Safety notices” on page v](#), [“Notices” on page 123](#), the *IBM Systems Safety Notices* manual, G229-9054, and the *IBM Environmental Notices and User Guide*, Z125-5823.

This edition applies to IBM® Power Systems servers that contain the POWER9™ processor and to all associated models.

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# Safety notices

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Safety notices may be printed throughout this guide:

- **DANGER** notices call attention to a situation that is potentially lethal or extremely hazardous to people.
- **CAUTION** notices call attention to a situation that is potentially hazardous to people because of some existing condition.
- **Attention** notices call attention to the possibility of damage to a program, device, system, or data.

## World Trade safety information

Several countries require the safety information contained in product publications to be presented in their national languages. If this requirement applies to your country, safety information documentation is included in the publications package (such as in printed documentation, on DVD, or as part of the product) shipped with the product. The documentation contains the safety information in your national language with references to the U.S. English source. Before using a U.S. English publication to install, operate, or service this product, you must first become familiar with the related safety information documentation. You should also refer to the safety information documentation any time you do not clearly understand any safety information in the U.S. English publications.

Replacement or additional copies of safety information documentation can be obtained by calling the IBM Hotline at 1-800-300-8751.

## German safety information

Das Produkt ist nicht für den Einsatz an Bildschirmarbeitsplätzen im Sinne § 2 der Bildschirmarbeitsverordnung geeignet.

## Laser safety information

IBM servers can use I/O cards or features that are fiber-optic based and that utilize lasers or LEDs.

## Laser compliance

IBM servers may be installed inside or outside of an IT equipment rack.



**DANGER:** When working on or around the system, observe the following precautions:

Electrical voltage and current from power, telephone, and communication cables are hazardous. To avoid a shock hazard:

- If IBM supplied the power cord(s), connect power to this unit only with the IBM provided power cord. Do not use the IBM provided power cord for any other product.
- Do not open or service any power supply assembly.
- Do not connect or disconnect any cables or perform installation, maintenance, or reconfiguration of this product during an electrical storm.
- The product might be equipped with multiple power cords. To remove all hazardous voltages, disconnect all power cords.
  - For AC power, disconnect all power cords from their AC power source.
  - For racks with a DC power distribution panel (PDP), disconnect the customer's DC power source to the PDP.
- When connecting power to the product ensure all power cables are properly connected.
  - For racks with AC power, connect all power cords to a properly wired and grounded electrical outlet. Ensure that the outlet supplies proper voltage and phase rotation according to the system rating plate.

- For racks with a DC power distribution panel (PDP), connect the customer's DC power source to the PDP. Ensure that the proper polarity is used when attaching the DC power and DC power return wiring.
- Connect any equipment that will be attached to this product to properly wired outlets.
- When possible, use one hand only to connect or disconnect signal cables.
- Never turn on any equipment when there is evidence of fire, water, or structural damage.
- Do not attempt to switch on power to the machine until all possible unsafe conditions are corrected.
- Assume that an electrical safety hazard is present. Perform all continuity, grounding, and power checks specified during the subsystem installation procedures to ensure that the machine meets safety requirements.
- Do not continue with the inspection if any unsafe conditions are present.
- Before you open the device covers, unless instructed otherwise in the installation and configuration procedures: Disconnect the attached AC power cords, turn off the applicable circuit breakers located in the rack power distribution panel (PDP), and disconnect any telecommunications systems, networks, and modems.



**DANGER:**

- Connect and disconnect cables as described in the following procedures when installing, moving, or opening covers on this product or attached devices.

To Disconnect:

1. Turn off everything (unless instructed otherwise).
2. For AC power, remove the power cords from the outlets.
3. For racks with a DC power distribution panel (PDP), turn off the circuit breakers located in the PDP and remove the power from the Customer's DC power source.
4. Remove the signal cables from the connectors.
5. Remove all cables from the devices.

To Connect:

1. Turn off everything (unless instructed otherwise).
2. Attach all cables to the devices.
3. Attach the signal cables to the connectors.
4. For AC power, attach the power cords to the outlets.
5. For racks with a DC power distribution panel (PDP), restore the power from the Customer's DC power source and turn on the circuit breakers located in the PDP.
6. Turn on the devices.

Sharp edges, corners and joints may be present in and around the system. Use care when handling equipment to avoid cuts, scrapes and pinching. (D005)

**(R001 part 1 of 2):**



**DANGER:** Observe the following precautions when working on or around your IT rack system:

- Heavy equipment—personal injury or equipment damage might result if mishandled.
- Always lower the leveling pads on the rack cabinet.
- Always install stabilizer brackets on the rack cabinet if provided, unless the earthquake option is to be installed..
- To avoid hazardous conditions due to uneven mechanical loading, always install the heaviest devices in the bottom of the rack cabinet. Always install servers and optional devices starting from the bottom of the rack cabinet.

- Rack-mounted devices are not to be used as shelves or work spaces. Do not place objects on top of rack-mounted devices. In addition, do not lean on rack mounted devices and do not use them to stabilize your body position (for example, when working from a ladder).



- Stability hazard:
  - The rack may tip over causing serious personal injury.
  - Before extending the rack to the installation position, read the installation instructions.
  - Do not put any load on the slide-rail mounted equipment mounted in the installation position.
  - Do not leave the slide-rail mounted equipment in the installation position.
- Each rack cabinet might have more than one power cord.
  - For AC powered racks, be sure to disconnect all power cords in the rack cabinet when directed to disconnect power during servicing.
  - For racks with a DC power distribution panel (PDP), turn off the circuit breaker that controls the power to the system unit(s), or disconnect the customer's DC power source, when directed to disconnect power during servicing.
- Connect all devices installed in a rack cabinet to power devices installed in the same rack cabinet. Do not plug a power cord from a device installed in one rack cabinet into a power device installed in a different rack cabinet.
- An electrical outlet that is not correctly wired could place hazardous voltage on the metal parts of the system or the devices that attach to the system. It is the responsibility of the customer to ensure that the outlet is correctly wired and grounded to prevent an electrical shock. (R001 part 1 of 2)

**(R001 part 2 of 2):**



**CAUTION:**

- Do not install a unit in a rack where the internal rack ambient temperatures will exceed the manufacturer's recommended ambient temperature for all your rack-mounted devices.
- Do not install a unit in a rack where the air flow is compromised. Ensure that air flow is not blocked or reduced on any side, front, or back of a unit used for air flow through the unit.
- Consideration should be given to the connection of the equipment to the supply circuit so that overloading of the circuits does not compromise the supply wiring or overcurrent protection. To provide the correct power connection to a rack, refer to the rating labels located on the equipment in the rack to determine the total power requirement of the supply circuit.
- *(For sliding drawers.)* Do not pull out or install any drawer or feature if the rack stabilizer brackets are not attached to the rack or if the rack is not bolted to the floor. Do not pull out more than one drawer at a time. The rack might become unstable if you pull out more than one drawer at a time.



- (For fixed drawers.) This drawer is a fixed drawer and must not be moved for servicing unless specified by the manufacturer. Attempting to move the drawer partially or completely out of the rack might cause the rack to become unstable or cause the drawer to fall out of the rack. (R001 part 2 of 2)



**CAUTION:** Removing components from the upper positions in the rack cabinet improves rack stability during relocation. Follow these general guidelines whenever you relocate a populated rack cabinet within a room or building.

- Reduce the weight of the rack cabinet by removing equipment starting at the top of the rack cabinet. When possible, restore the rack cabinet to the configuration of the rack cabinet as you received it. If this configuration is not known, you must observe the following precautions:
  - Remove all devices in the 32U position and above.
  - Ensure that the heaviest devices are installed in the bottom of the rack cabinet.
  - Ensure that there are little-to-no empty U-levels between devices installed in the rack cabinet below the 32U level, unless the received configuration specifically allowed it.
- If the rack cabinet you are relocating is part of a suite of rack cabinets, detach the rack cabinet from the suite.
- If the rack cabinet you are relocating was supplied with removable outriggers they must be reinstalled before the cabinet is relocated.
- Inspect the route that you plan to take to eliminate potential hazards.
- Verify that the route that you choose can support the weight of the loaded rack cabinet. Refer to the documentation that comes with your rack cabinet for the weight of a loaded rack cabinet.
- Verify that all door openings are at least 760 x 2083 mm (30 x 82 in.).
- Ensure that all devices, shelves, drawers, doors, and cables are secure.
- Ensure that the four leveling pads are raised to their highest position.
- Ensure that there is no stabilizer bracket installed on the rack cabinet during movement.
- Do not use a ramp inclined at more than 10 degrees.
- When the rack cabinet is in the new location, complete the following steps:
  - Lower the four leveling pads.
  - Install stabilizer brackets on the rack cabinet or in an earthquake environment bolt the rack to the floor.
  - If you removed any devices from the rack cabinet, repopulate the rack cabinet from the lowest position to the highest position.
- If a long-distance relocation is required, restore the rack cabinet to the configuration of the rack cabinet as you received it. Pack the rack cabinet in the original packaging material, or equivalent. Also lower the leveling pads to raise the casters off of the pallet and bolt the rack cabinet to the pallet.

(R002)

(L001)



**DANGER:** Hazardous voltage, current, or energy levels are present inside any component that has this label attached. Do not open any cover or barrier that contains this label. (L001)

(L002)



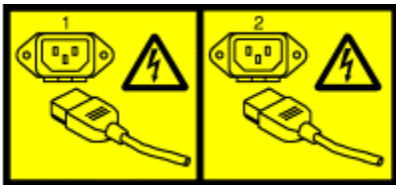


**DANGER:** Rack-mounted devices are not to be used as shelves or work spaces. Do not place objects on top of rack-mounted devices. In addition, do not lean on rack-mounted devices and do not use them to stabilize your body position (for example, when working from a ladder). Stability hazard:

- The rack may tip over causing serious personal injury.
- Before extending the rack to the installation position, read the installation instructions.
- Do not put any load on the slide-rail mounted equipment mounted in the installation position.
- Do not leave the slide-rail mounted equipment in the installation position.

(L002)

(L003)



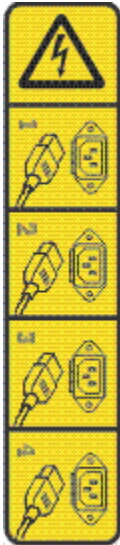
or



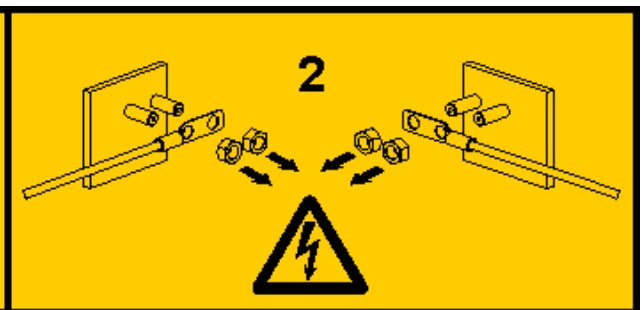
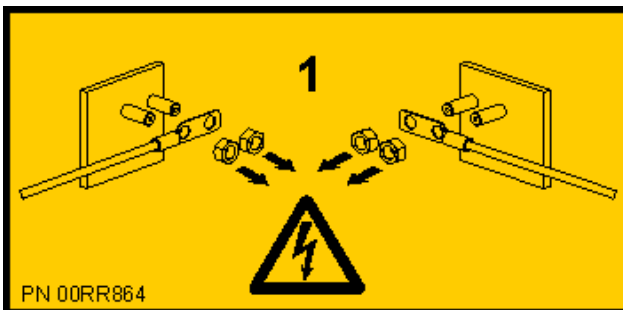
or



or



or



**DANGER:** Multiple power cords. The product might be equipped with multiple AC power cords or multiple DC power cables. To remove all hazardous voltages, disconnect all power cords and power cables. (L003)

(L007)



**CAUTION:** A hot surface nearby. (L007)

x Power Systems: Disk drives or solid-state drives

(L008)



**CAUTION:** Hazardous moving parts nearby. (L008)

All lasers are certified in the U.S. to conform to the requirements of DHHS 21 CFR Subchapter J for class 1 laser products. Outside the U.S., they are certified to be in compliance with IEC 60825 as a class 1 laser product. Consult the label on each part for laser certification numbers and approval information.



**CAUTION:** This product might contain one or more of the following devices: CD-ROM drive, DVD-ROM drive, DVD-RAM drive, or laser module, which are Class 1 laser products. Note the following information:

- Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.
- Use of the controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.

(C026)



**CAUTION:** Data processing environments can contain equipment transmitting on system links with laser modules that operate at greater than Class 1 power levels. For this reason, never look into the end of an optical fiber cable or open receptacle. Although shining light into one end and looking into the other end of a disconnected optical fiber to verify the continuity of optic fibers may not injure the eye, this procedure is potentially dangerous. Therefore, verifying the continuity of optical fibers by shining light into one end and looking at the other end is not recommended. To verify continuity of a fiber optic cable, use an optical light source and power meter. (C027)



**CAUTION:** This product contains a Class 1M laser. Do not view directly with optical instruments. (C028)



**CAUTION:** Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following information:

- Laser radiation when open.
- Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam. (C030)

(C030)



**CAUTION:** The battery contains lithium. To avoid possible explosion, do not burn or charge the battery.

*Do Not:*

- Throw or immerse into water
- Heat to more than 100 degrees C (212 degrees F)
- Repair or disassemble

Exchange only with the IBM-approved part. Recycle or discard the battery as instructed by local regulations. In the United States, IBM has a process for the collection of this battery. For information, call 1-800-426-4333. Have the IBM part number for the battery unit available when you call. (C003)



**CAUTION:** Regarding IBM provided VENDOR LIFT TOOL:

- Operation of LIFT TOOL by authorized personnel only.

- LIFT TOOL intended for use to assist, lift, install, remove units (load) up into rack elevations. It is not to be used loaded transporting over major ramps nor as a replacement for such designated tools like pallet jacks, walkies, fork trucks and such related relocation practices. When this is not practicable, specially trained persons or services must be used (for instance, riggers or movers).
- Read and completely understand the contents of LIFT TOOL operator's manual before using. Failure to read, understand, obey safety rules, and follow instructions may result in property damage and/or personal injury. If there are questions, contact the vendor's service and support. Local paper manual must remain with machine in provided storage sleeve area. Latest revision manual available on vendor's web site.
- Test verify stabilizer brake function before each use. Do not over-force moving or rolling the LIFT TOOL with stabilizer brake engaged.
- Do not raise, lower or slide platform load shelf unless stabilizer (brake pedal jack) is fully engaged. Keep stabilizer brake engaged when not in use or motion.
- Do not move LIFT TOOL while platform is raised, except for minor positioning.
- Do not exceed rated load capacity. See LOAD CAPACITY CHART regarding maximum loads at center versus edge of extended platform.
- Only raise load if properly centered on platform. Do not place more than 200 lb (91 kg) on edge of sliding platform shelf also considering the load's center of mass/gravity (CoG).
- Do not corner load the platforms, tilt riser, angled unit install wedge or other such accessory options. Secure such platforms -- riser tilt, wedge, etc options to main lift shelf or forks in all four (4x or all other provisioned mounting) locations with provided hardware only, prior to use. Load objects are designed to slide on/off smooth platforms without appreciable force, so take care not to push or lean. Keep riser tilt [adjustable angling platform] option flat at all times except for final minor angle adjustment when needed.
- Do not stand under overhanging load.
- Do not use on uneven surface, incline or decline (major ramps).
- Do not stack loads.
- Do not operate while under the influence of drugs or alcohol.
- Do not support ladder against LIFT TOOL (unless the specific allowance is provided for one following qualified procedures for working at elevations with this TOOL).
- Tipping hazard. Do not push or lean against load with raised platform.
- Do not use as a personnel lifting platform or step. No riders.
- Do not stand on any part of lift. Not a step.
- Do not climb on mast.
- Do not operate a damaged or malfunctioning LIFT TOOL machine.
- Crush and pinch point hazard below platform. Only lower load in areas clear of personnel and obstructions. Keep hands and feet clear during operation.
- No Forks. Never lift or move bare LIFT TOOL MACHINE with pallet truck, jack or fork lift.
- Mast extends higher than platform. Be aware of ceiling height, cable trays, sprinklers, lights, and other overhead objects.
- Do not leave LIFT TOOL machine unattended with an elevated load.
- Watch and keep hands, fingers, and clothing clear when equipment is in motion.
- Turn Winch with hand power only. If winch handle cannot be cranked easily with one hand, it is probably over-loaded. Do not continue to turn winch past top or bottom of platform travel. Excessive unwinding will detach handle and damage cable. Always hold handle when lowering, unwinding. Always assure self that winch is holding load before releasing winch handle.
- A winch accident could cause serious injury. Not for moving humans. Make certain clicking sound is heard as the equipment is being raised. Be sure winch is locked in position before releasing handle. Read instruction page before operating this winch. Never allow winch to unwind freely.

Freewheeling will cause uneven cable wrapping around winch drum, damage cable, and may cause serious injury.

- This TOOL must be maintained correctly for IBM Service personnel to use it. IBM shall inspect condition and verify maintenance history before operation. Personnel reserve the right not to use TOOL if inadequate. (C048)

### **Power and cabling information for NEBS (Network Equipment-Building System) GR-1089-CORE**

The following comments apply to the IBM servers that have been designated as conforming to NEBS (Network Equipment-Building System) GR-1089-CORE:

The equipment is suitable for installation in the following:

- Network telecommunications facilities
- Locations where the NEC (National Electrical Code) applies

The intrabuilding ports of this equipment are suitable for connection to intrabuilding or unexposed wiring or cabling only. The intrabuilding ports of this equipment *must not* be metalically connected to the interfaces that connect to the OSP (outside plant) or its wiring. These interfaces are designed for use as intrabuilding interfaces only (Type 2 or Type 4 ports as described in GR-1089-CORE) and require isolation from the exposed OSP cabling. The addition of primary protectors is not sufficient protection to connect these interfaces metalically to OSP wiring.

**Note:** All Ethernet cables must be shielded and grounded at both ends.

The ac-powered system does not require the use of an external surge protection device (SPD).

The dc-powered system employs an isolated DC return (DC-I) design. The DC battery return terminal *shall not* be connected to the chassis or frame ground.

The dc-powered system is intended to be installed in a common bonding network (CBN) as described in GR-1089-CORE.



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## Disk drives or solid-state drives

Find information about installing, removing, and replacing disk drives or solid-state drives (SSDs) in the 5105-22E, IBM Power® System L922 (9008-22L), IBM Power System S922 (9009-22A and 9009-22G), IBM Power System H922 (9223-22H), or IBM Power System H922S (9223-22S) server.

If you are installing, removing, or replacing mainstream SSDs, it is not supported to mix mainstream drives with enterprise drives in disk arrays. Also, you need to monitor the amount of life that is remaining in the mainstream drives. For more information about these drives, see [“Mainstream solid-state drives”](#) on page 116.

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### Installing a disk drive or solid-state drive in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

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Find information about installing a serial-attached SCSI (SAS) disk drive or a solid-state drive (SSD) in a 5105-22E, IBM Power System L922 (9008-22L), IBM Power System S922 (9009-22A and 9009-22G), IBM Power System H922 (9223-22H), or IBM Power System H922S (9223-22S) server.

#### About this task

If you are installing a disk drive or SSD in a 5887 disk drive enclosure or ESLL or ESLS storage enclosure, see [Enclosures and expansion units](http://www.ibm.com/support/knowledgecenter/POWER9/p9ham/p9ham_kickoff.htm) ([http://www.ibm.com/support/knowledgecenter/POWER9/p9ham/p9ham\\_kickoff.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9ham/p9ham_kickoff.htm)). Select the enclosure that you are working on, and then select **Installing parts > Disk drives or SSDs**.

Before you install a feature, ensure that the software that is required to support the feature is installed on your system. For more information about software prerequisites, see the [Power Systems Prerequisites](https://www14.software.ibm.com/support/customercare/iprt/home) website (<https://www14.software.ibm.com/support/customercare/iprt/home>). If the required software is not installed, see the following websites to download it, and then install it before you continue:

- To download firmware updates, software updates, and fixes, see the [Fix Central](http://www.ibm.com/support/fixcentral/) website (<http://www.ibm.com/support/fixcentral/>).
- To download Hardware Management Console (HMC) updates and fixes, see the [Hardware Management Console Support and downloads](https://www14.software.ibm.com/webapp/set2/sas/f/hmcl/home.html) website (<https://www14.software.ibm.com/webapp/set2/sas/f/hmcl/home.html>).

**Note:** Installing this feature is a customer task. You can complete this task yourself, or contact a service provider to complete the task for you. You might be charged a fee by the service provider for this service.

If your system is managed by the Hardware Management Console (HMC), use the HMC to install the part in the system. For instructions, see [Installing a part by using the HMC](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/hmcinstall.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/hmcinstall.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/hmcinstall.htm)).

If your system is not managed by an HMC, complete the steps in this procedure to install a disk drive or SSD.

### Preparing the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system to install a disk drive or solid-state drive

To prepare the system to install a disk drive or solid-state drive, complete the steps in this procedure.

#### About this task

**Note:** When drive slots are available in a server and enclosure, fill the slot positions in the server first. However, you can choose a different disk drive or solid-state drive placement that depends on your data protection strategy.

## Procedure

1. Review the SSD configuration rules if you are installing SSDs:

Solid-state drives (SSDs), also known as flash drives, follow similar rules as regular hard disk drives (HDDs). For example, SSDs physically resemble, install in the same manner, and in most of the same slots as HDDs. However, some restrictions and configuration rules are specific to the SSD.

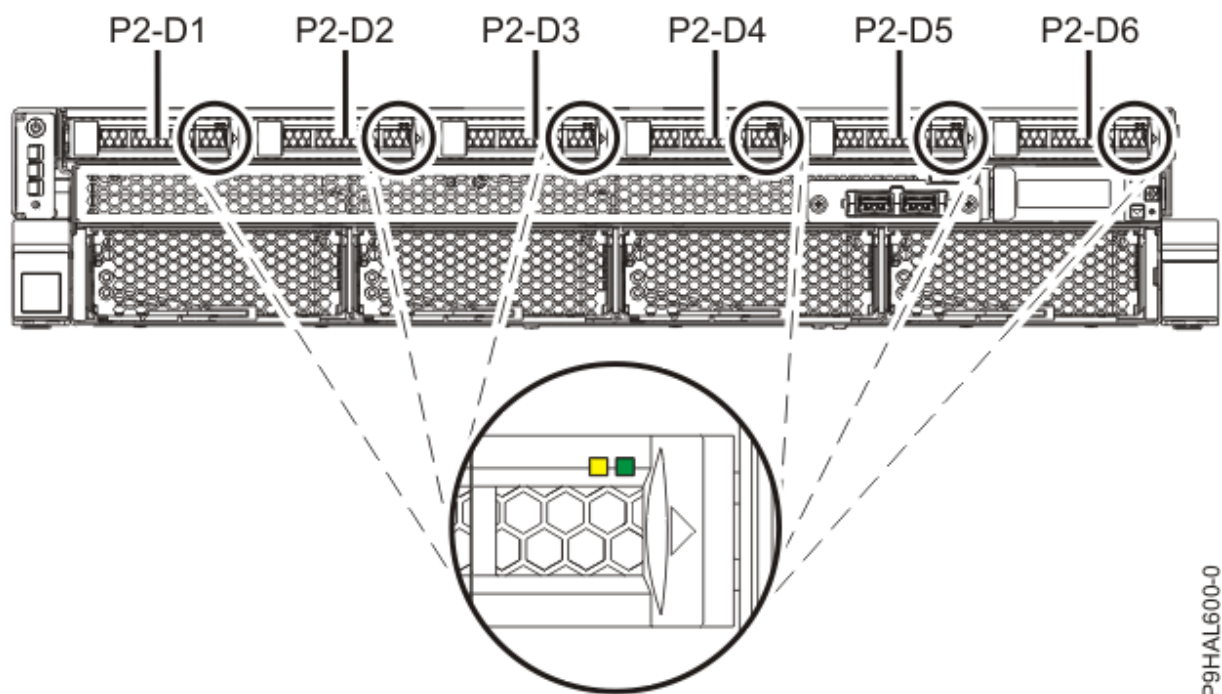
**Restriction:** If you are using the IBM i operating system, solid-state drives must be part of a RAID array or system mirroring in the system or logical partition that is controlled by IBM i.

Table 1. Solid-state drive rules for the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system	
Adapter	Mixing rules
PCIe3 x8 SAS RAID internal adapter 6 Gb (FC EJ1F, EJ1H, or EL68; CCIN 57D7)	<ul style="list-style-type: none"><li>• HDDs can be configured as just a bunch of disks (JBOD) or in RAID 0, 5, 6, or 10.</li><li>• SSDs must be configured in RAID 0, 5, 6, or 10. JBOD is not supported for SSDs.</li><li>• SSDs and HDDs can be mixed within the disk drive backplane, but cannot be mixed in the same RAID array.</li><li>• Feature code (FC) EJ1H or EL68 can be used to split the disk drive backplane into two sets of 4 drives.</li><li>• SSDs and HDDs can be mixed within each side of a split-disk disk drive backplane, but cannot be mixed in the same RAID array.</li></ul>
PCIe3 x8 cache SAS RAID Internal Adapter 6 Gb (FC EJ1G; CCIN 57DC)	<ul style="list-style-type: none"><li>• HDDs can be configured in RAID 0, 5, 6, 10, 5T2, 6T2, or 10T2. (JBOD is not supported).</li><li>• SSDs must be configured in RAID 0, 5, 6, 10, 5T2, 6T2, or 10T2. (JBOD is not supported).</li><li>• SSDs and HDDs can be mixed within a disk drive backplane, but cannot be mixed in the same RAID array.</li><li>• FC EJ1D also allows an external SAS port and the attachment of an external disk drive enclosure.</li><li>• IBM i does not support FC EJ1G.</li></ul>

2. Ensure that the software that is required to support the feature is installed on your system. For more information about software prerequisites, see the [IBM Prerequisite website](#). If the required firmware, software, or fix packs are not installed on your system, go to the [Fix Central website](#) to download and install them before you continue.
3. Review the drive and service indicator locations. The disk drive and SSD slots are located in the front of the system with two internal slots.

Figure 1 on page 3 shows the drive locations and service indicators for the front drives. Service indicators are located above the latch handle on the drives. Figure 2 on page 4 shows the internal drive locations and service indicators. Service indicators are located in the front of the system.





P9HAL600-0

*Figure 1. Front disk drive and service indicator locations for a 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system*

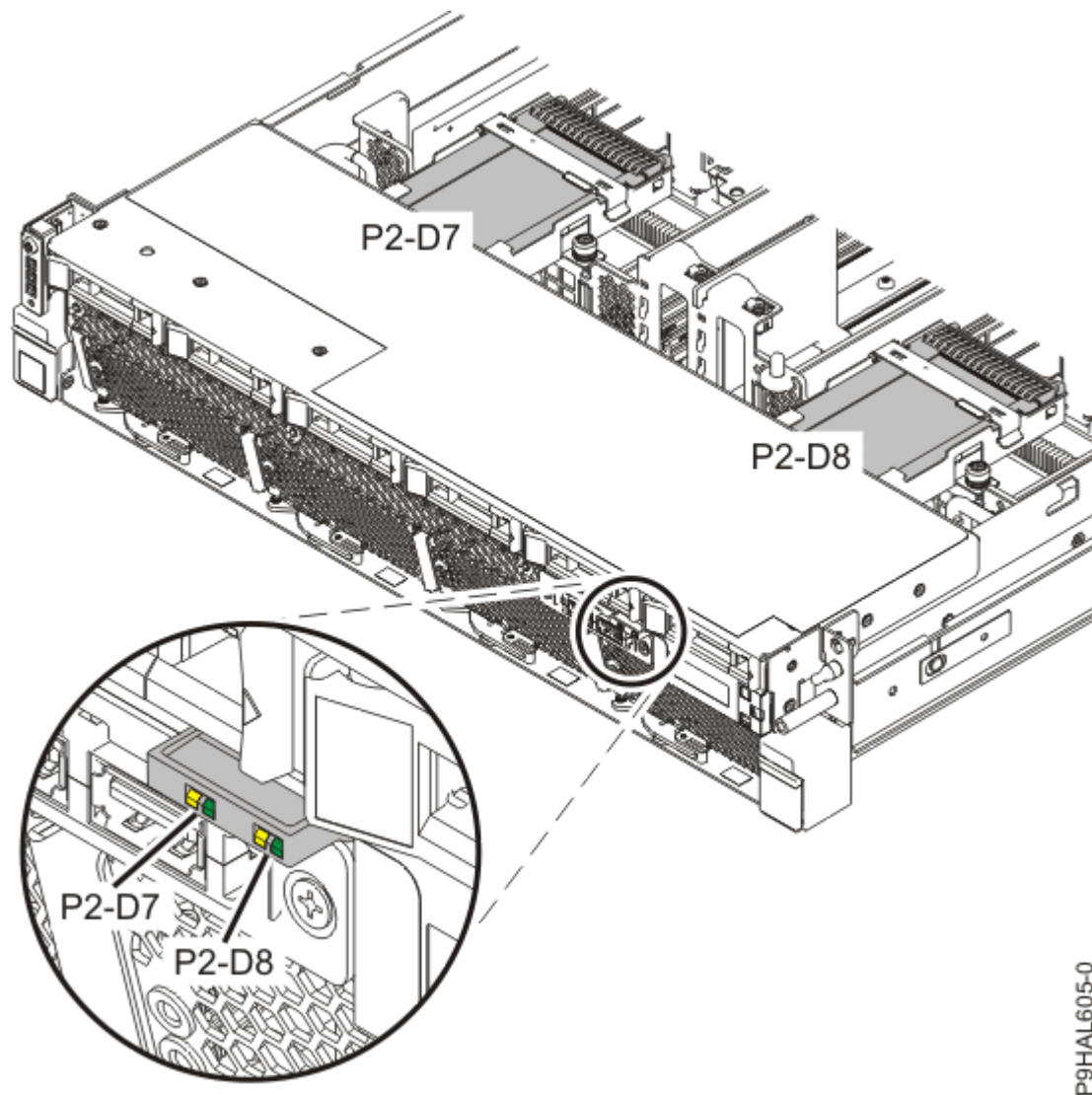


Figure 2. Internal drive and service indicator locations for a 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

4. Choose from the following options:

- If you want to install a drive when the system power is turned off, continue with step “5” on page 4.
- If the system power is turned on and if the AIX® operating system controls the slot, continue with step “7” on page 7.
- If the system power is turned on and if the IBM i operating system controls the slot, continue with step “9” on page 7.
- If your system power is turned on and if the Linux® operating system controls the slot, continue with step “11” on page 8.

5. To prepare the system to install a drive when the system is powered off, complete the following steps:

- a) Turn on the identify LED for an empty slot and the system.

For instructions, see [Identifying a part](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/sal.htm) (www.ibm.com/support/knowledgecenter/POWER9/p9haj/sal.htm).

Use the blue identify LED on the enclosure to locate the system. Ensure that the serial number of the system matches the serial number to be serviced.

- b) Record the position (an available empty slot) where the new disk drive or solid-state drive must be installed. For example, the next available drive slot might be P1-D3 or P2-D3.
- c) Stop the system. For instructions, see [Stopping a system](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm)).
- d) If applicable, open the rack door at the rear of the system.
- e) Label and disconnect the power cords from the system unit.

See Figure 3 on page 5.

**Notes:**

- This system might be equipped with two or more power supplies. If the removing and replacing procedures require the system power to be turned off, ensure that all the power sources to the system are disconnected.
- The power cord **(B)** is fastened to the system with hook-and-loop fastener **(A)**. If you are placing the system in a service position after you disconnect the power cords, ensure that you unstrap the fastener.

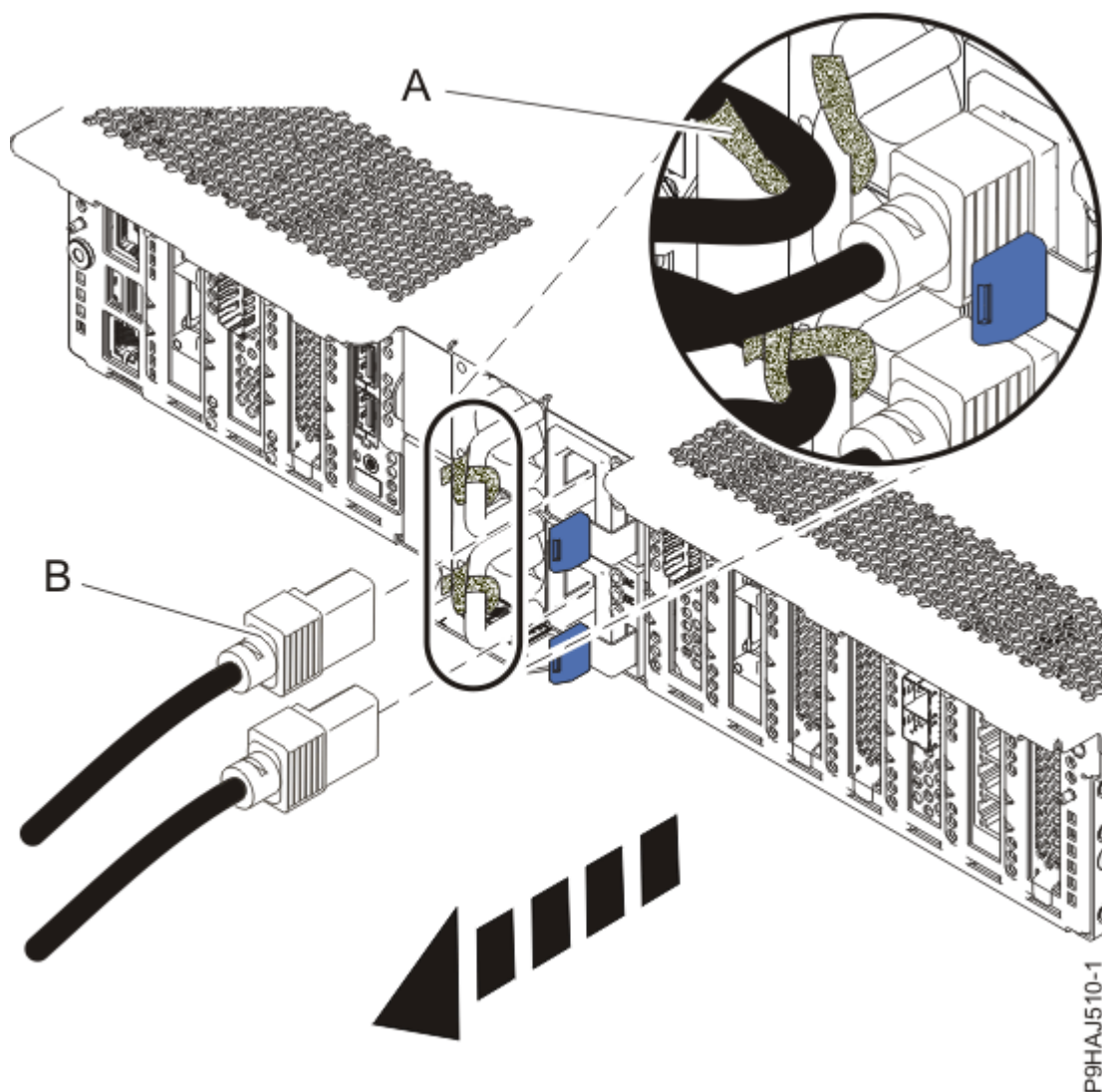
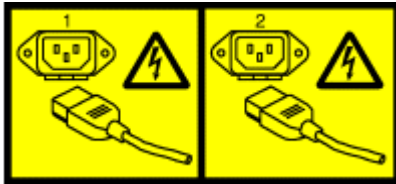


Figure 3. Removing the power cords

(L003)



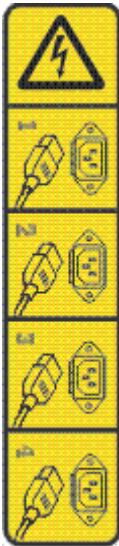
or



or

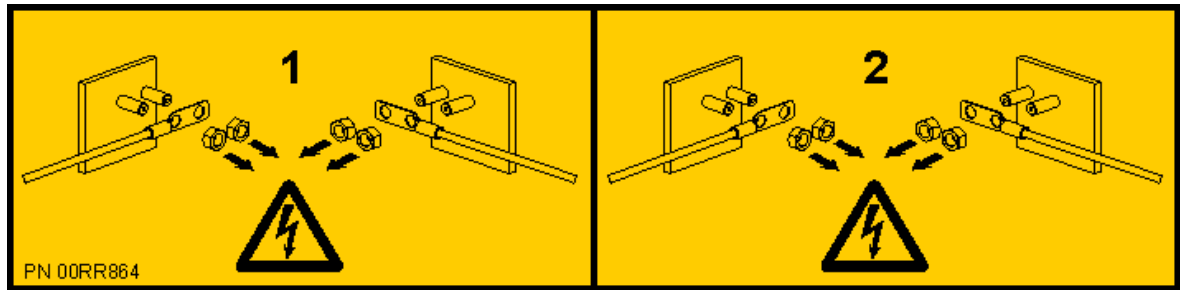


or



or





**DANGER:** Multiple power cords. The product might be equipped with multiple AC power cords or multiple DC power cables. To remove all hazardous voltages, disconnect all power cords and power cables. (L003)

6. Choose from the following options:

- If you recorded slot P2-D7 or P2-D8 (internal slots), continue with step “13” on page 9.
- If you recorded slot P2-D1 through P2-D6 (front slots), continue with step “14” on page 13.

7. To use the AIX operating system diagnostic command to identify an available slot, complete the following steps.

- a) Log in as root user.
- b) Type diag at the command line and then press Enter.
- c) On the **Diagnostic Operating Instructions** display, press Enter to continue.
- d) On the **Function Selection** display, select **Task Selection > RAID Array Manager > IBM SAS Disk Array Manager > Diagnostics and Recovery Options > SCSI and SCSI RAID Hot Plug Manager**.
- e) Select **Attach a Device to a SCSI Hot Swap Enclosure Device**.  
A list of empty slots in the SCSI hot swap enclosure device is shown.
- f) Record the position (an available empty slot) where the new disk drive or solid-state drive must be installed. For example, the next available drive slot might be P1-D3 or P2-D3.
- g) Scroll down to the slot number and press Enter.

8. Choose from the following options:

- If you recorded slot P2-D7 or P2-D8 (internal slots), continue with step “13” on page 9.
- If you recorded slot P2-D1 through P2-D6 (front slots), continue with step “14” on page 13.

9. To use the IBM i operating system to identify an available slot, complete the following steps:

- a) Record the physical location where the new disk drive or solid-state drive can be installed.
  - The physical location has the following form: U78D3 . 001 . AAAXXXX -P2 -D3 where U78D3 . 001 is the system identifier, AAAXXXX is the sequence number, and P2 -D3 is the drive slot location. Find the physical location U78D3 . 001 . AAAXXXX information from the control panel display on the system.
  - If you cannot find the location information from the control panel, find the label that is located on the front of the system or enclosure. The system identifier is listed after FC and the sequence number is the last 7 digits after SN or SEQ.



Figure 4. Example of a system or enclosure label

Use Table 2 on page 8 to find the system machine type and model that corresponds to the system identifier.

Table 2. System identifier for POWER9 systems and enclosures	
System identifier	System
U78D3.001	5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S
U78D2.001	9009-41A, 9009-41G, 9009-42A, 9009-42G, 9223-42H, or 9223-42S
U78D4.001	9040-MR9
U5887.001	5887 disk drive enclosure
UESLL.001	ESLL storage enclosure
UESLS.001	ESLS storage enclosure

In the example, U5887.001.AAAXXXX-D1-D24, you would install a drive in the 5887 disk drive enclosure with type 5887, model 001, sequence number AAAXXXX, and drive position D1–D24.

- b) To prepare the slot to install a drive by using the IBM i Hardware Service Manager, complete the following steps:

- 1) Sign on to service level authority.
- 2) Type `strsst` in the command line of the IBM i session and then press Enter.
- 3) Type your service tools user ID and service tools password in the Start Service Tools Sign On display, and then press Enter.

The service tools password is case-sensitive.

- 4) Select **Start a service tool > Hardware service manager > Device Concurrent Maintenance**.
- 5) In the **Specify either physical location** field, type the physical location that you previously recorded in this procedure.
- 6) Select 2 (Install device) for the Action to be completed.
- 7) Set the time delay in minutes. For example, for five minutes enter: 05.

**Important:** Do not press Enter until you are ready to install the drive.

10. Choose from the following options:

- If you recorded slot P2-D7 or P2-D8 (internal slots), continue with step “13” on page 9.
- If you recorded slot P2-D1 through P2-D6 (front slots), continue with step “14” on page 13.

11. To prepare the system to install a drive by using the Linux operating system, complete the following steps:

- a) Log in as root user.
- b) Type `iprconfig` on the command line of the Linux session, and then press Enter.

The IBM Power RAID Configuration Utility display is shown.

- c) Select **Work with disk unit recovery > Concurrent add device**.

Type `t` if you want to toggle through different location code representations.

- d) Type 1 next to the location into which you want to install the disk drive or solid-state drive and press Enter.

The Verify Device Concurrent Add display is shown and the service indicator flashes for the selected slot.

**Important:** Do not press Enter until you are ready to install the drive.

12. Choose from the following options:

- If you recorded slot P2-D7 or P2-D8 (internal slots), continue with step [“13”](#) on page 9.
  - If you recorded slot P2-D1 through P2-D6 (front slots), continue with step [“14”](#) on page 13.
13. To access the internal drives, complete the following steps:
- a) If applicable, open the rack front door.
  - b) Open the side latches **(A)** and pull the latches to slide the system unit fully into the service position, until the slides click and hold the system unit securely. Ensure that the screws inside the latches are not secured to the rack.

Remove the hook-and-loop fasteners that secure the cable management arms. Ensure that the cable management arms can move freely. Ensure that the cables at the rear of the system do not catch or bind as you pull the system unit into the service position.

Do not pull out or install any drawer or feature if the rack stabilizer brackets are not attached to the rack. Do not pull out more than one drawer at a time. The rack might become unstable if you pull out more than one drawer at a time.





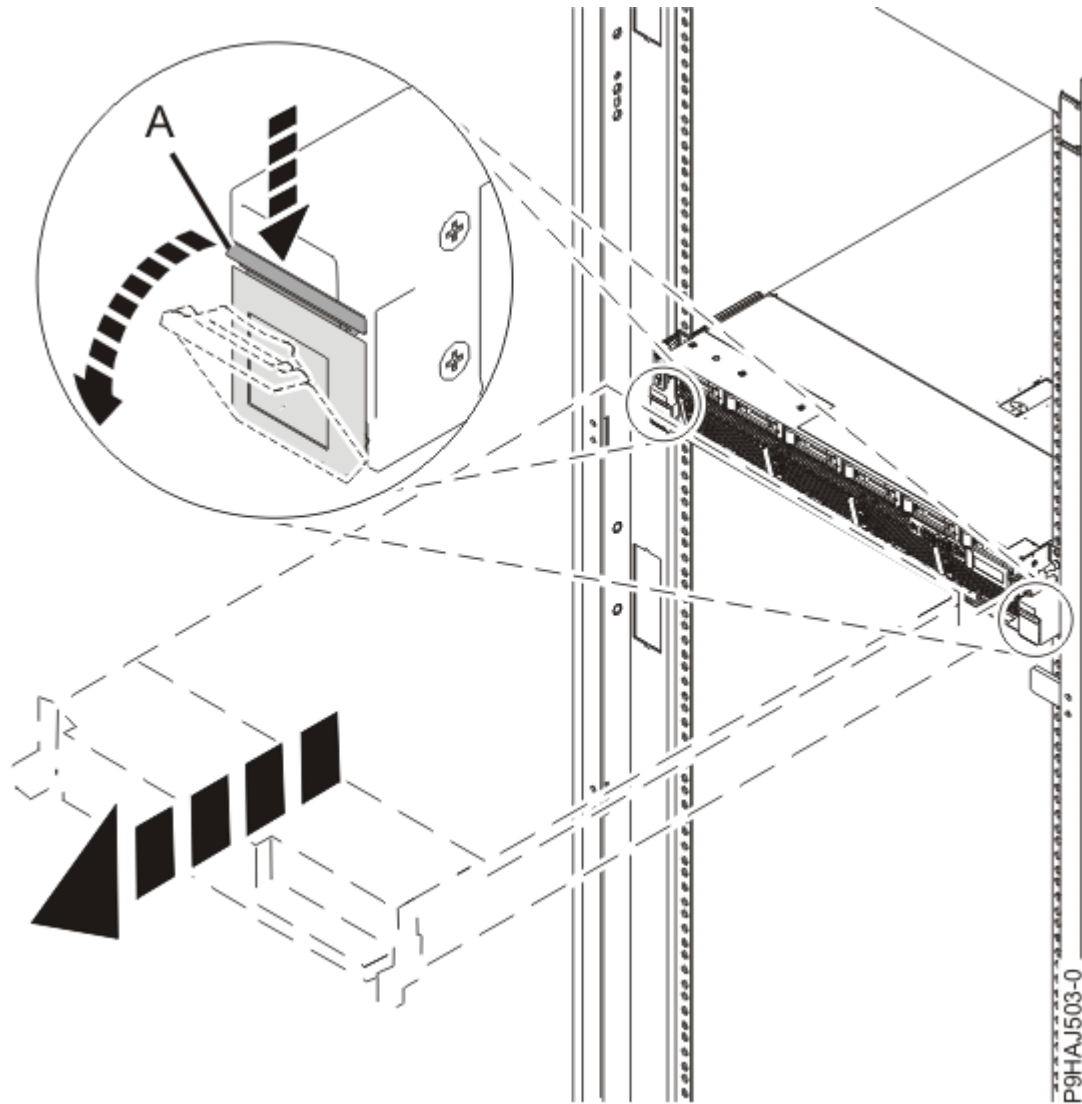


Figure 5. Releasing the side latches

- c) Attach the electrostatic discharge (ESD) wrist strap. Your system has an ESD jack on the front and on the rear of the system. Plug the ESD wrist strap into the ESD jack.



**Attention:**

- Attach an electrostatic discharge (ESD) wrist strap to the front ESD jack, to the rear ESD jack, or to an unpainted metal surface of your hardware to prevent the electrostatic discharge from damaging your hardware.
- When you use an ESD wrist strap, follow all electrical safety procedures. An ESD wrist strap is used for static control. It does not increase or decrease your risk of receiving electric shock when using or working on electrical equipment.
- If you do not have an ESD wrist strap, just prior to removing the product from ESD packaging and installing or replacing hardware, touch an unpainted metal surface of the system for a minimum of 5 seconds.



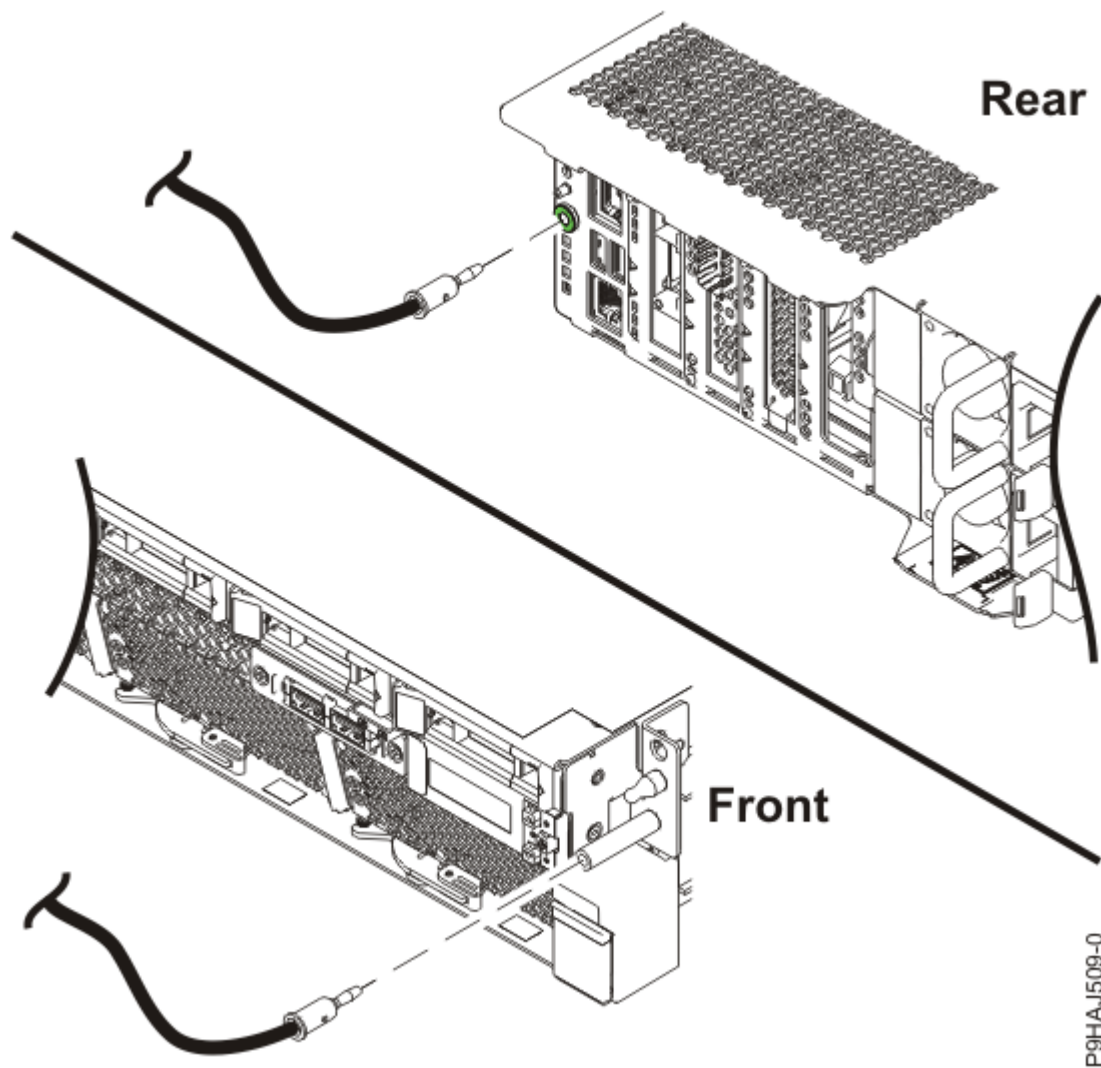
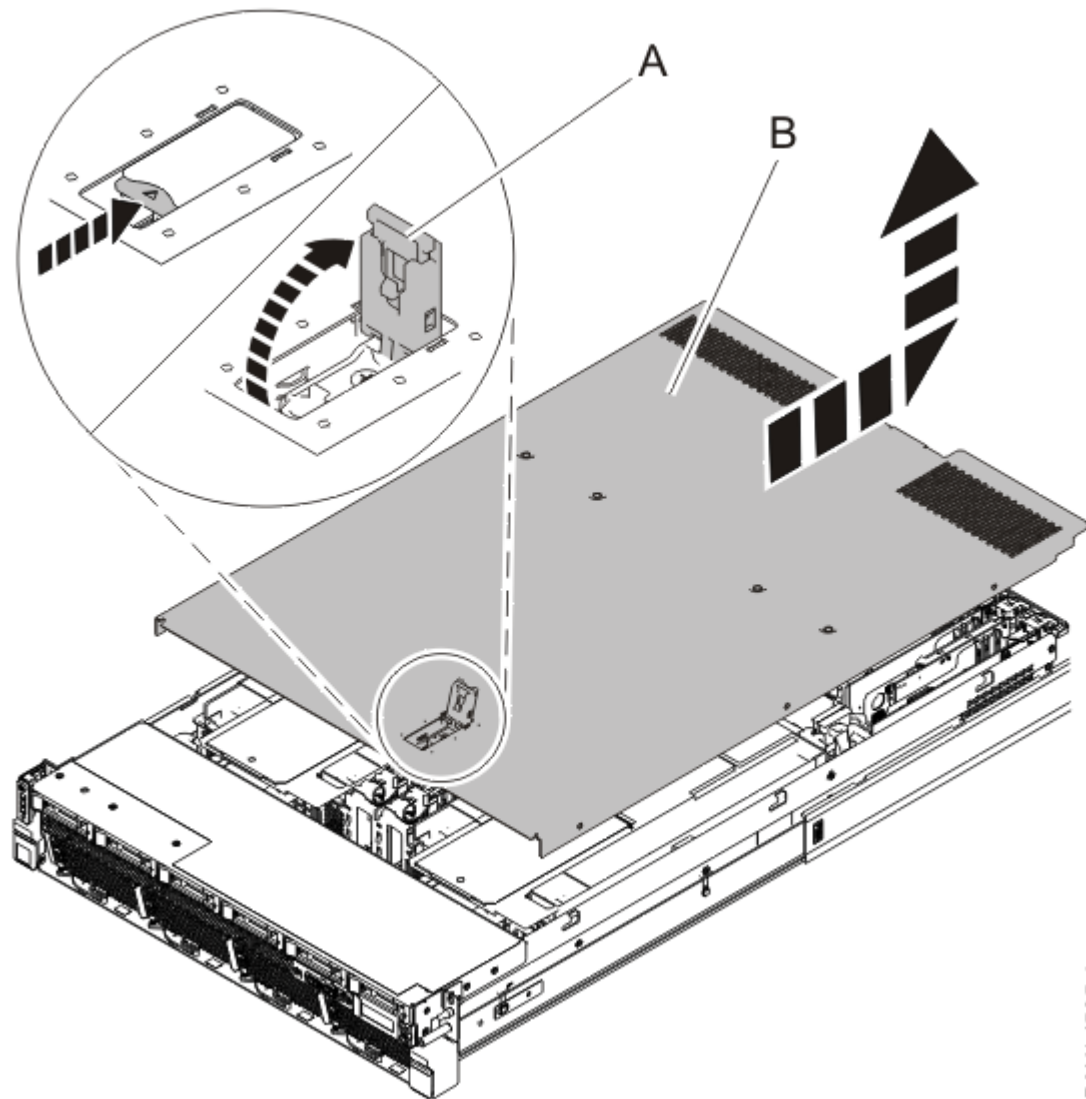


Figure 6. Location of the ESD plugs on an 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

- d) Release the service access cover latch by pushing the release latch **(A)** in the direction shown.
- e) Slide the cover **(B)** off the system unit. When the front of the service access cover clears the upper frame ledge, lift the cover up and off the system unit.



**Attention:** Operating the system without the service access cover on for more than 10 minutes when the system power is turned on might damage the system components.



P9HAJ505-1

*Figure 7. Removing the service access cover*

- f) Open the hinged access door **(A)** on the air baffle above the slot you want to access.

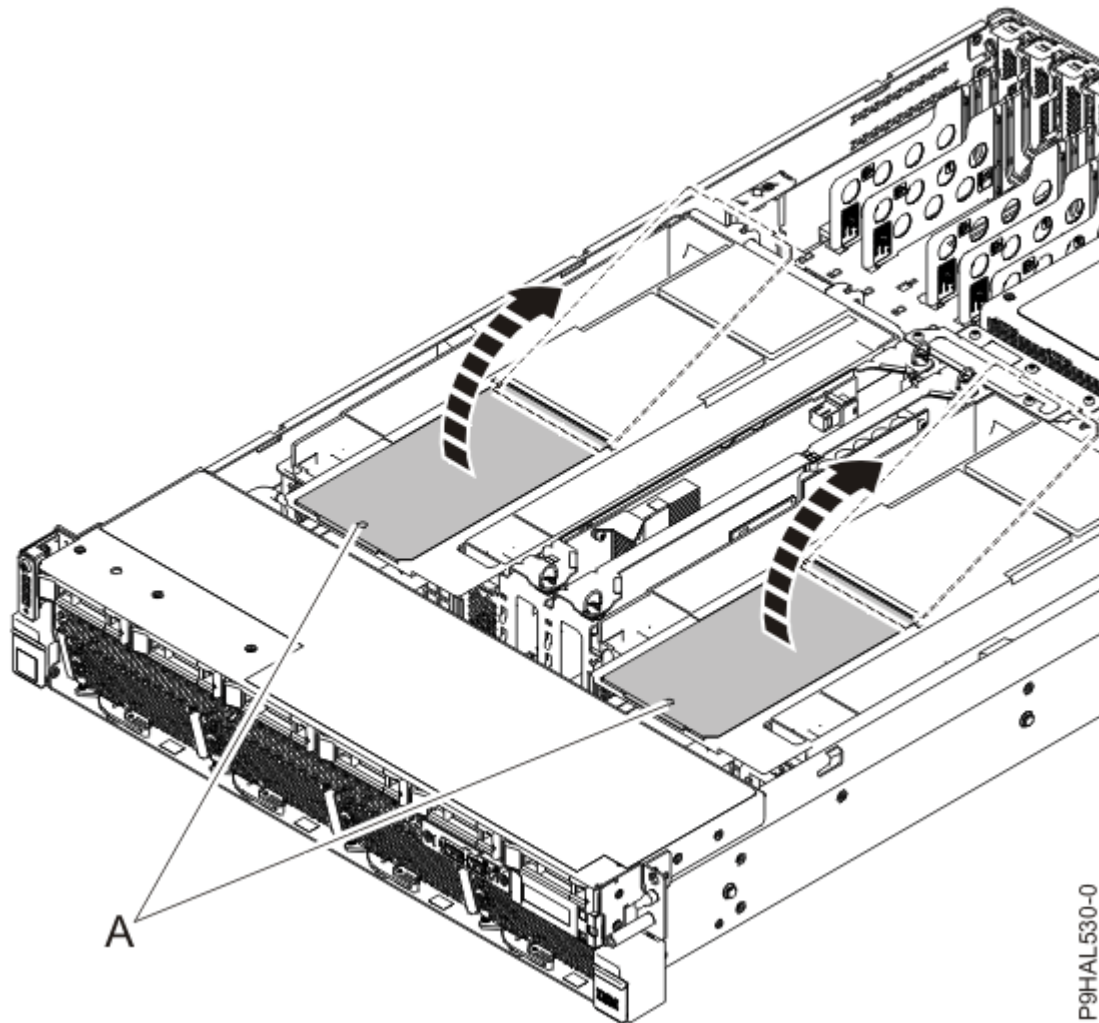


Figure 8. Opening the hinged access doors on the air baffles in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

14. Find the package that contains the new drive.



**Attention:** Drives are fragile. Handle with care.

15. Choose from the following options:

- a) If you are installing drives in the front of the system, go to step [“16” on page 13](#).
- b) If you are installing internal drives, go to step [“17” on page 14](#).

16. Attach the electrostatic discharge (ESD) wrist strap. Your system has an ESD jack on the front and on the rear of the system. Plug the ESD wrist strap into the ESD jack.



**Attention:**

- Attach an electrostatic discharge (ESD) wrist strap to the front ESD jack, to the rear ESD jack, or to an unpainted metal surface of your hardware to prevent the electrostatic discharge from damaging your hardware.
- When you use an ESD wrist strap, follow all electrical safety procedures. An ESD wrist strap is used for static control. It does not increase or decrease your risk of receiving electric shock when using or working on electrical equipment.

- If you do not have an ESD wrist strap, just prior to removing the product from ESD packaging and installing or replacing hardware, touch an unpainted metal surface of the system for a minimum of 5 seconds.

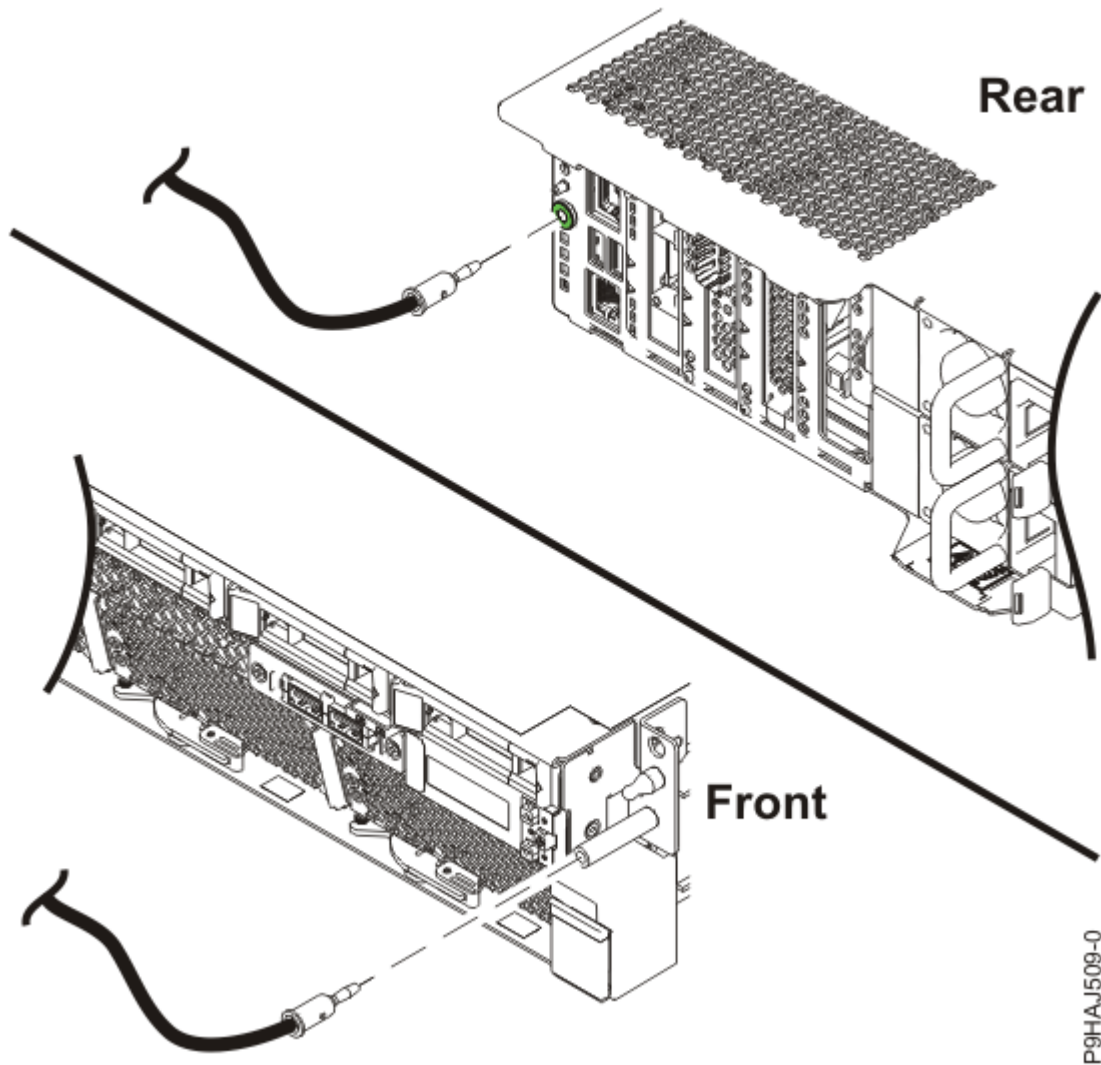


Figure 9. Location of the ESD plugs on an 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

17. Remove the drive from the static-protective package and place it on an ESD mat.

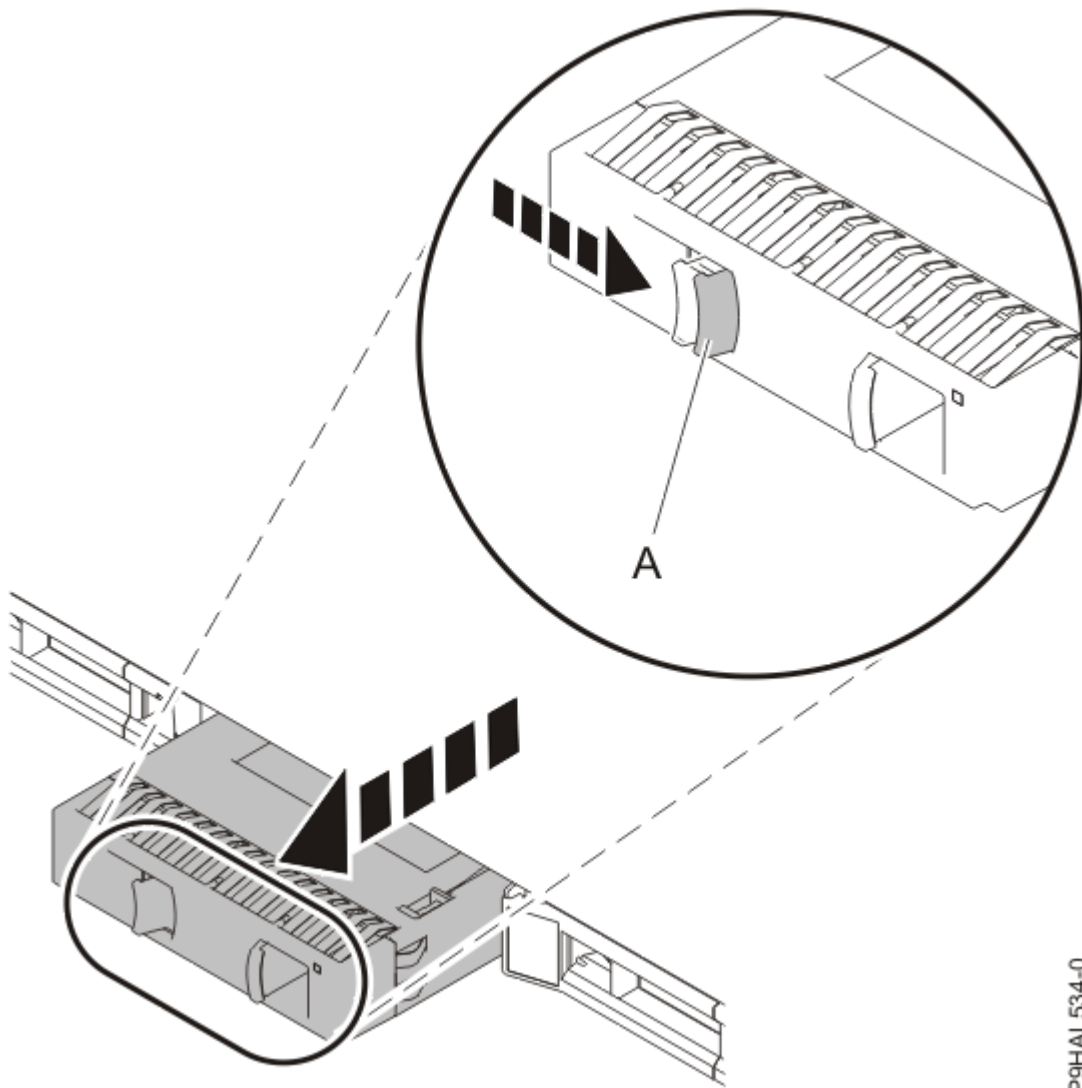
### Installing a disk drive or solid-state drive in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

To install a disk drive or solid-state drive (SSD) in the system, complete the steps in this procedure.

#### Procedure

1. Ensure that you have the electrostatic discharge (ESD) wrist strap on and that the ESD clip is plugged into a ground jack or connected to an unpainted metal surface. If not, do so now.
2. If the slot you want to use contains a drive filler, remove the drive filler from the slot.
  - a. Press the lock **(A)** on the handle of the filler in the direction that is shown.
  - b. Hold the handle and pull out the filler from the slot.

**Note:** The internal slots do not have fillers.

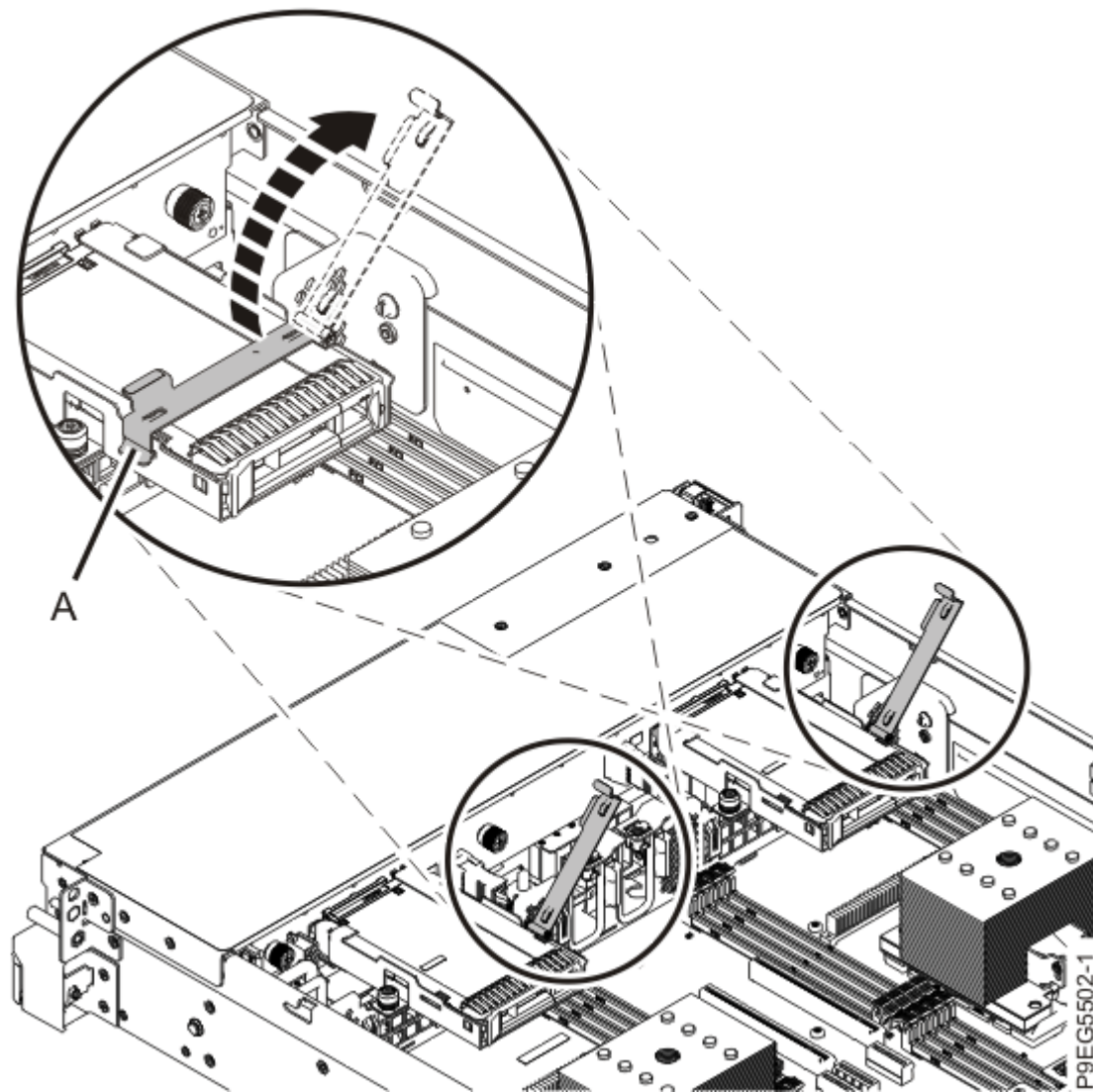


P9HAL534-0

*Figure 10. Removing a drive filler*

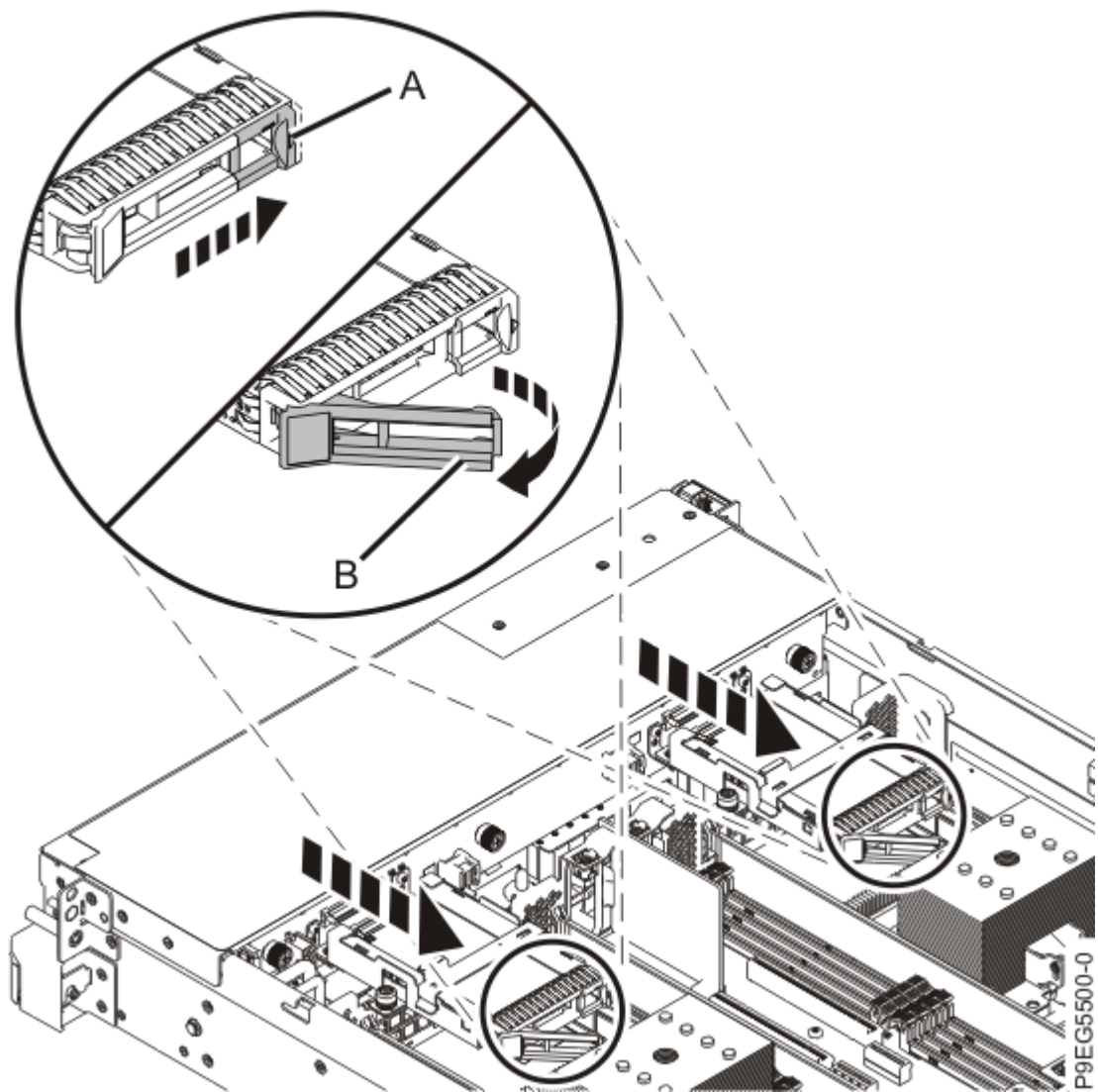
3. Choose from the following options:
  - If the system power is turned off, continue with step [“4” on page 15](#).
  - If the system power is turned on and if the AIX operating system controls the slot, continue with step [“9” on page 21](#).
  - If the system power is turned on and if the IBM i operating system controls the slot, continue with step [“14” on page 26](#).
  - If the system power is turned on and if the Linux operating system controls the slot, continue with step [“19” on page 31](#).
4. To install a drive in a system when the system power is turned off, choose from the following options:
  - To install a drive in slot P2-D7 or P2-D8 inside the system, continue with step [“5” on page 15](#).
  - To install a drive in slots P2-D1 through P2-D6 on the front of the system, continue with step [“7” on page 20](#).
5. To install a drive in slot P2-D7 or P2-D8 inside the system when the system is powered off, complete the following steps:
  - a) Open the drive holder lever **(A)**.



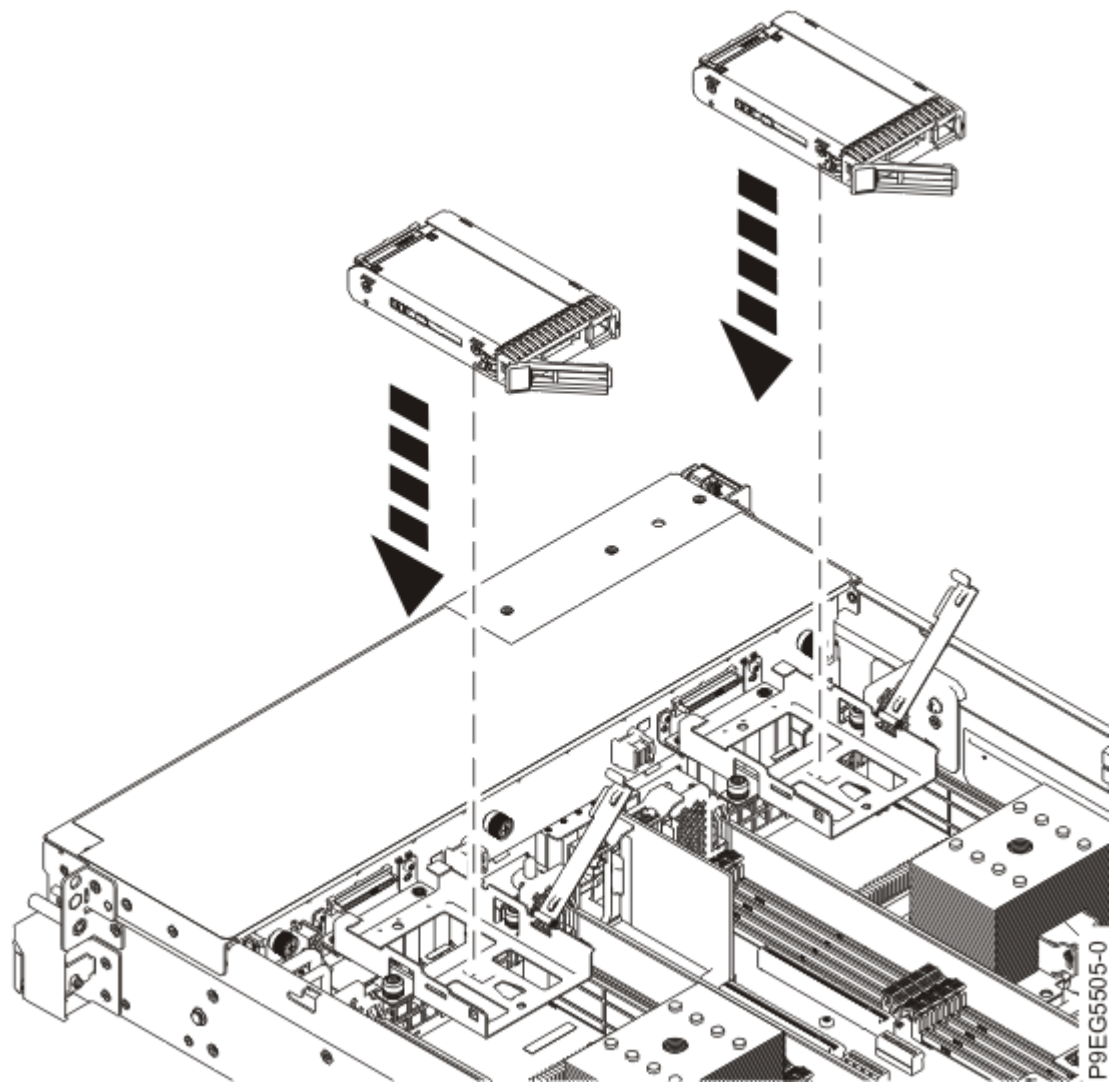


*Figure 11. Opening the drive holder lever*

- b) Unlock the drive handle (**B**) by pressing the handle release latch (**A**) in the direction that is shown, and pulling out the handle toward you.



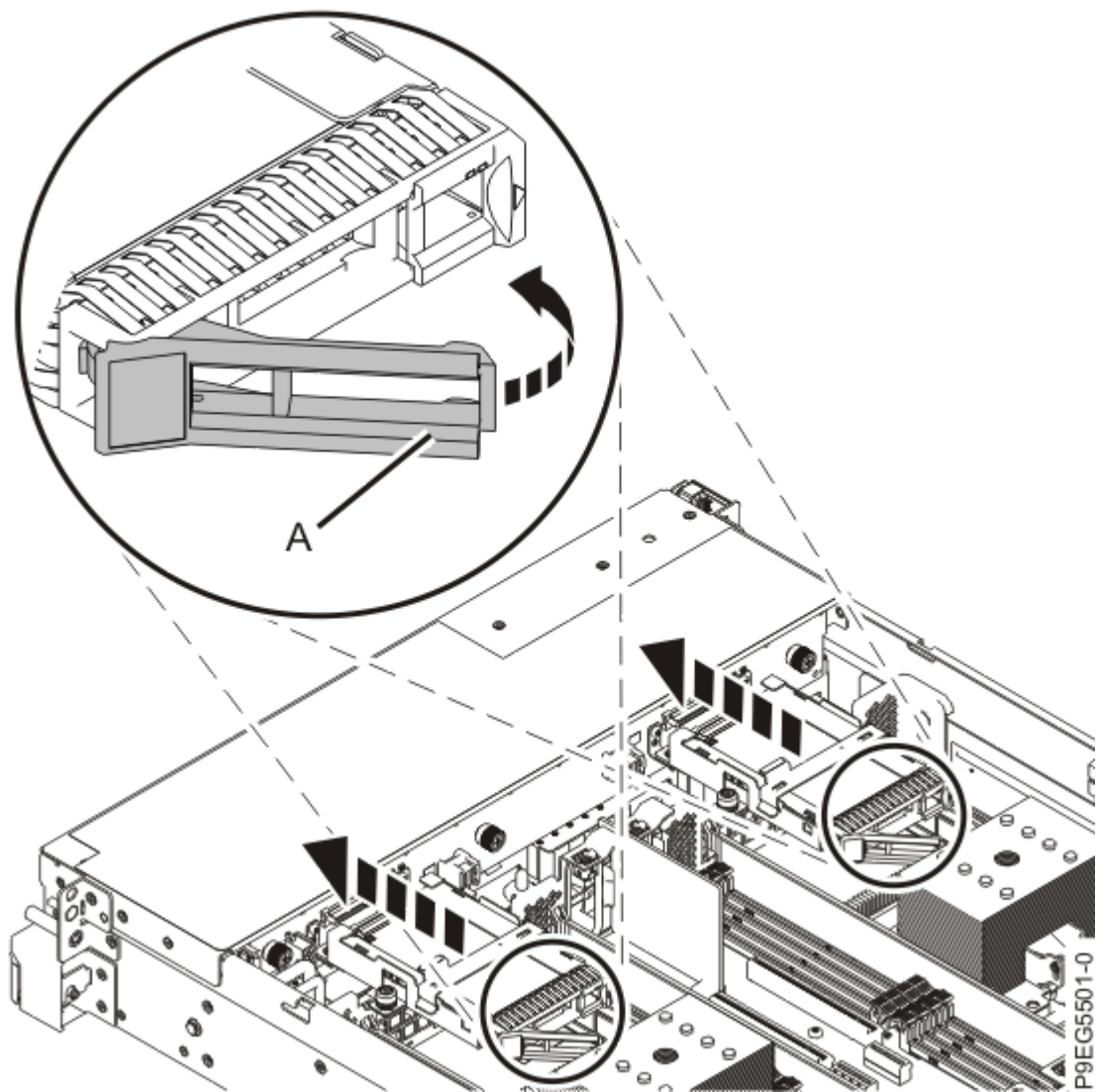
*Figure 12. Unlatching the drive handle*  
c) Lower the drive into the drive tray.



*Figure 13. Lowering the drive into the drive tray*

- d) Slide the drive forward by using the drive handle until it contacts the disk drive backplane.
- e) Push drive handle **(A)** until the drive is fully seated and the drive handle locks.





*Figure 14. Locking the drive handle*

f) Close the drive holder lever **(A)** over the drive.

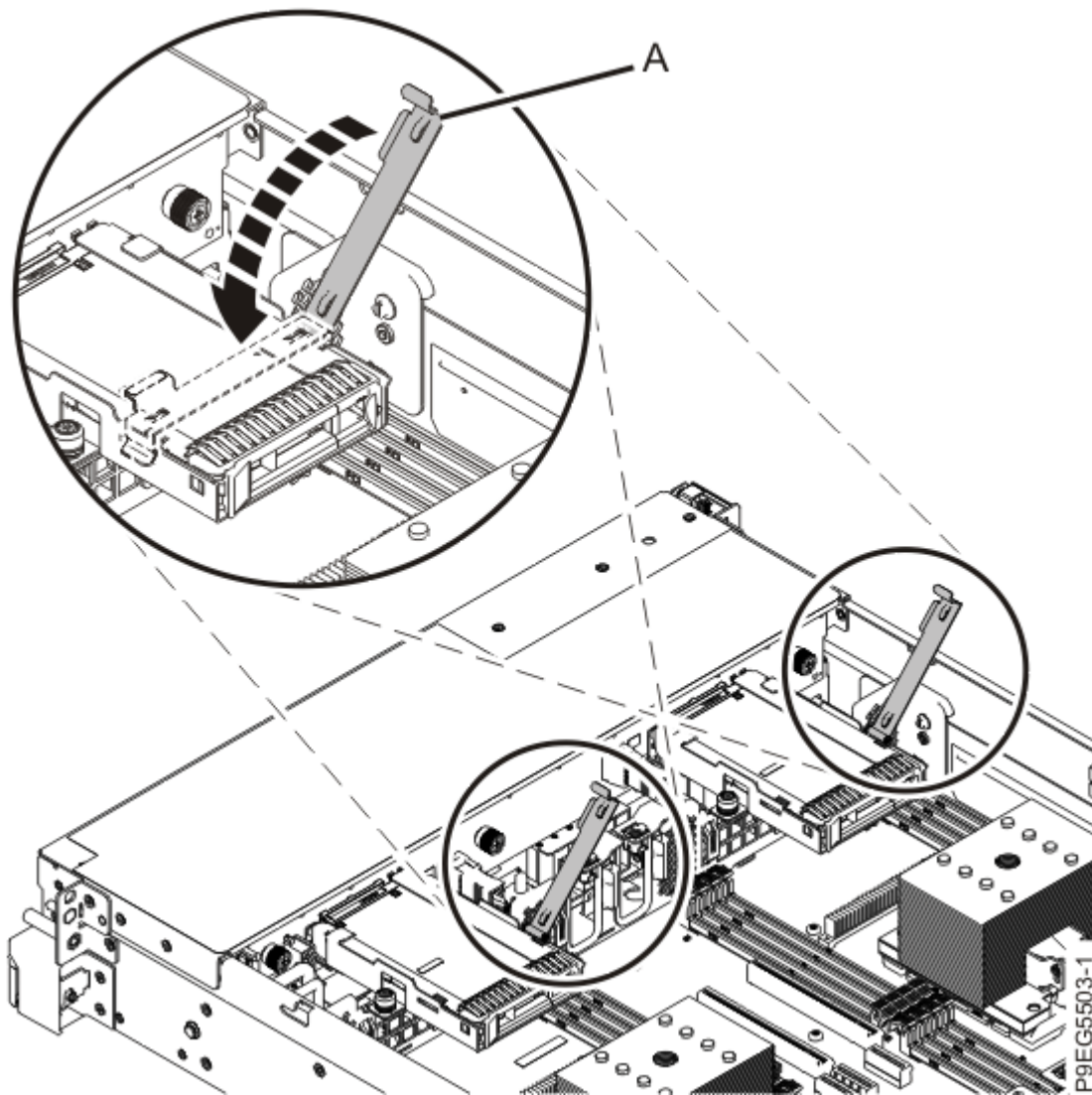
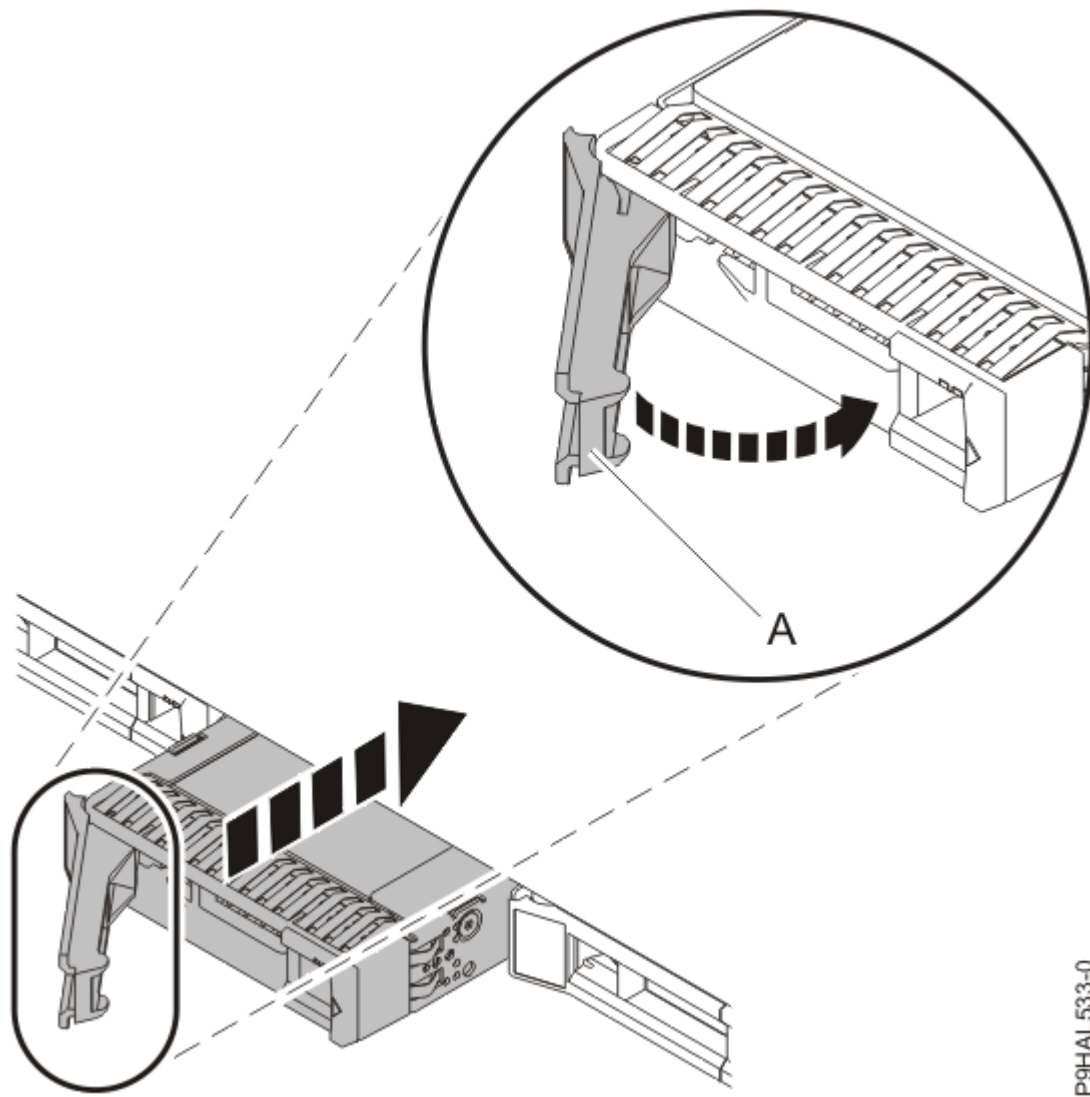


Figure 15. Closing the drive holder lever

6. Continue with step “23” on page 36.

7. To install or replace a drive in the front of a system when the system is powered off, complete the following steps:

- a) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle toward you. If the handle is not all the way out, the drive does not slide into the system.
- b) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.
- c) Slide the drive all the way into the system.
- d) Push the drive bay handle (**A**) in until it locks.



P9HAL533-0

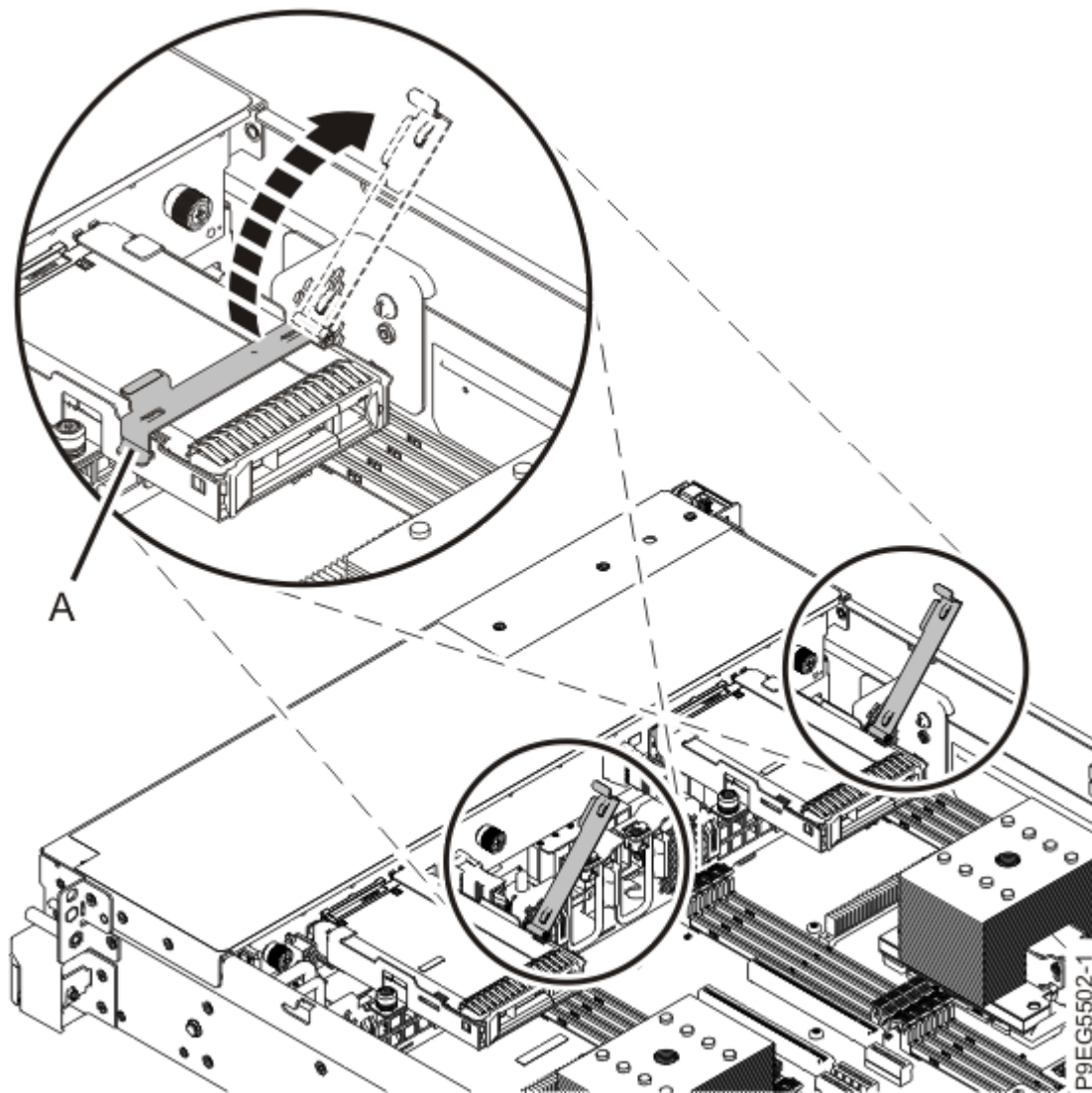
Figure 16. Installing a drive in a system

**Important:** Ensure that the drive is fully seated and is all the way into the system.

8. Continue with step “23” on page 36.
9. To install a drive in a system when the system is powered on and by using the AIX operating system, choose from the following options:
  - To install a drive inside the system, continue with step “10” on page 21.
  - To install a drive in the front of the system, continue with step “12” on page 25.
10. To install or replace a drive in slot P2-D7 or P2-D8 inside of the system by using the AIX operating system, complete the following steps:

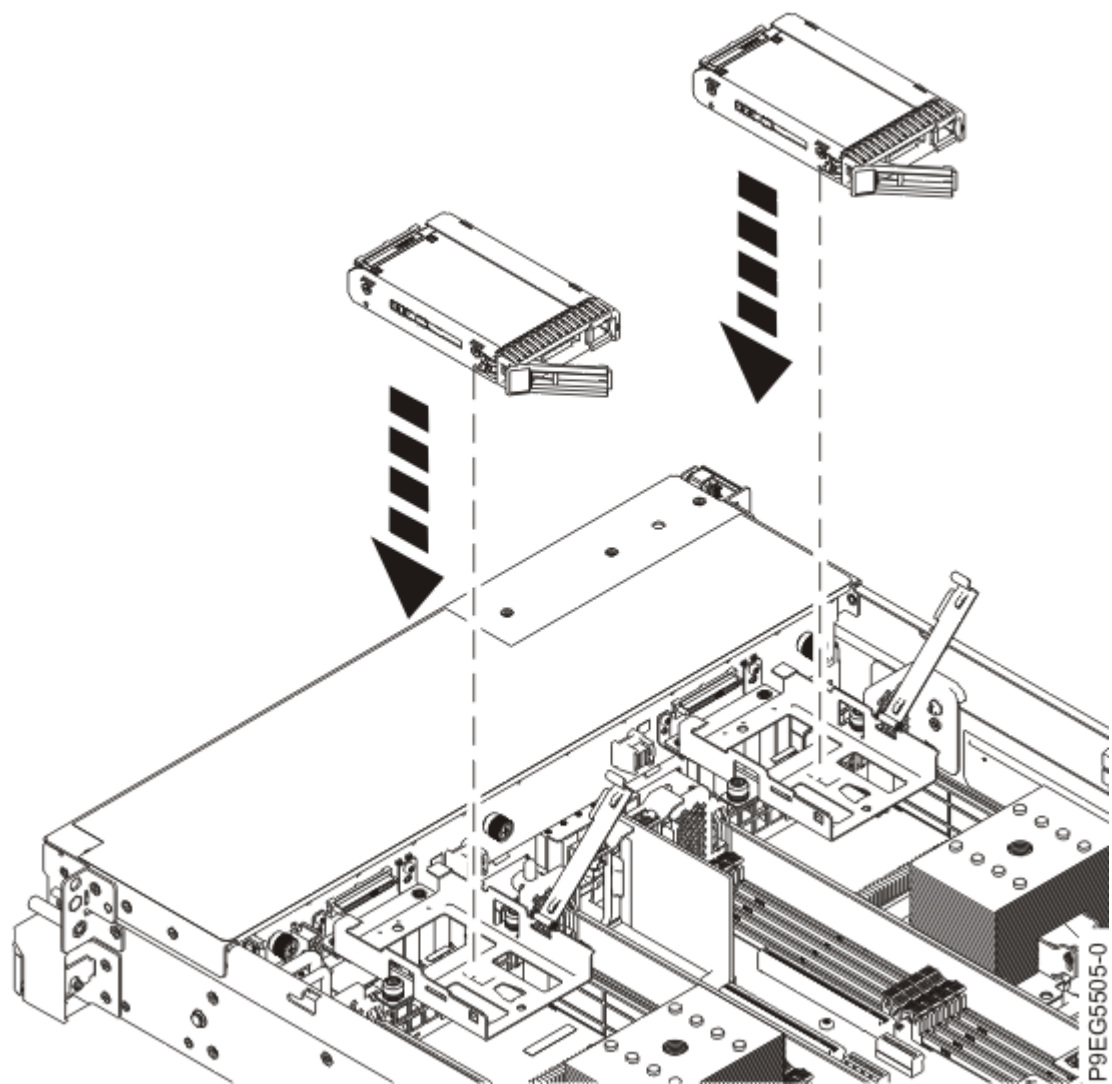
**Important:** During this procedure, you need to work with the system administrator to indicate on the console that you want to remove the drive. If this process exceeds the 10-minute service limitation with the system access cover removed and with the system power turned on, place the service access cover back on the system before you work with the system administrator to maintain proper system cooling.

- a) Open the drive holder lever **(A)**.



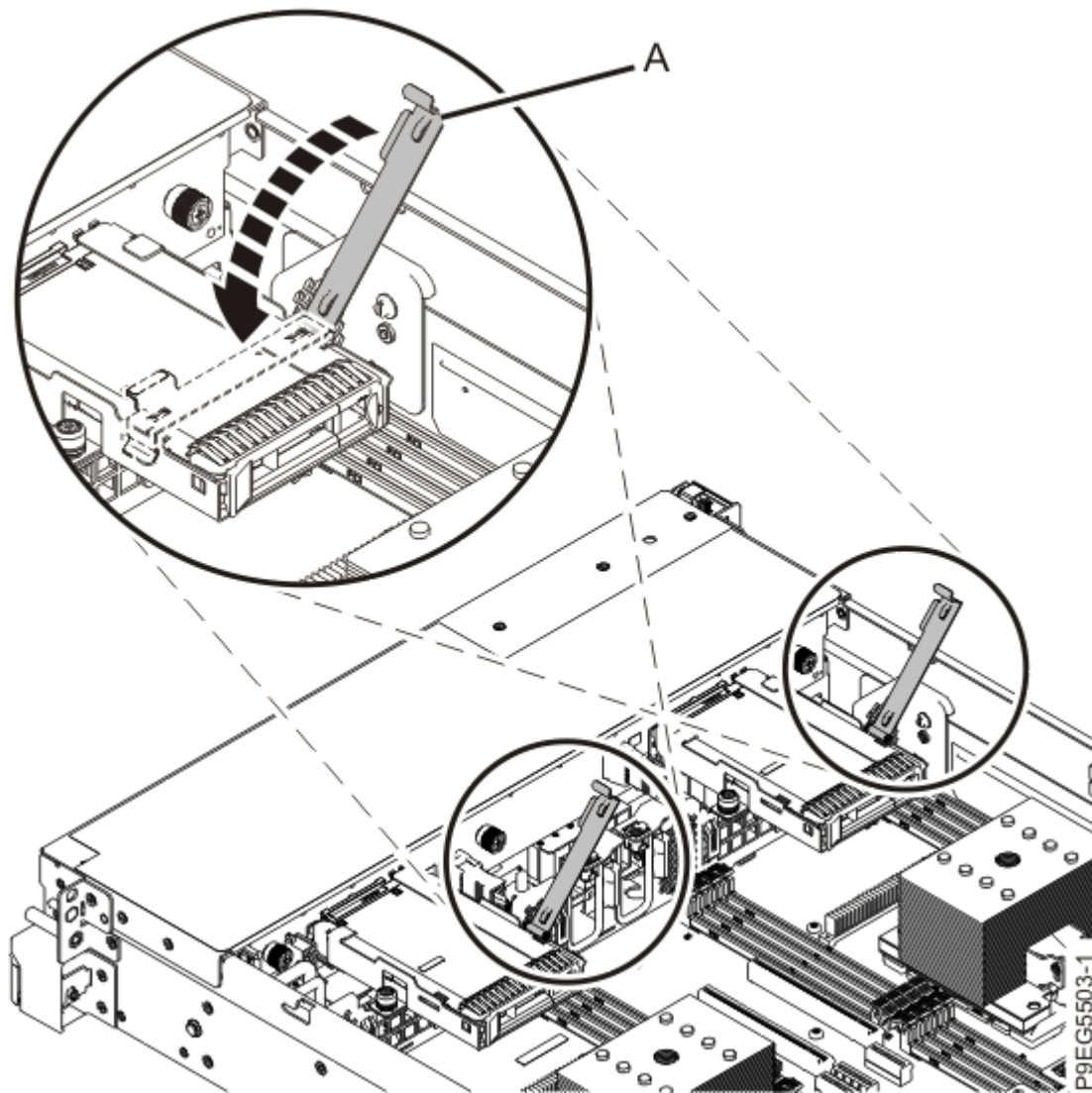
*Figure 17. Opening the drive holder lever*

- b) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
- c) Lower the drive into the drive tray.



*Figure 18. Lowering the drive into the drive tray*  
d) Close the drive holder lever **(A)** over the drive.





*Figure 19. Closing the drive holder lever*

- e) When the identify LED turns on solid, use the drive handle to slide the drive all the way into the system. When the drive is seated in the disk drive backplane, push in the drive handle **(A)** until it locks.

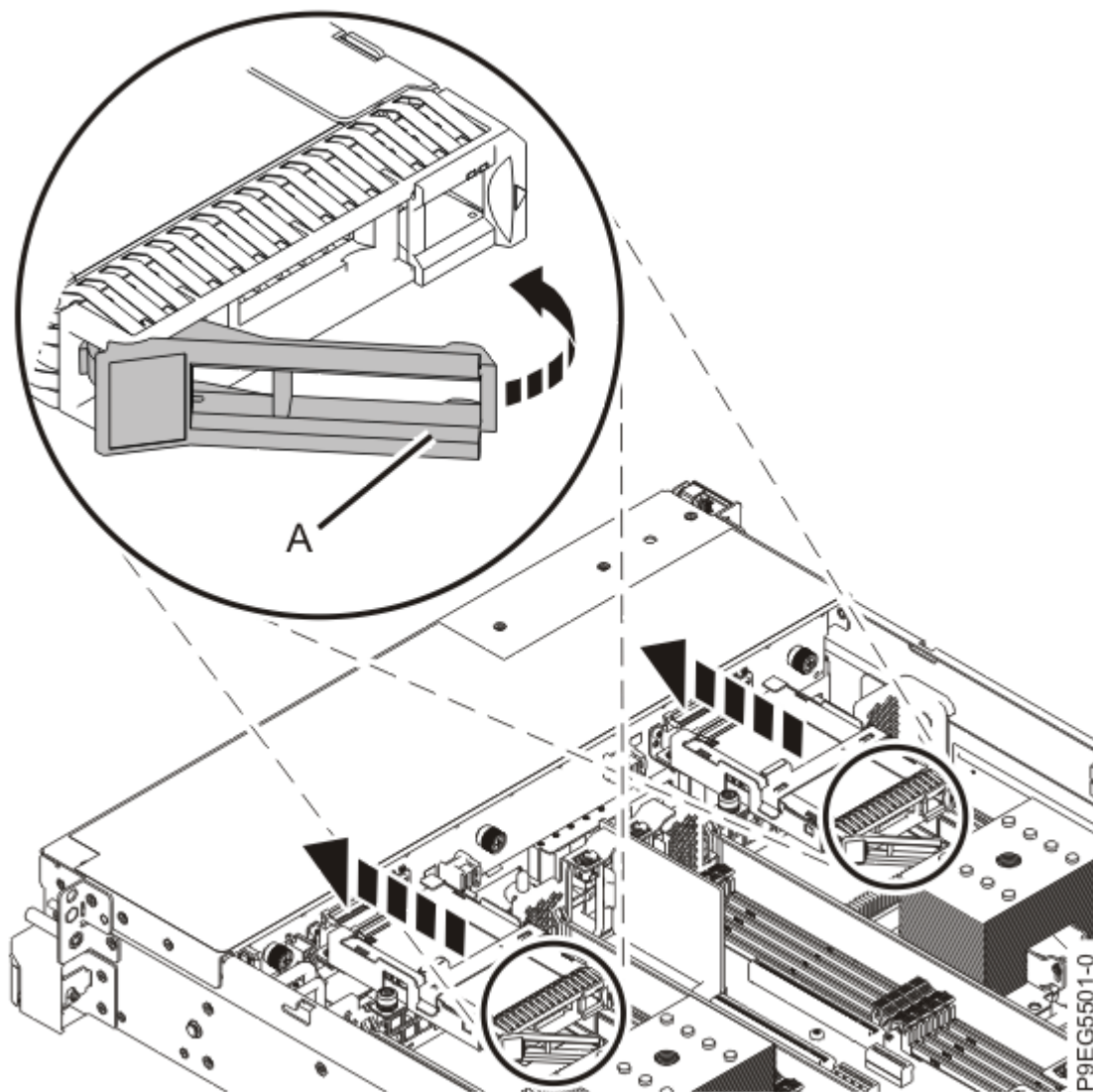
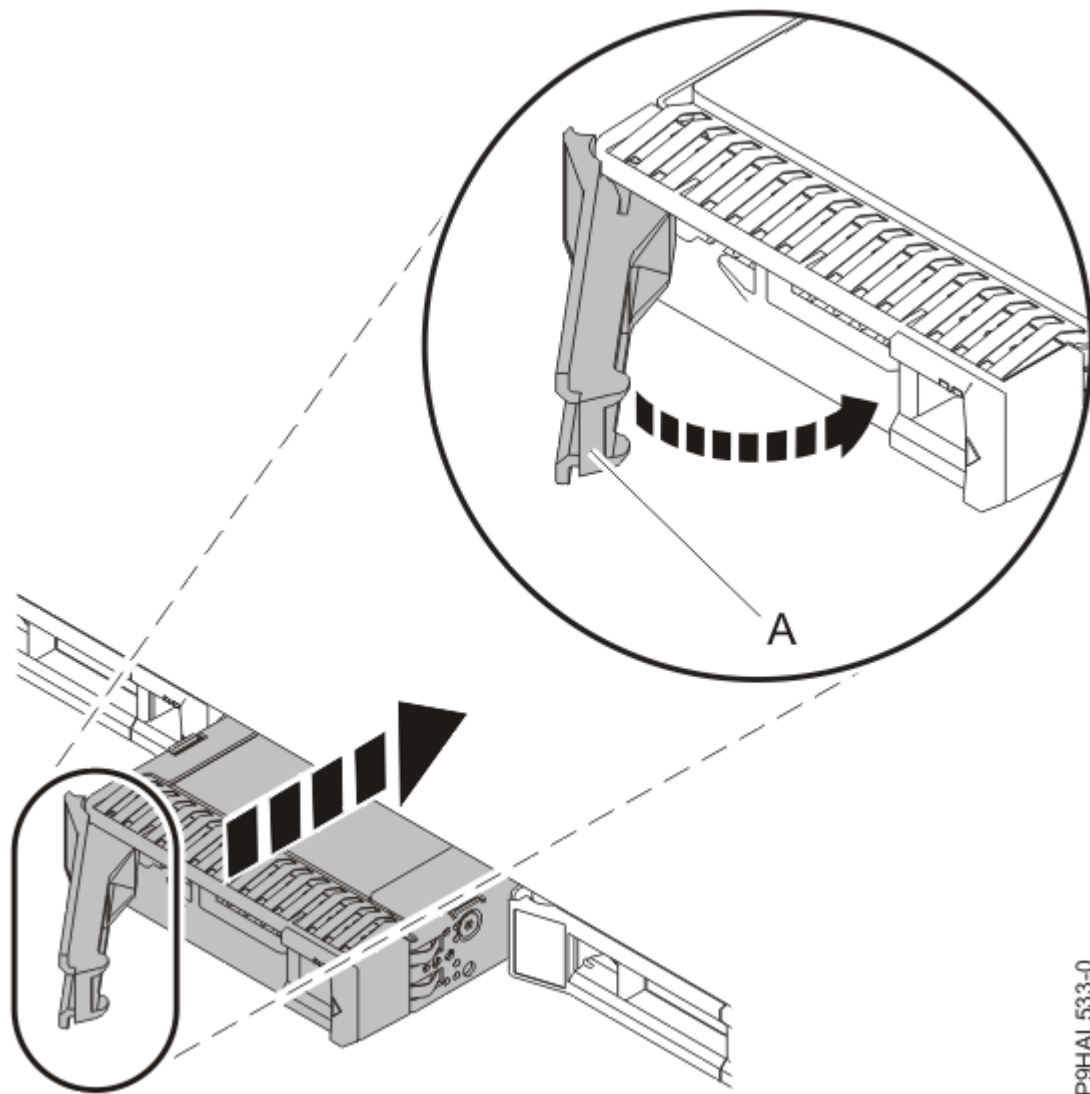


Figure 20. Locking the drive handle

- f) Press Enter on the console to indicate that you installed the drive.
- 11. Continue with step “23” on page 36.
- 12. To install or replace a drive in the front of the system or enclosure by using the AIX operating system, complete the following steps:
  - a) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
  - b) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.
  - c) Slide the drive all the way into the system, and push in the drive handle (**A**) until it locks.



P9HAL533-0

Figure 21. Installing a drive in a system

**Important:** Ensure that the drive is fully seated and is all the way into the system.

d) Press Enter on the console to indicate that you installed the drive.

13. Continue with step “23” on page 36.

14. To install a drive in a system when the system is powered on and by using the IBM i operating system, choose from the following options:

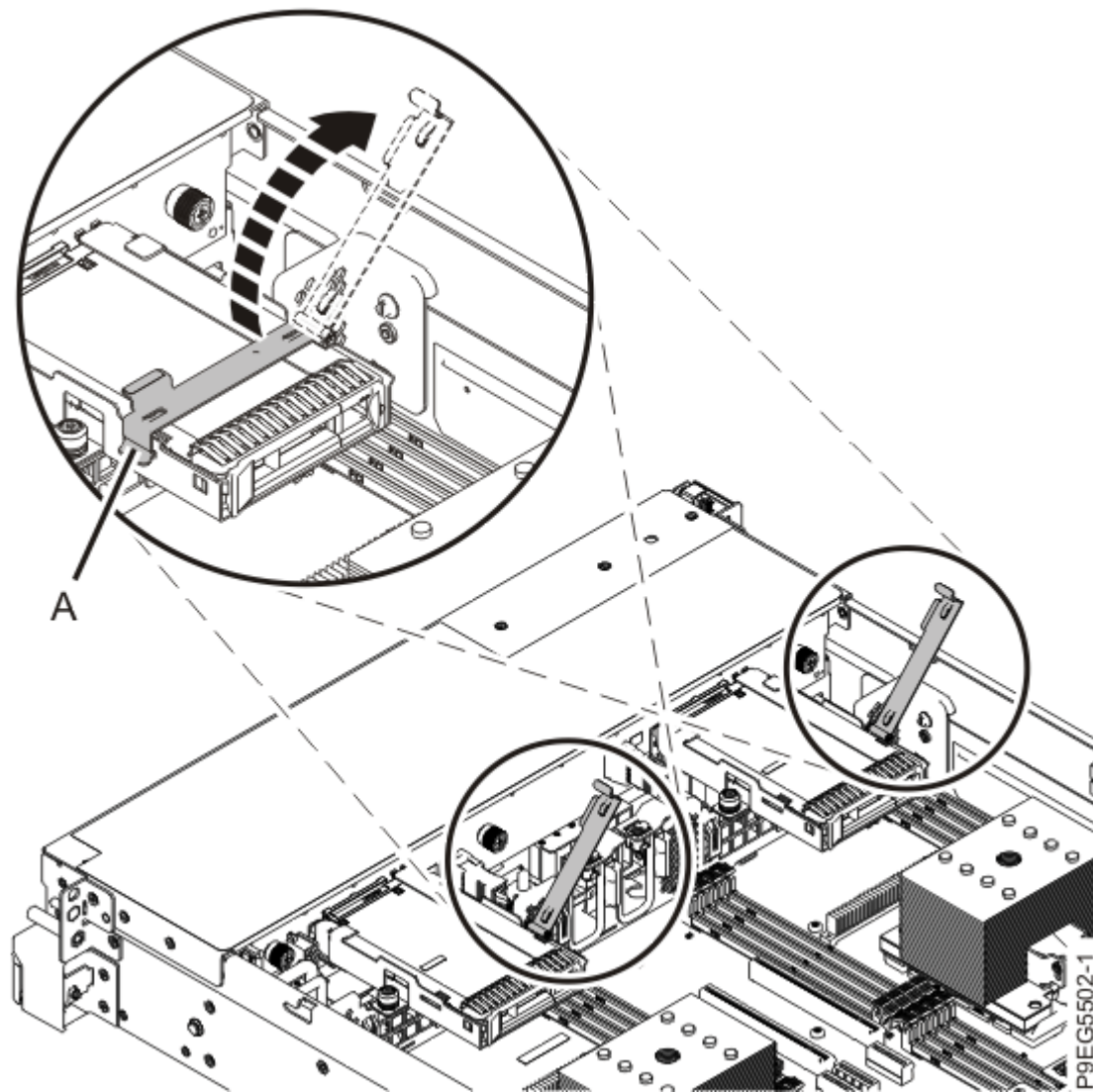
- To install a drive inside the system, continue with step “15” on page 26.
- To install a drive in the front of the system, continue with step “17” on page 30.

15. To install a drive in slot P2-D7 or P2-D8 inside the system when the system is powered on and by using the IBM i operating system, complete the following steps:

**Important:** During this procedure, you need to work with the system administrator to indicate on the console that you want to remove the drive. If this process exceeds the 10-minute service limitation with the system access cover removed and with the system power turned on, place the service access cover back on the system before you work with the system administrator to maintain proper system cooling.

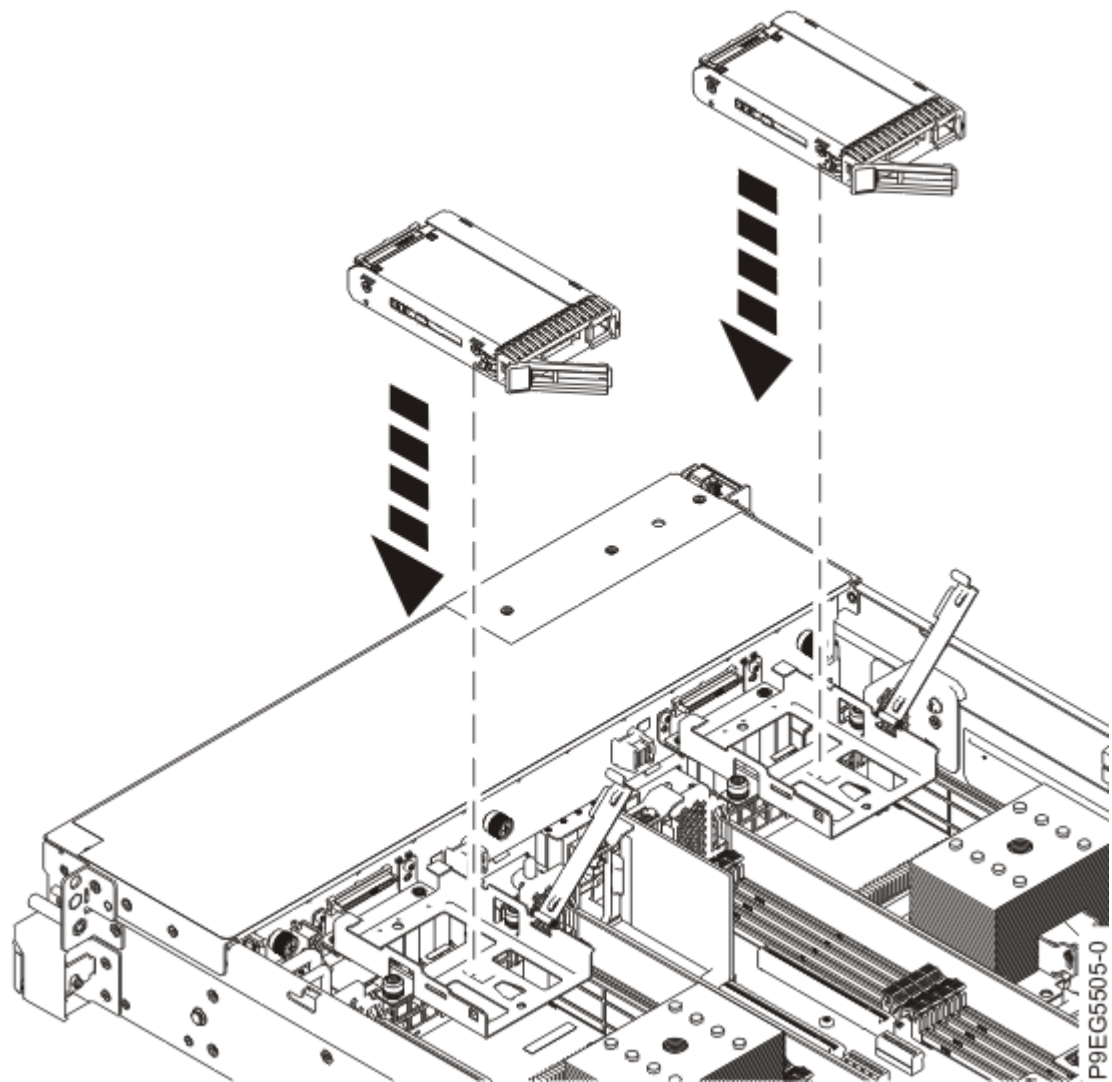
a) Open the drive holder lever (**A**).





*Figure 22. Opening the drive holder lever*

- b) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
- c) Lower the drive into the drive tray.



*Figure 23. Lowering the drive into the drive tray*  
d) Close the drive holder lever **(A)** over the drive.

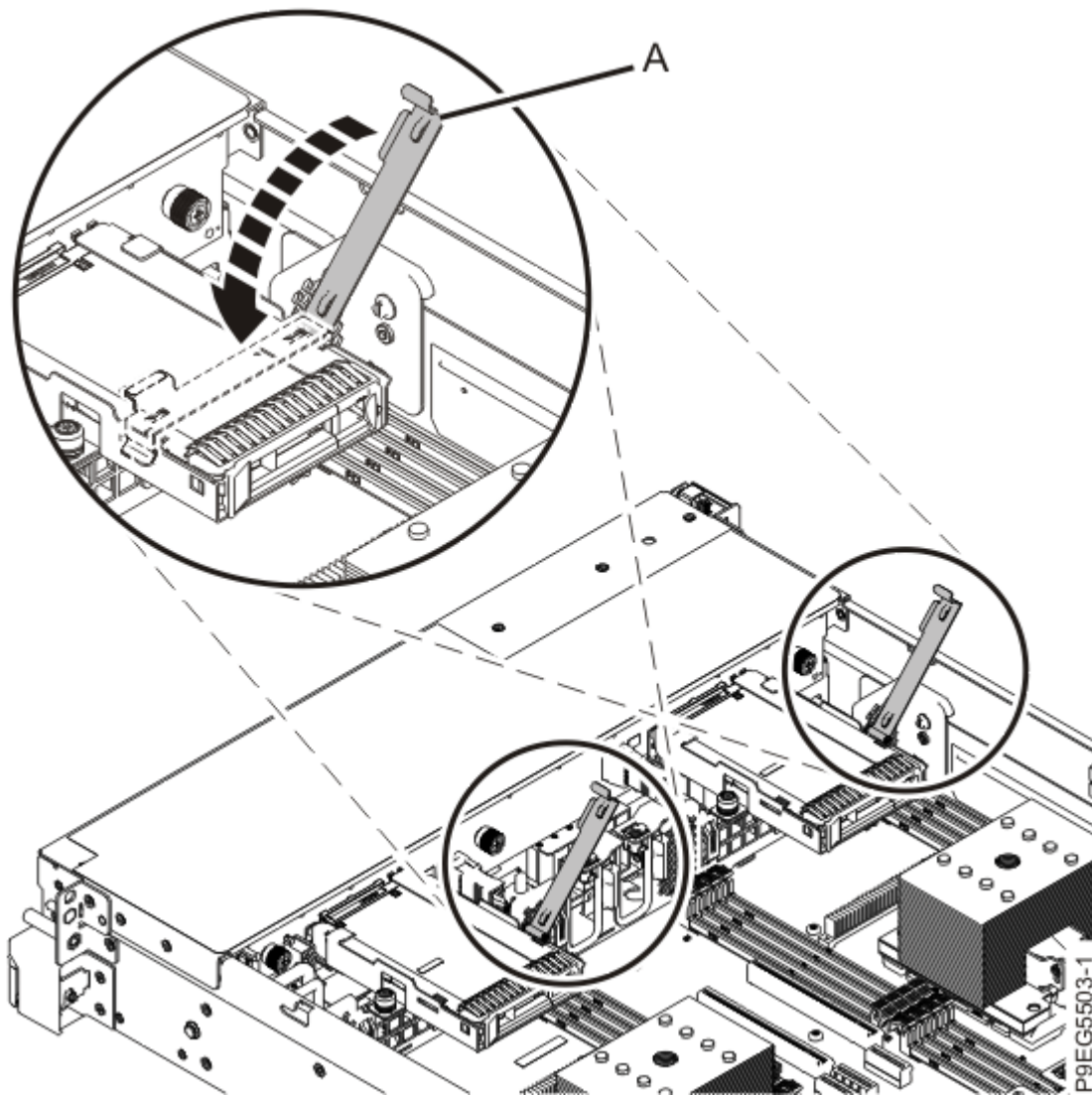


Figure 24. Closing the drive holder lever

- e) Return to the Hardware service manager (HSM) display and select the slot where you want to install the drive.
- f) Press **Enter** on the console.

**Important:** When you press **Enter**, after your selected time delay, the service indicator light turns on (solid) for 18 seconds. You then have 18 seconds to slide the drive all the way in and then to lock it in place by pushing in the drive handle. You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the disk drive or solid-state drive.

- g) When the identify LED turns on solid, use the drive handle to slide the drive all the way into the system, and push in the drive handle **(A)** until it locks.

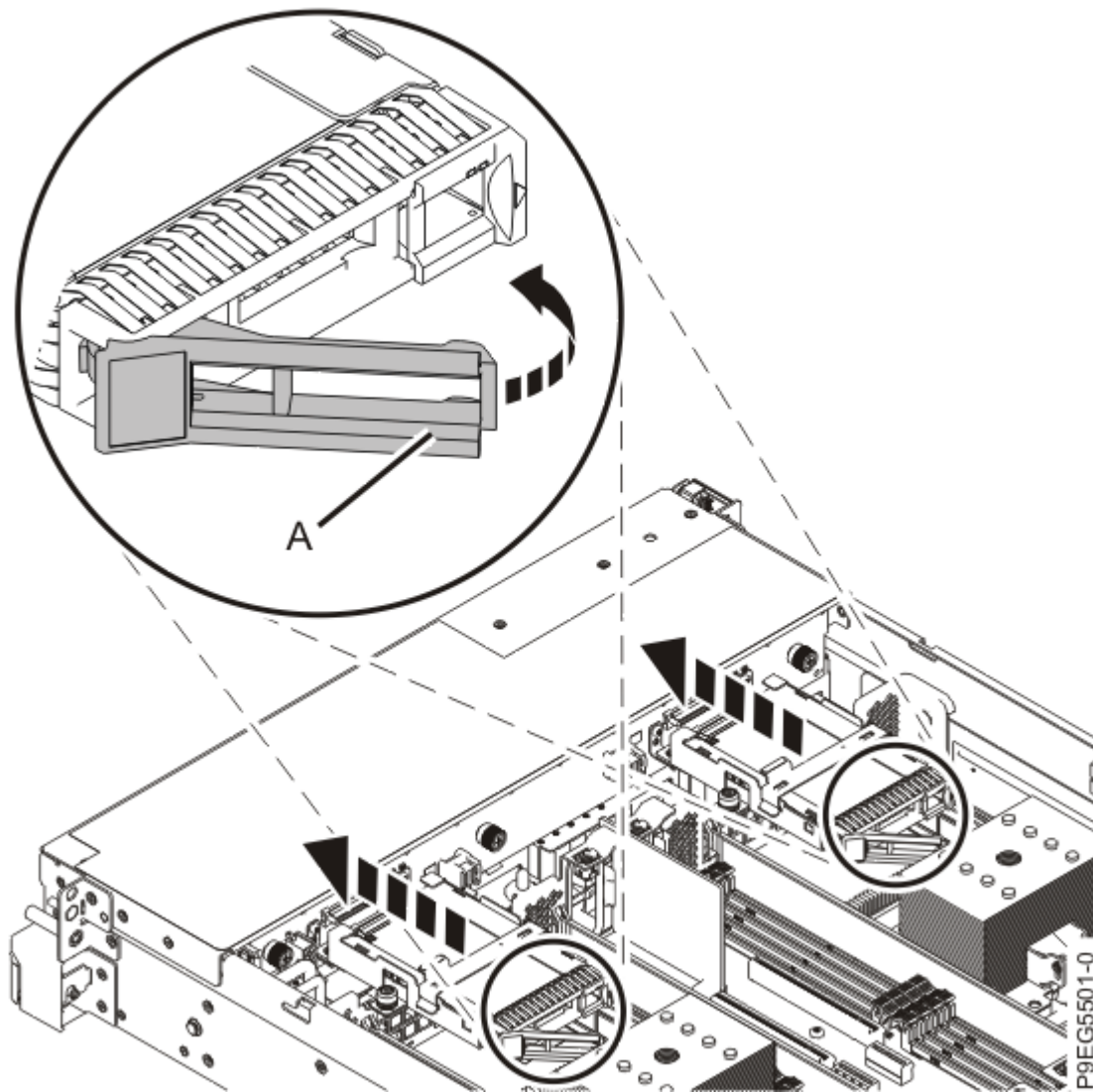
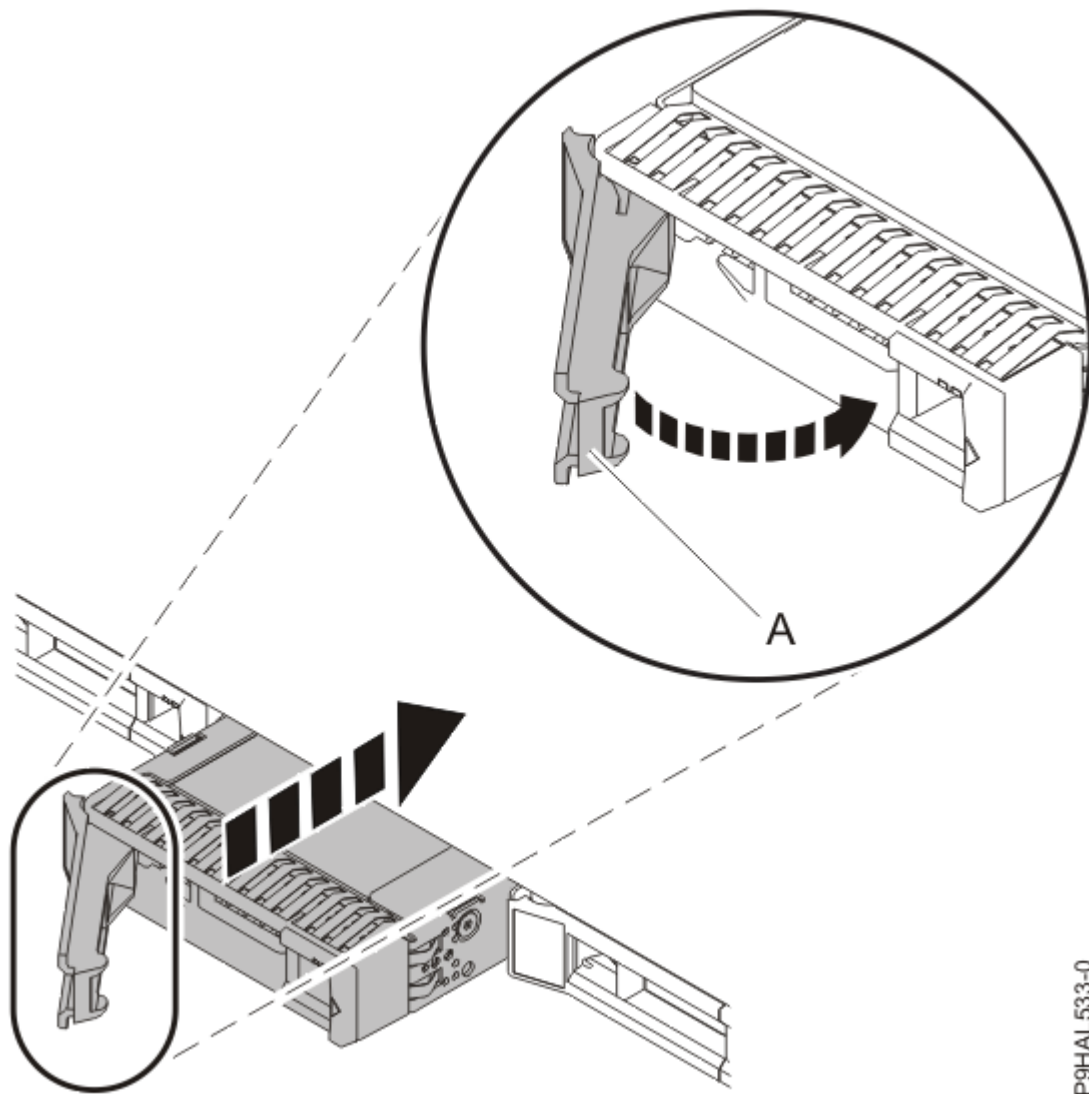


Figure 25. Locking the drive handle

- h) On the console, press Enter to indicate that you installed the drive.
- 16. Continue with step “23” on page 36.
- 17. To install a drive in the front of the system or enclosure by using the IBM i operating system, complete the following steps:
  - a) Unlock the drive bay handle **(A)** by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
  - b) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.
  - c) Slide the drive halfway into the system.
  - d) Select the drive that you want to install in the HSM display.
  - e) Press Enter on the console.

**Important:** When you press Enter, after your selected time delay, the service indicator light turns on (solid) for 18 seconds. You then have 18 seconds to slide the drive all the way in and then lock it in place by pushing in the drive handle. You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the disk drive or solid-state drive.

  - f) When the identify LED turns on solid, slide the drive all the way into the system, and push in the drive handle **(A)** until it locks.



P9HAL533-0

Figure 26. Installing a drive in a system

**Important:** Ensure that the drive is fully seated and is all the way into the system.

g) Press Enter on the console to indicate that you installed the drive.

18. Continue with step “23” on page 36.

19. To install a drive in a system when the system is powered on and by using the Linux operating system, choose from the following options:

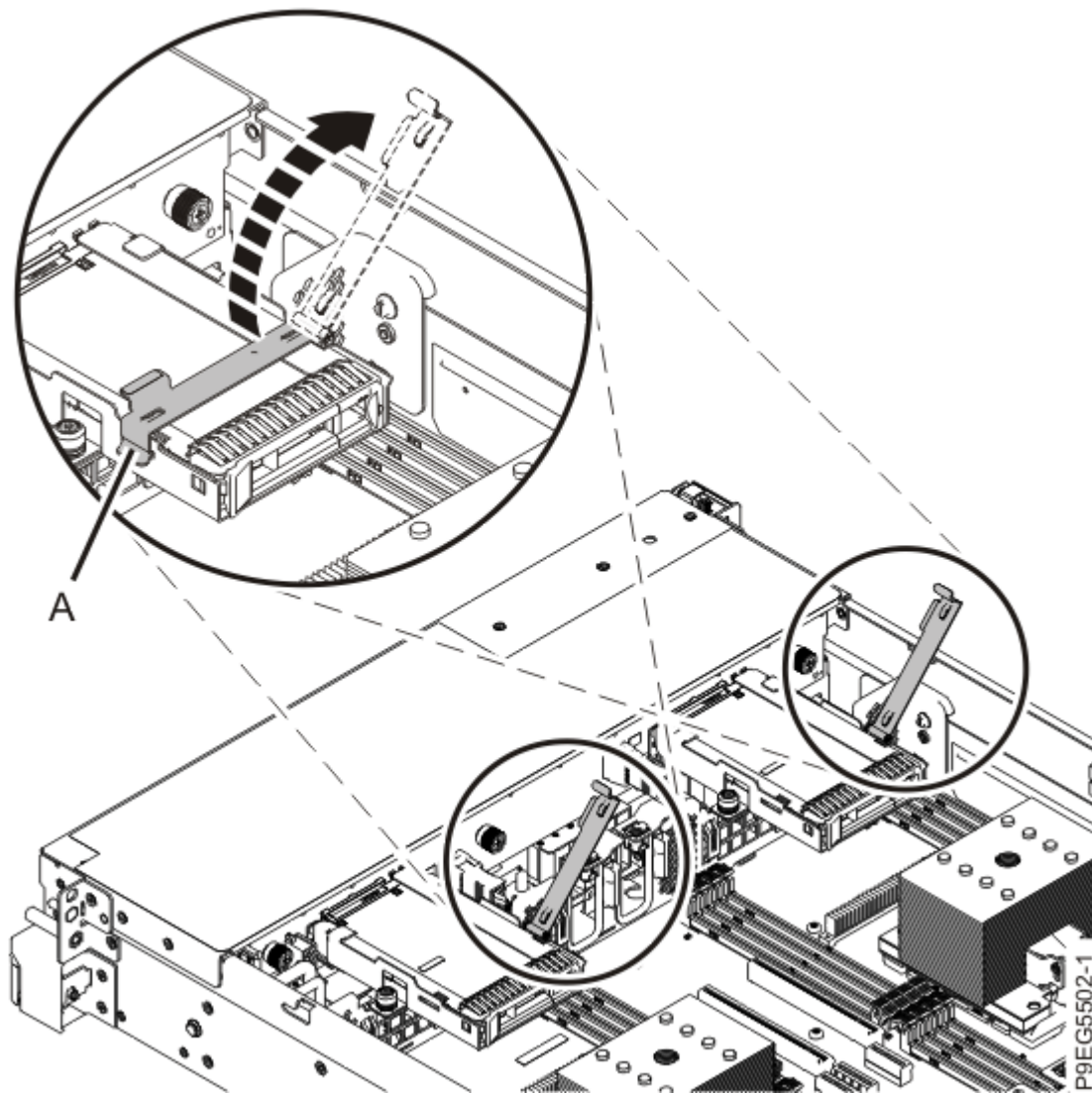
- To install a drive inside the system, continue with step “20” on page 31.
- To install a drive in the front of the system, continue with step “22” on page 35.

20. To install a drive in slot P2-D7 or P2-D8 inside the system when the system is powered on and by using the Linux operating system, complete the following steps:

**Important:** During steps “20.e” on page 34 - “20.g” on page 35, you will need to work with the system administrator to indicate via the Linux console that you want to install the drive. If this process will exceed the 10 minute service limitation with the system access cover removed and with the system power turned on, place the service access cover back on the system prior to working with the system administrator to maintain proper system cooling.

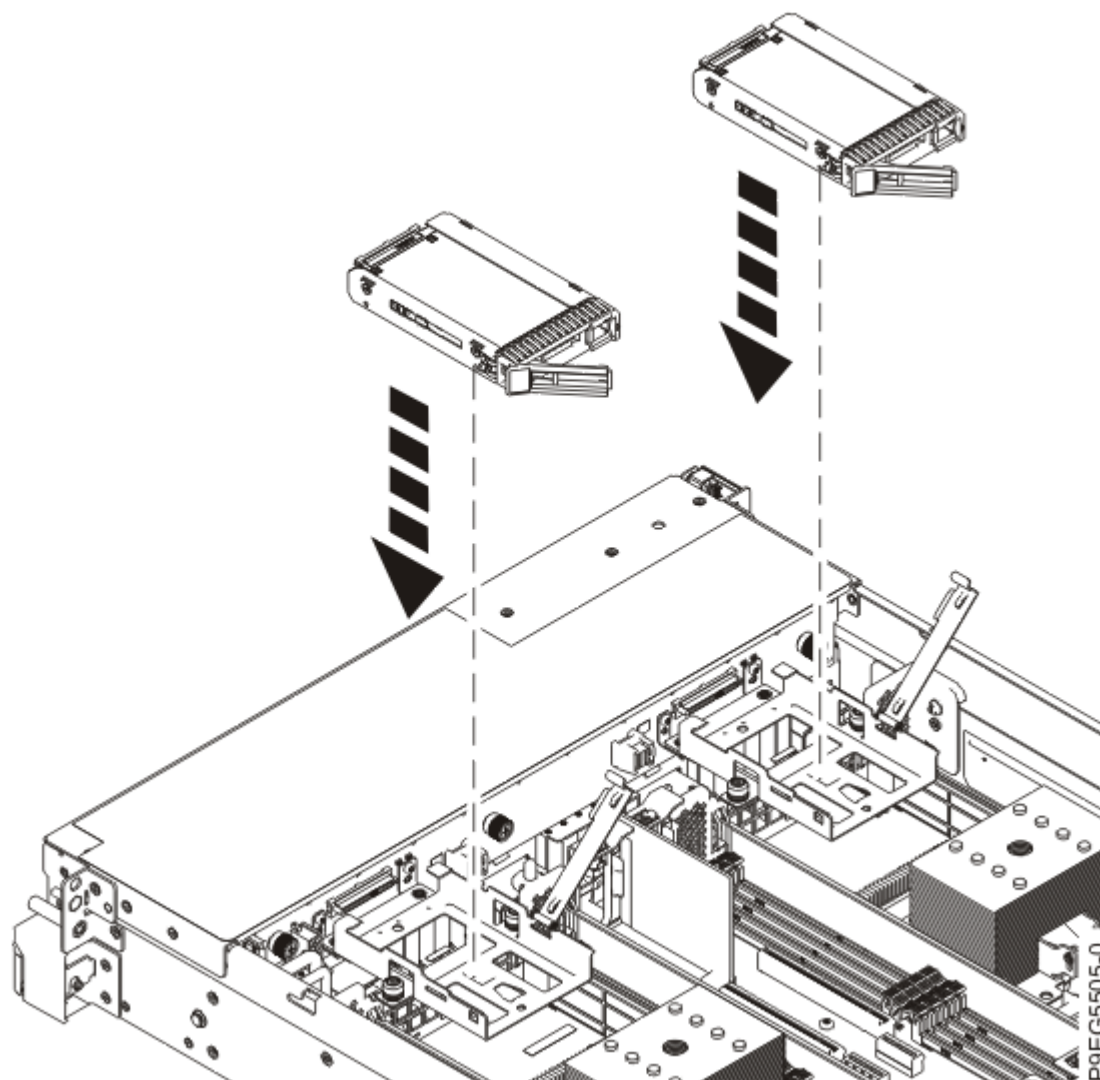
a) Open the drive holder lever (A).



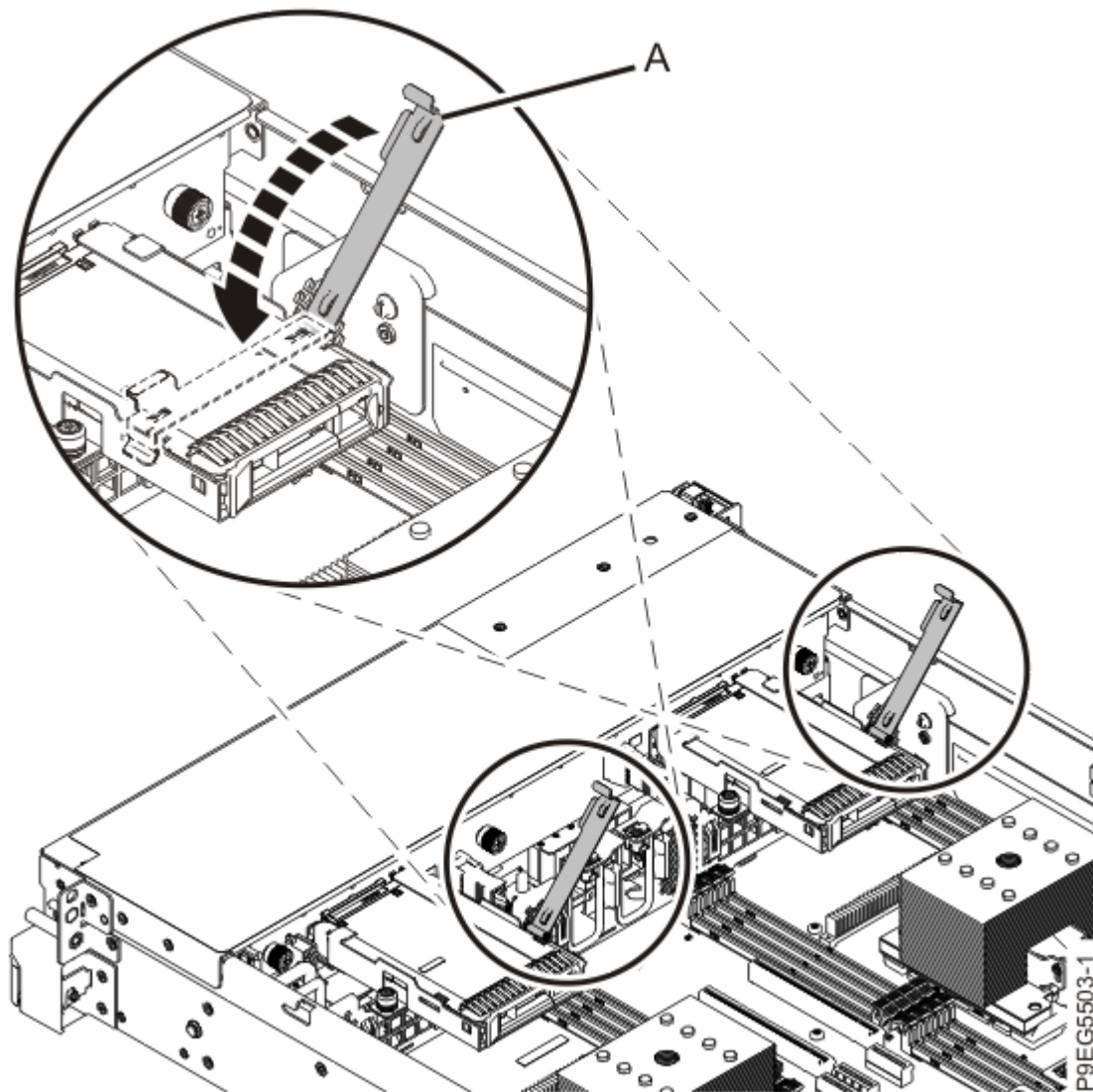


*Figure 27. Opening the drive holder lever*

- b) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
- c) Lower the drive into the drive tray.



*Figure 28. Lowering the drive into the drive tray*  
d) Close the drive holder lever **(A)** over the drive.



*Figure 29. Closing the drive holder lever*

- e) Return to the console, and then press Enter. Verify that the selected slot is the slot in which you want to install the drive. Press Enter again to confirm the device add operation.
- f) When the identify LED flashes for the selected slot, slide the drive all the way into the slot, and push the drive bay handle **(A)** in until it locks.

**Important:** Ensure that the drive is fully seated and is all the way into the system.



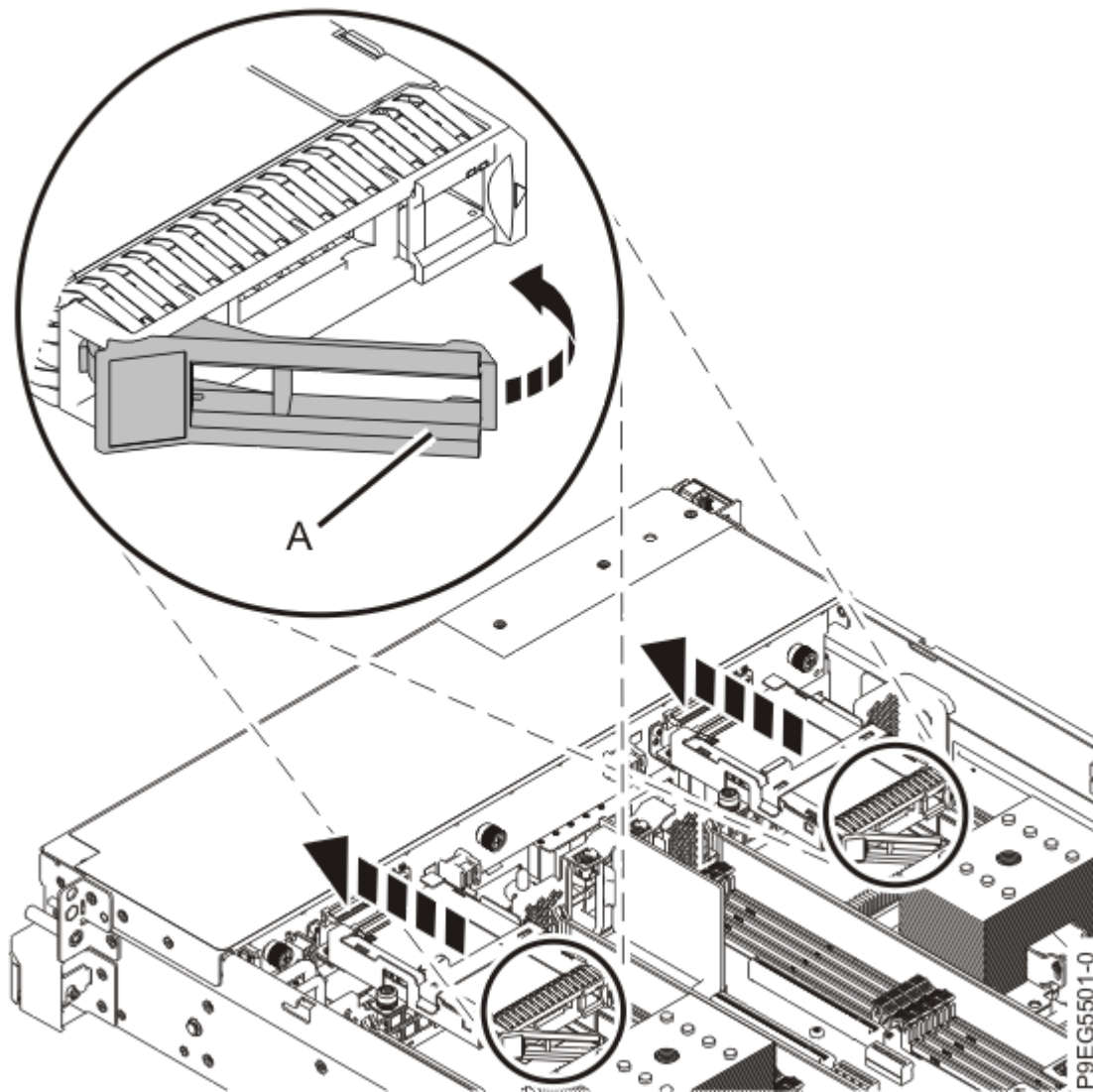
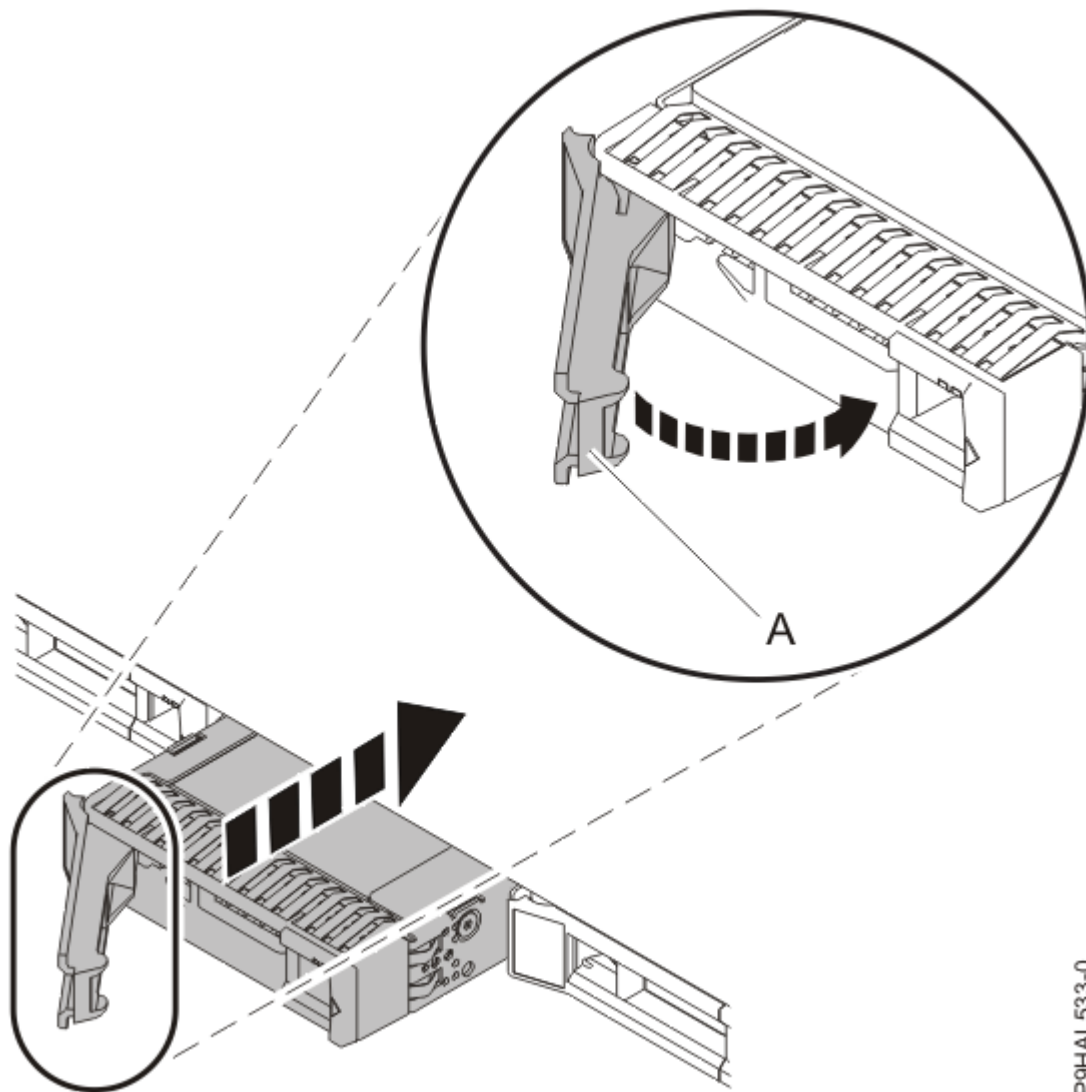


Figure 30. Locking the drive handle

- g) Press **Enter** on the console to indicate that you installed the drive.
- 21. Continue with step “23” on page 36.
- 22. To install a drive in the front of the system or enclosure by using the Linux operating system, complete the following steps:
  - a) Unlock the drive bay handle (**A**) by pressing it and pulling it out. If the handle is not all the way out, the drive does not slide into the system.
  - b) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.
  - c) Slide the drive halfway into the system.
  - d) Return to the console, and then press **Enter**. Verify that the selected slot is the slot in which you want to install the drive. Press **Enter** again to confirm the device add operation.
  - e) When the identify LED flashes for the selected slot, slide the drive all the way into the slot, and push the drive bay handle (**A**) in until it locks.



P9HAL533-0

Figure 31. Installing a drive in a system

**Important:** Ensure that the drive is fully seated and is all the way into the system.

f) Press Enter on the console to indicate that you installed the drive.

23. If you want to install more drives, repeat the steps in this procedure. If necessary, remove the service access cover.

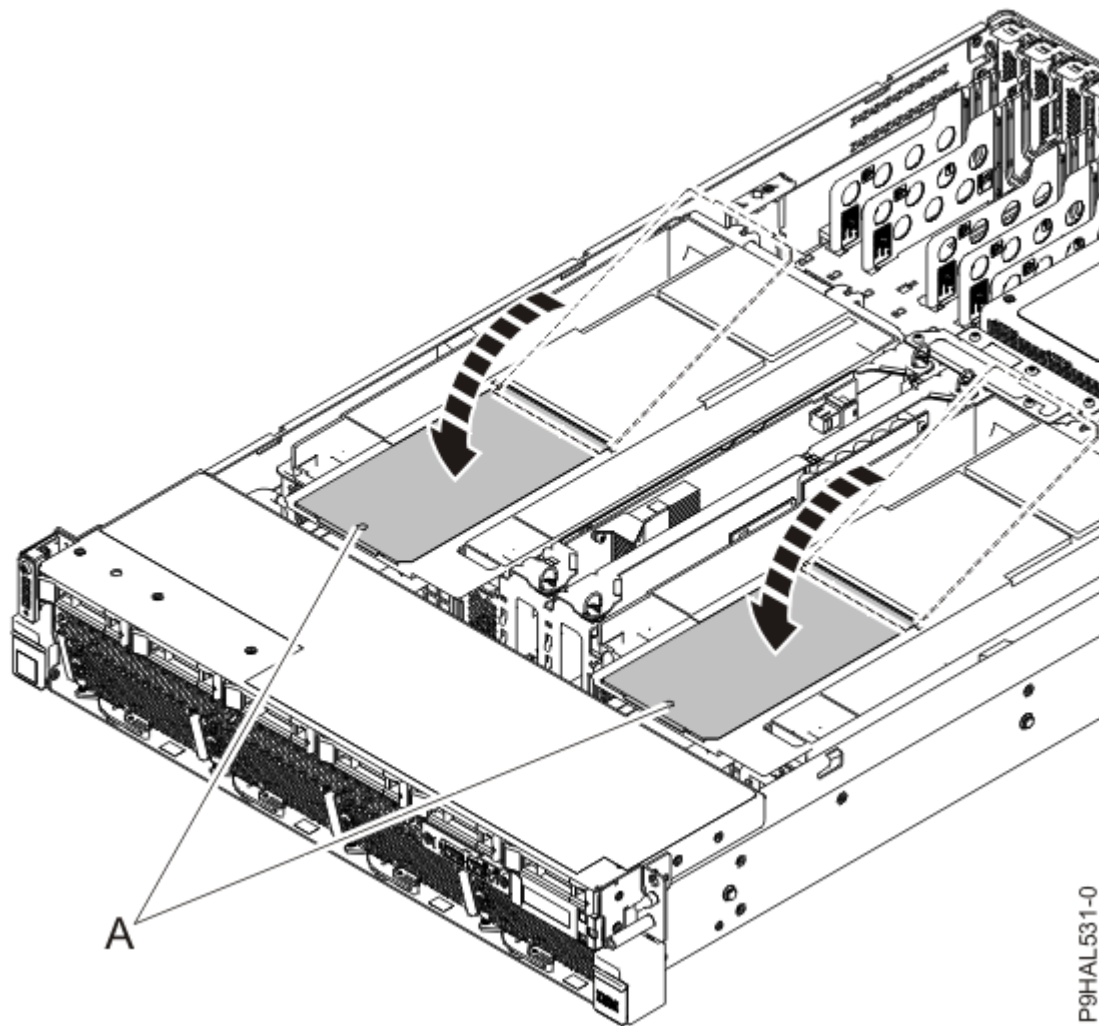
### Preparing the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system for operation after installing a disk drive or solid-state drive

To prepare the system for operation after you install a disk drive or solid-state drive (SSD), complete the steps in this procedure.

#### Procedure

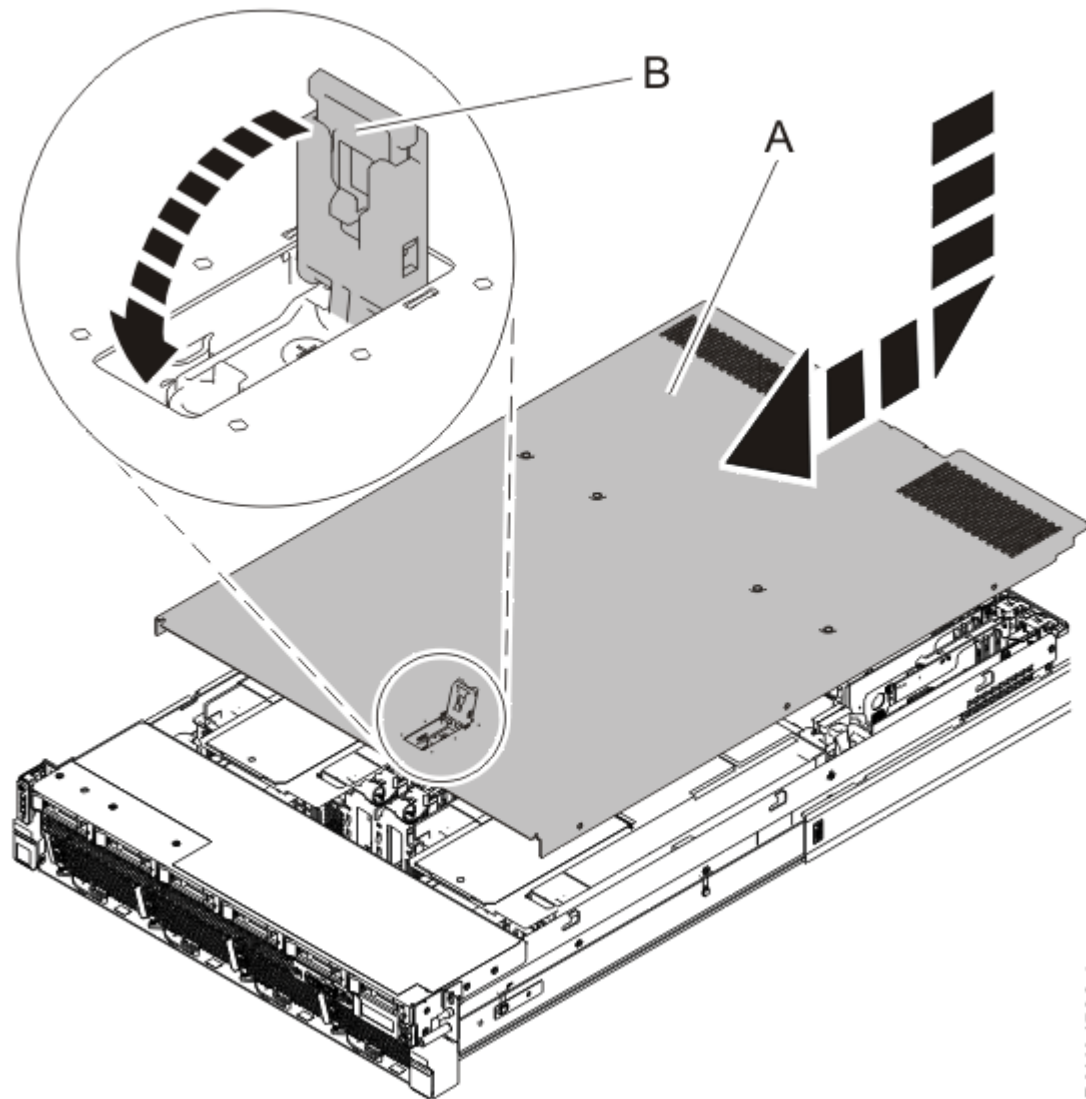
1. Ensure that you have the electrostatic discharge (ESD) wrist strap on and that the ESD clip is plugged into a ground jack or connected to an unpainted metal surface. If not, do so now.
2. Did you install drives inside the system?
  - **Yes:** Go to step “3” on page 36.
  - **No:** go to step “4” on page 39.
3. If you installed a drive inside the system, complete the following steps:

- a) Close any open hinged access doors **(A)** on the air baffles.



*Figure 32. Closing the hinged access doors on the air baffles in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system*

- b) Slide the service access cover **(A)** onto the system unit.  
c) Close the release latch **(B)** by pushing it in the direction shown.

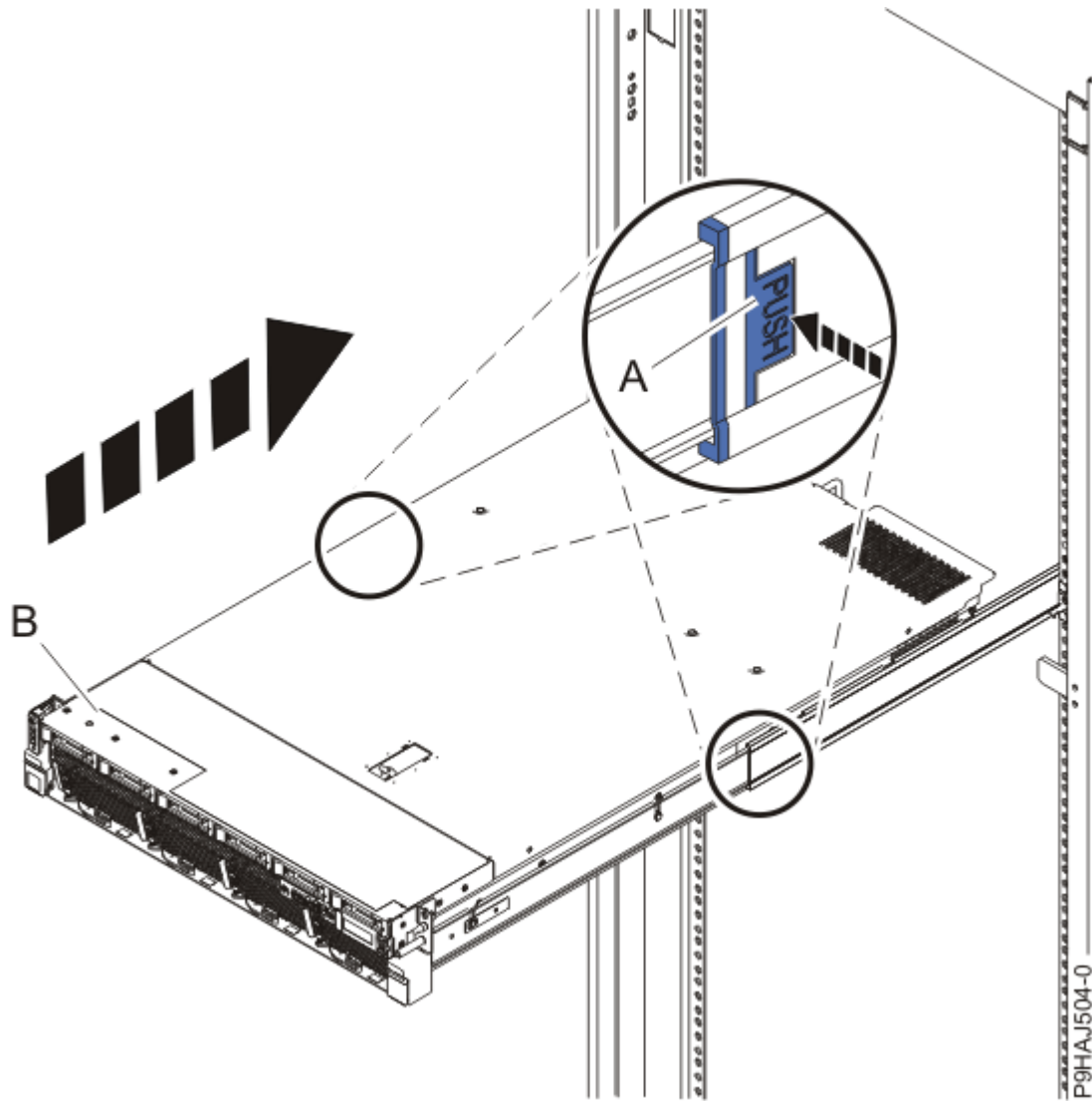


P9HAJ506-1

*Figure 33. Installing the service access cover*

- d) Unlock the blue rail safety latches **(A)** by pushing them inward.
- e) Push the system unit **(B)** back into the rack until both release latches of the system unit lock into position.

Ensure that the cable management arms can move freely. Ensure that the cables at the rear of the unit do not catch or bind as you push the unit into the operating position.



*Figure 34. Placing the system into the operating position*

4. Choose from the following options:
  - a. If your system is powered off, continue with step [“5”](#) on [page 39](#).
  - b. If your system is powered on, continue with step [“8”](#) on [page 40](#).
5. Using your labels, reconnect the power cords **(A)** to the system unit. Fasten the power cords to the system using the hook-and-loop fasteners **(B)** as shown in [Figure 35](#) on [page 40](#).



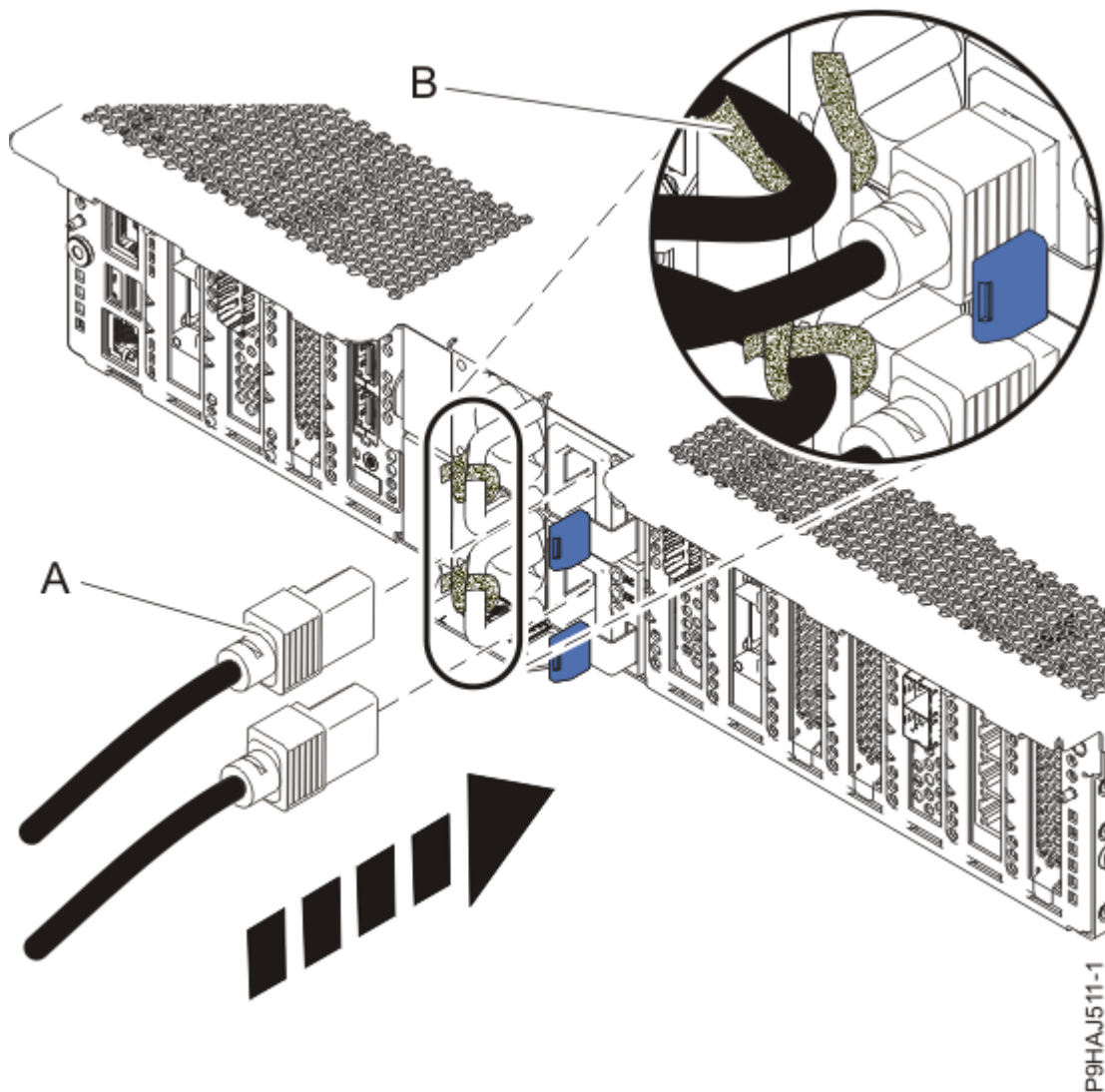


Figure 35. Connecting the power cords

6. Close the rack rear door.
7. Start the system. For instructions, see [Starting a system](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm)).
8. To configure the newly installed disk drive or SSD, choose one of the following options:
  - If the AIX operating system controls the slot where you installed a new drive, continue with step “9” on page 40.
  - If the IBM i operating system controls the slot where you installed a new drive, continue with step “12” on page 41.
  - If the Linux operating system controls the slot where you installed a new drive, continue with step “15” on page 42.
9. To use the AIX operating system to configure the drive, choose from the following options:
  - If you installed the drive when the system was powered off, when you start the system, the AIX operating system automatically configures the devices in the system when the system is started.
  - If you installed the drive when the system was powered on, continue with the next step.
10. To configure the drive with the AIX operating system when you installed the drive when the system was powered on, complete the following steps:

**Note:** A customer must complete this step.

- a. Press the **F3** key on the console to return to the **SCSI and SCSI RAID Hot Plug Manager** menu.
  - b. Select **Configure Added/Replaced Devices** and press Enter.
  - c. When the configuration is complete, press **F3** twice to return to the **IBM SAS Disk Array Manager** menu.
  - d. Select **List SAS Disk Array Configuration** and press Enter. The newly installed drive or drives will be shown at the bottom of the list of arrays and drives.
11. To verify the drive, continue with step [“17” on page 42](#).
12. If you are using the IBM i operating system, choose from the following options:
  - If you installed or replaced a non-configured drive, continue with step [“13” on page 41](#).
  - If you installed or replaced a configured drive, continue with step [“17” on page 42](#).
13. To use the IBM i operating system to configure the drive, complete the following steps:
  - a. To display unconfigured drives, complete the following steps:
    - 1) If necessary, start System Service Tools (SST) by typing **strsst** on the command line of the IBM i session, and then press Enter.
    - 2) Type your service tools user ID and service tools password on the Start Service Tools (STRSST) Sign On display, and then press Enter.  
The service tools password is case-sensitive.
    - 3) Select **Work with Disk Units > Display disk configuration > Display non-configured units**.  
The drives that you installed are listed. The serial numbers must match the serial numbers that you recorded (the last four digits).  
  
**Note:** The new drives might take up to five minutes to appear in the list. If the drive is not listed, ensure that the drives were installed properly.
    - 4) Press **F12** twice to return to the **Work with Disk Units** window.
  - b. Choose from the following options:
    - To configure a new drive with device-parity protection, go to step [“13.c” on page 41](#).
    - To configure a new drive with mirror protection, go to step [“13.d” on page 41](#).
    - To configure a new drive with hot-spare protection, go to step [“13.e” on page 42](#).
  - c. To configure a drive with IBM i device-parity protection, complete the following steps:
    - 1) Select **Work with disk configuration > Work with device parity protection**.
    - 2) Select the type of device-parity you want on the set: **RAID-5**, **RAID-6**, or **RAID-10**. Hot-Spare disk protection can also be selected.  
  
**Note:** The following conditions must be met before device-parity starts.
      - Enough drives must be available to create a new parity set.
      - All drives in a parity set must be the same capacity with a minimum number of two, three, or four drives (depending on RAID level) and maximum of 32 drives in the resulting parity set.
      - All drives that are attached to an advanced function input/output adapter must be recognized by the system. If not, repeat this step (a-c).
    - 3) After the conditions are met and device-parity is started, press **F12** twice to return to the **Work with Disk Units** display.
    - 4) If you have an attached printer, print the configuration list. From the **Hardware service manager** menu, press **F6** (print the configuration). The configuration prints. Save this list for future use.
  - d. To configure a drive with IBM i mirror-protection, complete the following steps:
    - 1) Select **Work with disk configuration**.
    - 2) Select the option to Add units to auxiliary storage pools (ASPs) and to balance data.

- 3) Specify the number of the ASP to which you want to add the drive, and then press Enter. The system ASP is **ASP 1**. The **Confirm Add Units** display shows the configuration in your system when the add operation completes.

**Note:** If you selected the wrong ASP, press **F12** to change your options.

- 4) Press **F10** to Confirm Add and Balance. The add process takes several minutes to complete. The balancing of the data between the disks in the ASP might take hours to complete. However, the balancing task runs in the background and you can run normal operations.

**Notes:**

- If the ASP is mirror protected, drives must be added in pairs of the same capacity.
  - When one or more pairs of drives are added to a mirrored ASP, they automatically become mirror protected.
  - To start mirrored protection on an ASP, go to the [IBM i Knowledge Center](http://www-01.ibm.com/support/knowledgecenter/ssw_ibm_i/welcome) website ([http://www-01.ibm.com/support/knowledgecenter/ssw\\_ibm\\_i/welcome](http://www-01.ibm.com/support/knowledgecenter/ssw_ibm_i/welcome)) and select the version of the IBM i operating system you are using. Then, use Search to find the Working with mirrored protection topic.
- 5) When the message Selected units have been added successfully is shown, press **F3** three times and press Enter to return to the **Main menu** display.
  - 6) If you have an attached printer, print the configuration list. From the **Hardware service manager** menu, press **F6** (print the configuration). The configuration prints. Save this list for future use.
- e. To configure a drive with IBM i hot-spare protection, complete the following steps:
- 1) Select **Work with disk configuration > Start hot spare**. A list of non-configured disk units that can be a Hot-Spare unit under an IOA are displayed.
  - 2) Select the disk units that you want to set for a Hot-Spare configuration.
  - 3) If you have an attached printer, print the configuration list. From the **Hardware service manager** menu, press **F6** (print the configuration). The configuration prints. Save this list for future use.
14. To verify the drive, continue with step “17” on page 42.
15. To use the Linux operating system to configure the drive, choose from the following options:
- If you installed the drive when the system was powered off, when you start the system, the Linux operating system automatically configures the devices in the system when the system is started. Continue with step “17” on page 42.
  - If you installed the drive when the system was powered on, continue with the next step.
16. To configure the drive with the Linux operating system when you installed the drive when the system was powered on, complete the following steps:
- a) Type **q** to return to the **IBM Power RAID Configuration Utility** menu.
  - b) Type **1** and press Enter to select Display hardware status.
- The newly-installed drive or drives is shown at the beginning of the list of drives and arrays.
17. Verify the installed part.
- If you replaced the part because of a service action, verify the installed part. For instructions, see [Verifying a repair](http://www.ibm.com/support/knowledgecenter/POWER9/p9ect/pxect_verifyrepair.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9ect/pxect\\_verifyrepair.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9ect/pxect_verifyrepair.htm)).
  - If you installed the part for any other reason, verify the installed part. For instructions, see [Verifying the installed part](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/pxhaj_hsmverify.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/pxhaj\\_hsmverify.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/pxhaj_hsmverify.htm)).
18. Turn off the identify LED. For instructions, see [Deactivating an identify LED](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/p9haj_turn_off_identify_led.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/p9haj\\_turn\\_off\\_identify\\_led.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/p9haj_turn_off_identify_led.htm)).



## Removing and replacing a disk drive or solid-state drive in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

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Find information about removing and replacing a serial-attached SCSI (SAS) disk drive or a solid-state drive (SSD) in the 5105-22E, IBM Power System L922 (9008-22L), IBM Power System S922 (9009-22A and 9009-22G), IBM Power System H922 (9223-22H), or IBM Power System H922S (9223-22S) server.

### About this task

If you are removing and replacing a disk drive or solid-state drive in a 5887 disk drive enclosure or ESLL or ESLS storage enclosure, see *Enclosures and expansion units* ([http://www.ibm.com/support/knowledgecenter/POWER9/p9ham/p9ham\\_kickoff.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9ham/p9ham_kickoff.htm)). Select the enclosure that you are working on, and then select **Removing and replacing parts > Disk drives or solid-state drives (SSDs)**.

**Note:** Removing or replacing this feature is a customer task. You can complete this task yourself, or contact a service provider to complete the task for you. You might be charged a fee by the service provider for this service.

If your system is managed by the Hardware Management Console (HMC), use the HMC to repair a part in the system. For instructions, see *Repairing a part by using the HMC* ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/p9haj\\_hmc\\_repair.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/p9haj_hmc_repair.htm)).

If your system is not managed by an HMC, complete the steps in this procedure to remove and replace a disk drive or SSD.

## Preparing the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system to remove and replace a disk drive or solid-state drive

To prepare the system to remove and replace a disk drive or solid-state drive (SSD), complete the steps in this procedure.

### Procedure

1. Back up the data on the drive you plan to remove depending on the operating system you are using.
  - **AIX:** Ensure that all data on that drive or the array that contains the drive is backed up and removed from the drive.
    - If the drive that is being replaced is protected by Raid-5, Raid-6, or Raid-10 and the array remains functional after removing the drive, it is not necessary to back up or remove data.
    - If the drive you are removing is a mirrored drive, you must suspend mirror protection on the drive before you remove the drive. Contact your system administrator for assistance.
    - If the drives are just a bunch of disks (JBOD) or a Raid array that will not remain functional when the drive is removed (that is, Raid-0), ensure that the disks are in the defined state by completing the following steps:
      - a. Remove data access methods from the JBOD or failing array (that is, file systems, databases, and so on).
      - b. Delete the array.
      - c. Unconfigure the JBOD.
  - **IBM i:** Ensure that all data on that drive or the array that contains the drive is backed up and removed from the drive. If the drive that is being replaced is protected by RAID-5, RAID-6, RAID-10, or mirroring, it is not necessary to back up or remove data.
  - **Linux:** Ensure that all data on that drive or the array that contains the drive is backed up and removed from the drive.
    - If the drive that is being replaced is protected by RAID, it is not necessary to back up or remove data.

- If the drive you are removing is mirrored, you need to break the mirror before you remove the drive. Contact your system administrator for assistance.
  - If the drives are just a bunch of disks (JBOD), ensure that the disks are in the defined state.
2. Review the drive and service indicator locations. The disk drive and SSD slots are located in the front of the system with two internal slots.

Figure 36 on page 44 shows the drive locations and service indicators for the front drives. Service indicators are located above the latch handle on the drives. Figure 37 on page 45 shows the internal drive locations and service indicators. Service indicators are located in the front of the system.

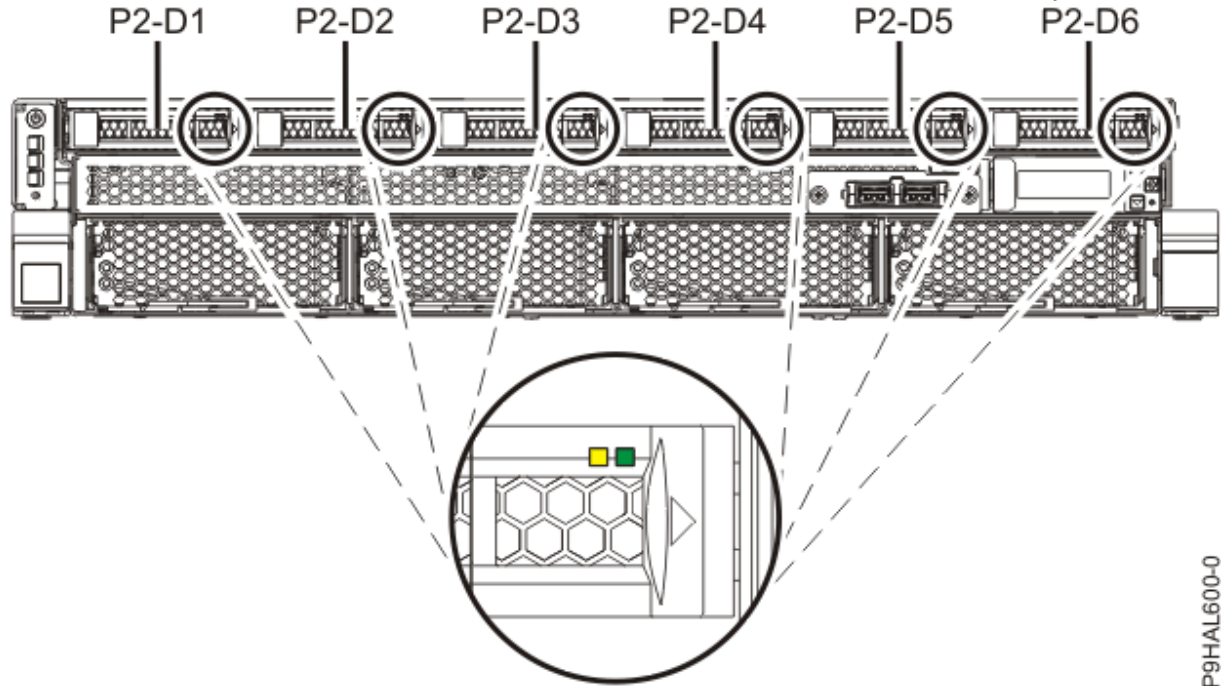


Figure 36. Front disk drive and service indicator locations for a 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

P9HAL600-0

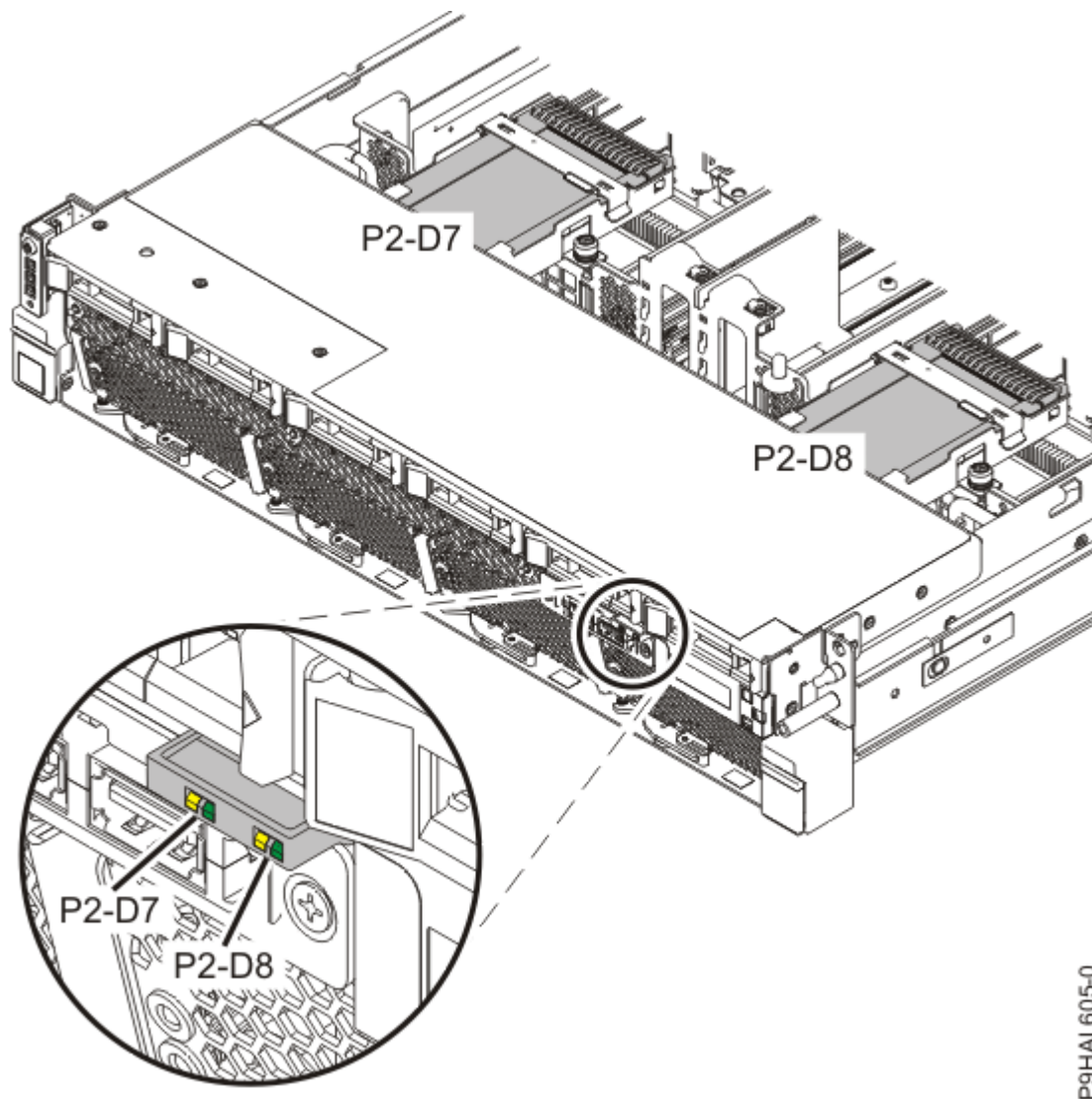


Figure 37. Internal drive and service indicator locations for a 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

3. Select from the following options:

- If you want to remove a drive when the system is powered off, continue with step [“4” on page 45](#).
- If you want to remove a drive by using the AIX operating system when the system power is turned on, continue with step [“6” on page 48](#).
- If you want to remove a drive by using the IBM i operating system when the system is powered on, continue with step [“8” on page 48](#).
- If you want to remove a drive by using the Linux operating system when the system is powered on, continue with step [“10” on page 51](#).

4. To prepare the system to remove a drive from the system when the system is powered off, complete the following steps:

- a) Turn on the identify LED for the drive to be removed and for the system.

For instructions, see [Identifying a part](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/sal.htm) (www.ibm.com/support/knowledgecenter/POWER9/p9haj/sal.htm).

Use the blue identify LED on the enclosure to locate the system. Ensure that the serial number of the system matches the serial number to be serviced.

- b) Record the position where the disk drive or solid-state drive will be removed. For example, the drive slot might be P1-D3 or P2-D3.
- c) Stop the system. For instructions, see [Stopping a system](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm)).
- d) If applicable, open the rack door at the rear of the system.
- e) Label and disconnect the power cords from the system unit.

See [Figure 38](#) on page 46.

**Notes:**

- This system might be equipped with two or more power supplies. If the removing and replacing procedures require the system power to be turned off, ensure that all the power sources to the system are disconnected.
- The power cord **(B)** is fastened to the system with hook-and-loop fastener **(A)**. If you are placing the system in a service position after you disconnect the power cords, ensure that you unstrap the fastener.

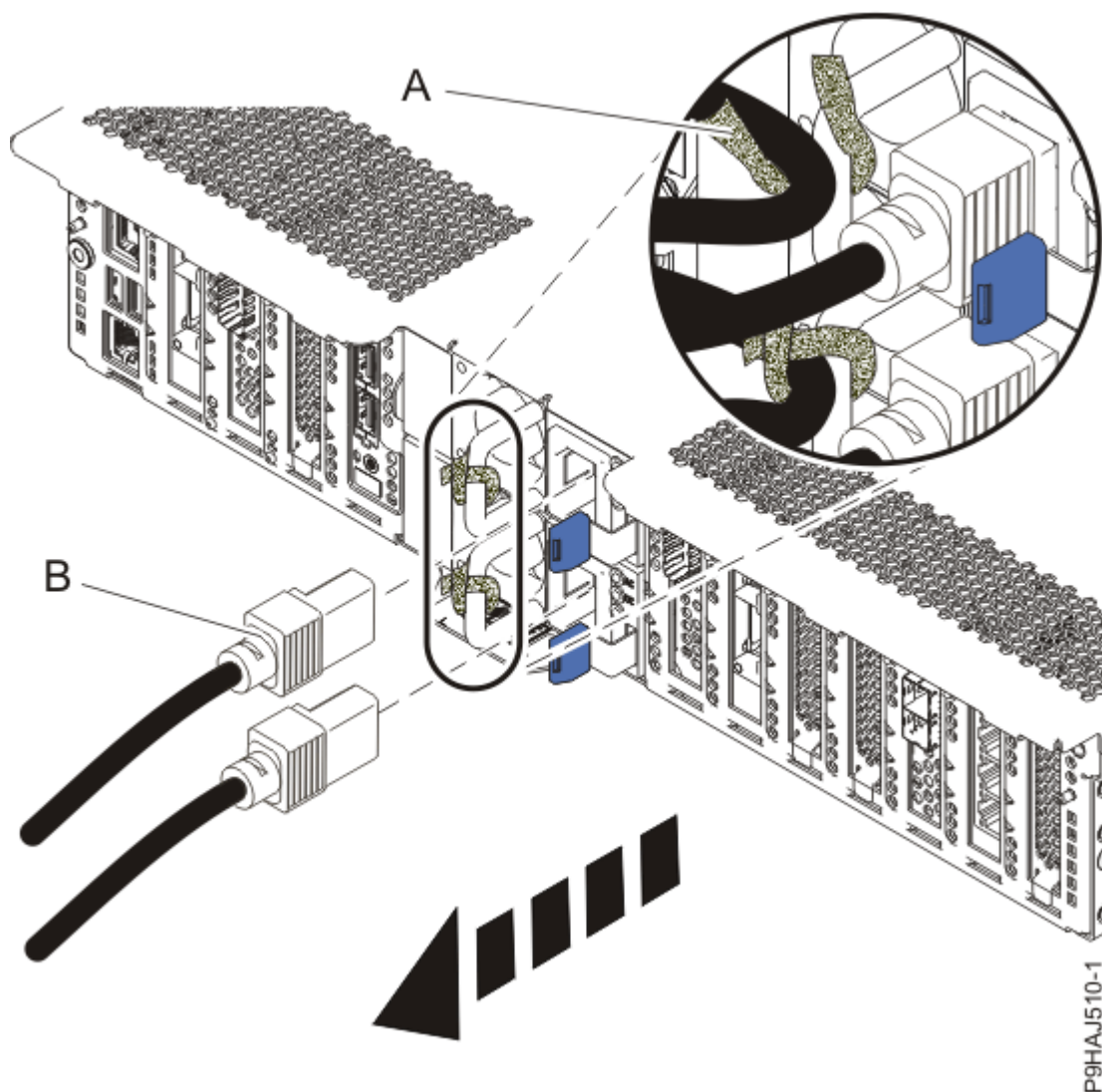
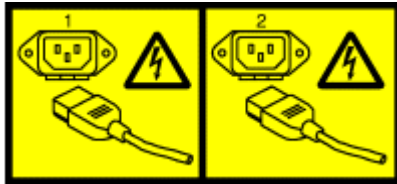


Figure 38. Removing the power cords

(L003)



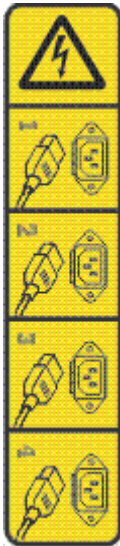
or



or

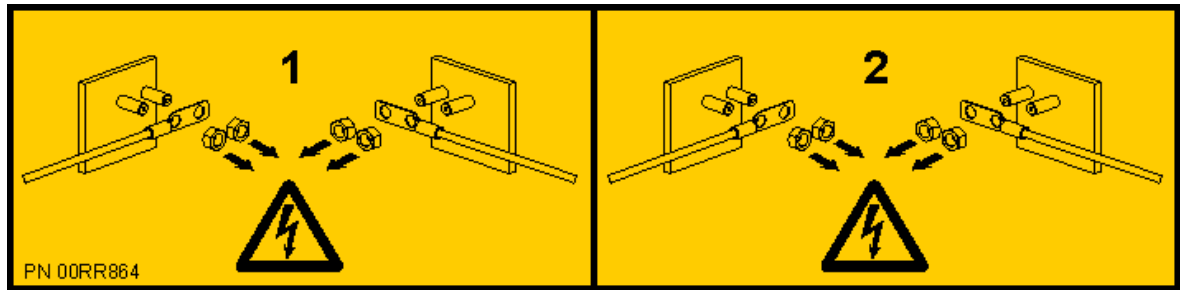


or



or





**DANGER:** Multiple power cords. The product might be equipped with multiple AC power cords or multiple DC power cables. To remove all hazardous voltages, disconnect all power cords and power cables. (L003)

5. Choose from the following options:

- If the slot you recorded is P2-D7 or P2-D8, you will need to access the internal drive slots. Continue with step “12” on page 52.
- If the slot you recorded is P2-D1 through P2-D6, continue with step “13” on page 55.

6. To prepare the system to remove a drive by using the AIX operating system, complete the following steps:

- a) Log in as root user.
- b) Type `diag` at the command line and then press Enter.
- c) On the **Diagnostic Operating Instructions** display, press Enter to continue.
- d) On the **Function Selection** display, select **Task Selection > RAID Array Manager > IBM SAS Disk Array Manager > Diagnostics and Recovery Options > SCSI and SCSI RAID Hot Plug Manager**.
- e) Identify the location of the drive to be removed by selecting **Identify a Device Attached to an SCSI Hot Swap Enclosure Device**.
- f) Choose the slot corresponding to the drive, and then press Enter.

**Notes:** If the device is in use and cannot be removed, complete the following actions:

- Ensure that the device is not in use and that the device can be unconfigured.
  - If the device is in a Raid array that will go to a failed state when you remove the drive, the array must be deleted first. See [Deleting a disk array \(www.ibm.com/support/knowledgecenter/POWER9/p9ebj/sasdeletingasdiskarray.htm\)](http://www.ibm.com/support/knowledgecenter/POWER9/p9ebj/sasdeletingasdiskarray.htm).
  - If the drive you are removing is mirrored, you will need to break the mirror before you remove the drive. Contact your system administrator for assistance.
- g) Verify that the identify LED for the slot is flashing rapidly, and record the location of the drive.
  - h) Press Enter to stop the LED from flashing and continue.
  - i) Prepare to remove the drive by pressing **F3** to return to the **SCSI and SCSI RAID Hot Plug Manager** display.
  - j) Select **Replace/Remove a Device Attached to an SCSI Hot Swap Enclosure Device**.
  - k) Select the drive that you want to remove and press Enter.

Follow the on-screen prompts.

7. Choose from the following options:

- If the slot you recorded is P2-D7 or P2-D8, you will need to access the internal drive slots. Continue with step “12” on page 52.
- If the slot you recorded is P2-D1 through P2-D6, continue with step “13” on page 55.

8. To prepare the system to remove a drive by using the IBM i operating system, complete the following steps:

- a) Determine the protection status of the drive that you are replacing by completing the following steps:



- 1) Sign on with at least service level authority.
- 2) Type `strsst` on the command line of the IBM i session, and then press Enter.
- 3) Type your service tools user ID and service tools password on the **Start Service Tools (STRSST) Sign On** display, and then press Enter.

The service tools password is case-sensitive.

- 4) Select **Work with disk units > Display Disk Configuration > Display Disk Configuration Status**.

A list of each auxiliary storage pool (ASP) displays, showing the drives that are members of the ASP. The Status column shows one of the following protection statuses for the ASP:

- **Mirrored.** These ASPs are configured for mirrored protection. If the failing drive has mirrored protection, record the status of both drives in the mirrored pair. You need this information in the recovery procedure.
- **Unprotected.** An ASP with a status of Unprotected might contain drives that are device-parity protected. Record the status of the failing drive as it is shown in the Status column of the Display Disk Configuration Status display.

**Tip:** Use the **F1 (Help)** key for more information about the meaning of a status for any drive.

- b) Determine whether the drive to be removed is a non-configured drive by completing the following steps:

- 1) Type `strsst` on the command line of the IBM i session, and then press Enter.
- 2) Type your service tools user ID and service tools password, and then press Enter.

The service tools password is case-sensitive.

- 3) Select **Work with disk units > Display Disk Configuration > Display non-configured units**, and then press Enter.

Is the failed drive listed as a non-configured drive in the display?

- **No:** You must suspend the drive. Continue with step “8.c” on page 49.
- **Yes:** Determine whether the drive to be removed was replaced by a hot spare when it failed. Continue with step “8.e” on page 50.

- c) Verify that the mirrored drive that you are removing has a status of Suspended.

- 1) Sign on with service level authority.
- 2) Type `strsst` on the command line of the IBM i session and then press Enter.
- 3) Type your service tools user ID and service tools password in the Start Service Tools Sign On display. Press Enter.

The service tools password is case-sensitive.

- 4) Select **Work with disk units > Display Disk Configuration > Display Disk Configuration Status**.

Does the drive that is mirrored to the drive that you are replacing (same drive number) have a status of Active?

- **No:** A service provider must replace the drive. Contact your next level of support.
- **Yes:** Continue with the next step.

- d) Does the drive that you are replacing have a status of Suspended?

- **Yes:** Press F3 repeatedly to exit System Service Tools and return to the main menu. Then, continue with the next step.
- **No:** To suspend mirrored protection on the drive that you are replacing, complete the following steps:
  - 1) Press F3 from the **Display Disk Configuration** display to return to the **Work with Disk Units** display.



- 2) Select **Work with Disk Unit Recovery > Suspend mirrored protection** and select the option to suspend the drive that you are replacing.
  - 3) Press F3 repeatedly to exit System Service Tools and return to the main menu.
- e) Determine whether the drive to be removed was replaced by a hot-spare drive when it failed.
- 1) Go to the Product Activity Log.
  - 2) Determine whether an xxxx9031 error was logged close to the same time of the original disk failure. This error indicates that the data to the hot-spare drive was automatically rebuilt.
  - 3) Determine whether an error was logged for the drive during a repair when the system was powered on.

Did you find the Product Activity Log entry that is related to this problem?

- **Yes:** Return to the Service Action Log to find the entry that lists Disk Drive and Carrier as the possible failing item. If you find the failing item, go to step [“8.f” on page 50](#). If not, go to step [“8.g” on page 50](#).
  - **No:** Exit the Product Activity Log. Then, go to step [“8.g” on page 50](#).
- f) Select the concurrent maintenance option within the Service Action Log. Record the drive location that is shown.
- Then, go to step [“8.j” on page 51](#).
- g) From the Hardware Service Manager display, navigate to the **Select Device Concurrent Maintenance** option. Press Enter.
- h) Choose from the following options:
- If the drive location is shown on the **Select Device Concurrent Maintenance** display, continue with step [“8.j” on page 51](#).
  - If the drive location is not shown on the **Select Device Concurrent Maintenance** display, continue with the next step.
- i) If the physical location does not show on the Device Concurrent Maintenance display, you must type the physical location where you are replacing the drive.

#### Notes:

- The physical location has the following form: U78D3 . 001 . AAAXXXX - P2 - D3 where U78D3 . 001 is the system identifier, AAAXXXX is the sequence number, and P2 - D3 is the drive slot location. Find the physical location U78D3 . 001 . AAAXXXX information from the control panel display on the system.
- If you cannot find the location information from the control panel, find the label that is located on the front of the system or enclosure. The system identifier is listed after FC and the sequence number is the last 7 digits after SN or SEQ.



Figure 39. Example of a system or enclosure label

Use [Table 3 on page 51](#) to find the system machine type and model that corresponds to the system identifier.

Table 3. System identifier for POWER9 systems and enclosures

System identifier	System
U78D3.001	5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S
U78D2.001	9009-41A, 9009-41G, 9009-42A, 9009-42G, 9223-42H, or 9223-42S
U78D4.001	9040-MR9
U5887.001	5887 disk drive enclosure
UESLL.001	ESLL storage enclosure
UESLS.001	ESLS storage enclosure

In the example, U5887.001.AAAXXXX-D1-D24, you would install a drive in the 5887 disk drive enclosure with type 5887, model 001, sequence number AAAXXXX, and drive position D1–D24.

- j) To set the time delay for removing the drive by using the IBM i operating system, complete the following steps:

- 1) Select 1 (Remove device) for the action to be completed.
- 2) Set the time delay in minutes. For example, for five minutes, enter: 05.

**Note:** You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the drive.

**Important:** Do not press Enter now.

- 3) Locate the service indicator that corresponds to the position of the drive that you are removing from a system. The service indicators are located above the drive latch.

9. Choose from the following options:

- If the slot you recorded is P2-D7 or P2-D8, you will need to access the internal drive slots. Continue with step “12” on page 52.
- If the slot you recorded is P2-D1 through P2-D6, continue with step “13” on page 55.

10. To prepare the system to remove a drive by using the Linux operating system, complete the following steps:

- a) Log in as root user.
- b) Type **iprconfig** on the command line of the Linux session, and then press Enter.  
The IBM Power RAID Configuration Utility display is shown.
- c) Select **Analyze log > View most recent ipr error messages**.
- d) Find the entry in the log file for the drive you want to replace.
- e) Record the location information for the drive.

**Note:** The location information is in either of the following forms:

**0:0:5:0**

In this example, 0 is the SCSI host number, 0 is the SCSI bus, 5 is the SCSI target ID, and 0 is the logical unit number (LUN).

**0/00-0E-02**

In this example, 0 is the SCSI host number, 00 is the I/O adapter (IOA) SAS port, 0E is the expander port, and 02 is the device port.

- f) Type **q** twice.  
The IBM Power RAID Configuration Utility display is shown.
- g) Select **Display hardware status**. Press Enter.
- h) Look for the drive at the SCSI location you recorded.

- i) Type **q** to return to the IBM Power RAID Configuration Utility display.
- j) Select **3. Work with disk unit recovery > 2. Concurrent remove device**. Press Enter.
- k) Type 1 (Select) next to the location for this drive (0:0:5:0 or 0/00-0E-02).

The **Verify Device Concurrent Remove** display is shown. The service indicator flashes for that drive slot. Follow the on-screen prompts.

11. Choose from the following options:

- If the slot you recorded is P2-D7 or P2-D8, you will need to access the internal drive slots. Continue with step [“12” on page 52](#).
- If the slot you recorded is P2-D1 through P2-D6, continue with step [“13” on page 55](#).

12. To access the internal slots, complete the following steps:

- a) If applicable, open the rack front door.
- b) Open the side latches (**A**) and pull the latches to slide the system unit fully into the service position, until the slides click and hold the system unit securely. Ensure that the screws inside the latches are not secured to the rack.

Remove the hook-and-loop fasteners that secure the cable management arms. Ensure that the cable management arms can move freely. Ensure that the cables at the rear of the system do not catch or bind as you pull the system unit into the service position.

Do not pull out or install any drawer or feature if the rack stabilizer brackets are not attached to the rack. Do not pull out more than one drawer at a time. The rack might become unstable if you pull out more than one drawer at a time.



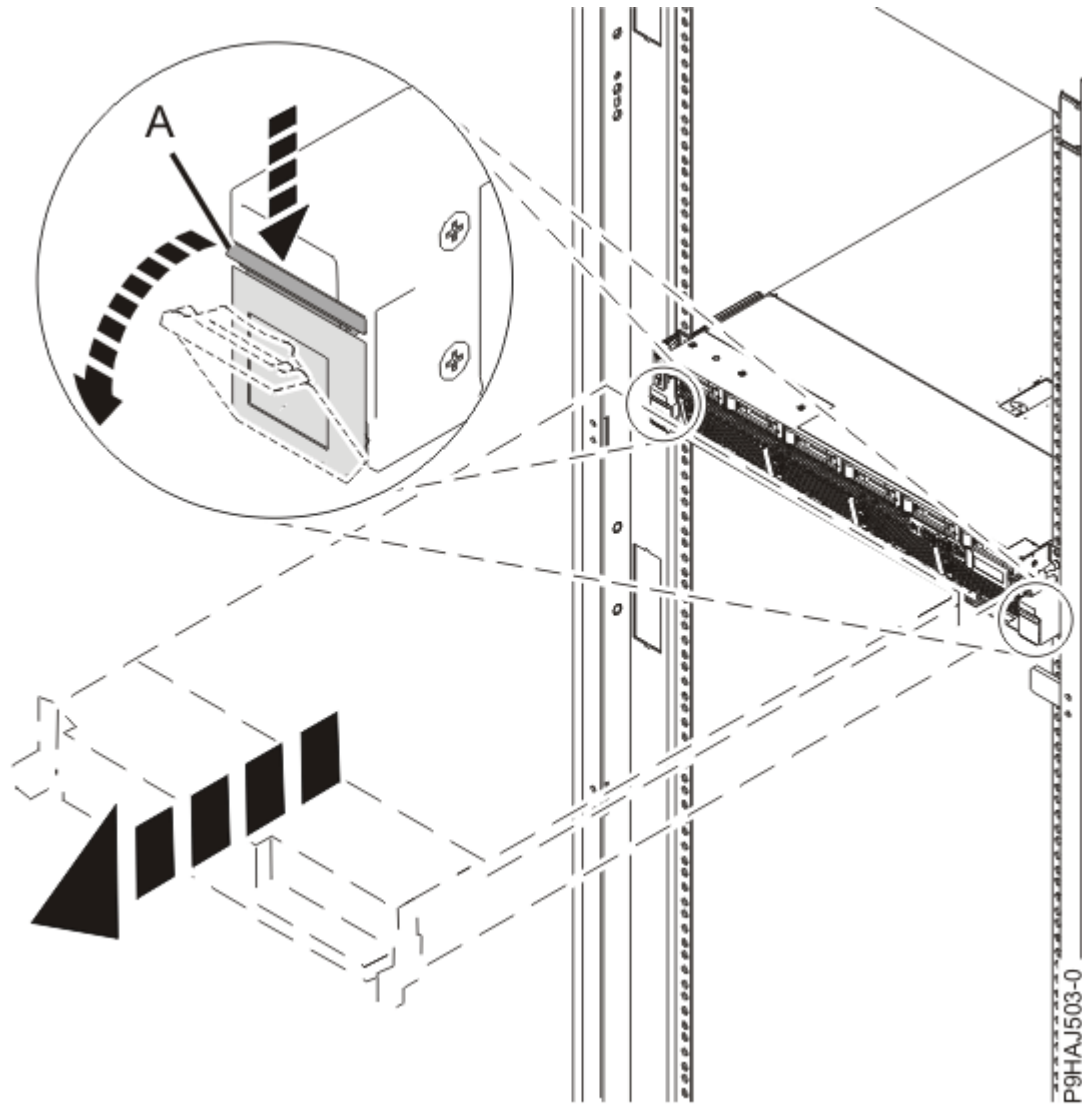


Figure 40. Releasing the side latches

- c) Attach the electrostatic discharge (ESD) wrist strap. Your system has an ESD jack on the front and on the rear of the system. Plug the ESD wrist strap into the ESD jack.



**Attention:**

- Attach an electrostatic discharge (ESD) wrist strap to the front ESD jack, to the rear ESD jack, or to an unpainted metal surface of your hardware to prevent the electrostatic discharge from damaging your hardware.
- When you use an ESD wrist strap, follow all electrical safety procedures. An ESD wrist strap is used for static control. It does not increase or decrease your risk of receiving electric shock when using or working on electrical equipment.
- If you do not have an ESD wrist strap, just prior to removing the product from ESD packaging and installing or replacing hardware, touch an unpainted metal surface of the system for a minimum of 5 seconds.

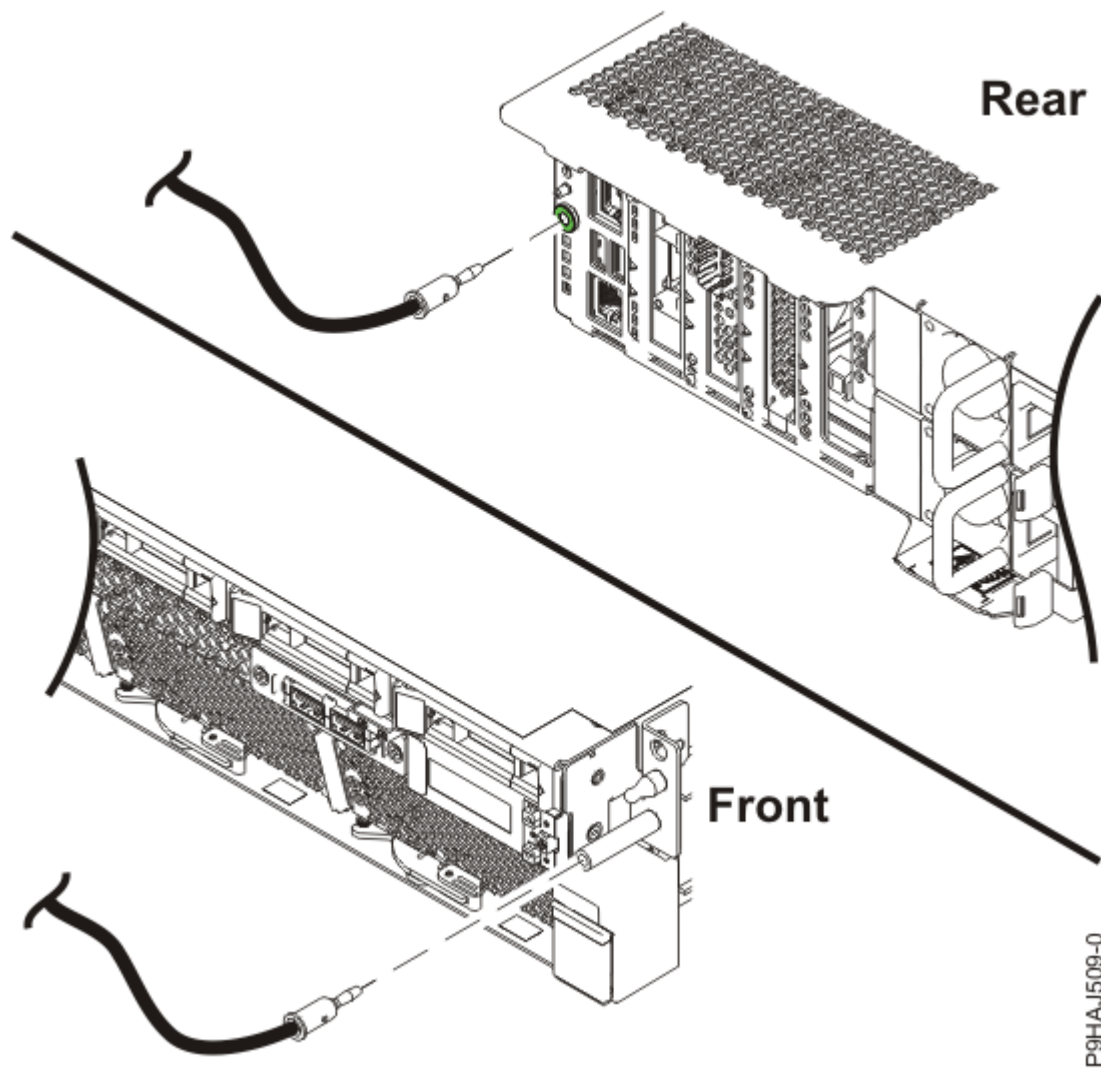


Figure 41. Location of the ESD plugs on an 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

- d) Release the service access cover latch by pushing the release latch **(A)** in the direction shown.
- e) Open the hinged access door **(A)** on the air baffle above the slot you want to access.

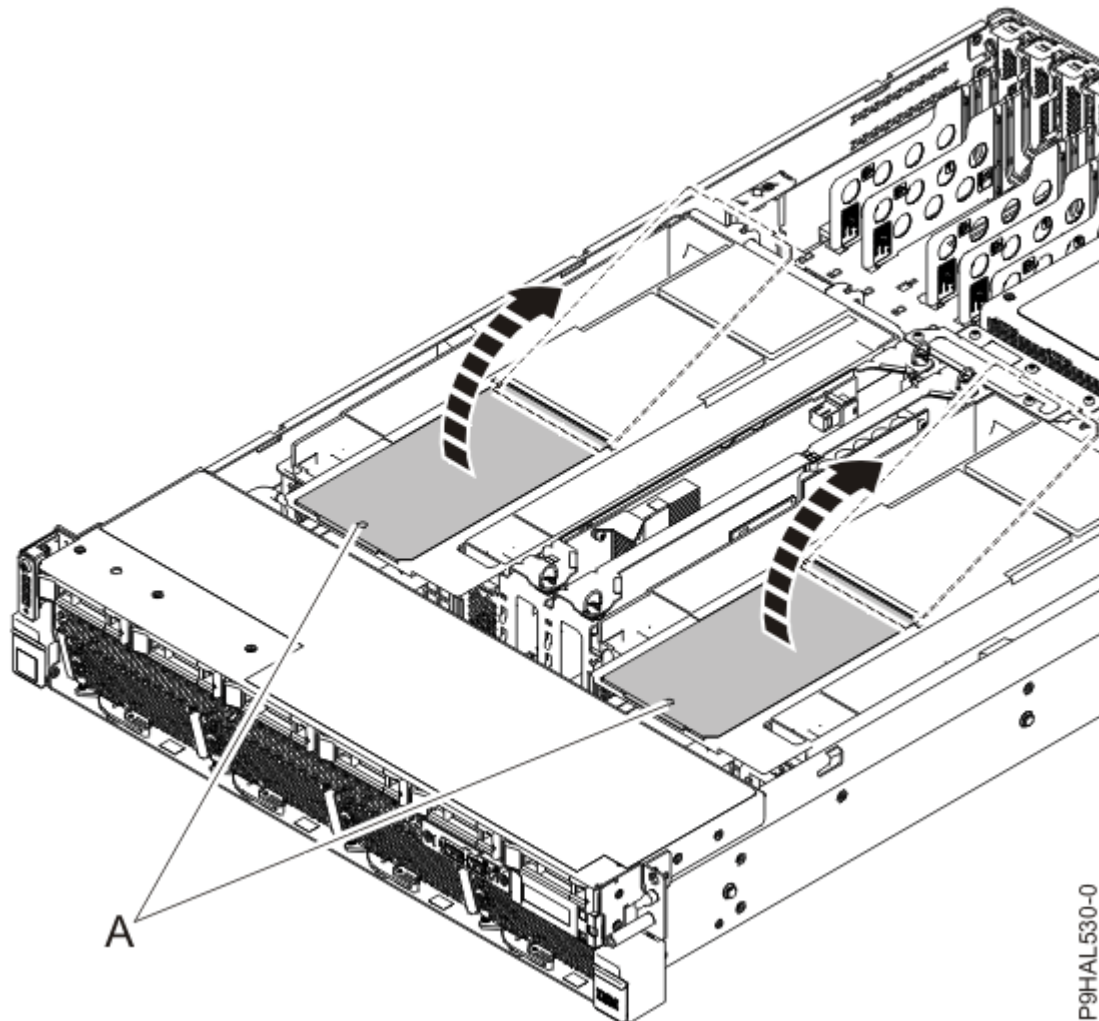


Figure 42. Opening the hinged access doors on the air baffles in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

13. Find the package that contains the new drive.



**Attention:** Drives are fragile. Handle with care.

14. Choose from the following options:

- a) If you are removing and replacing drives in the front of the system, go to step [“15” on page 55](#).
- b) If you are removing and replacing internal drives, go to step [“16” on page 56](#).

15. Attach the electrostatic discharge (ESD) wrist strap.

The ESD wrist strap must be connected to an unpainted metal surface until the service procedure is completed, and if applicable, until the service access cover is replaced.



**Attention:**

- Attach an electrostatic discharge (ESD) wrist strap to the front ESD jack, to the rear ESD jack, or to an unpainted metal surface of your hardware to prevent the electrostatic discharge from damaging your hardware.
- When you use an ESD wrist strap, follow all electrical safety procedures. An ESD wrist strap is used for static control. It does not increase or decrease your risk of receiving electric shock when using or working on electrical equipment.

- If you do not have an ESD wrist strap, just prior to removing the product from ESD packaging and installing or replacing hardware, touch an unpainted metal surface of the system for a minimum of 5 seconds. If at any point in this service process you move away from the system, it is important to again discharge yourself by touching an unpainted metal surface for at least 5 seconds before you continue with the service process.

16. Remove the drive from the static-protective package and place it on an ESD mat.

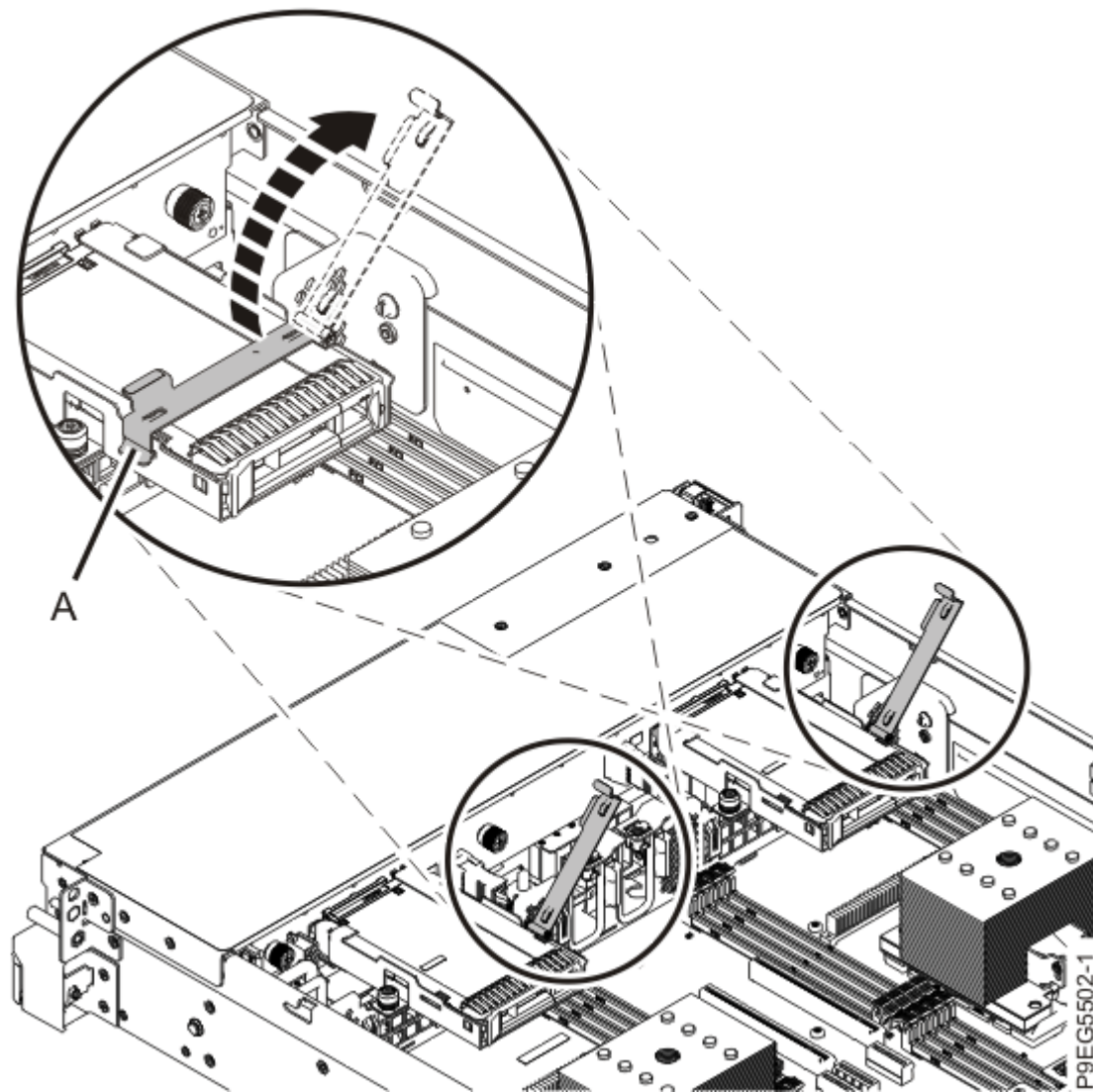
## **Removing a disk drive or solid-state drive from the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system**

To remove a disk drive or solid-state drive (SSD) from the system, complete the steps in this procedure.

### **Procedure**

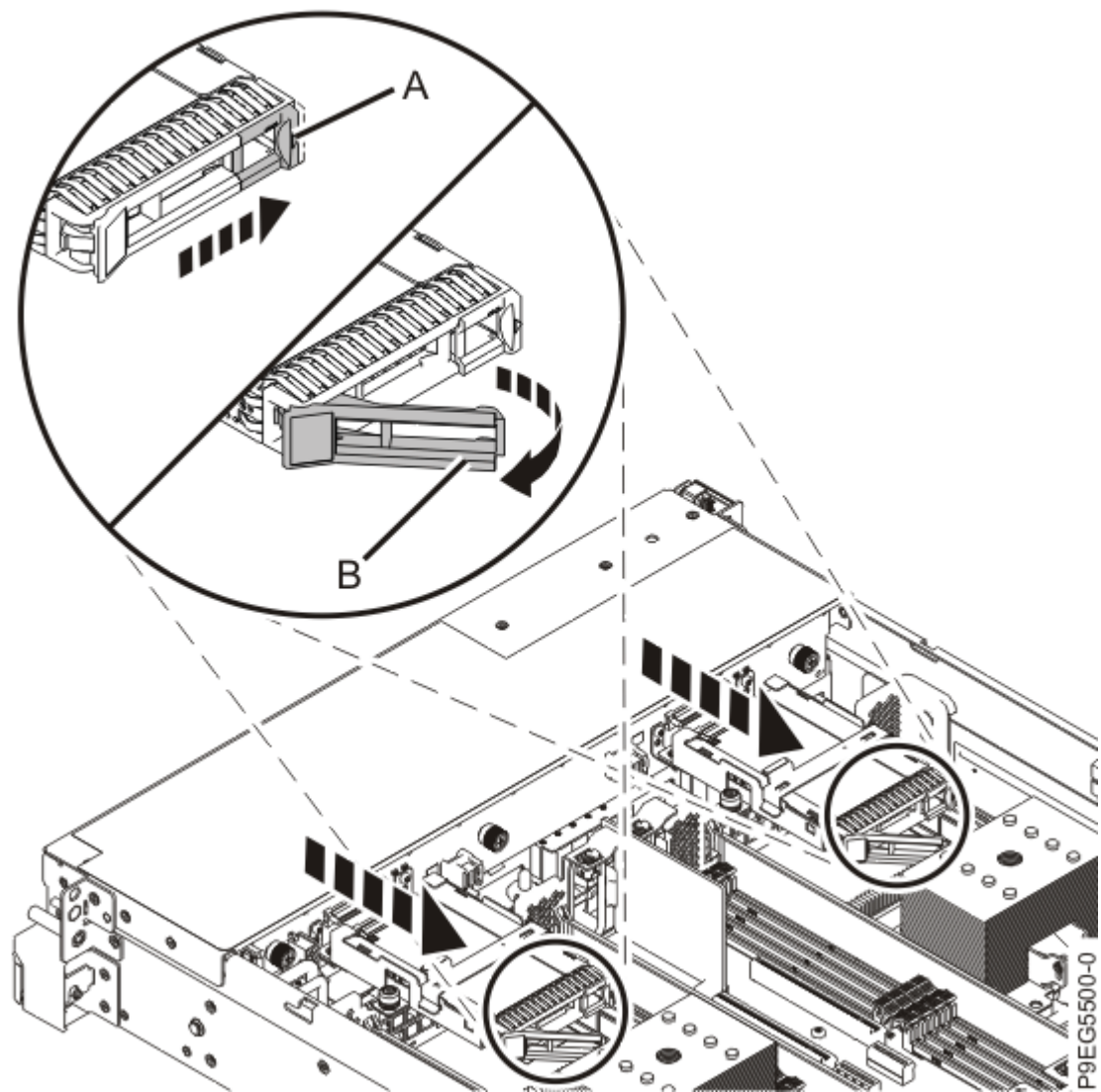
1. Ensure that you have the electrostatic discharge (ESD) wrist strap on and that the ESD clip is plugged into a ground jack or connected to an unpainted metal surface. If not, do so now.
2. Choose from the following options:
  - If the system is powered off, continue with step [“3” on page 56](#).
  - If the system power is turned on and if the AIX operating system controls the slot, continue with step [“8” on page 60](#).
  - If the system is powered on and if the IBM i operating system controls the slot, continue with step [“13” on page 62](#).
  - If the system is powered on and if the Linux operating system controls the slot, continue with step [“18” on page 66](#).
3. To remove a drive from a system when the system is powered off, choose from the following options:
  - To remove a drive from slot P2-D7 or P2-D8 inside the system, continue with step [“4” on page 56](#).
  - To remove a drive from slot P2-D1 through P2-D6 on the front of the system, continue with step [“6” on page 59](#).
4. To remove a drive from inside the system when the system is powered off, complete the following steps:
  - a) Open the drive holder lever **(A)**.





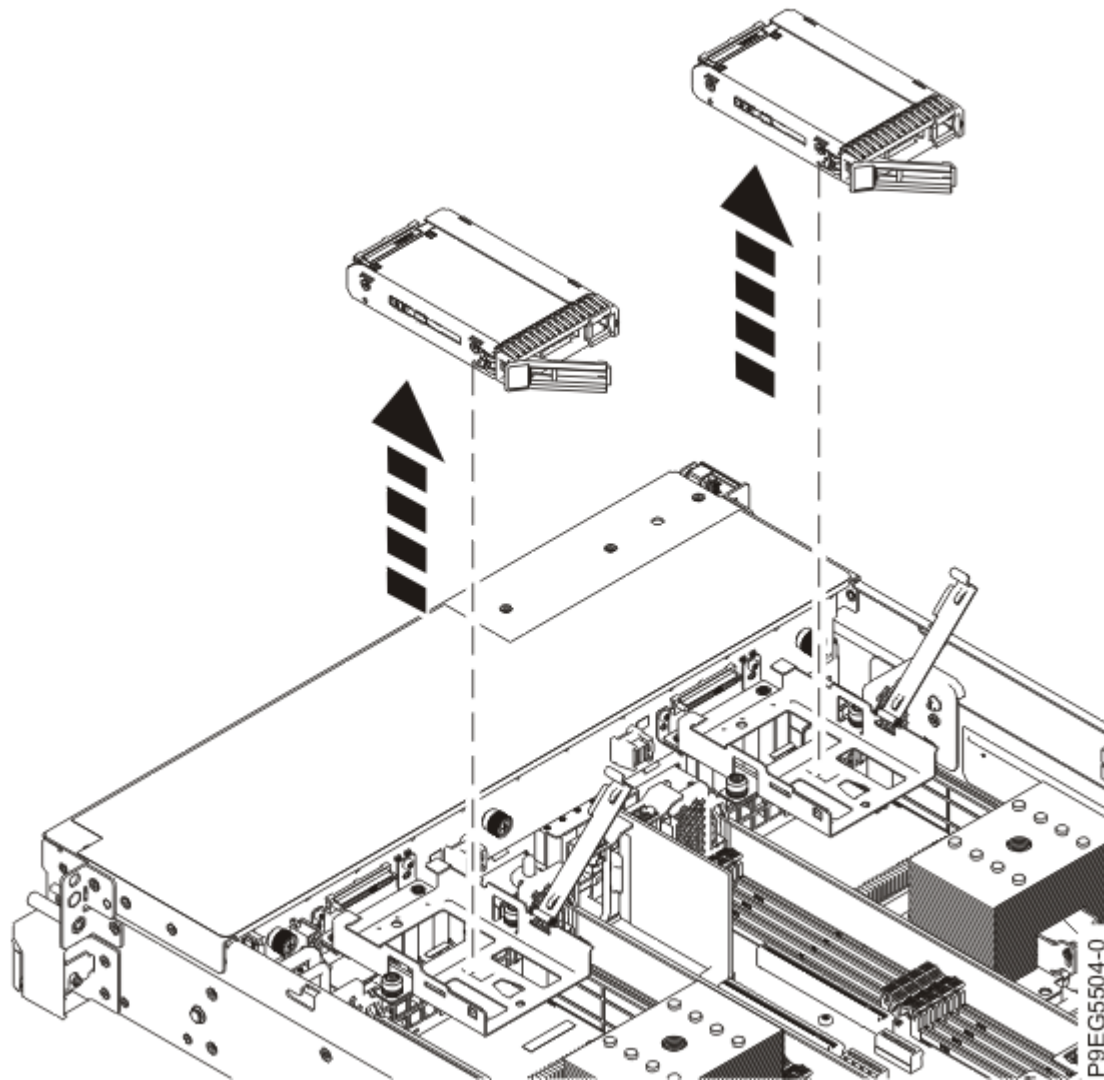
*Figure 43. Opening the drive holder lever*

- b) Unlock the drive handle (**B**) by pressing the handle release latch (**A**) in the direction that is shown, and pulling out the handle toward you.



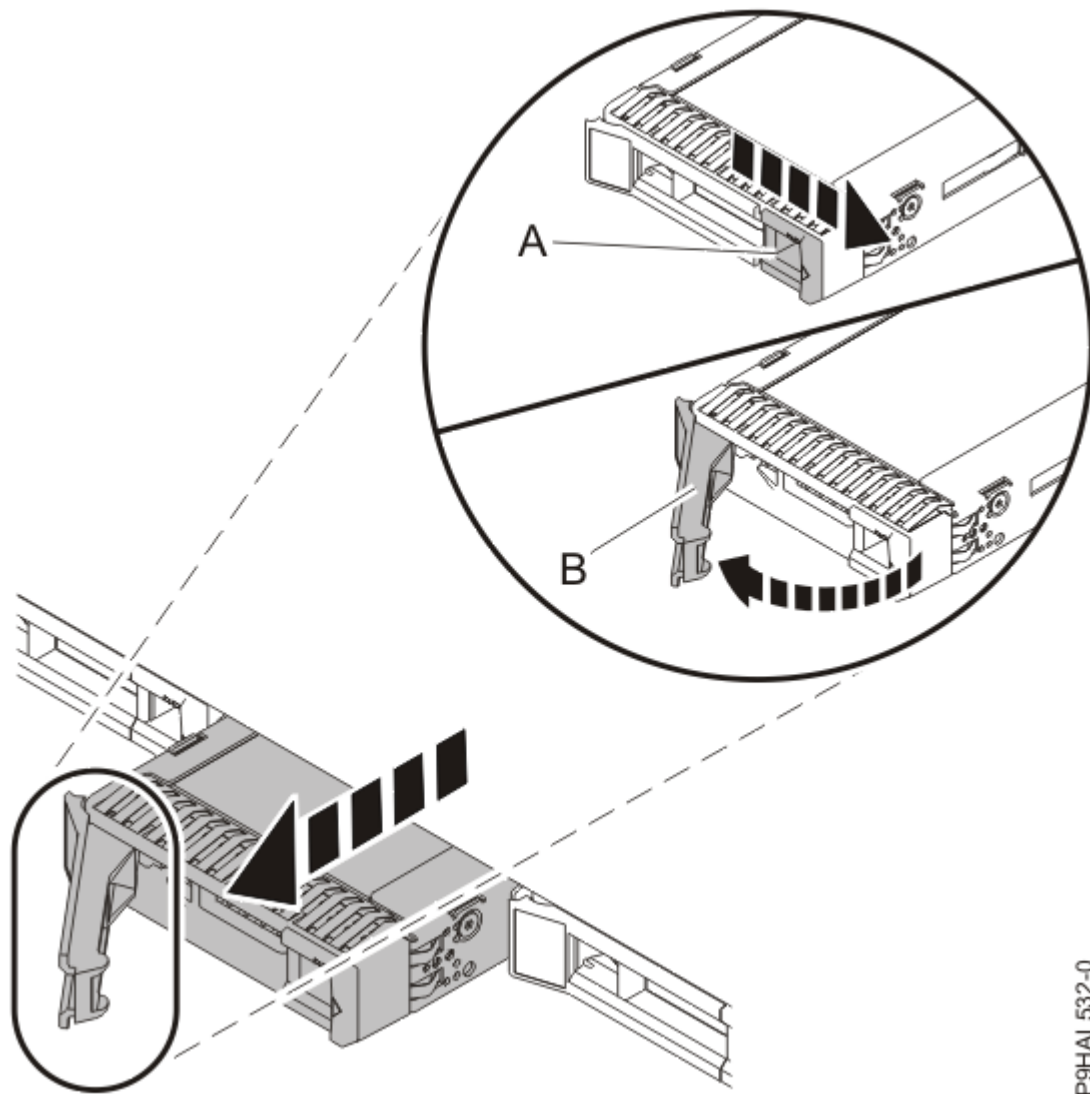
*Figure 44. Unlatching the drive handle*

- c) Using the drive handle, pull the drive about 2.5 cm (1 in.) from the disk drive backplane.
- d) Lift the drive from the system as shown.



*Figure 45. Lifting the drive*

5. Continue with step [“22”](#) on page 70.
6. To remove a drive from the front of the system when the system is powered off, complete the following steps:
  - a) Unlock the drive handle **(B)** by pressing the handle release latch **(A)** in the direction that is shown, and pulling out the handle toward you. If the handle is not all the way out, the drive cannot slide out of the system.



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Figure 46. Unlocking and removing the drive

- b) Support the bottom of the drive as you slide it out of the system.
7. Continue with step [“22” on page 70](#).
8. To remove a drive from the system by using the AIX operating system, choose from the following options:
  - To remove a drive from slot P2-D7 or P2-D8 inside the system, continue with step [“9” on page 60](#).
  - To remove a drive from slot P2-D1 through P2-D6 in the front of the system, continue with step [“11” on page 61](#).
9. To remove a drive from inside the system by using the AIX operating system, complete the following steps:
  - a) When the identify LED turns on solid, unlock the drive bay handle **(B)** by pressing the handle release latch **(A)** in the direction that is shown and pulling the handle out.

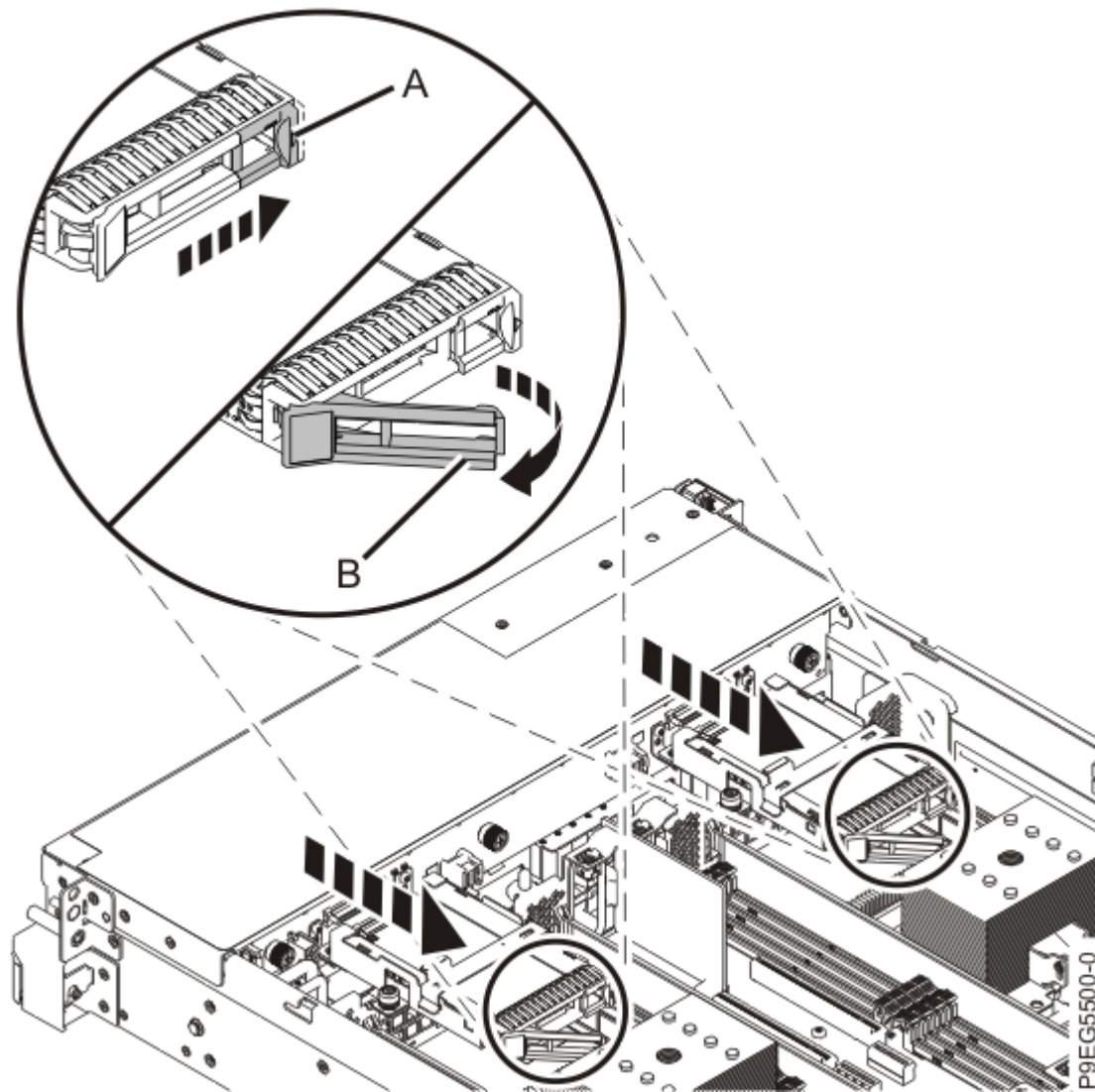
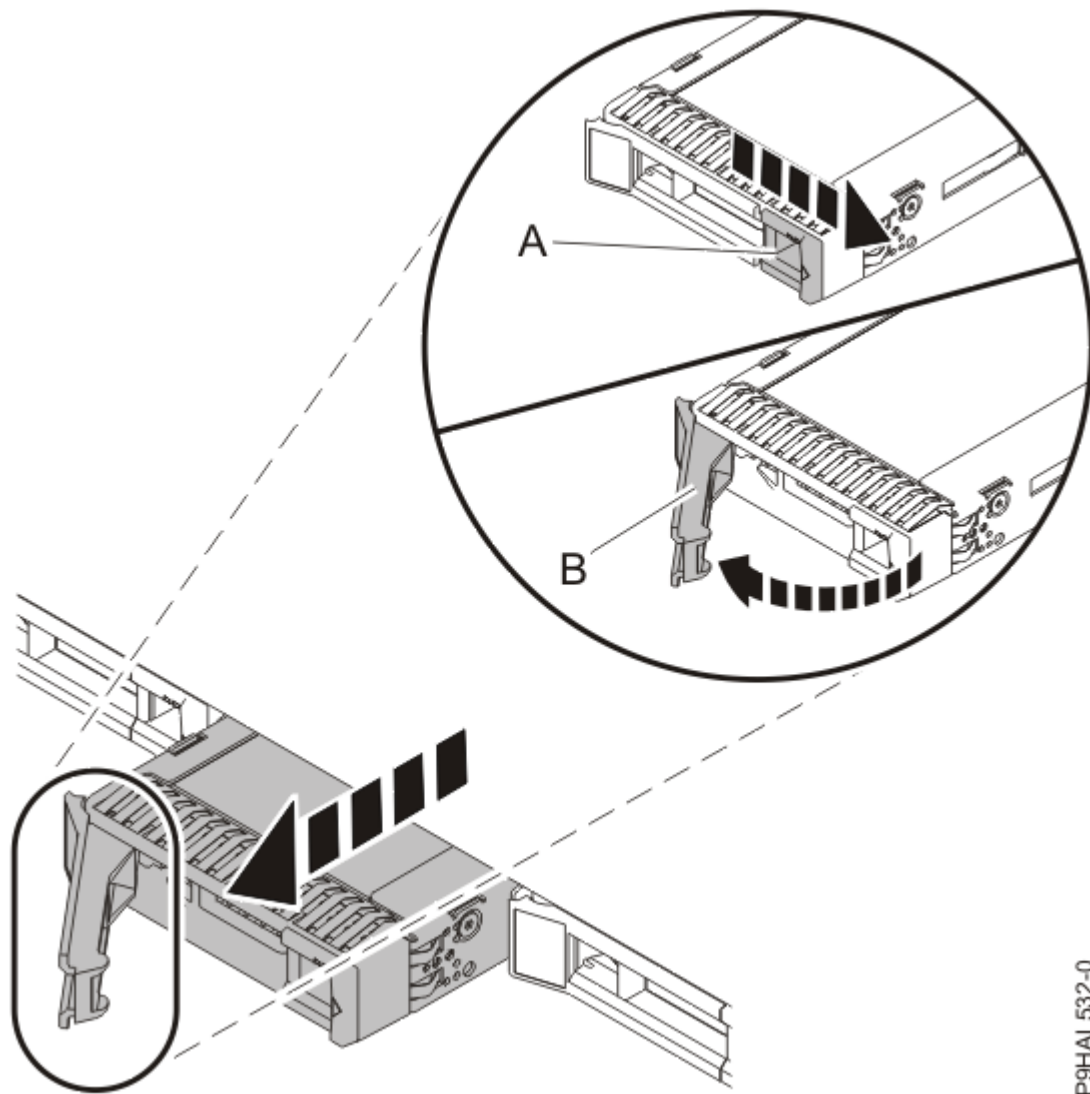


Figure 47. Unlatching the drive

- b) If you want to replace the drive, continue with the next step. If you are permanently removing the drive, press Enter on the console to indicate that you removed the drive. The identify LED turns off.
10. Continue with step [“22”](#) on page 70.
11. To remove a drive from the front of the system by using the AIX operating system, complete these steps.
  - a) When the identify LED turns on solid, unlock the drive bay handle **(B)** by pressing the handle release latch **(A)** in the direction that is shown and pulling the handle out toward you. If the handle is not all the way out, the drive cannot slide out of the system.





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Figure 48. Unlocking and removing the drive

- b) Support the bottom of the drive as you slide it out of the system.
- c) If you want to replace the drive, continue with the next step. If you are permanently removing the drive, press Enter on the console to indicate that you removed the drive. The identify LED turns off.
12. Continue with step “22” on page 70.
13. To remove a drive from the system by using the IBM i operating system, choose from the following options:
  - To remove a drive from slot P2-D7 or P2-D8 inside the system, continue with step “14” on page 62.
  - To remove a drive from slot P2-D1 through P2-D6 in the front of the system, continue with step “16” on page 65.
14. To remove a drive from inside the system by using the IBM i operating system, complete the following steps:
  - a) Select the drive that you want to remove on the console, and then press Enter.

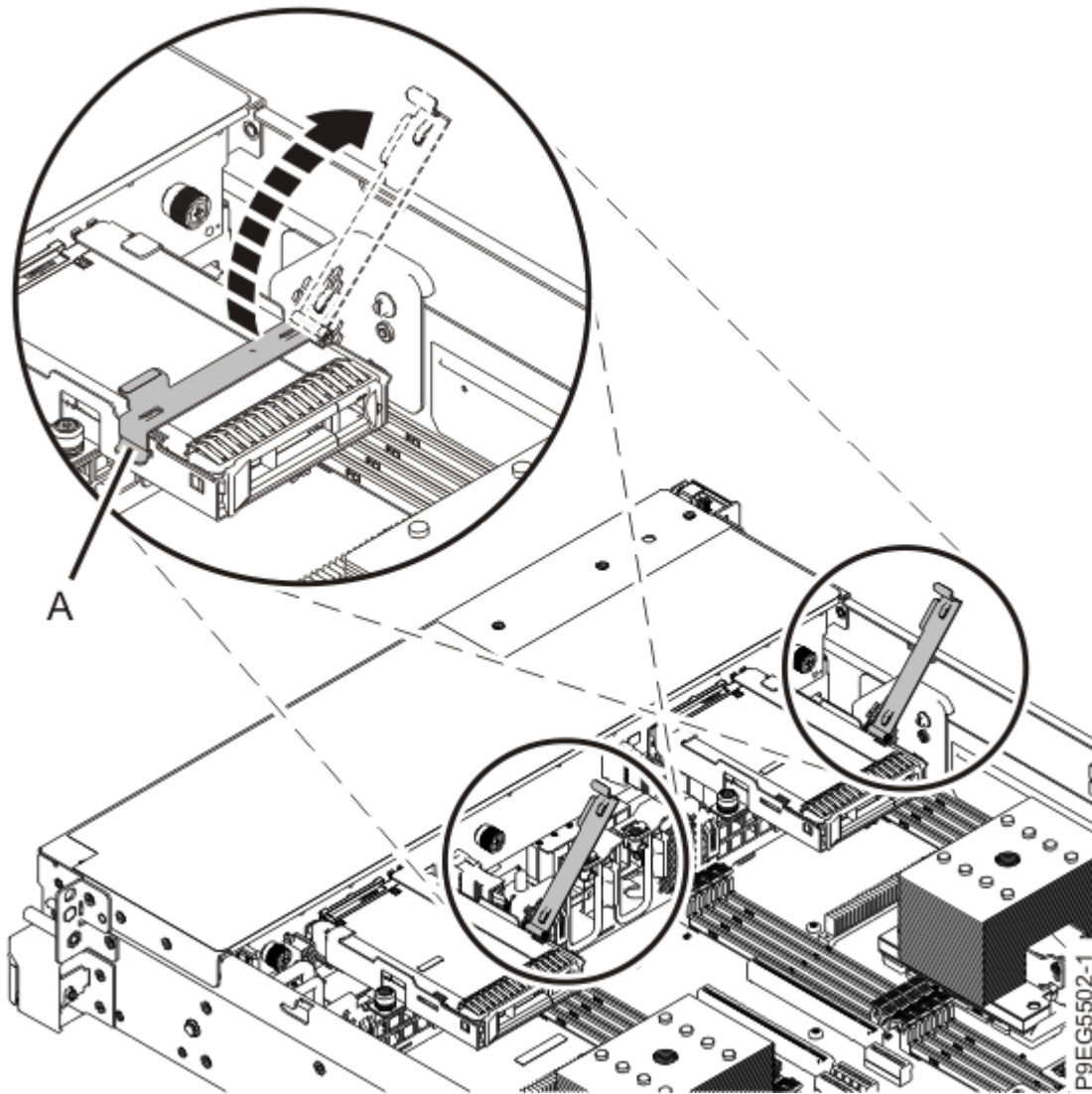
**Important:**

  - When you press Enter, after your selected time delay, the service indicator light turns on (solid) for 18 seconds. You then have 18 seconds to unlock and remove the drive. You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the disk drive or solid-state drive.



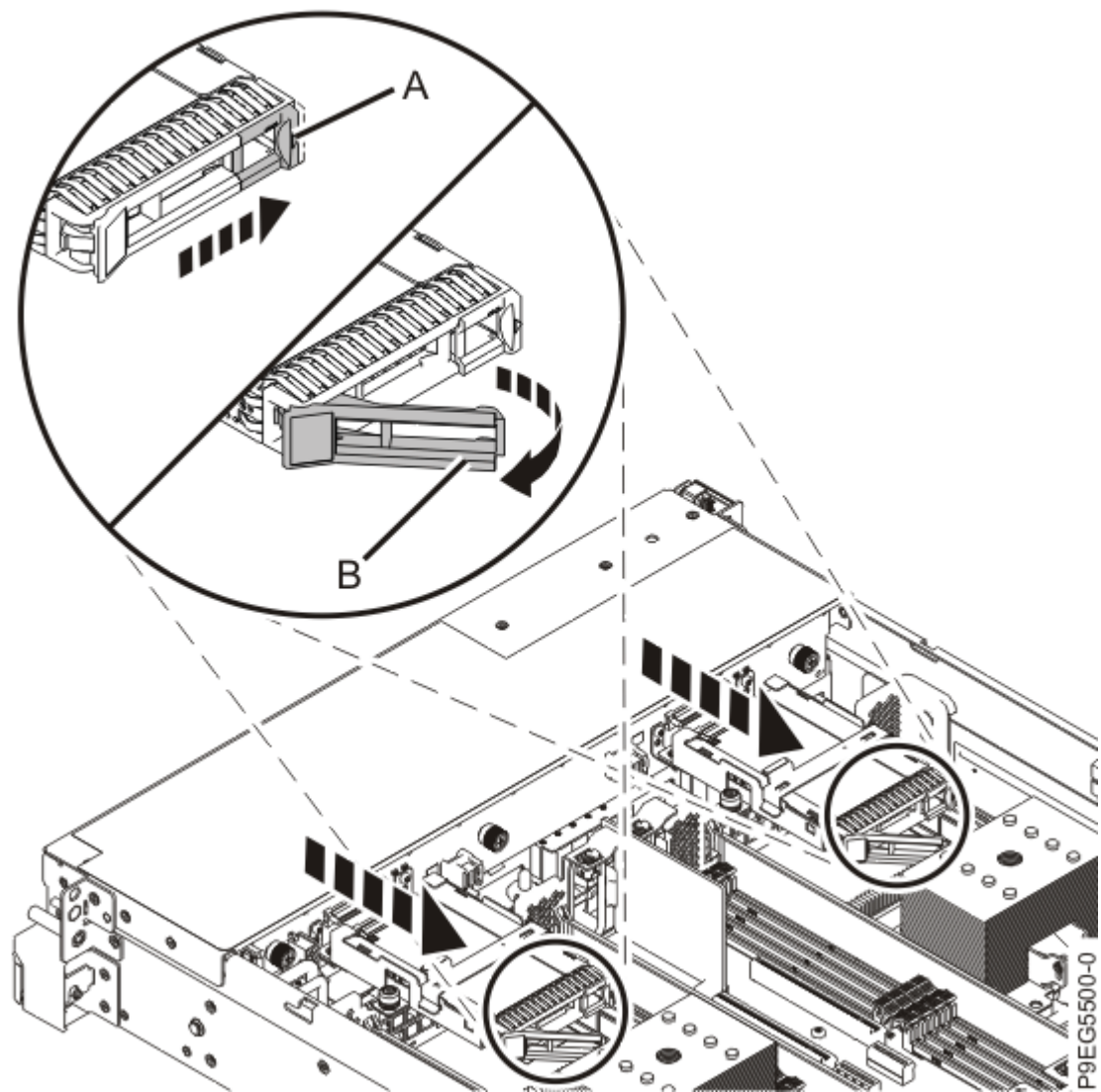
- If the service indicator light was already turned on due to a failed device, you will not see a change in the service indicator light until after the first 18 seconds. You need to wait until the service indicator light goes off and then turns back on (solid). You have two cycles of the light that turns on (solid) to unlock and remove the drive.

b) Open the drive holder lever **(A)**.



*Figure 49. Opening the drive holder lever*

c) When the identify LED turns on solid, unlock the drive bay handle **(B)** by pressing the handle release latch **(A)** in the direction that is shown and pulling the handle out.



*Figure 50. Unlatching the drive*

- d) Use the drive handle to pull the drive about 2.5 cm (1 in.) from the disk drive backplane.
- e) Lift the drive from the system.

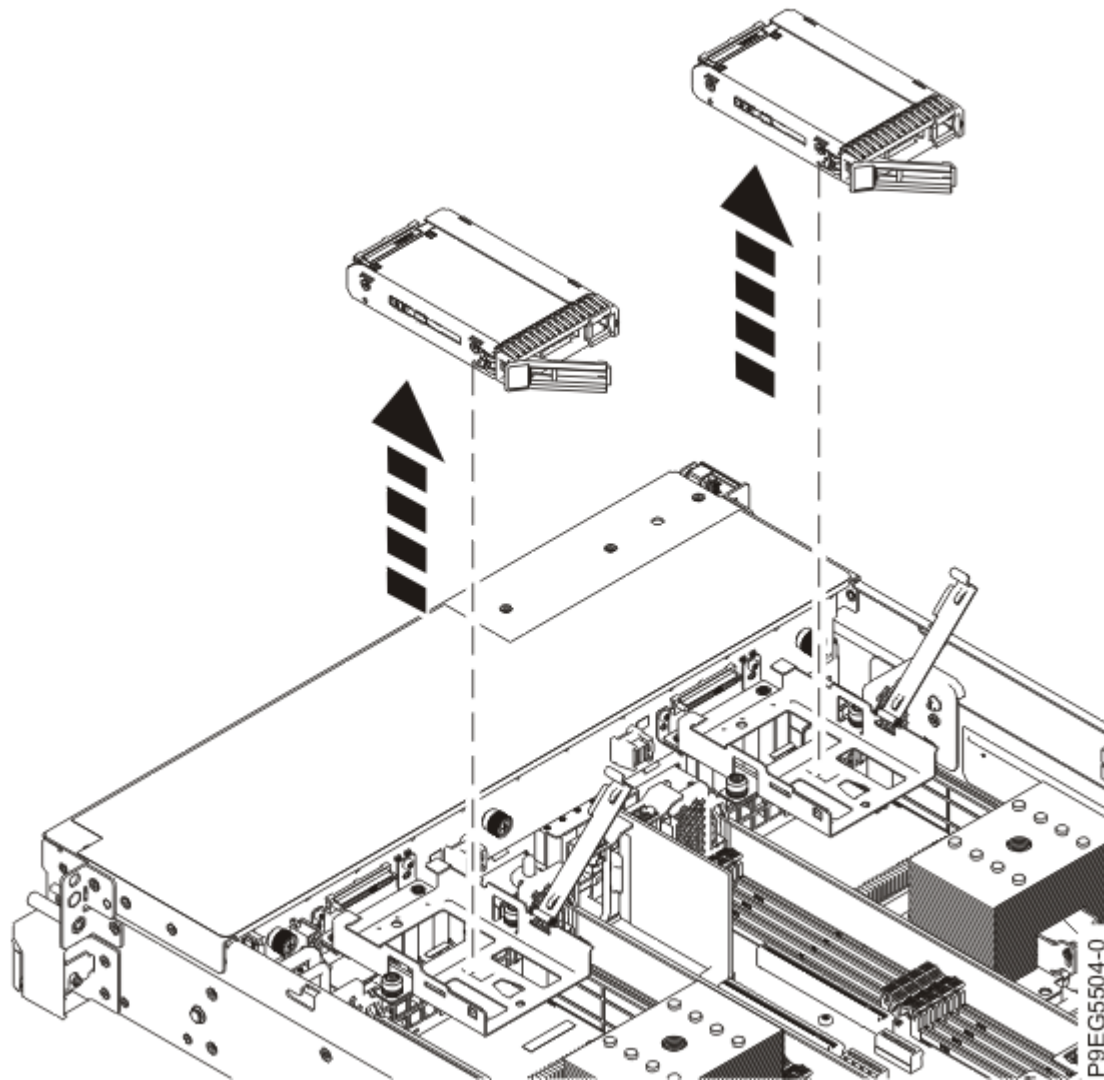
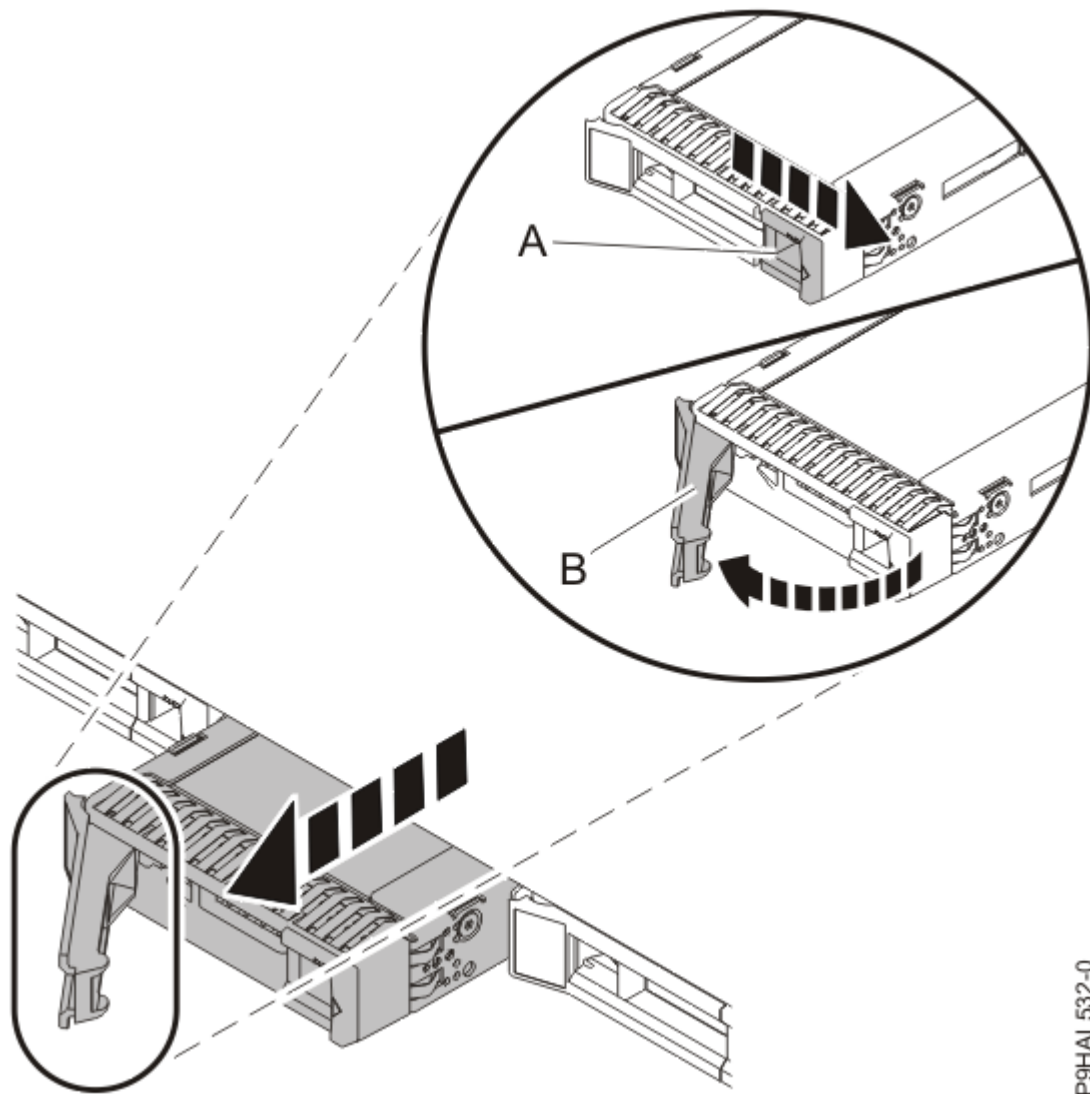


Figure 51. Lifting the drive

- f) Press Enter on the console to indicate that you removed the drive. The identify LED turns off.
15. Continue with step “22” on page 70.
16. To remove a drive from the front of a system by using the IBM i operating system, complete the following steps:
  - a) Select the drive that you want to remove on the console, and then press Enter.

**Important:**

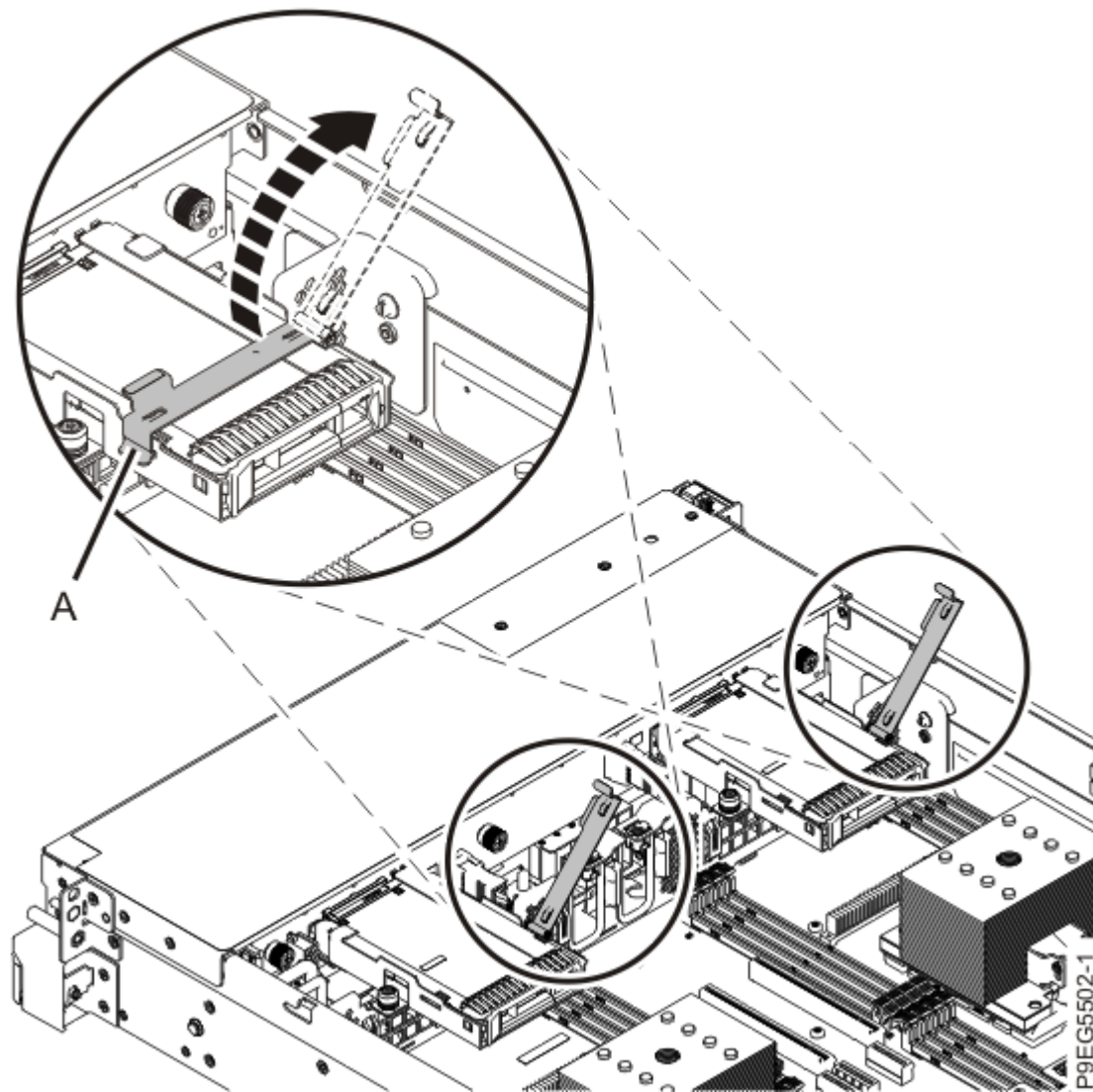
- When you press Enter, after your selected time delay, the service indicator light turns on (solid) for 18 seconds. You then have 18 seconds to unlock and remove the drive. You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the disk drive or solid-state drive.
  - If the service indicator light was already turned on due to a failed device, you will not see a change in the service indicator light until after the first 18 seconds. You need to wait until the service indicator light goes off and then turns back on (solid). You have two cycles of the light that turns on (solid) to unlock and remove the drive.
- b) When the identify LED turns on solid, unlock the drive bay handle (**B**) by pressing the handle release latch (**A**) in the direction that is shown and pulling the handle out toward you. If the handle is not all the way out, the drive cannot slide out of the system.



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Figure 52. Unlocking and removing the drive

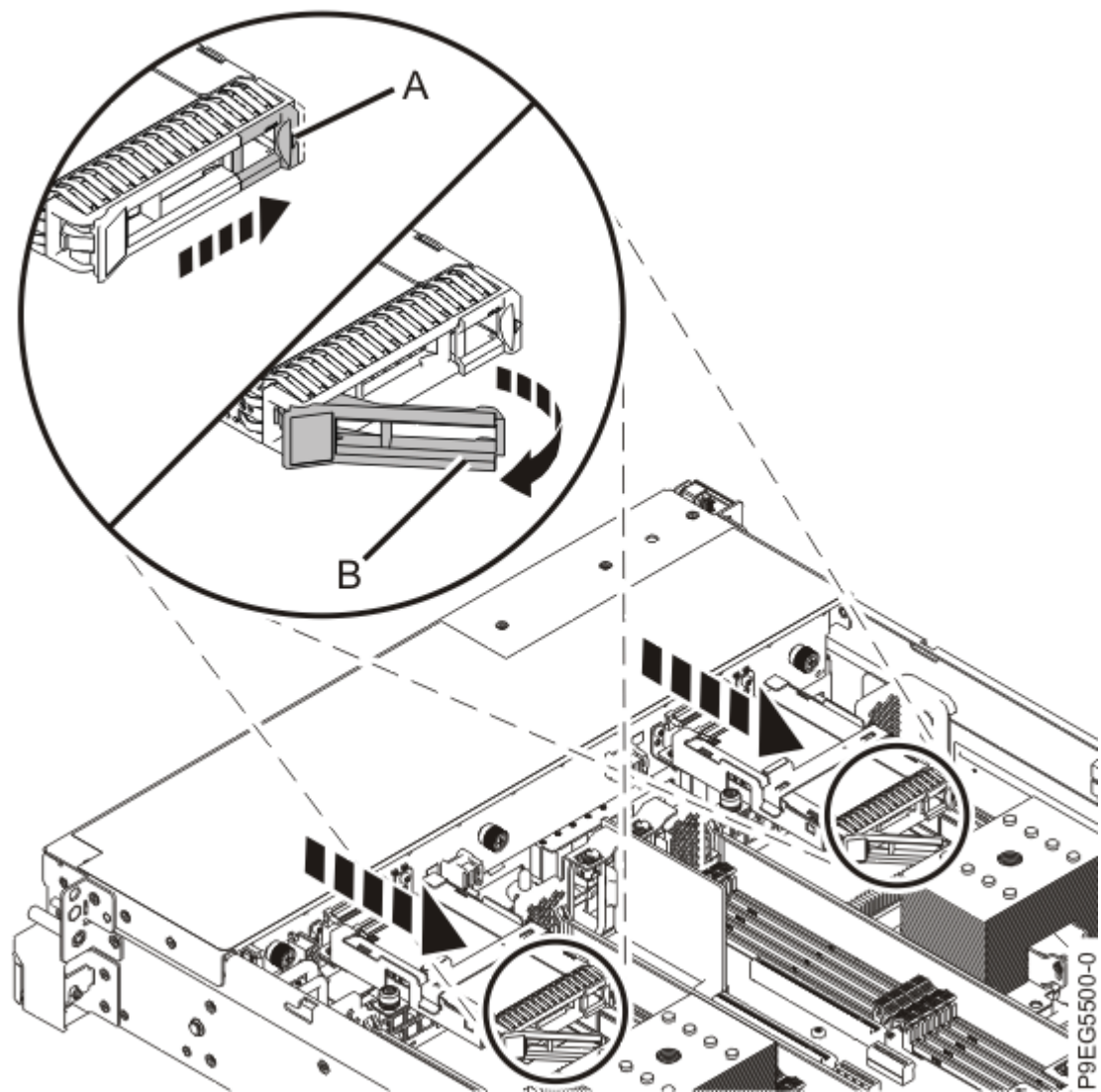
- c) Support the bottom of the drive as you slide out of the system.
  - d) Press **Enter** on the console to indicate that you removed the drive. The identify LED turns off.
17. Continue with step “22” on page 70.
  18. To remove a drive from the system by using the Linux operating system, choose from the following options:
    - To remove a drive from slot P2-D7 or P2-D8 inside the system, continue with step “19” on page 66.
    - To remove a drive from slot P2-D1 through P2-D6 in the front of the system, continue with step “21” on page 69.
  19. To remove a drive from inside of the system by using the Linux operating system, complete the following steps:
    - a) Open the drive holder lever **(A)**.



*Figure 53. Opening the drive holder lever*

- b) When the identify LED turns on solid, unlock the drive bay handle (**B**) by pressing the handle release latch (**A**) in the direction that is shown and pulling the handle out.

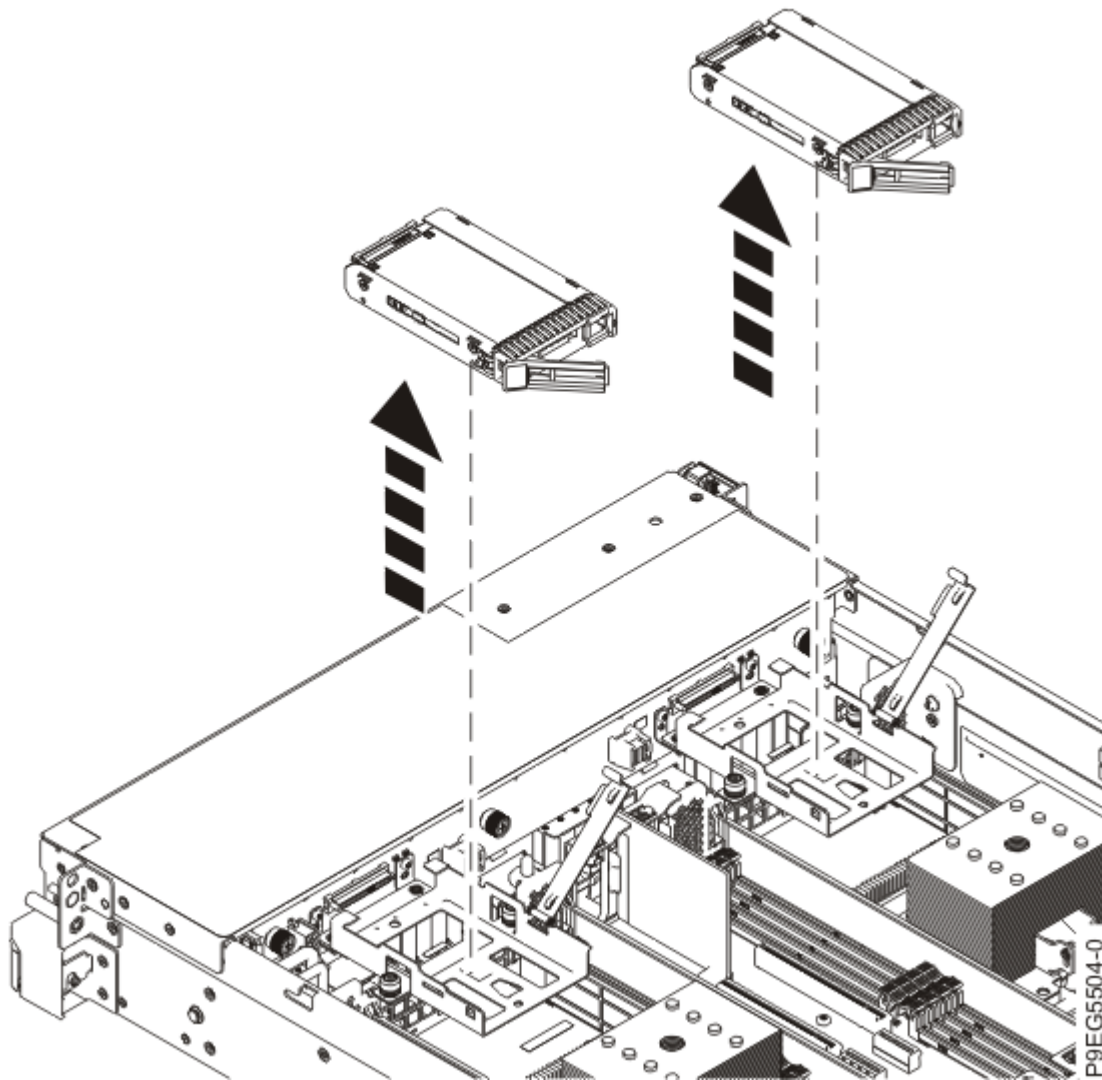




*Figure 54. Unlatching the drive*

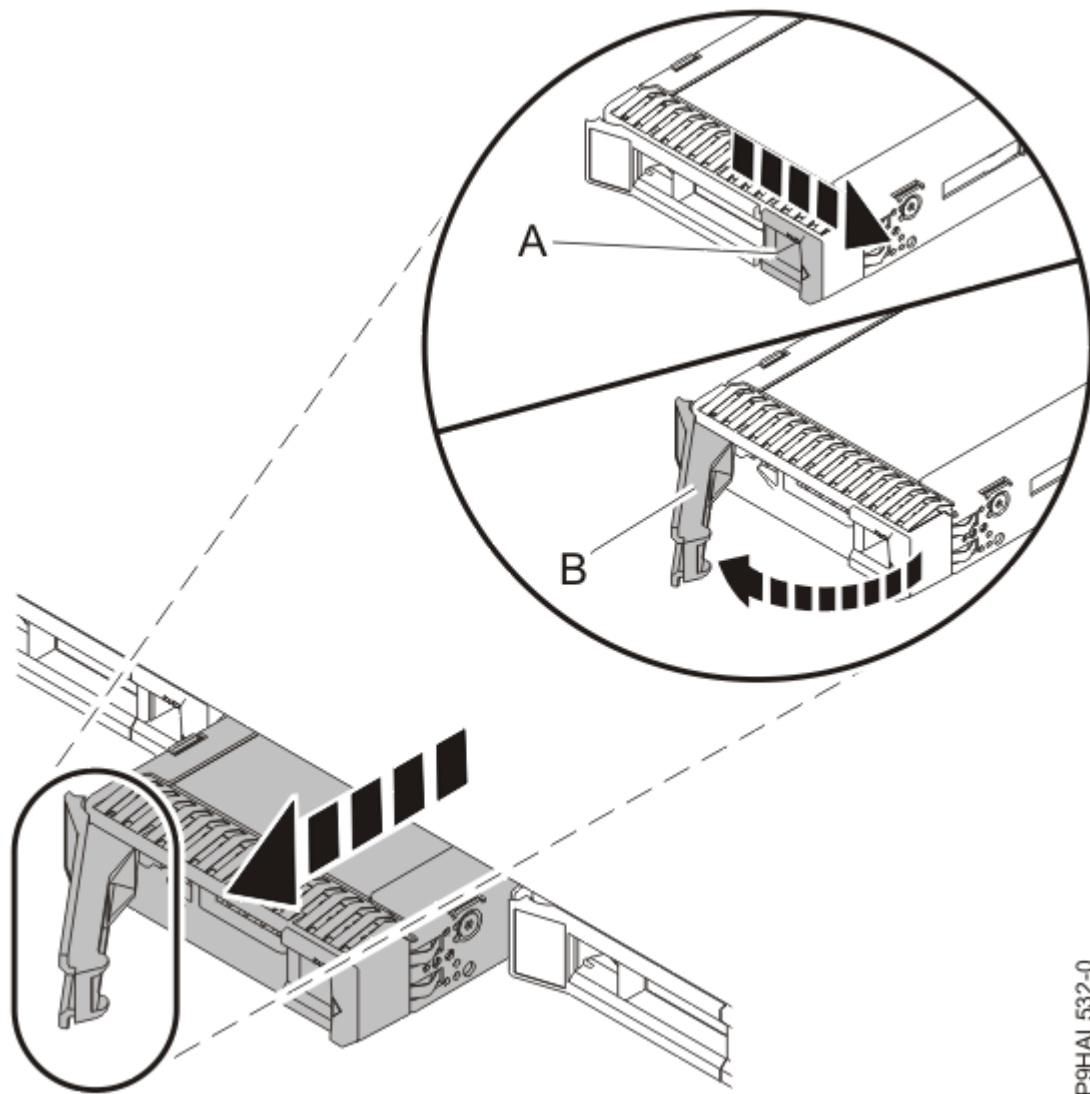
- c) Use the drive handle to pull the drive about 2.5 cm (1 in.) from the disk drive backplane.
- d) Lift the drive from the system.





*Figure 55. Lifting the drive*

- e) Press Enter on the console to indicate that you removed the drive. The identify LED turns off.
- 20. Continue with step [“22” on page 70](#).
- 21. To remove a drive from the front of the system by using the Linux operating system, complete the following steps:
  - a) When the identify LED turns on solid, unlock the drive bay handle **(B)** by pressing the handle release latch **(A)** in the direction that is shown and pulling the handle out toward you. If the handle is not all the way out, the drive cannot slide out of the system.



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Figure 56. Unlocking and removing the drive

- b) Support the bottom of the drive as you slide it out of the system, holding the drive by its sides.
  - c) Press **Enter** on the console to indicate that you removed the drive. The identify LED turns off.
22. If you want to remove another drive, repeat this procedure.

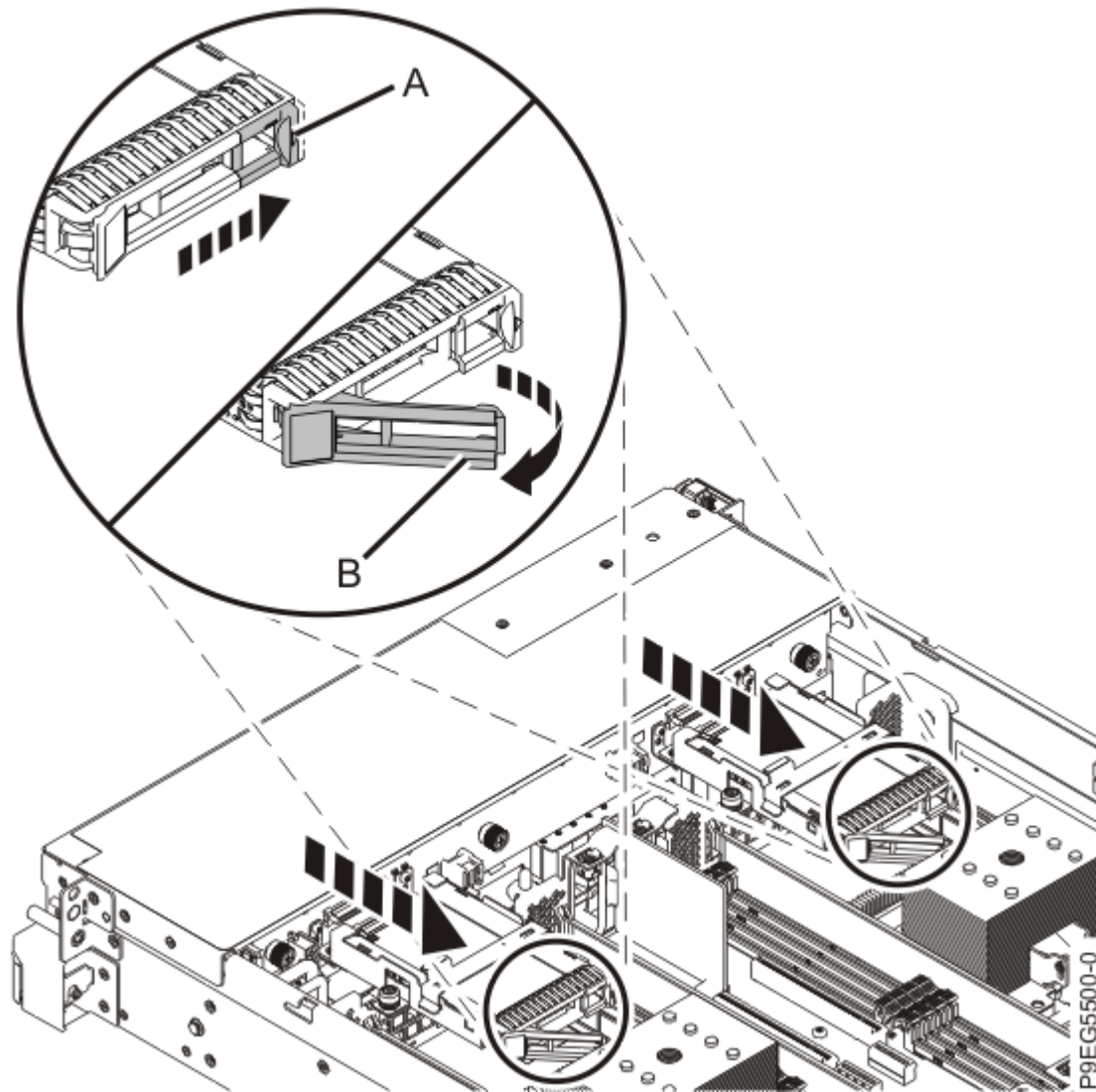
## Replacing a disk drive or solid-state drive in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

To replace a disk drive or solid-state drive (SSD) in the system, complete the steps in this procedure.

### Procedure

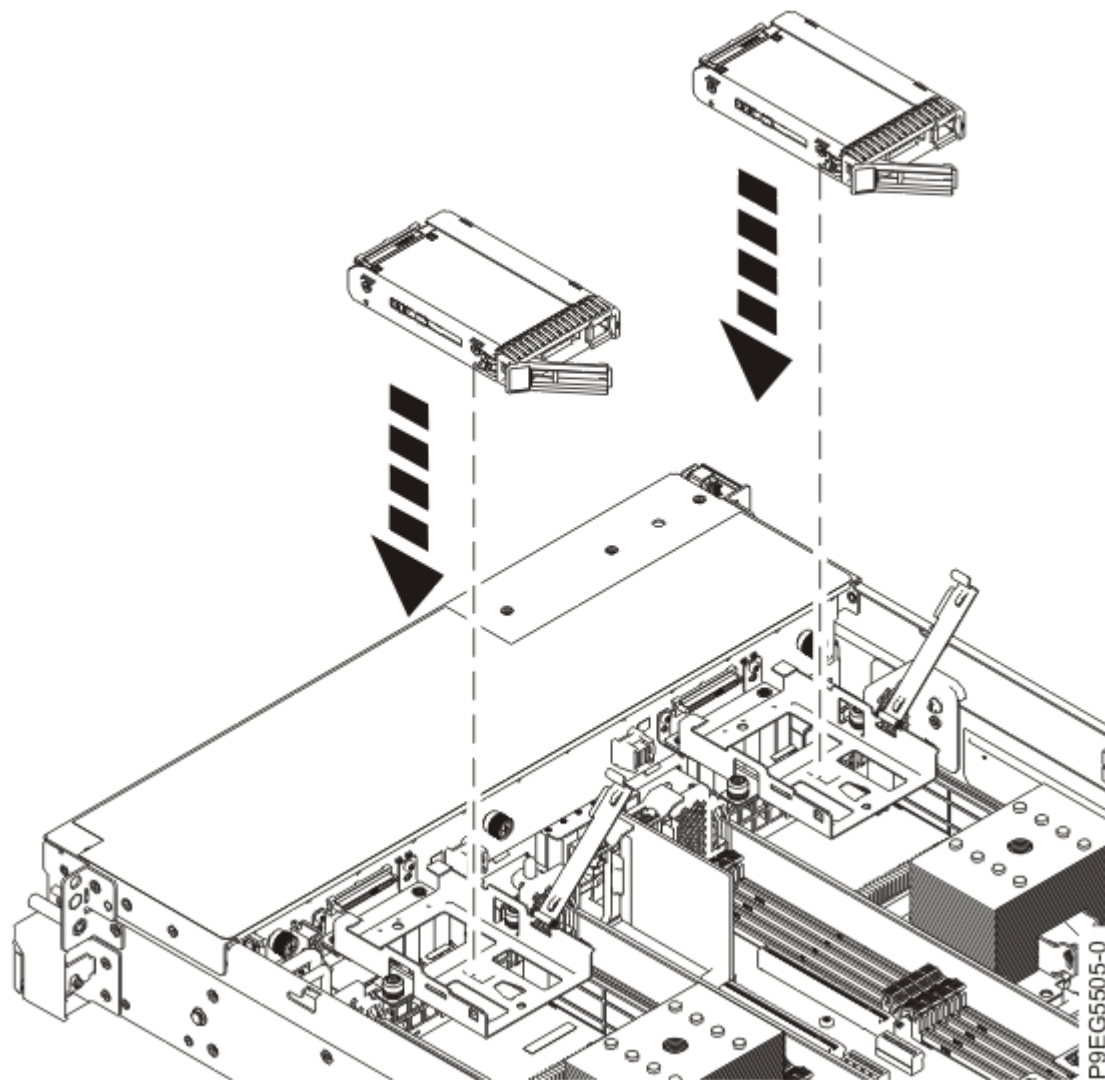
1. Ensure that you have the electrostatic discharge (ESD) wrist strap on and that the ESD clip is plugged into a ground jack or connected to an unpainted metal surface. If not, do so now.
2. Choose from the following options:
  - If the system is powered off, continue with step “3” on page 71.
  - If the system is powered on and is running the AIX operating system, continue with step “8” on page 75.
  - If the system is powered on and is running the IBM i operating system, continue with step “13” on page 80.

- If the system is powered on and is running the Linux operating system, continue with step “18” on page 84.
3. To replace a drive in a system when the system is powered off, choose from the following options:
    - To replace a drive inside the system (slot P2-D7 or P2-D8), continue with step “4” on page 71.
    - To replace a drive in the front of the system (slots P2-D1 through P2-D6), continue with step “6” on page 74.
  4. To replace a drive in slot P2-D7 or P2-D8 inside the system when the system is powered off, complete the following steps:
    - a) Unlock the drive handle **(B)** by pressing the handle release latch **(A)** in the direction that is shown, and pulling out the handle toward you.



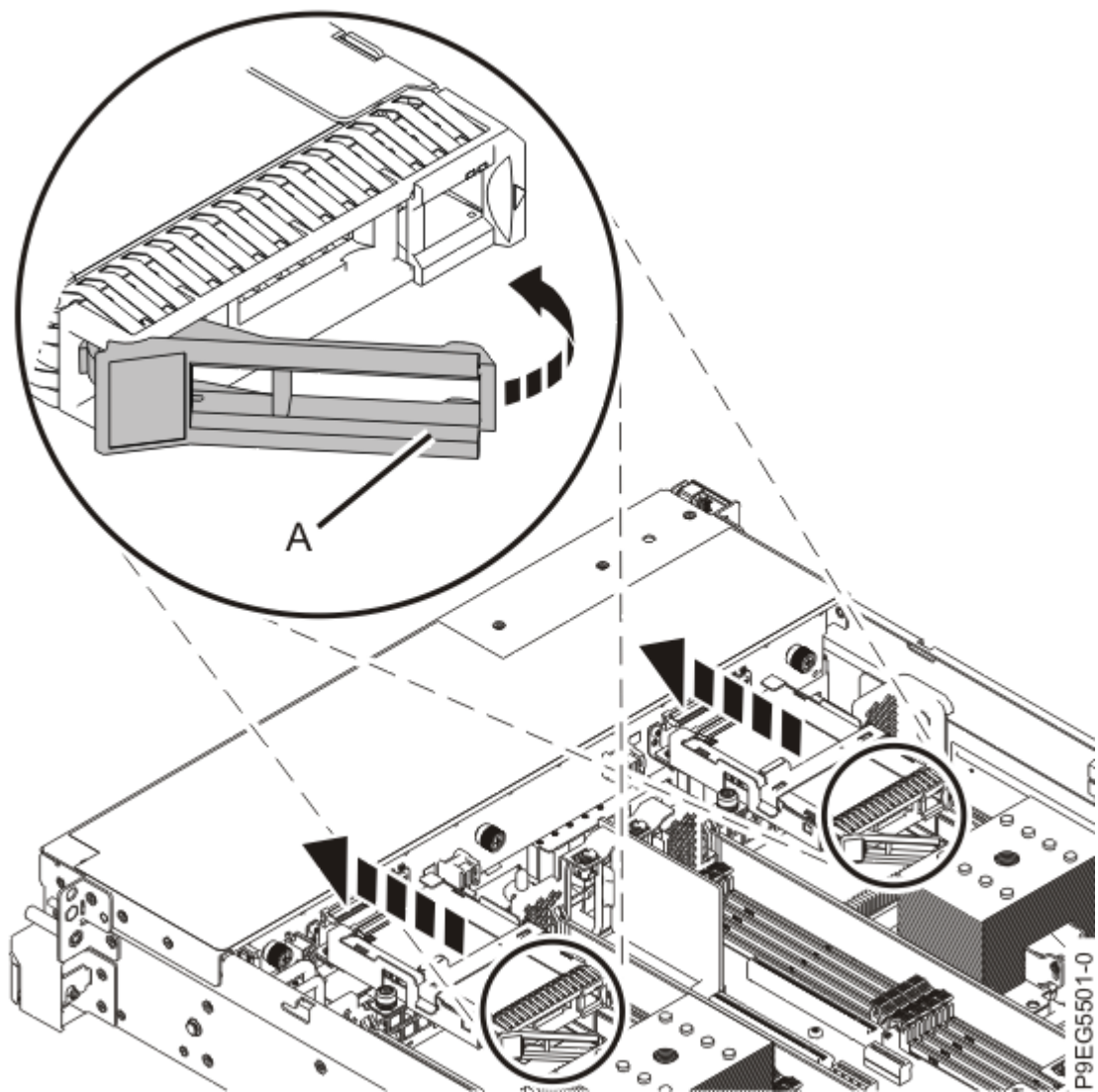
*Figure 57. Unlatching the drive handle*

- b) Lower the drive into the drive tray.



*Figure 58. Lowering the drive into the drive tray*

- c) Slide the drive forward by using the drive handle until it contacts the disk drive backplane.
- d) Push drive handle **(A)** until the drive is fully seated and the drive handle locks.



*Figure 59. Locking the drive handle*

e) Close the drive holder lever **(A)** over the drive.



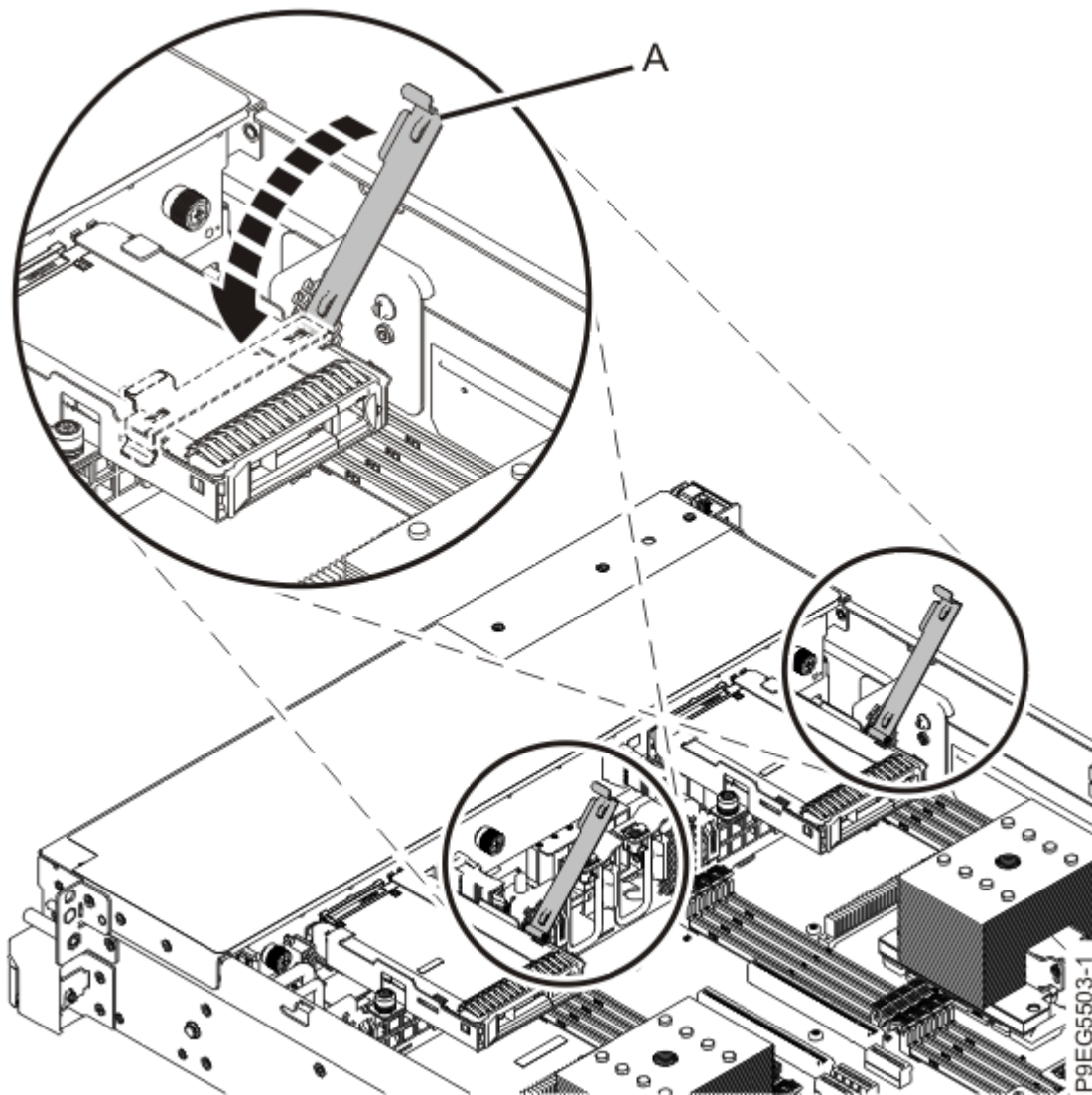
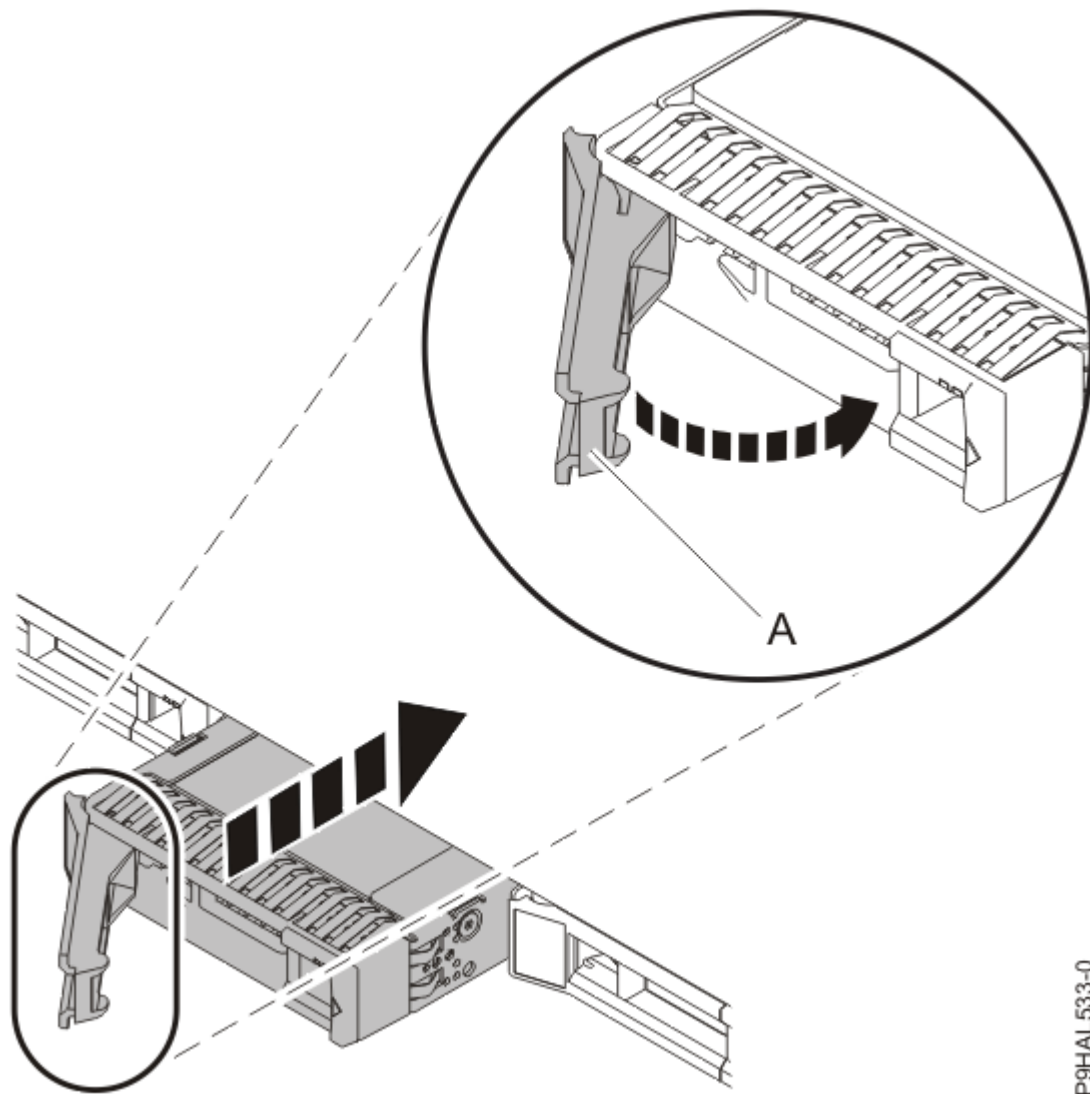


Figure 60. Closing the drive holder lever

5. Continue with step [“22”](#) on page 88.
6. To install or replace a drive in the front of a system when the system is powered off, complete the following steps:
  - a) Unlock the drive bay handle **(A)** by pressing the handle release latch and pulling out the handle toward you. If the handle is not all the way out, the drive does not slide into the system.
  - b) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.
  - c) Slide the drive all the way into the system.
  - d) Push the drive bay handle **(A)** in until it locks.





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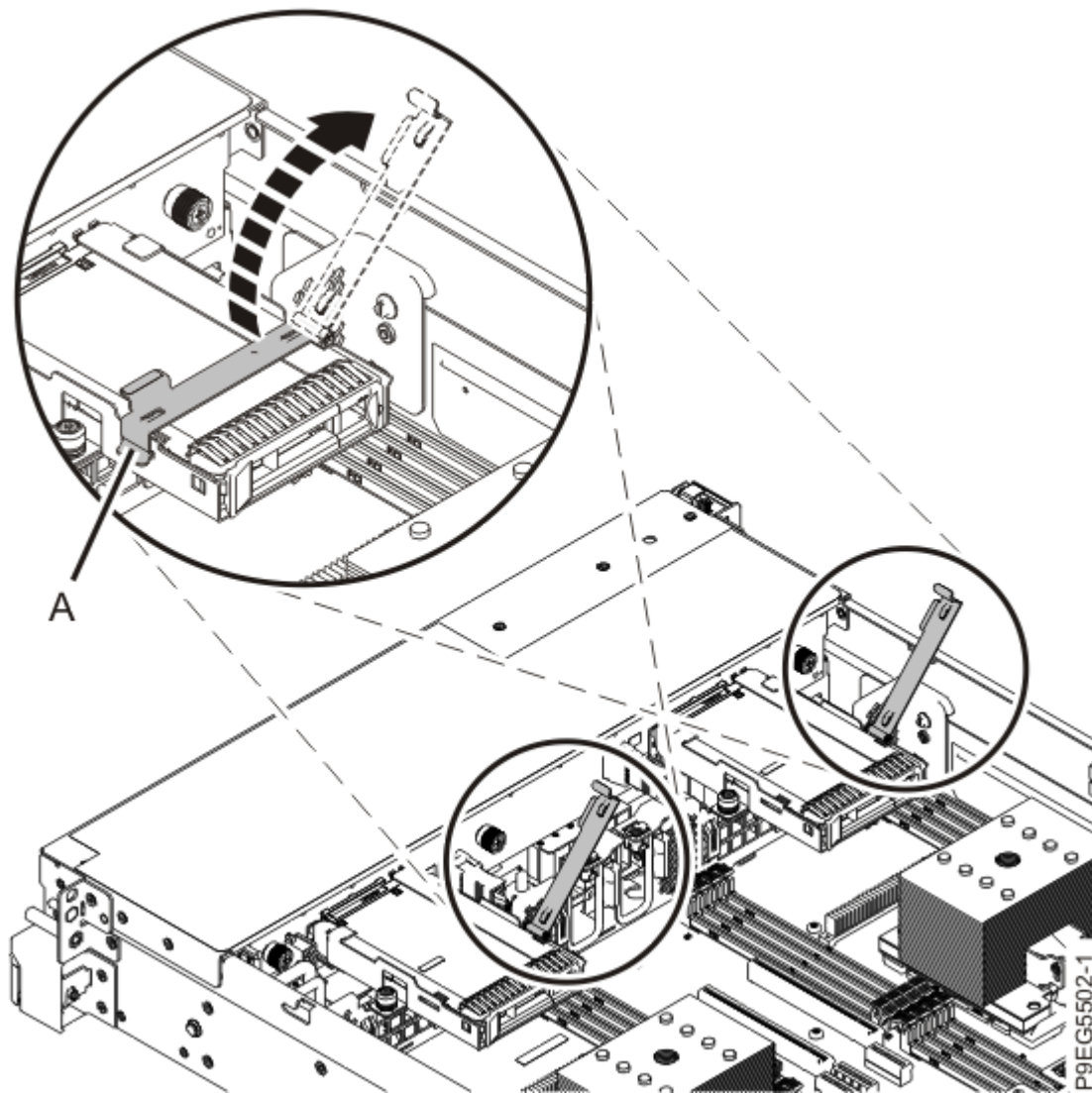
Figure 61. Installing a drive in a system

**Important:** Ensure that the drive is fully seated and is all the way into the system.

7. Continue with step “22” on page 88.
8. To replace a drive in a system by using the AIX operating system, choose from the following options:
  - To replace a drive in slots P2-D7 or P2-D8 inside the system, continue with step “9” on page 75.
  - To replace a drive in slots P2-D1 - P2-D6 in the front of the system, continue with step “11” on page 79.
9. To install or replace a drive in slot P2-D7 or P2-D8 inside of the system by using the AIX operating system, complete the following steps:

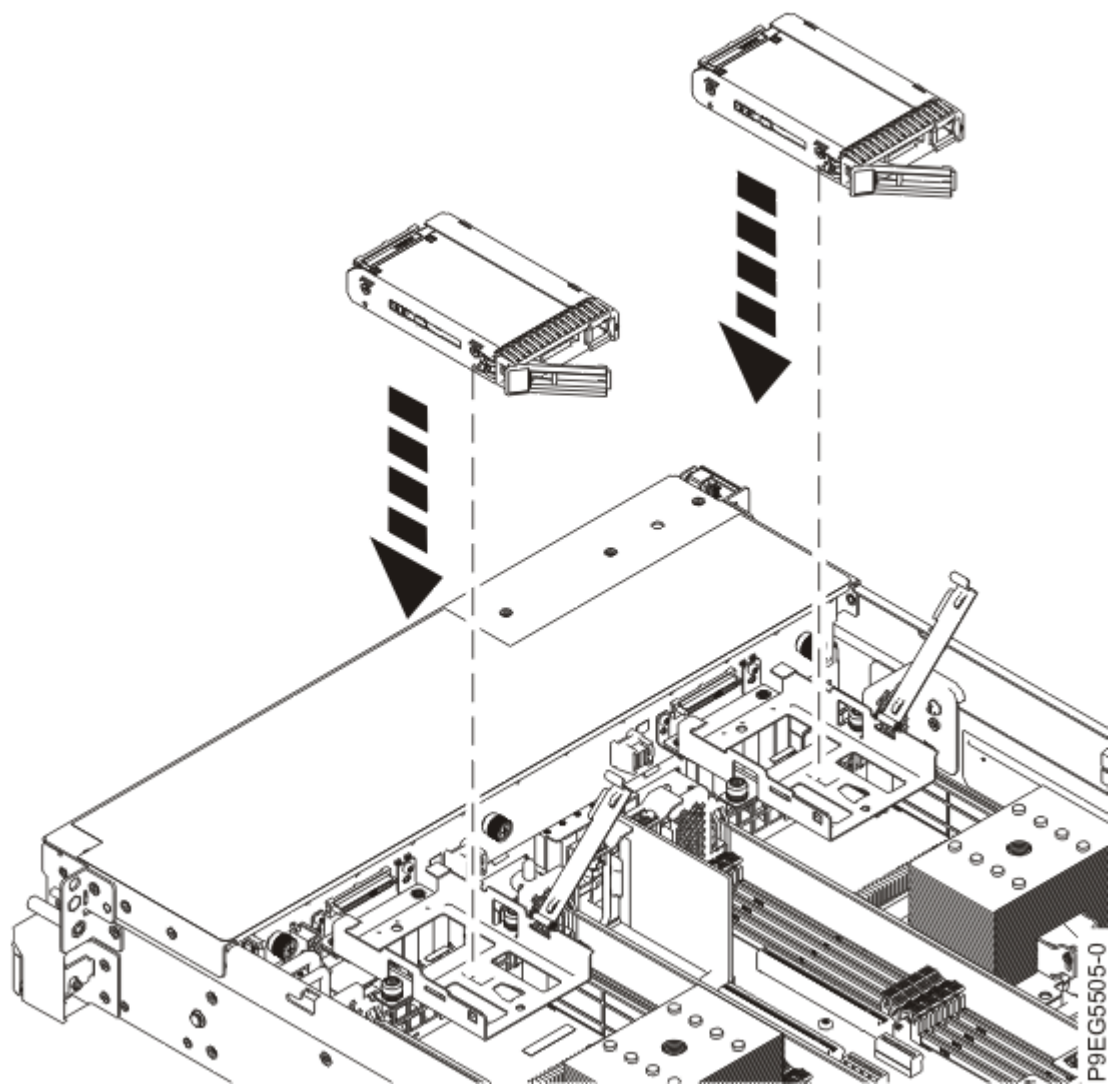
**Important:** During this procedure, you need to work with the system administrator to indicate on the console that you want to remove the drive. If this process exceeds the 10-minute service limitation with the system access cover removed and with the system power turned on, place the service access cover back on the system before you work with the system administrator to maintain proper system cooling.

- a) Open the drive holder lever **(A)**.

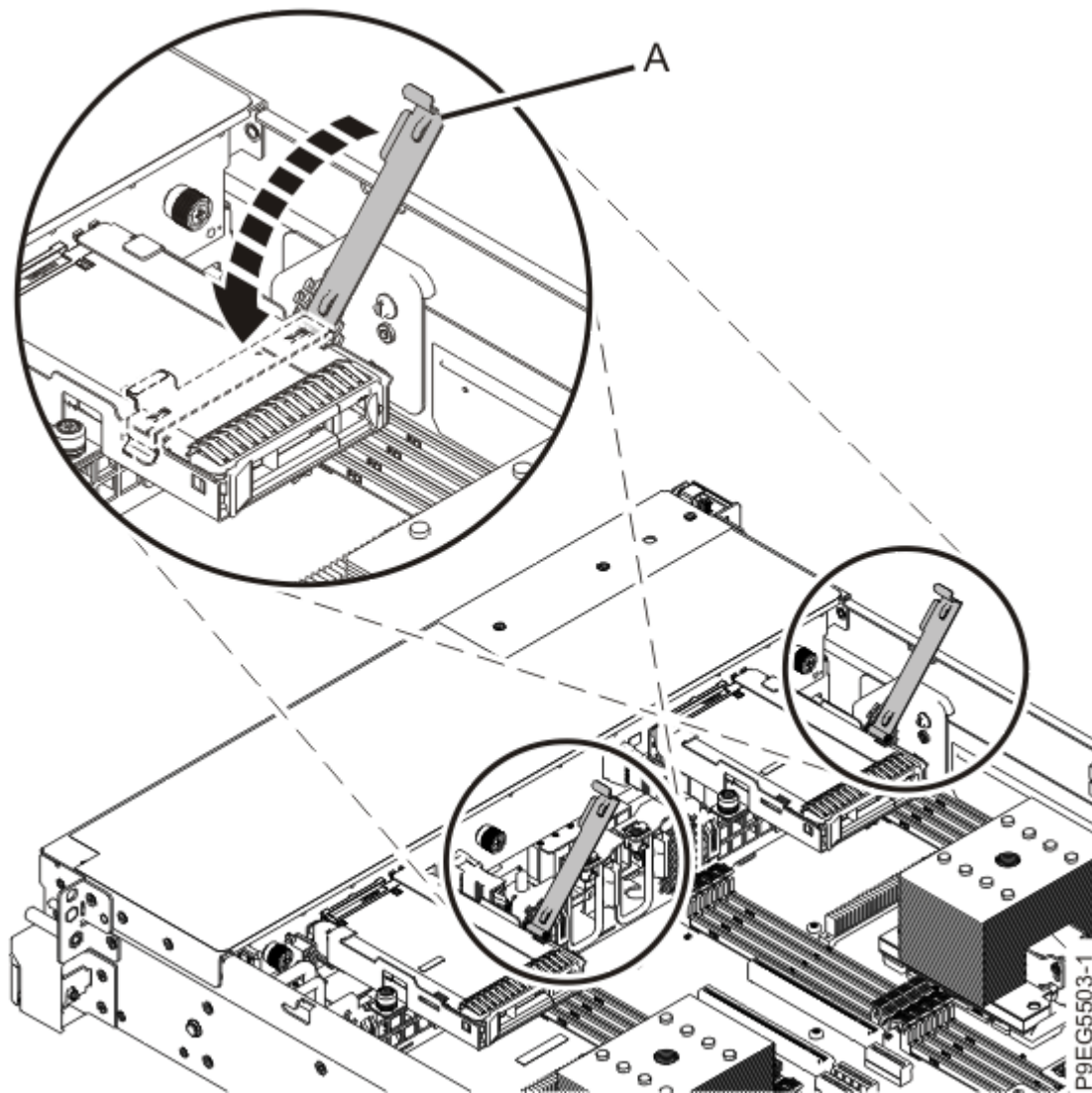


*Figure 62. Opening the drive holder lever*

- b) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
- c) Lower the drive into the drive tray.



*Figure 63. Lowering the drive into the drive tray*  
d) Close the drive holder lever **(A)** over the drive.



*Figure 64. Closing the drive holder lever*

- e) When the identify LED turns on solid, use the drive handle to slide the drive all the way into the system. When the drive is seated in the disk drive backplane, push in the drive handle **(A)** until it locks.

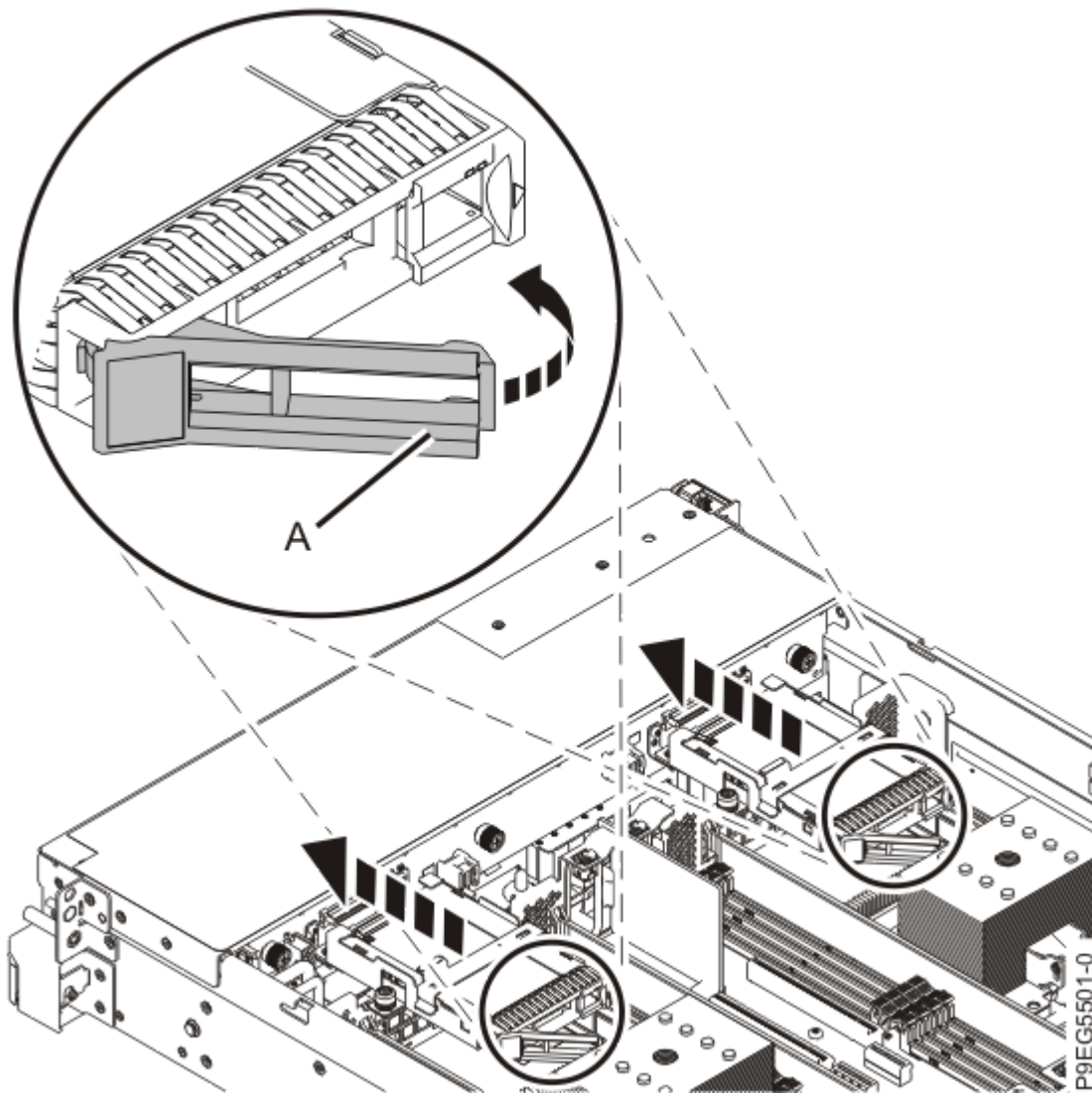
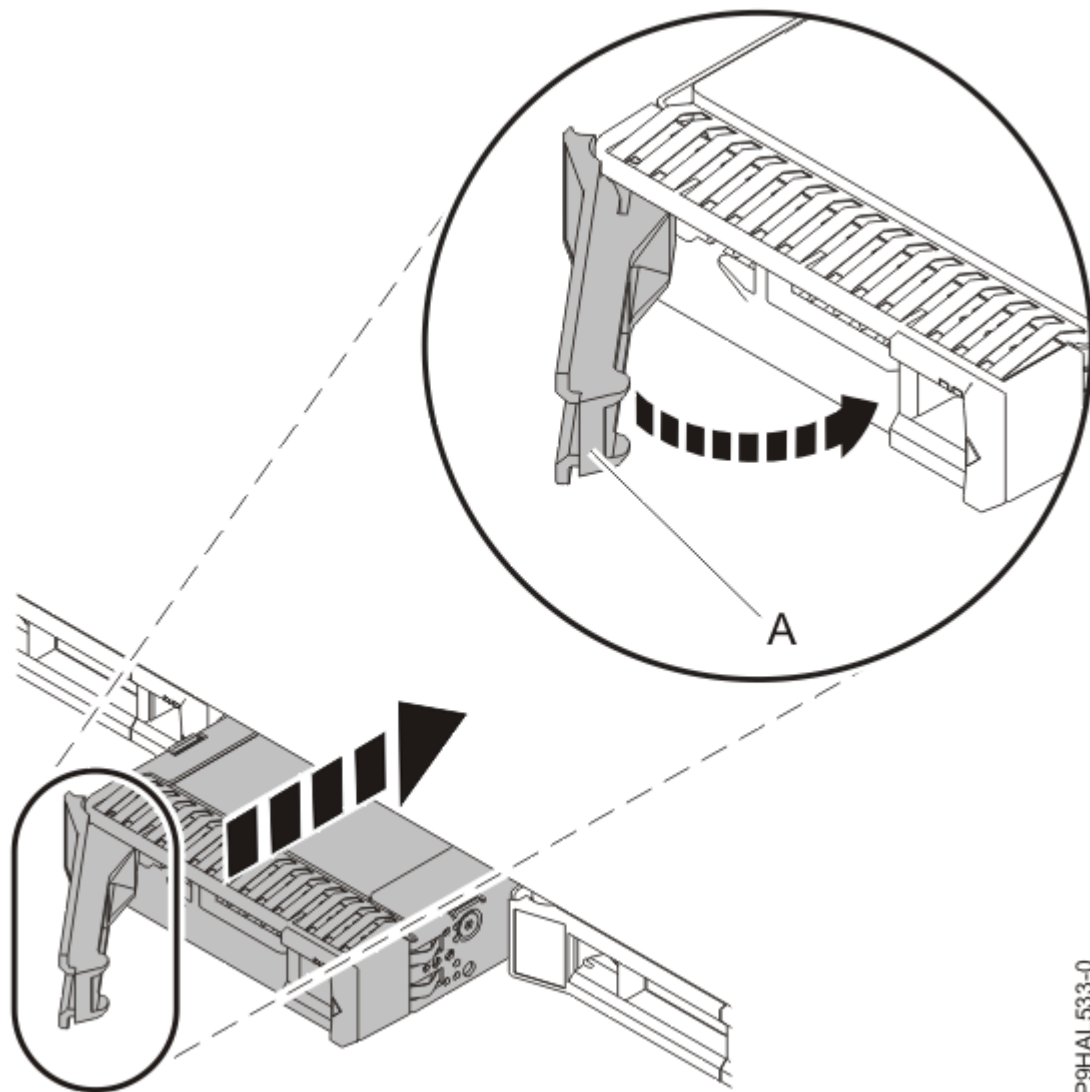


Figure 65. Locking the drive handle

- f) Press Enter on the console to indicate that you installed the drive.
- 10. Continue with step “22” on page 88.
- 11. To install or replace a drive in the front of the system or enclosure by using the AIX operating system, complete the following steps:
  - a) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
  - b) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.
  - c) Slide the drive all the way into the system, and push in the drive handle (**A**) until it locks.





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Figure 66. Installing a drive in a system

**Important:** Ensure that the drive is fully seated and is all the way into the system.

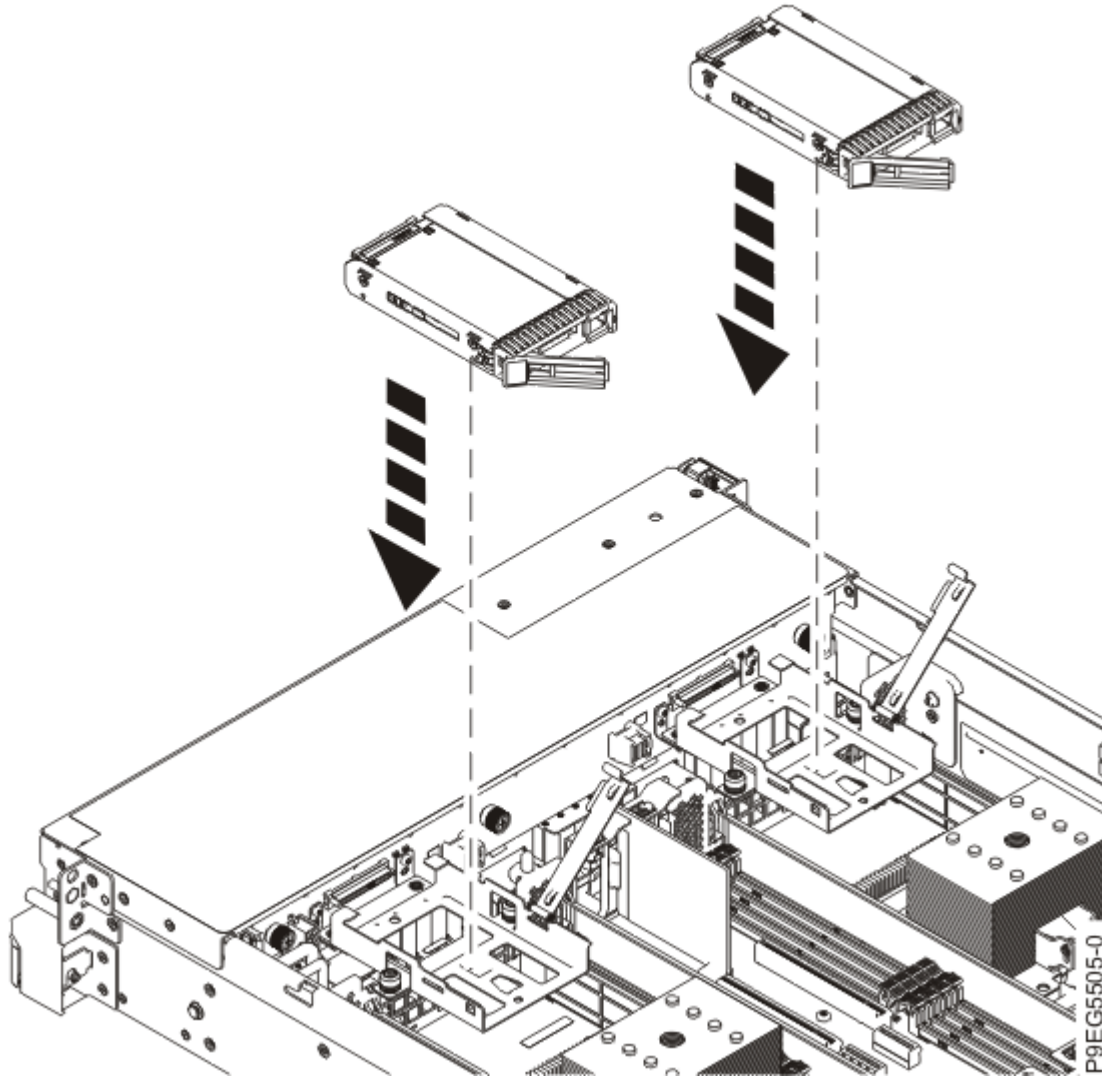
- d) Press Enter on the console to indicate that you installed the drive.
12. Continue with step “22” on page 88.
13. To replace a drive in a system when the system is powered on and by using the IBM i operating system, choose from the following options:
  - To replace a drive in slot P2-D7 or P2-D8 inside the system, continue with step “14” on page 80.
  - To replace a drive in slots P2-D1 through P2-D6 on the front of the system, continue with step “16” on page 83.
14. To replace a drive in slot P2-D7 or P2-D8 inside the system by using the IBM i operating system, complete the following steps:
  - a) Return to the console and wait until the Concurrent Maintenance Results display is shown.
    - 1) Press **P12**.
    - 2) The physical locations that you entered while you removed the drive might still show on the display. If not, retype the physical location where you want to install the replacement drive.
    - 3) Select 2 (Install device) for the action to be completed.
    - 4) Set the time delay. For example, for five minutes, enter: 05.



**Note:** You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the drive.

**Important:** Do not press Enter yet.

- b) Unlock the drive bay handle **(A)** by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
- c) Lower the drive into the drive tray.



*Figure 67. Lowering the drive into the drive tray*

- d) Close the drive holder lever **(A)** over the drive.

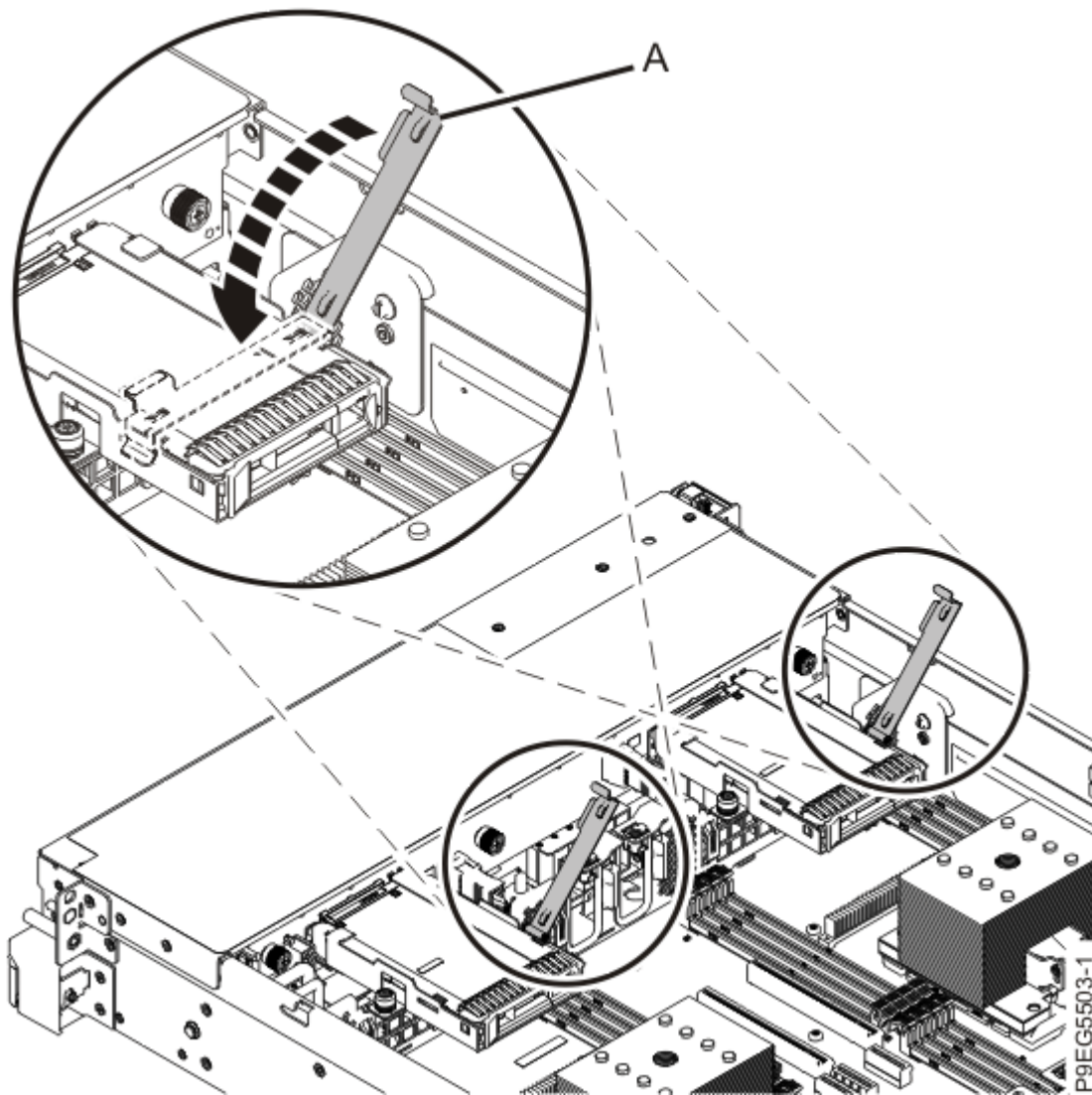


Figure 68. Closing the drive holder lever

- e) Select the drive that you want to install in the Hardware service manager (HSM) display.
- f) Press **Enter** on the console.

**Important:** When you press **Enter**, after your selected time delay, the service indicator light turns on (solid) for 18 seconds. You then have 18 seconds to slide the drive all the way in and then to lock it in place by pushing in the drive handle. You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the disk drive or solid-state drive.

- g) When the identify LED turns on solid, use the drive handle to slide the drive all the way into the system, and push in the drive handle **(A)** until it locks.

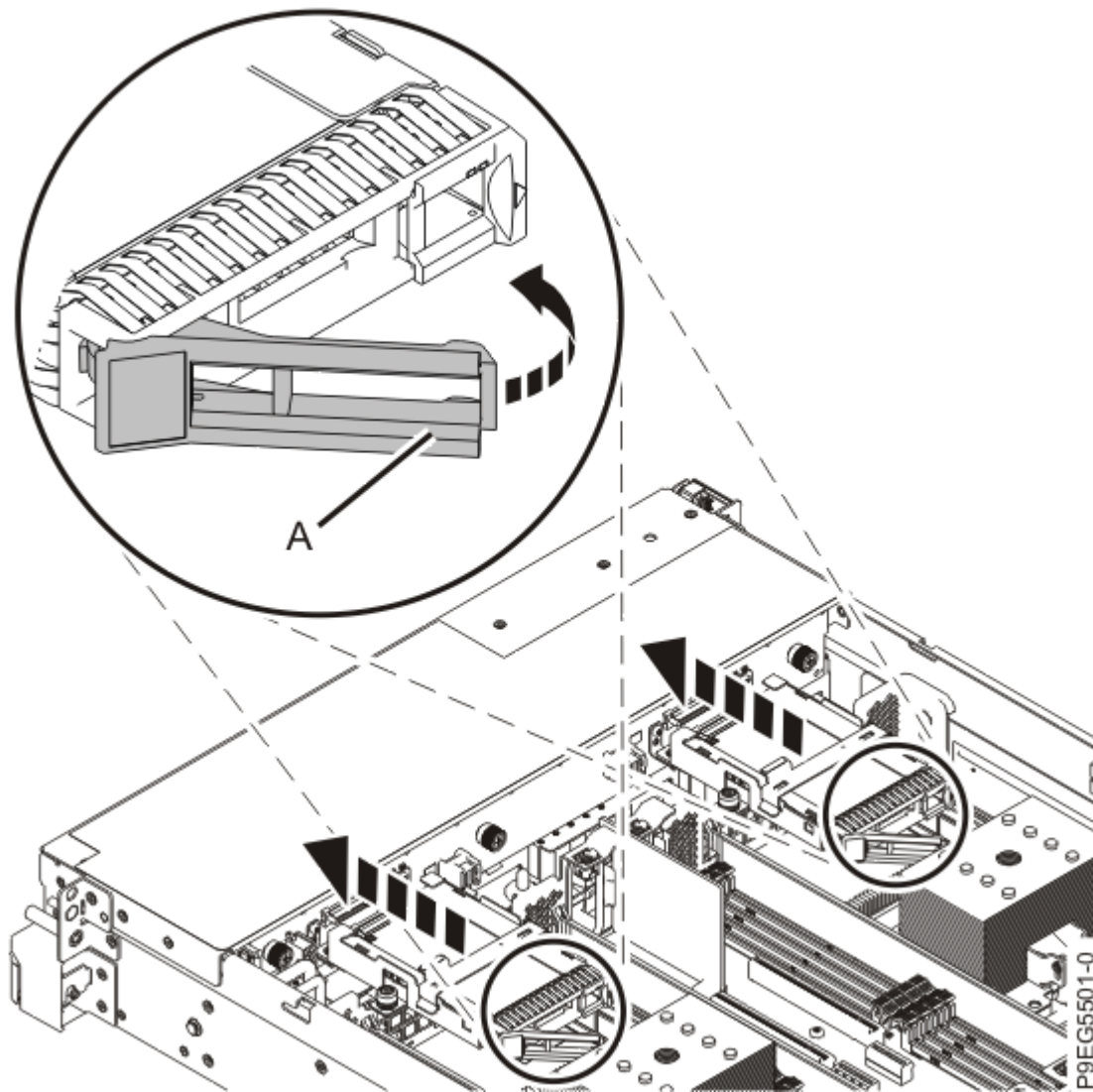


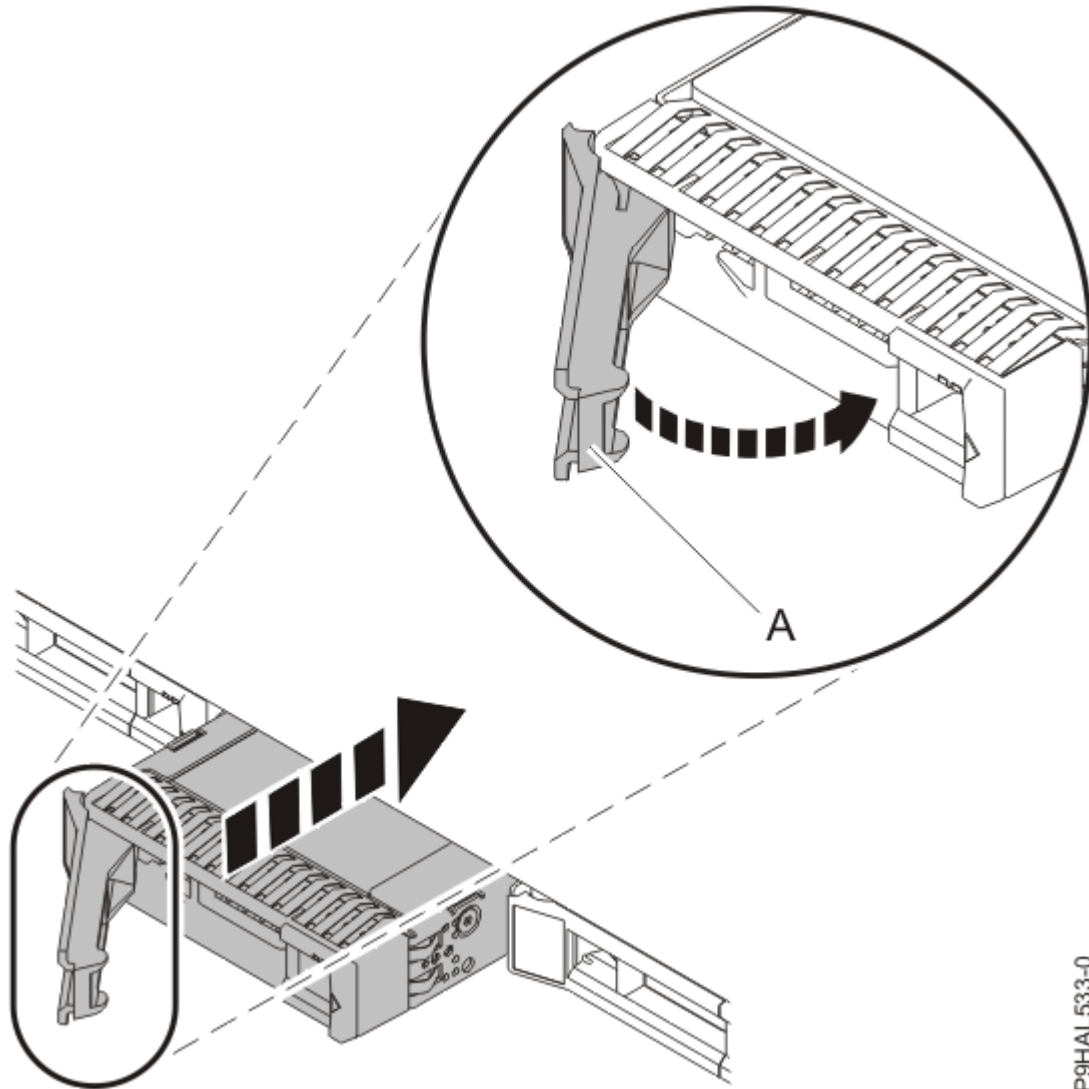
Figure 69. Locking the drive handle

- h) Press Enter on the console to indicate that you installed the drive.
  - 15. Continue with step “22” on page 88.
  - 16. To replace a drive on the front of the system by using the IBM i operating system, complete the following steps:
    - a) Return to the console and wait until the Concurrent Maintenance Results display is shown.
      - 1) Press **P12**.
      - 2) The physical locations that you entered while you removed the drive might still show on the display. If not, retype the physical location where you want to install the replacement drive.
      - 3) Select 2 (Install device) for the action to be completed.
      - 4) Set the time delay. For example, for five minutes, enter: 05.
- Note:** You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the drive.
- Important:** Do not press Enter yet.
- b) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
  - c) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.

- d) Slide the drive halfway into the system.
- e) Select the drive that you want to install in the Hardware service manager (HSM) display.
- f) Press Enter on the console.

**Important:** When you press Enter, after your selected time delay, the service indicator light turns on (solid) for 18 seconds. You then have 18 seconds to slide the drive all the way in and then to lock it in place by pushing in the drive handle. You can set an appropriate time delay of 01 - 19 minutes to allow adequate time to access the disk drive or solid-state drive.

- g) When the identify LED turns on solid, slide the drive all the way into the system, and push in the drive handle **(A)** until it locks.



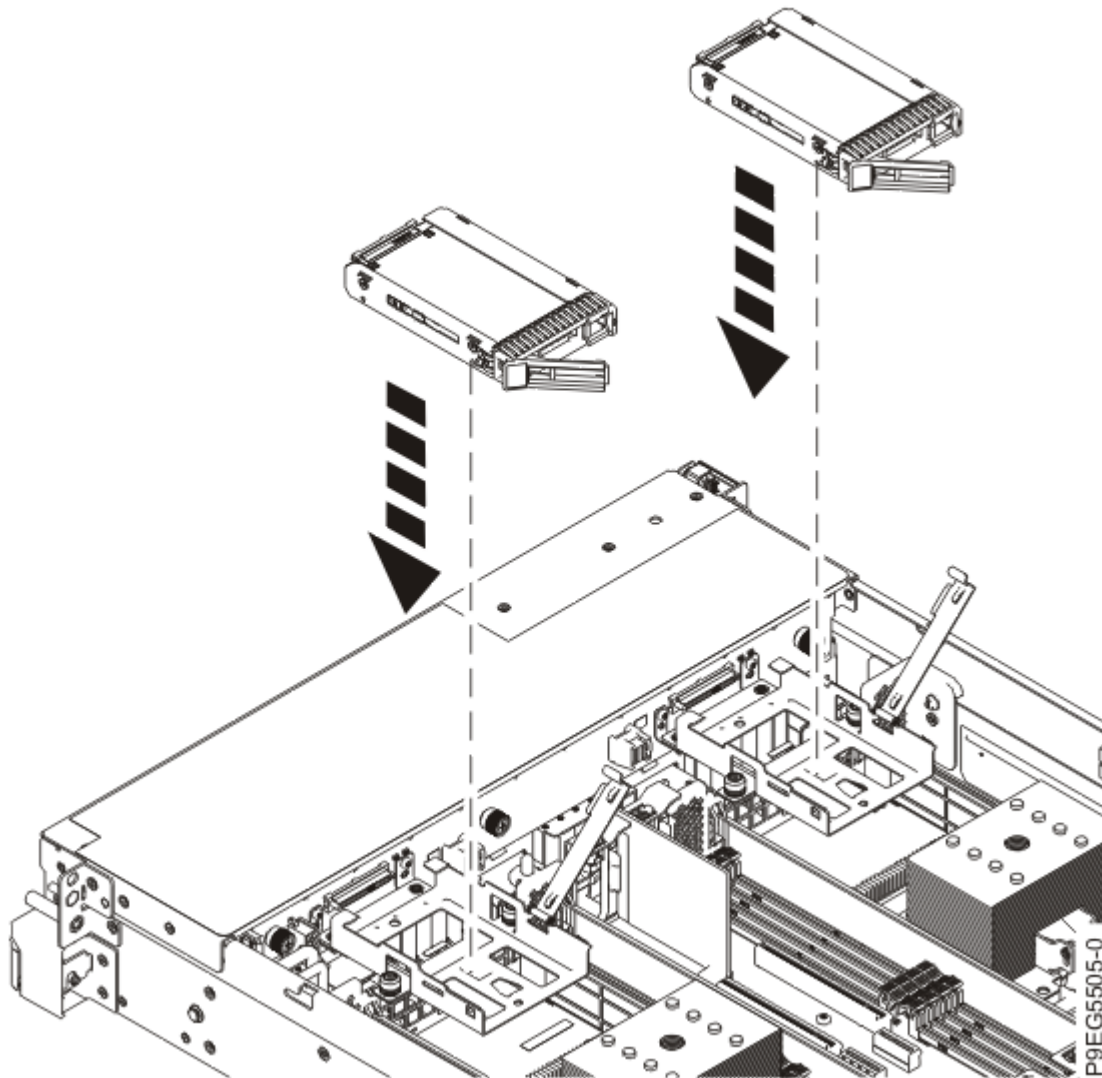
P9HAL533-0

Figure 70. Replacing a drive in a system

**Important:** Ensure that the drive is fully seated and is all the way into the system.

- h) Press Enter on the console to indicate that you installed the drive.
17. Continue with step [“22”](#) on page 88.
  18. To replace a drive in a system when the system is powered on and by using the Linux operating system, choose from the following options:
    - To replace a drive in slot P2-D7 or P2-D8 inside the system, continue with step [“19”](#) on page 85.
    - To replace a drive slots P2-D1 through P2-D6 in the front of the system, continue with step [“21”](#) on page 87.

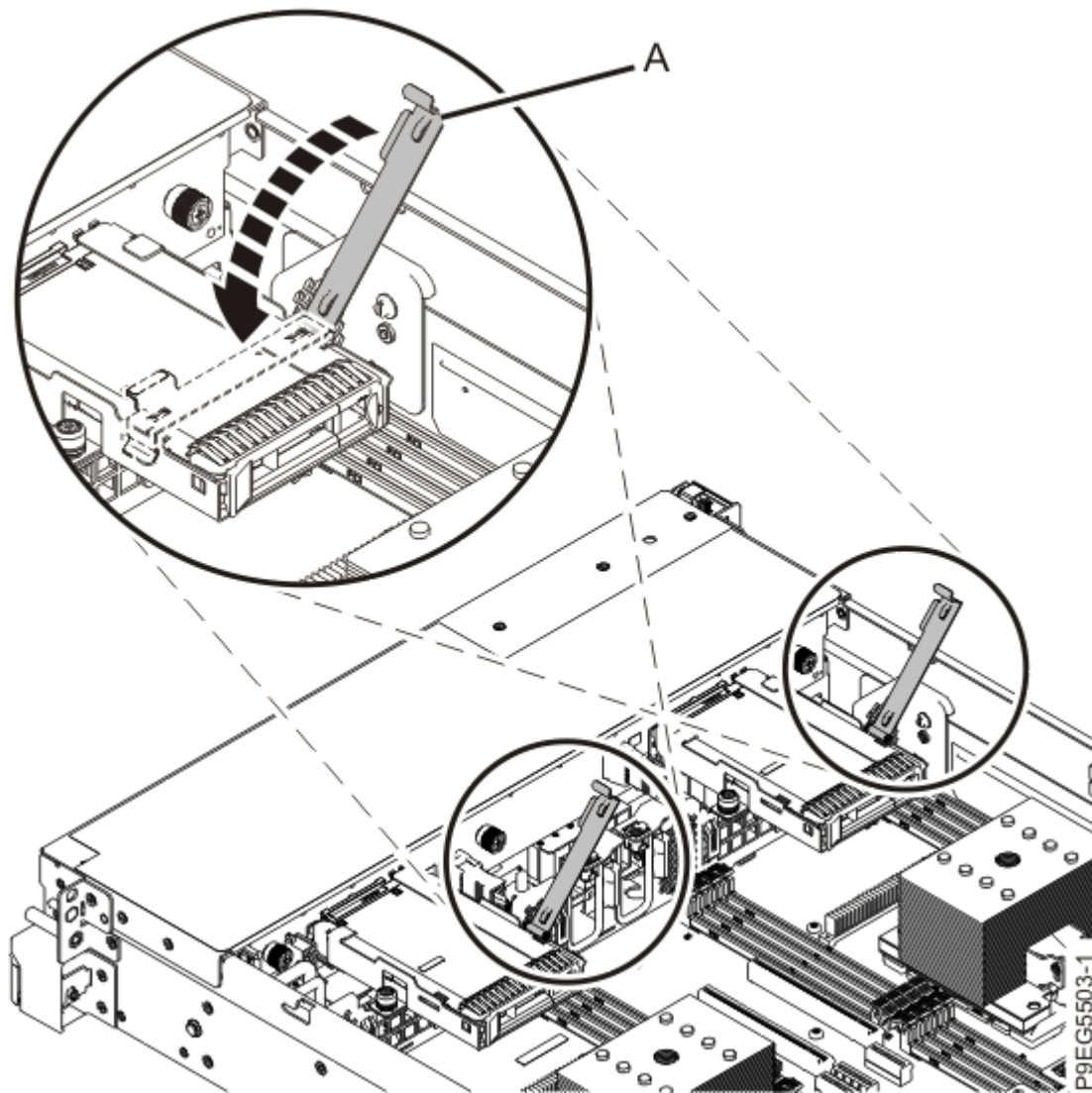
19. To replace a drive in slot P2-D7 or P2-D8 inside the system by using the Linux operating system, complete the following steps:
- From the IBM Power RAID Configuration Utility display, select **Work with disk unit recovery > Concurrent add device**.
  - Type 1 (Select) next to the location from which you removed the disk drive or solid-state drive. The Verify Device Concurrent Add display is shown.
  - Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
  - Lower the drive into the drive tray.



*Figure 71. Lowering the drive into the drive tray*

- Close the drive holder lever (**A**) over the drive.





*Figure 72. Closing the drive holder lever*

- f) Return to the console, and then press Enter. Verify that the selected slot is the slot in which you want to install the drive. Press Enter again to confirm the device add operation.
- g) When the identify LED flashes for the selected slot, slide the drive all the way into the slot, and push the drive bay handle **(A)** in until it locks.



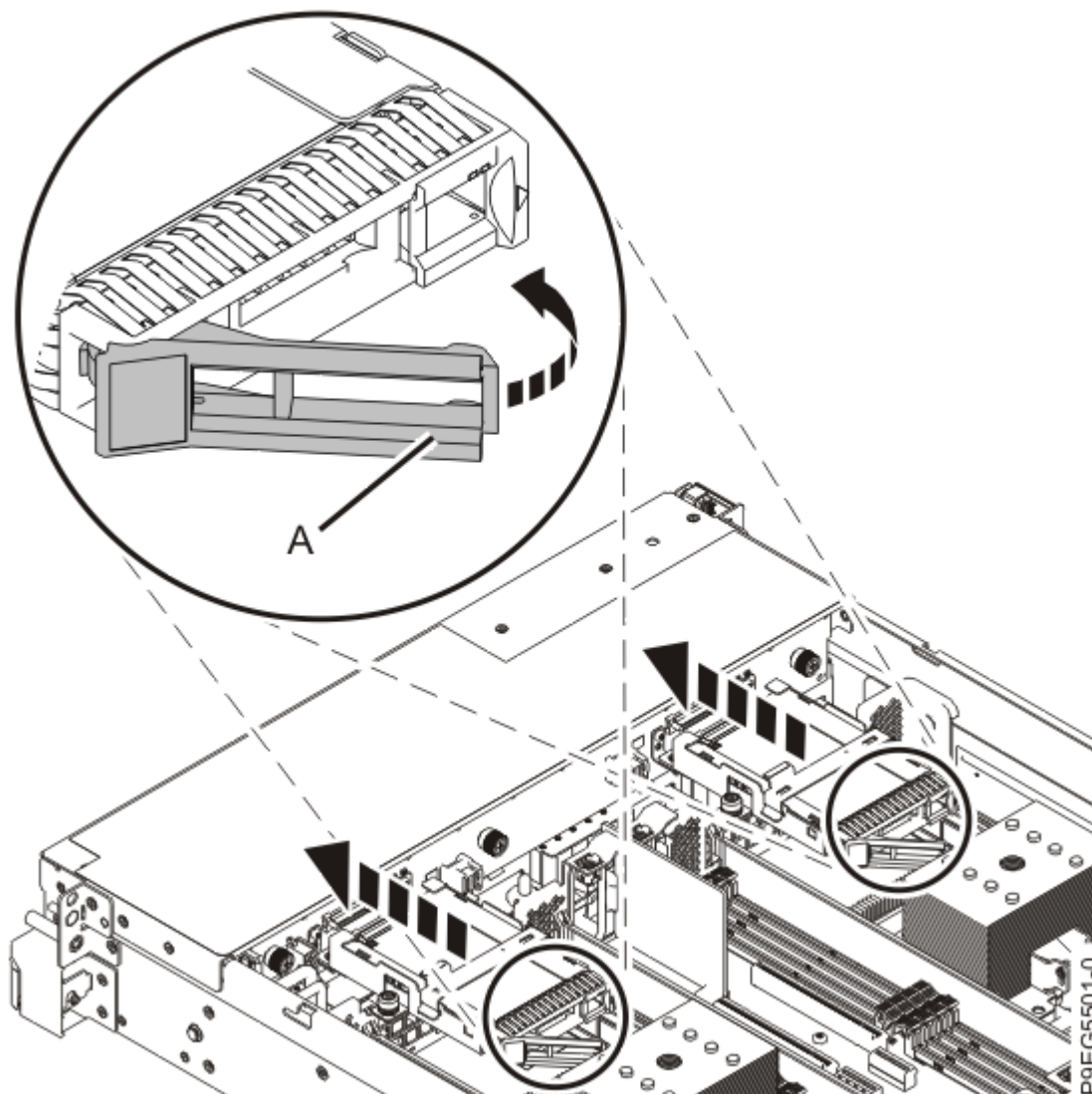
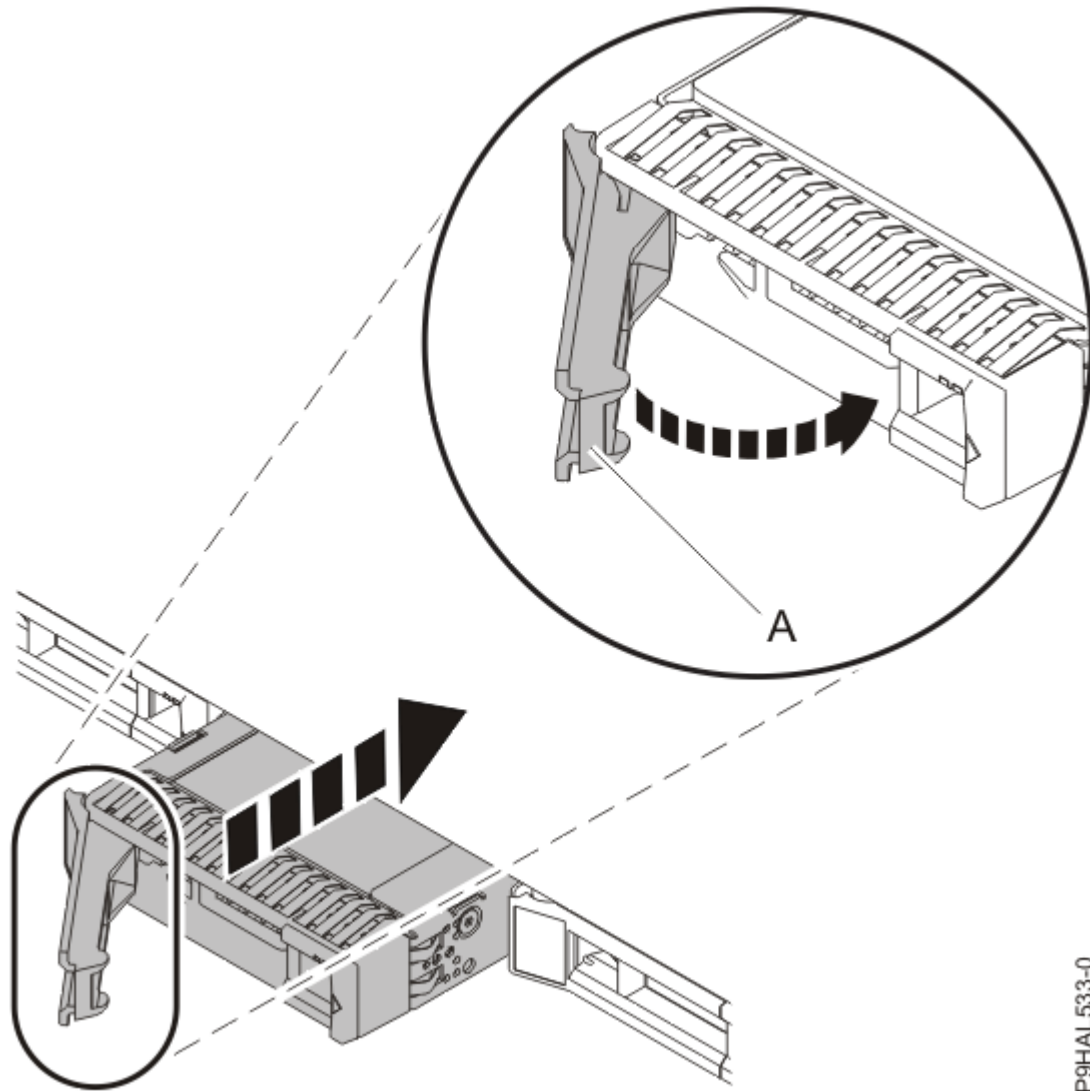


Figure 73. Locking the drive handle

- h) Press Enter on the **Complete Device Concurrent Add** display to indicate that the drive is installed. The service indicator stops flashing and turns off for that drive.
20. Continue with step “22” on page 88.
21. To replace a drive by using the Linux operating system, complete the following steps:
  - a) From the IBM Power RAID Configuration Utility display, select **Work with disk unit recovery > Concurrent add device**.
  - b) Type 1 (Select) next to the location from which you removed the disk drive or solid-state drive. The Verify Device Concurrent Add display is shown.
  - c) Unlock the drive bay handle (**A**) by pressing the handle release latch and pulling out the handle. If the handle is not all the way out, the drive does not slide into the system.
  - d) Hold the drive by the top and bottom edges as you position the drive, and prepare to insert it into the drive slot.
  - e) Slide the drive halfway into the system.
  - f) Return to the console, and then press Enter. Verify that the selected slot is the slot in which you want to install the drive. Press Enter again to confirm the device add operation.
  - g) When the identify LED flashes for the selected slot, slide the drive all the way into the slot, and push the drive bay handle (**A**) in until it locks.

**Important:** Ensure that the drive is fully seated and is all the way into the system.



P9HAL533-0

Figure 74. Installing a drive in a system

- h) Press Enter on the **Complete Device Concurrent Add** display to indicate that the drive is installed. The service indicator stops flashing and turns off for that drive slot.
22. If you want to replace another drive, repeat this procedure.

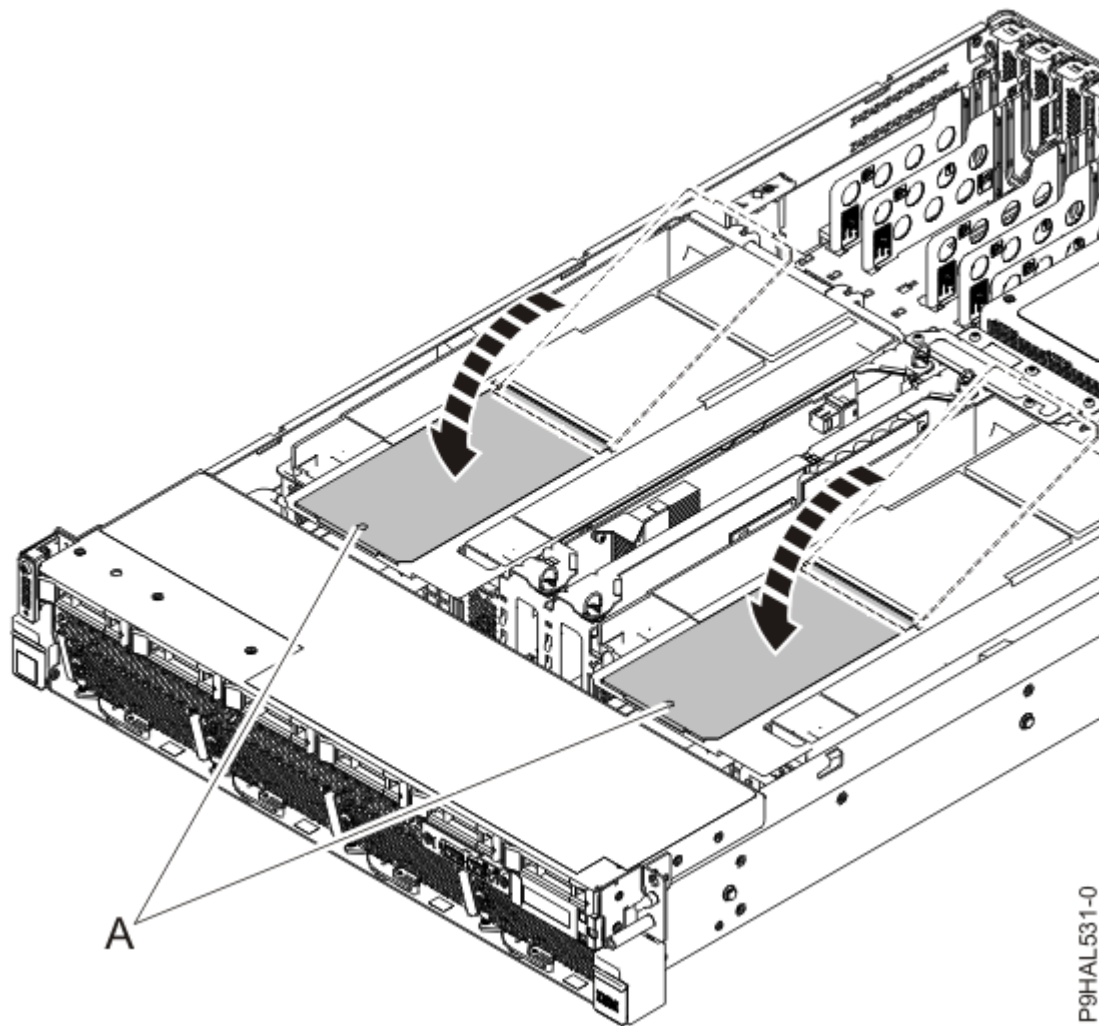
### Preparing the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system for operation after removing and replacing a disk drive or solid-state drive (SSD)

To prepare the system for operation after you replace a disk drive or solid-state drive (SSD), complete the steps in this procedure.

#### Procedure

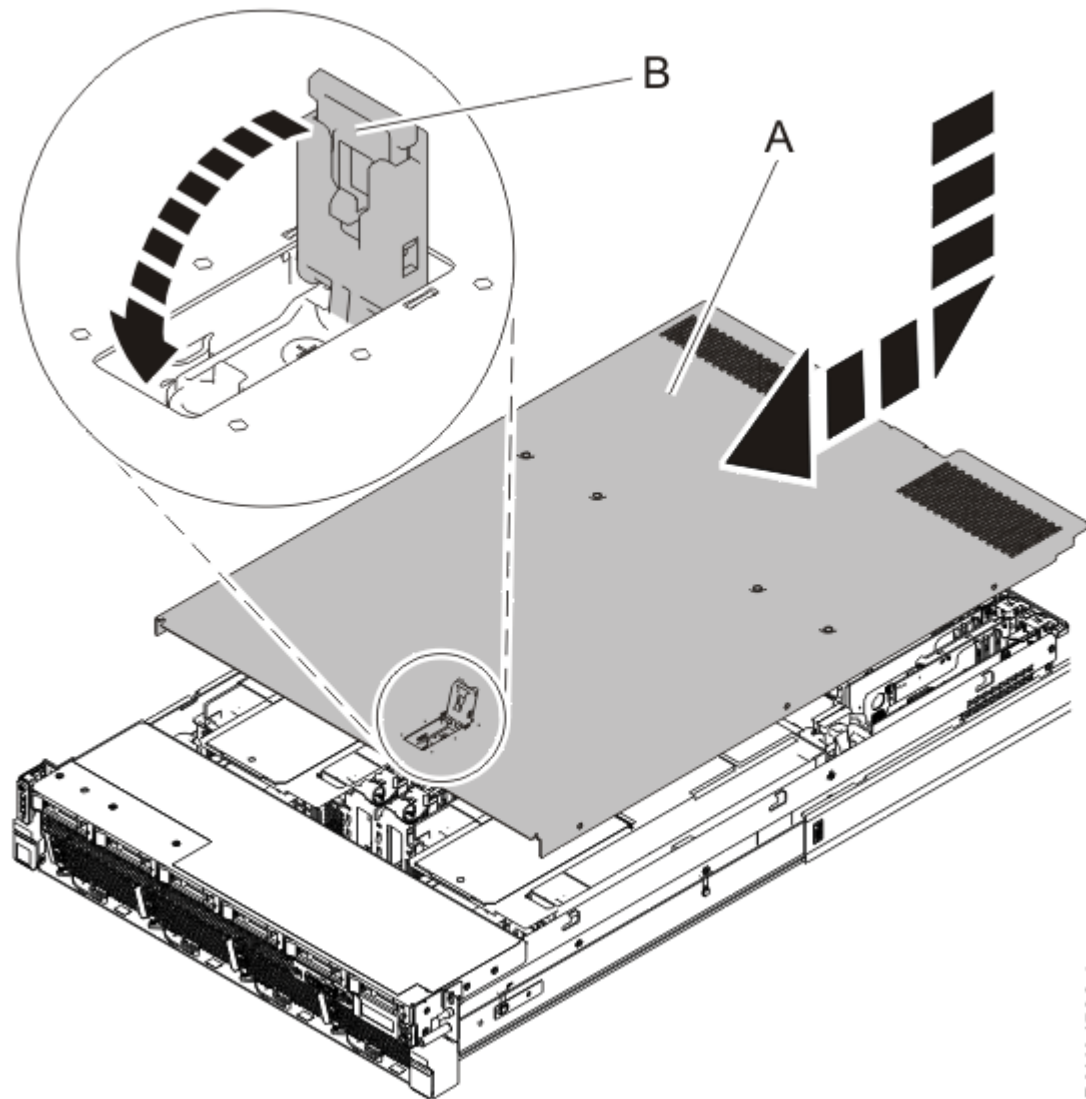
1. Ensure that you have the electrostatic discharge (ESD) wrist strap on and that the ESD clip is plugged into a ground jack or connected to an unpainted metal surface. If not, do so now.
2. Did you replace drives inside the system?
  - **Yes:** Go to step “3” on page 88.
  - **No:** Go to step “4” on page 91.
3. If you replaced a drive inside the system, complete the following steps:

- a) Close any open hinged access doors **(A)** on the air baffles.



*Figure 75. Closing the hinged access doors on the air baffles in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system*

- b) Slide the service access cover **(A)** onto the system unit.  
c) Close the release latch **(B)** by pushing it in the direction shown.

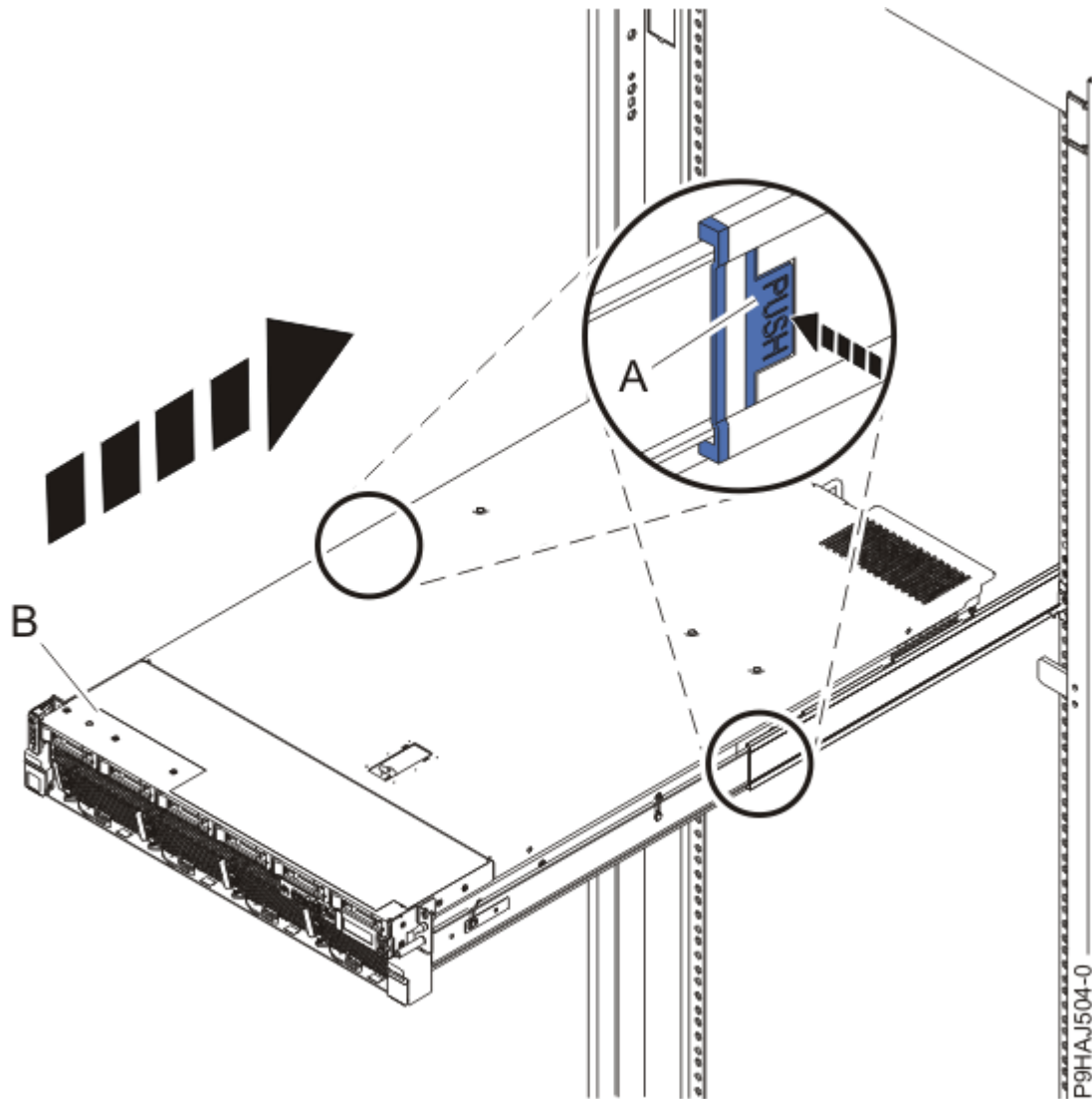


P9HAJ506-1

*Figure 76. Installing the service access cover*

- d) Unlock the blue rail safety latches **(A)** by pushing them inward.
- e) Push the system unit **(B)** back into the rack until both release latches of the system unit lock into position.

Ensure that the cable management arms can move freely. Ensure that the cables at the rear of the unit do not catch or bind as you push the unit into the operating position.



*Figure 77. Placing the system into the operating position*

4. Choose from the following options:
  - a. If your system is powered off, continue with step [“5” on page 91](#).
  - b. If your system is powered on, continue with step [“8” on page 92](#).
5. Using your labels, reconnect the power cords **(A)** to the system unit. Fasten the power cords to the system using the hook-and-loop fasteners **(B)** as shown in [Figure 78 on page 92](#).



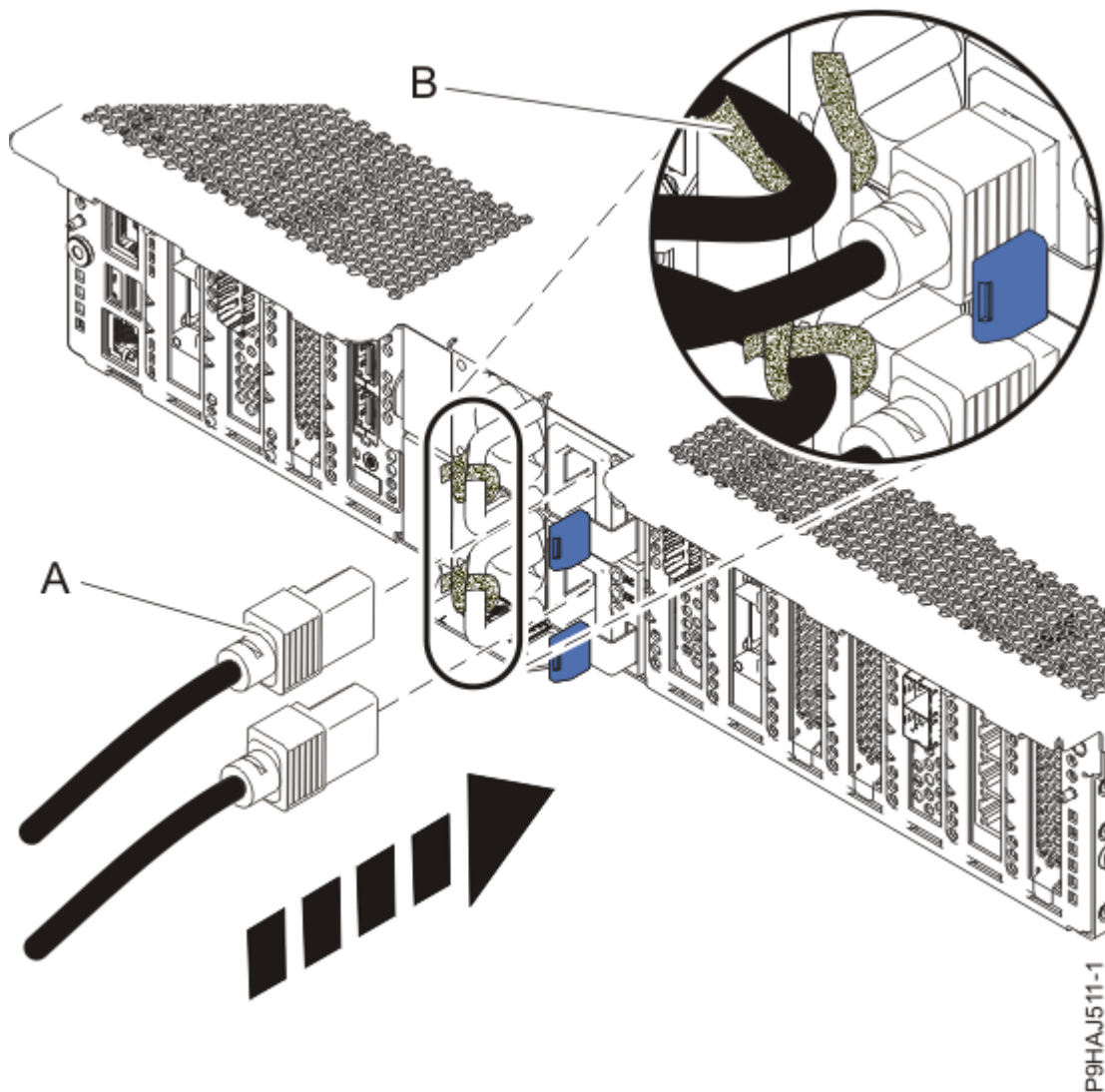


Figure 78. Connecting the power cords

6. If applicable, close the rack door at the rear of the system.
7. Start the system. For instructions, see [Starting a system](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm)).
8. To configure the newly installed disk drive or SSD, choose one of the following options:
  - If the AIX operating system controls the slot where you installed a new drive, continue with step “9” on page 92.
  - If the IBM i operating system controls the slot where you installed a new drive, continue with step “12” on page 93.
  - If the Linux operating system controls the slot where you installed a new drive, continue with step “15” on page 94.
9. To use the AIX operating system to configure the drive, choose from the following options:
  - If you installed the drive when the system was powered off, when you start the system, the AIX operating system automatically configures the devices in the system when the system is started. Continue with step “17” on page 94.
  - If you installed the drive when the system was powered on, continue with the next step.
10. To configure the drive with the AIX operating system when you installed the drive when the system was powered on, complete the following steps:

**Note:** A customer must complete this step.



- a. Press the **F3** key on the console to return to the **SCSI and SCSI RAID Hot Plug Manager** menu.
  - b. Select **Configure Added/Replaced Devices** and press Enter.
  - c. When the configuration is complete, press **F3** twice to return to the **IBM SAS Disk Array Manager** menu.
  - d. Select **List SAS Disk Array Configuration** and press Enter. The newly installed drive or drives will be shown at the bottom of the list of arrays and drives.
11. To rebuild the drive, continue with step [“17” on page 94](#).
  12. If you are using the IBM i operating system, choose from the following options:
    - If you installed or replaced a non-configured drive, continue with step [“13” on page 93](#).
    - If you installed or replaced a configured drive, continue with step [“25” on page 95](#).
  13. To use the IBM i operating system to configure the drive, complete the following steps:
    - a. To display unconfigured drives, complete the following steps:
      - 1) If necessary, start System Service Tools (SST) by typing **strsst** on the command line of the IBM i session, and then press Enter.
      - 2) Type your service tools user ID and service tools password on the Start Service Tools (STRSST) Sign On display, and then press Enter.  
The service tools password is case-sensitive.
      - 3) Select **Work with Disk Units > Display disk configuration > Display non-configured units**.  
The drives that you installed are listed. The serial numbers must match the serial numbers that you recorded (the last four digits).  
  
**Note:** The new drives might take up to five minutes to appear in the list. If the drive is not listed, ensure that the drives were installed properly.
      - 4) Press **F12** twice to return to the **Work with Disk Units** window.
    - b. Choose from the following options:
      - To configure a new drive with device-parity protection, go to step [“13.c” on page 93](#).
      - To configure a new drive with mirror protection, go to step [“13.d” on page 93](#).
      - To configure a new drive with hot-spare protection, go to step [“13.e” on page 94](#).
    - c. To configure a drive with IBM i device-parity protection, complete the following steps:
      - 1) Select **Work with disk configuration > Work with device parity protection**.
      - 2) Select the type of device-parity you want on the set: **RAID-5**, **RAID-6**, or **RAID-10**. Hot-Spare disk protection can also be selected.  
  
**Note:** The following conditions must be met before device-parity starts.
        - Enough drives must be available to create a new parity set.
        - All drives in a parity set must be the same capacity with a minimum number of two, three, or four drives (depending on RAID level) and maximum of 32 drives in the resulting parity set.
        - All drives that are attached to an advanced function input/output adapter must be recognized by the system. If not, repeat this step (a-c).
      - 3) After the conditions are met and device-parity is started, press **F12** twice to return to the **Work with Disk Units** display.
      - 4) If you have an attached printer, print the configuration list. From the **Hardware service manager** menu, press **F6** (print the configuration). The configuration prints. Save this list for future use.
    - d. To configure a drive with IBM i mirror-protection, complete the following steps:
      - 1) Select **Work with disk configuration**.
      - 2) Select the option to Add units to auxiliary storage pools (ASPs) and to balance data.

- 3) Specify the number of the ASP to which you want to add the drive, and then press Enter. The system ASP is **ASP 1**. The **Confirm Add Units** display shows the configuration in your system when the add operation completes.

**Note:** If you selected the wrong ASP, press **F12** to change your options.

- 4) Press **F10** to Confirm Add and Balance. The add process takes several minutes to complete. The balancing of the data between the disks in the ASP might take hours to complete. However, the balancing task runs in the background and you can run normal operations.

**Notes:**

- If the ASP is mirror protected, drives must be added in pairs of the same capacity.
  - When one or more pairs of drives are added to a mirrored ASP, they automatically become mirror protected.
  - To start mirrored protection on an ASP, go to the [IBM i Knowledge Center](http://www-01.ibm.com/support/knowledgecenter/ssw_ibm_i/welcome) website ([http://www-01.ibm.com/support/knowledgecenter/ssw\\_ibm\\_i/welcome](http://www-01.ibm.com/support/knowledgecenter/ssw_ibm_i/welcome)) and select the version of the IBM i operating system you are using. Then, use Search to find the Working with mirrored protection topic.
- 5) When the message Selected units have been added successfully is shown, press **F3** three times and press Enter to return to the **Main menu** display.
  - 6) If you have an attached printer, print the configuration list. From the **Hardware service manager** menu, press **F6** (print the configuration). The configuration prints. Save this list for future use.
- e. To configure a drive with IBM i hot-spare protection, complete the following steps:
- 1) Select **Work with disk configuration > Start hot spare**. A list of non-configured disk units that can be a Hot-Spare unit under an IOA are displayed.
  - 2) Select the disk units that you want to set for a Hot-Spare configuration.
  - 3) If you have an attached printer, print the configuration list. From the **Hardware service manager** menu, press **F6** (print the configuration). The configuration prints. Save this list for future use.
14. Continue with step [“17” on page 94](#).
15. To use the Linux operating system to configure the drive, choose from the following options:
- If you installed the drive when the system was powered off, when you start the system, the Linux operating system automatically configures the devices in the system when the system is started. Continue with step [“17” on page 94](#).
  - If you installed the drive when the system was powered on, continue with the next step.
16. To configure the drive with the Linux operating system when you installed the drive when the system was powered on, complete the following steps:
- a) Type **q** to return to the **IBM Power RAID Configuration Utility** menu.
  - b) Type **1** and press Enter to select Display hardware status.
- The newly-installed drive or drives is shown at the beginning of the list of drives and arrays.
17. To rebuild the data on the replacement drive, or to recover from a failed or missing array, choose one of the following options:
- If the AIX operating system controls the slot where you replaced a drive, continue with step [“18” on page 94](#).
  - If the IBM i operating system controls the slot where you replaced a drive, continue with step [“25” on page 95](#).
  - If the Linux operating system controls the slot where you replaced a drive, continue with step [“27” on page 96](#).
18. To rebuild a drive by using the AIX operating system, complete the following steps:

**Notes:**

- If a hot-spare drive is available when the drive is moved to the failed state, the AIX operating system will add the hot-spare drive to the array while replacing the failed drive, and the array rebuild operation will start automatically. No additional steps are required. To check the status of the array rebuild operation, continue with step “18.c” on page 95.
  - If you deleted the array previously, continue with step “23” on page 95.
    - a) Press the **F3** key on the console to return to the **SCSI and SCSI RAID Hot Plug Manager** menu.
    - b) When the configuration is complete, press F3 twice to return to the **IBM SAS Disk Array Manager** menu.
    - c) Select **List SAS Disk Array Configuration**.
19. Choose from the following options:
- If the state of the array is Degraded, continue with step “20” on page 95.
  - If the state of the array is Failed or Missing, continue with step “22” on page 95.
20. If the state of the array is Degraded, complete the following steps to change the state of the array to Optimal:
- a) Press **F3** to return to the IBM SAS Disk Array Manager menu.
  - b) Select **Reconstruct a SAS Disk Array** and press Enter.
  - c) Select the pdisk that you want to reconstruct, which should be the drive that you just installed.
- The array is rebuilt.
21. To verify the drive, continue with step “28” on page 96.
22. If the state of the array is **Failed** or **Missing**, delete and recreate the array. Then, restore the data from the backup.



**Attention:** All data on the disk array will be lost.

To delete the array, complete the following steps:

- a) Start the IBM SAS Disk Array Manager. From the AIX Diagnostics, select **Task Selection > RAID Array Manager > IBM SAS Disk Array Manager**.
  - b) Select **Delete a SAS Disk Array > IBM SAS RAID Controller**.
  - c) Select the disk array to delete.
23. To recreate the RAID Array and restore data from the backup, complete the following steps:
- a) Select **Create an IBM SAS Disk Array**.
  - b) Select the IBM SAS RAID Controller on which you want to create an array.
  - c) Select the RAID level for the array. For more information about selecting an appropriate RAID level, see [Supported RAID levels](http://www.ibm.com/support/knowledgecenter/POWER9/p9ebj/sassupportedraidlevels.htm) (www.ibm.com/support/knowledgecenter/POWER9/p9ebj/sassupportedraidlevels.htm).
  - d) Select the stripe size in kilobytes for the array. For more information about the stripe-size parameter, see [Stripe-unit size](http://www.ibm.com/support/knowledgecenter/POWER9/p9ebj/sasstripeunitsize.htm) (www.ibm.com/support/knowledgecenter/POWER9/p9ebj/sasstripeunitsize.htm).
  - e) Select the disks that you want to use in the array according to the requirements displayed on the screen and press Enter.
- Note:** To reduce the creation time of the new array, format and zero the drives using the Create an Array Candidate pdisk and Format to RAID block size function before creating the new array.
- Data must be restored from a backup disk. The disk array can be added to a volume group. Logical volumes and file systems can also be created. Use the standard AIX procedures to complete these tasks, and use the array in the same way that you would use any hdisk.
24. To verify the drive, continue with step “28” on page 96.
25. To rebuild a drive by using the IBM i operating system, complete the following steps:

- a. If necessary, start System Service Tools (SST) by typing `strsst` on the command line of the IBM i session, and then press Enter.
- b. Type your service tools user ID and service tools password on the Start Service Tools (STRSST) Sign On display. Press Enter.

The service tools password is case-sensitive.

- c. Select **Work with disk units > Work with disk unit recovery**.

- d. Choose from the following options:

- If the drive you are rebuilding had device-parity protection (RAID), complete the following steps:
  - 1) Select **Rebuild disk unit data** and select 1 to rebuild the drive that you removed. The rebuild process might take several minutes to complete.
  - 2) Press **F5** to refresh the display until the **Percent complete** shows 5%.
  - 3) When the display shows at least 5% complete, you can either continue to monitor this display to completion, or press **F3** three times and press Enter to exit SST.
- If the drive you are rebuilding had mirrored protection, complete the following steps:
  - 1) Select **Replace configured unit** and press Enter.
  - 2) Select the configured drive that you are exchanging (suspended drive) and press Enter.
  - 3) Select the drive that you installed on the Select Replacement Unit display and press Enter. This drive has a non-configured status.

**Note:** In some cases, it might take several minutes for a new drive to display. Repeat these steps until the new drive is shown.
  - 4) Press Enter to confirm your choice for replacement. The replacement process might take several minutes to complete.
  - 5) Press **F3** (Exit) to return to the Work with disk units display.
  - 6) Select **Display disk configuration > Display disk configuration status**. Mirrored status shows Resuming. When complete, the mirrored status shows Active. This process might take several minutes to complete. You can either monitor this display to completion, or press **F3** (Exit) three times, and then press Enter to return to the IBM i main menu.

26. To verify the drive, continue with step “28” on page 96.

27. To rebuild a drive by using the Linux operating system, complete the following steps:

- a. Log in as root user.
- b. Type `iprconfig` on the command line of the Linux session and press Enter.
- c. Select **Work with disk unit recovery > Rebuild disk unit data**.
- d. Type 1 (Rebuild) next to the drive you want to rebuild and press Enter.

**Note:** Completing a rebuild on a drive overwrites the data currently on the drive.

- e. To confirm that you want to rebuild the data on the drive, press Enter. A message is shown when the rebuild starts. The rebuild process might take several minutes to complete.

28. Verify the installed part.

- If you replaced the part because of a service action, verify the installed part. For instructions, see [Verifying a repair](http://www.ibm.com/support/knowledgecenter/POWER9/p9ect/pxect_verifyrepair.htm) (www.ibm.com/support/knowledgecenter/POWER9/p9ect/pxect\_verifyrepair.htm).
- If you installed the part for any other reason, verify the installed part. For instructions, see [Verifying the installed part](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/pxhaj_hsmverify.htm) (www.ibm.com/support/knowledgecenter/POWER9/p9haj/pxhaj\_hsmverify.htm).

## Permanently removing a disk drive or solid-state drive from the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

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Find information about permanently removing a serial-attached SCSI (SAS) disk drive or a solid-state drive (SSD) from the 5105-22E, IBM Power System L922 (9008-22L), IBM Power System S922 (9009-22A and 9009-22G), IBM Power System H922 (9223-22H), or IBM Power System H922S (9223-22S) server.

### About this task

**Note:** Removing or replacing this feature is a customer task. You can complete this task yourself, or contact a service provider to complete the task for you. You might be charged a fee by the service provider for this service.

If your system is managed by the Hardware Management Console (HMC), use the HMC to remove a part from the system. For instructions, see [Removing a part by using the HMC](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/hmcremove.htm) (www.ibm.com/support/knowledgecenter/POWER9/p9haj/hmcremove.htm).

If your system is not managed by an HMC, complete the steps in this procedure to permanently remove a disk drive or SSD.

### Preparing the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system to permanently remove a disk drive or solid-state drive

To prepare the system to permanently remove a disk drive or solid-state drive, complete the steps in this procedure.

#### Procedure

1. Back up the data on the drive you plan to remove depending on the operating system you are using.
  - **AIX:** Ensure that all data on that drive or the array that contains the drive is backed up and removed from the drive.
    - If the drive that is being replaced is protected by Raid-5, Raid-6, or Raid-10 and the array remains functional after removing the drive, it is not necessary to back up or remove data.
    - If the drive you are removing is a mirrored drive, you must suspend mirror protection on the drive before you remove the drive. Contact your system administrator for assistance.
    - If the drives are just a bunch of disks (JBOD) or a Raid array that will not remain functional when the drive is removed (that is, Raid-0), ensure that the disks are in the defined state by completing the following steps:
      - a. Remove data access methods from the JBOD or failing array (that is, file systems, databases, and so on).
      - b. Delete the array.
      - c. Unconfigure the JBOD.
  - **IBM i:** Ensure that all data on that drive or the array that contains the drive is backed up and removed from the drive. If the drive that is being replaced is protected by RAID-5, RAID-6, RAID-10, or mirroring, it is not necessary to back up or remove data.
  - **Linux:** Ensure that all data on that drive or the array that contains the drive is backed up and removed from the drive.
    - If the drive that is being replaced is protected by RAID, it is not necessary to back up or remove data.
    - If the drive you are removing is mirrored, you need to break the mirror before you remove the drive. Contact your system administrator for assistance.
    - If the drives are just a bunch of disks (JBOD), ensure that the disks are in the defined state.

2. Review the drive and service indicator locations. The disk drive and SSD slots are located in the front of the system with two internal slots.

Figure 79 on page 98 shows the drive locations and service indicators for the front drives. Service indicators are located above the latch handle on the drives. Figure 80 on page 99 shows the internal drive locations and service indicators. Service indicators are located in the front of the system.

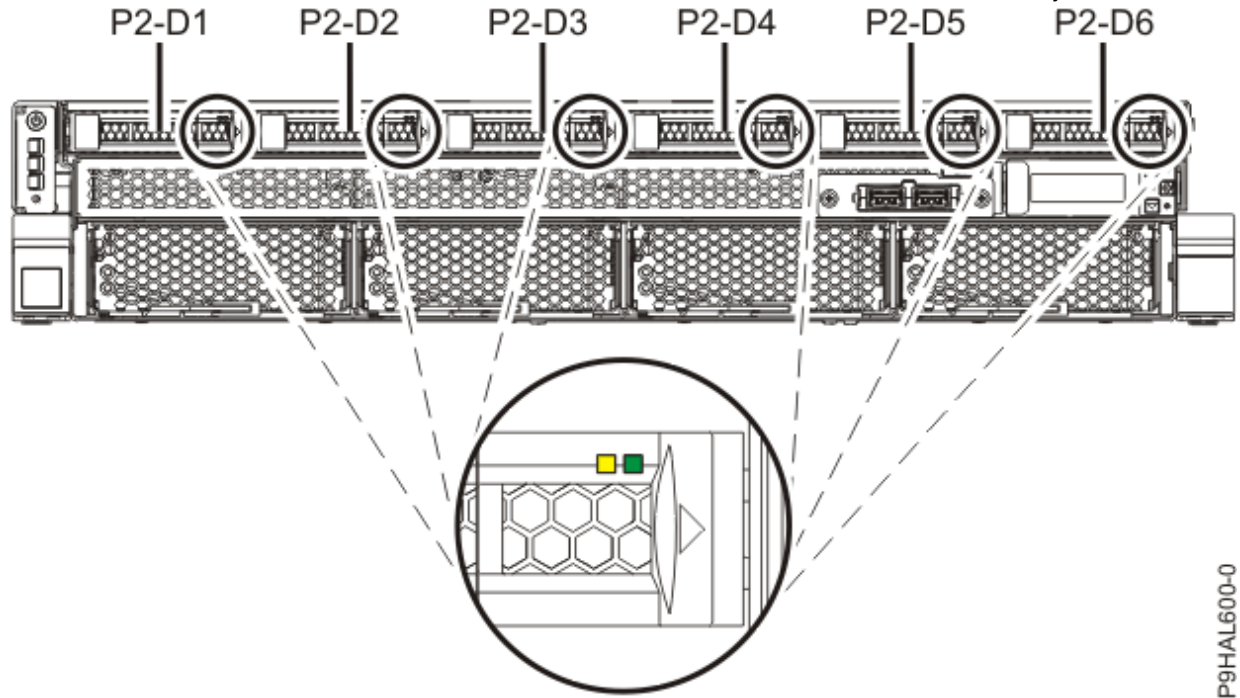
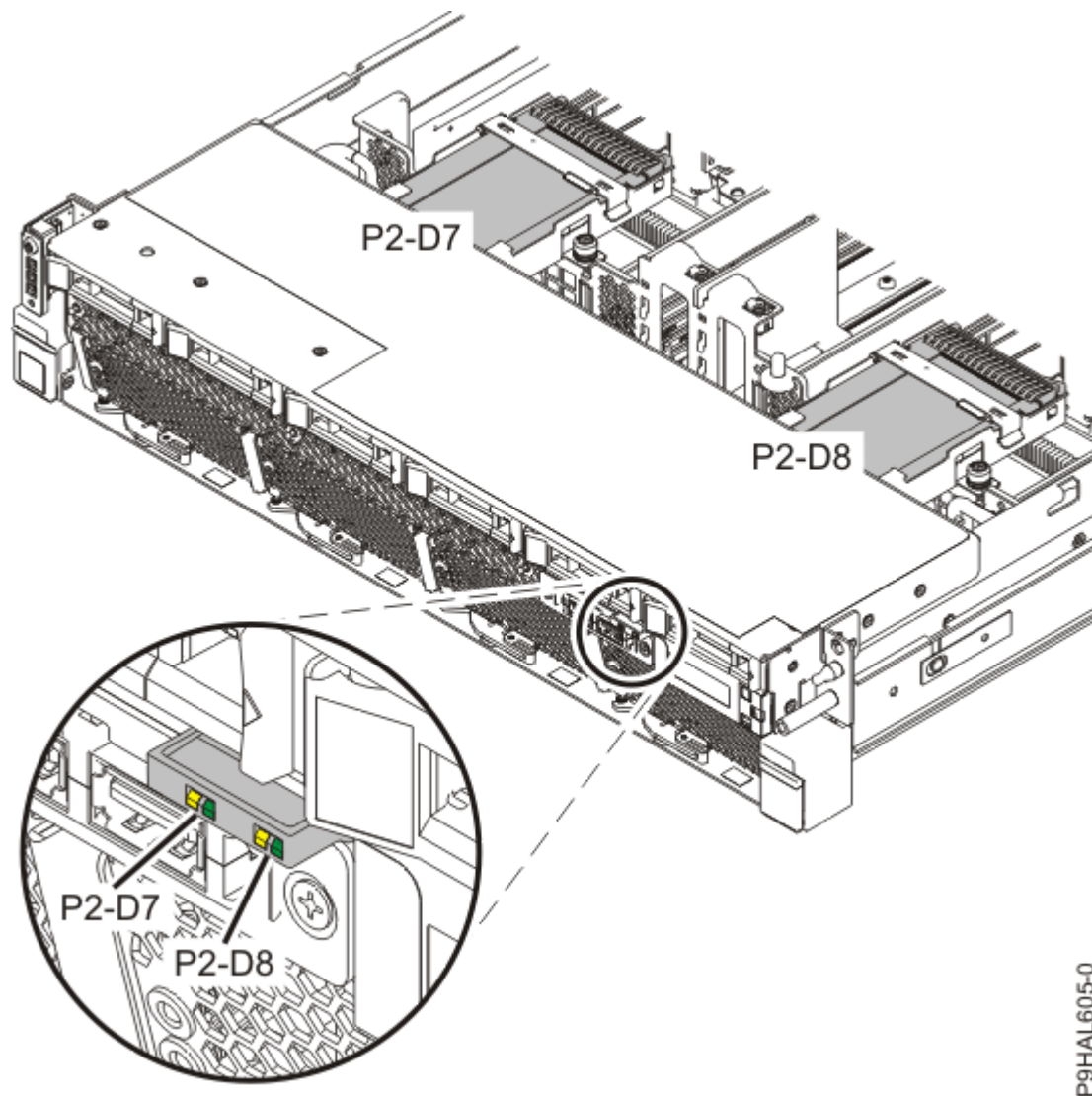


Figure 79. Front disk drive and service indicator locations for a 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system





P9HAL605-0

Figure 80. Internal drive and service indicator locations for a 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

3. To prepare the system to permanently remove a drive when the system is powered off, complete the following steps:
  - a) Turn on the identify LED for the drive to be removed and for the system.  
For instructions, see [Identifying a part](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/sal.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/sal.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/sal.htm)).  
Use the blue identify LED on the enclosure to locate the system. Ensure that the serial number of the system matches the serial number to be serviced.
  - b) Record the position where the disk drive or solid-state drive will be permanently removed. For example, the drive slot might be P1-D3 or P2-D3.
  - c) Stop the system. For instructions, see [Stopping a system](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustopsys.htm)).
  - d) If applicable, open the rack door at the rear of the system.
  - e) Label and disconnect the power cords from the system unit.  
See [Figure 81 on page 100](#).

**Notes:**

- This system might be equipped with two or more power supplies. If the removing and replacing procedures require the system power to be turned off, ensure that all the power sources to the system are disconnected.
- The power cord **(B)** is fastened to the system with hook-and-loop fastener **(A)**. If you are placing the system in a service position after you disconnect the power cords, ensure that you unstrap the fastener.

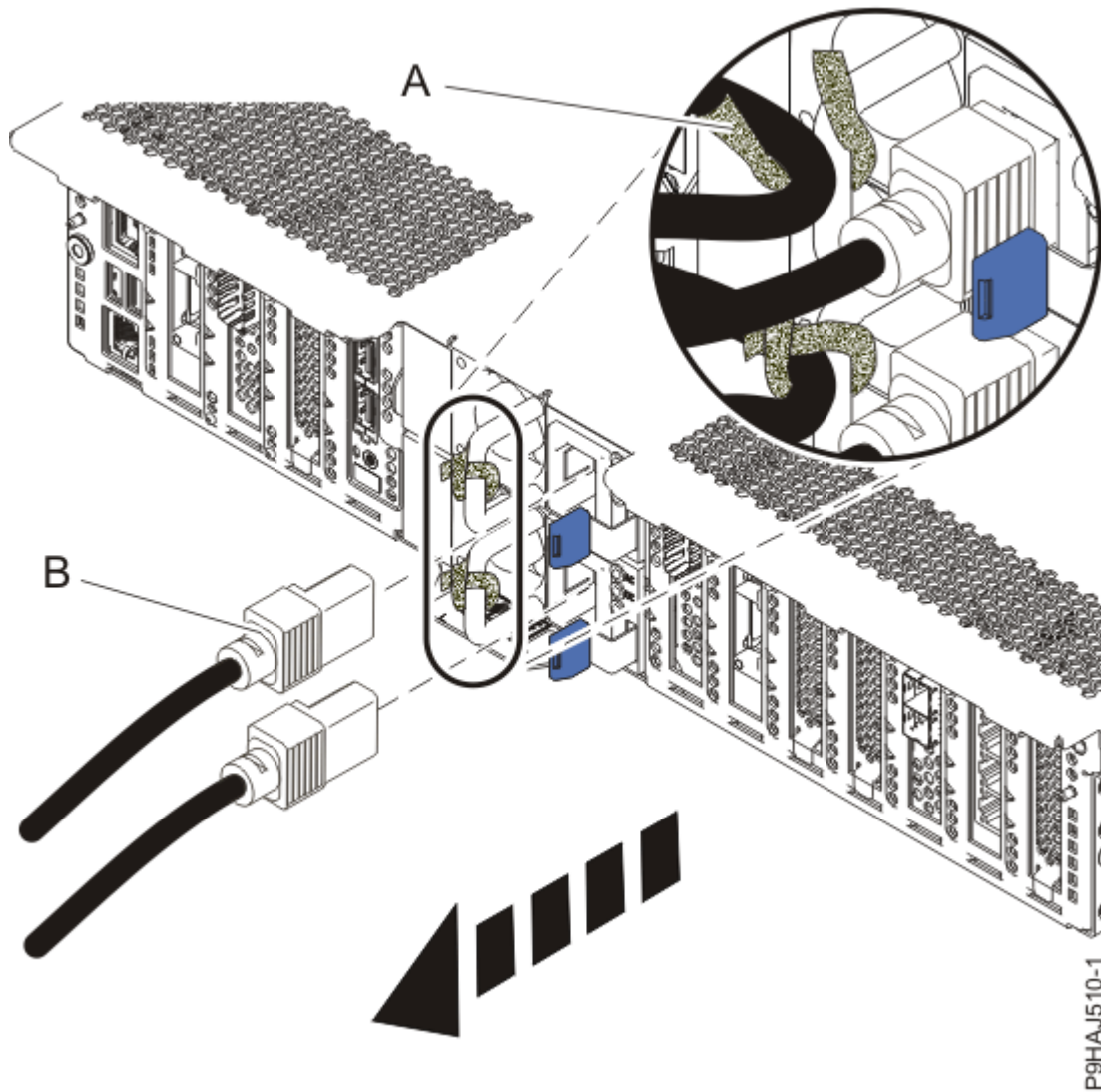
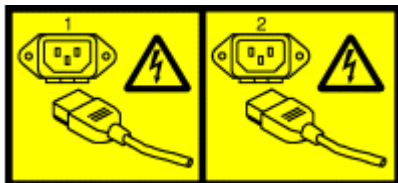


Figure 81. Removing the power cords

(L003)



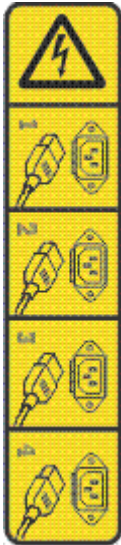
or



or

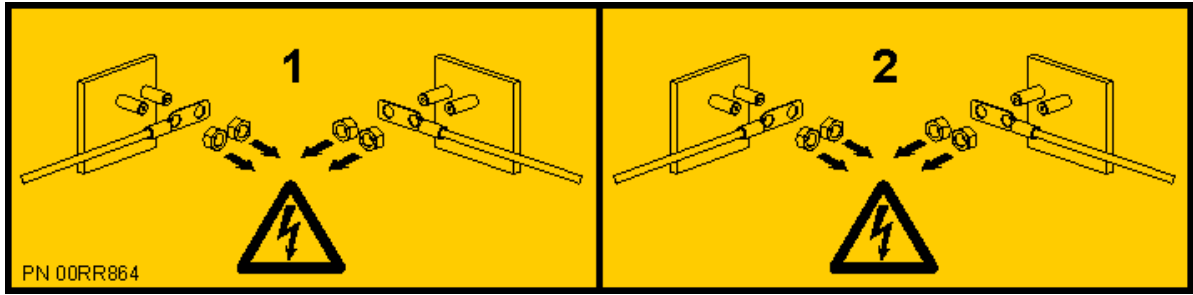


or



or





**DANGER:** Multiple power cords. The product might be equipped with multiple AC power cords or multiple DC power cables. To remove all hazardous voltages, disconnect all power cords and power cables. (L003)

4. Choose from the following options:

- If you recorded slot P2-D1 through P2-D6, continue with [“5” on page 102](#).
- If you recorded slot P2-D7 or P2-D8, you will need to access the drives inside the system, continue with step [“7” on page 102](#).

5. Attach the electrostatic discharge (ESD) wrist strap.

The ESD wrist strap must be connected to an unpainted metal surface until the service procedure is completed, and if applicable, until the service access cover is replaced.



**Attention:**

- Attach an electrostatic discharge (ESD) wrist strap to the front ESD jack, to the rear ESD jack, or to an unpainted metal surface of your hardware to prevent the electrostatic discharge from damaging your hardware.
- When you use an ESD wrist strap, follow all electrical safety procedures. An ESD wrist strap is used for static control. It does not increase or decrease your risk of receiving electric shock when using or working on electrical equipment.
- If you do not have an ESD wrist strap, just prior to removing the product from ESD packaging and installing or replacing hardware, touch an unpainted metal surface of the system for a minimum of 5 seconds. If at any point in this service process you move away from the system, it is important to again discharge yourself by touching an unpainted metal surface for at least 5 seconds before you continue with the service process.

6. This ends the procedure.

7. To access the drives inside the system, complete the following steps:

- a) Open the side latches **(A)** and pull the latches to slide the system unit fully into the service position, until the slides click and hold the system unit securely. Ensure that the screws inside the latches are not secured to the rack.

Remove the hook-and-loop fasteners that secure the cable management arms. Ensure that the cable management arms can move freely. Ensure that the cables at the rear of the system do not catch or bind as you pull the system unit into the service position.

Do not pull out or install any drawer or feature if the rack stabilizer brackets are not attached to the rack. Do not pull out more than one drawer at a time. The rack might become unstable if you pull out more than one drawer at a time.

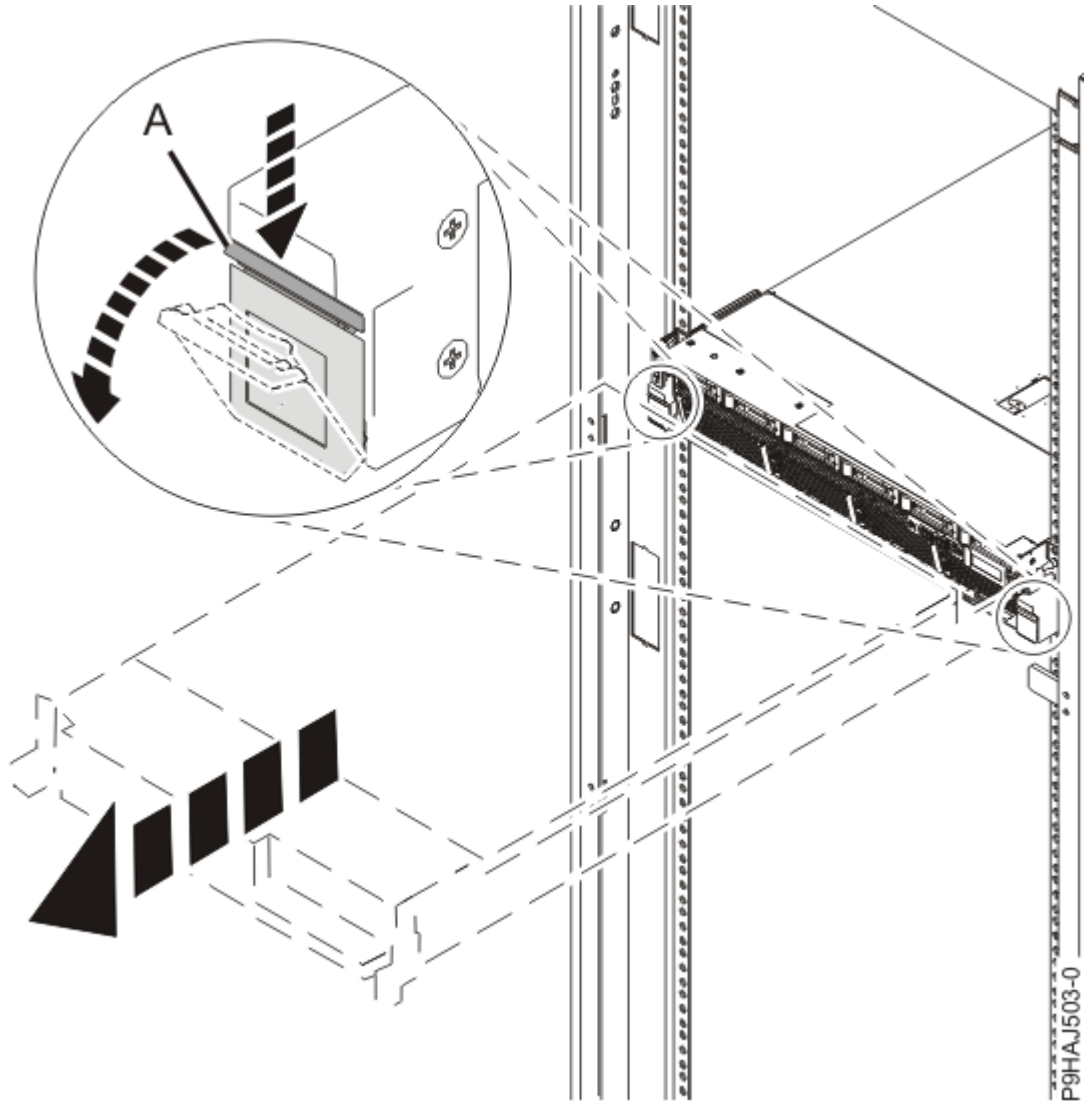


Figure 82. Releasing the side latches

b) Attach the electrostatic discharge (ESD) wrist strap.

The ESD wrist strap must be connected to an unpainted metal surface until the service procedure is completed, and if applicable, until the service access cover is replaced.



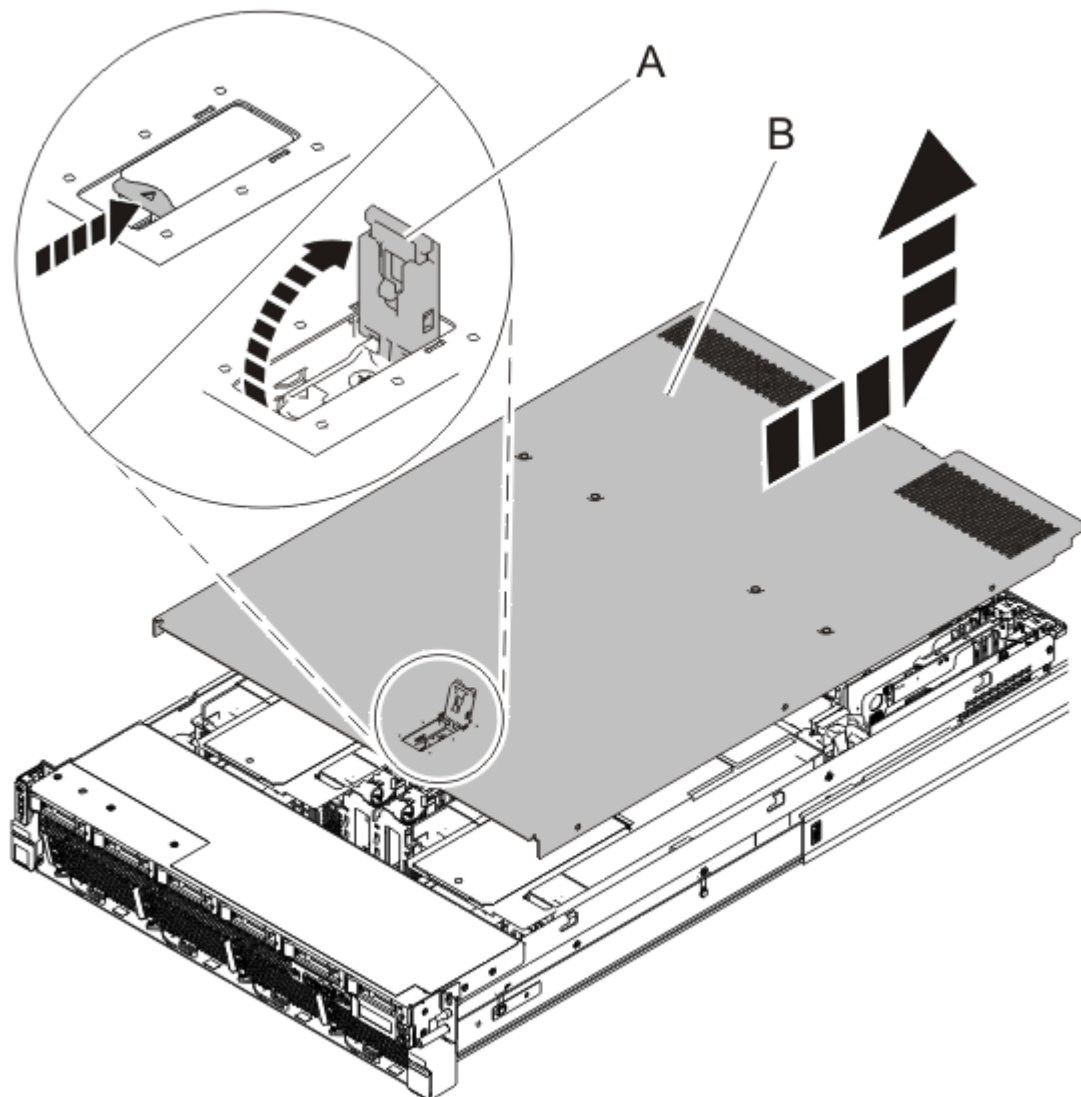
**Attention:**

- Attach an electrostatic discharge (ESD) wrist strap to the front ESD jack, to the rear ESD jack, or to an unpainted metal surface of your hardware to prevent the electrostatic discharge from damaging your hardware.

- When you use an ESD wrist strap, follow all electrical safety procedures. An ESD wrist strap is used for static control. It does not increase or decrease your risk of receiving electric shock when using or working on electrical equipment.
  - If you do not have an ESD wrist strap, just prior to removing the product from ESD packaging and installing or replacing hardware, touch an unpainted metal surface of the system for a minimum of 5 seconds. If at any point in this service process you move away from the system, it is important to again discharge yourself by touching an unpainted metal surface for at least 5 seconds before you continue with the service process.
- c) Release the service access cover latch by pushing the release latch **(A)** in the direction shown.
- d) Slide the cover **(B)** off the system unit. When the front of the service access cover clears the upper frame ledge, lift the cover up and off the system unit.



**Attention:** Operating the system without the service access cover on for more than 10 minutes when the system power is turned on might damage the system components.



P9HAJ505-1

Figure 83. Removing the service access cover

- e) Open the hinged access door **(A)** on the air baffle above the slot you want to access.



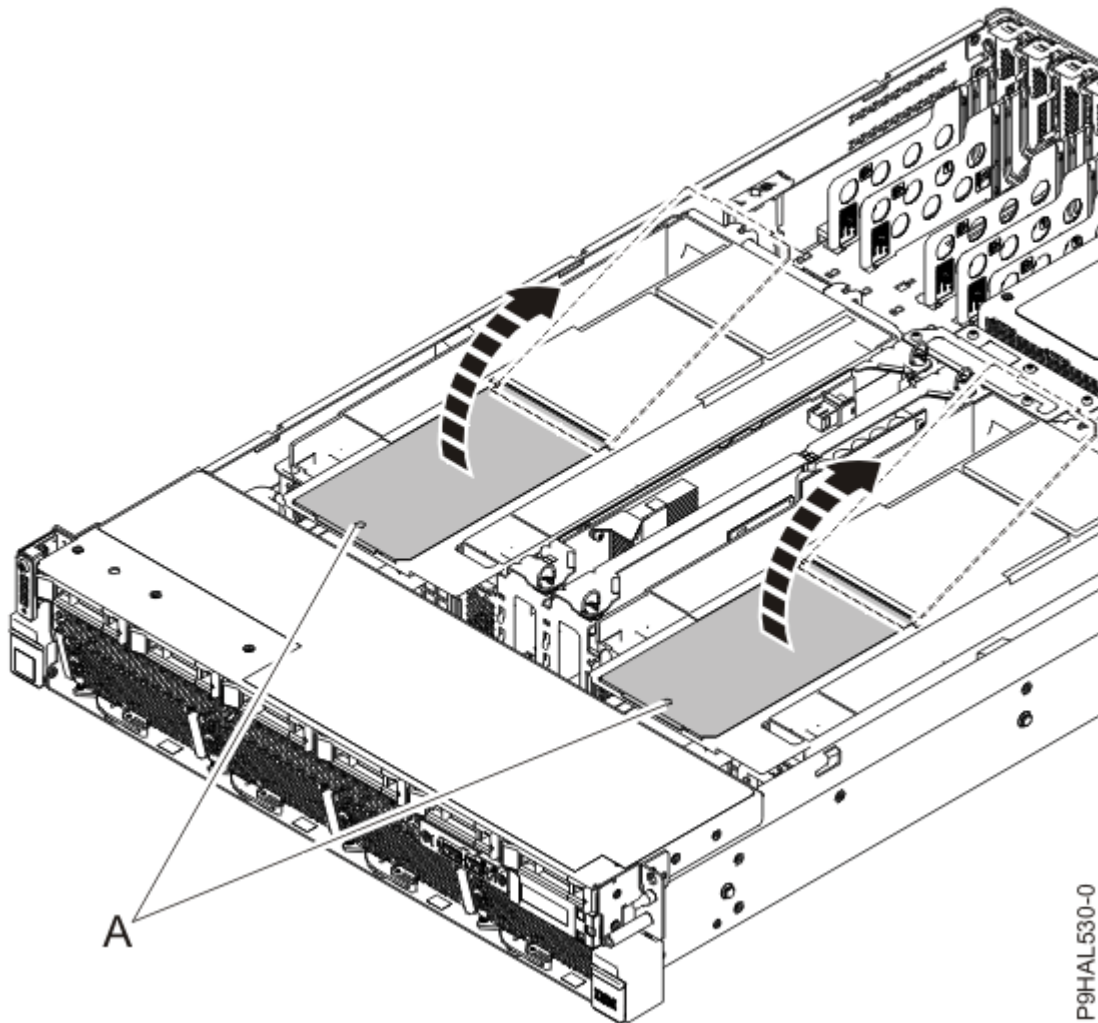


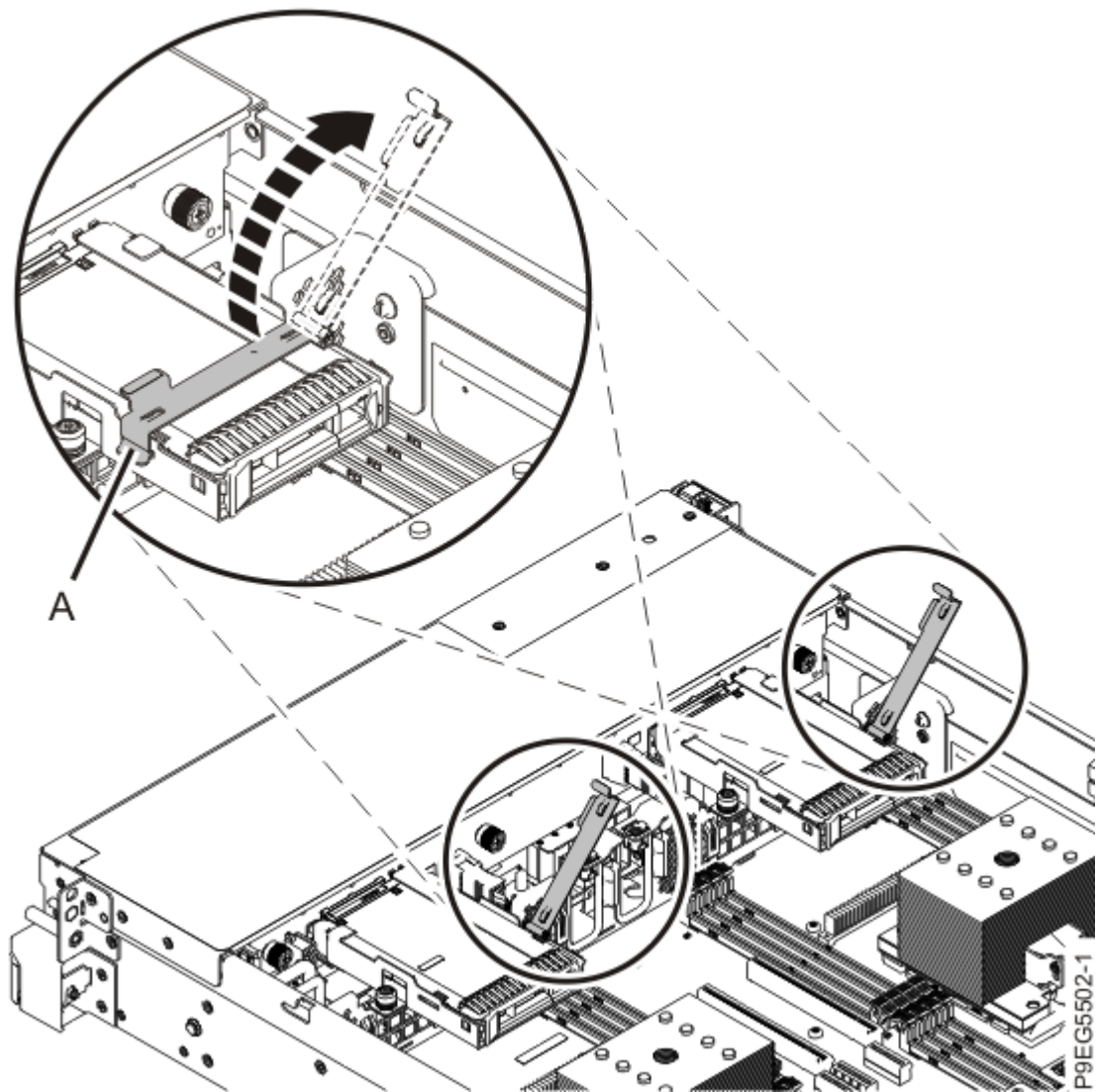
Figure 84. Opening the hinged access doors on the air baffles in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

### Permanently removing a disk drive or solid-state drive from the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

To permanently remove a disk drive or solid-state drive (SSD) from the system, complete the steps in this procedure.

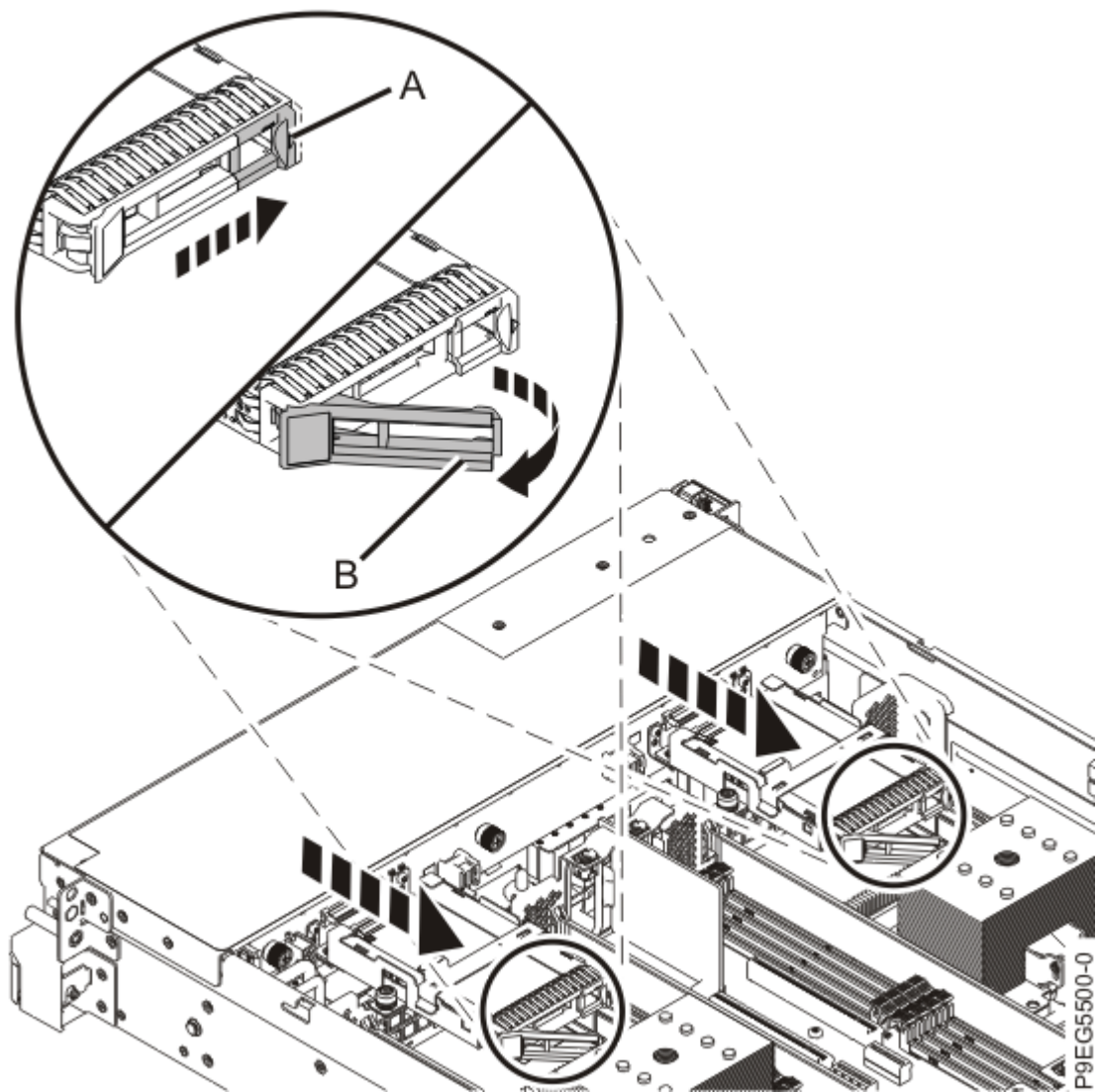
#### Procedure

1. Ensure that you have the electrostatic discharge (ESD) wrist strap on and that the ESD clip is plugged into a ground jack or connected to an unpainted metal surface. If not, do so now.
2. To permanently remove a drive from a system, choose from the following options:
  - To remove an internal drive, continue with step “3” on page 105.
  - To remove a front drive, continue with step “6” on page 109.
3. To remove a drive from inside the system when the system is powered off, complete the following steps:
  - a) Open the drive holder lever (A).



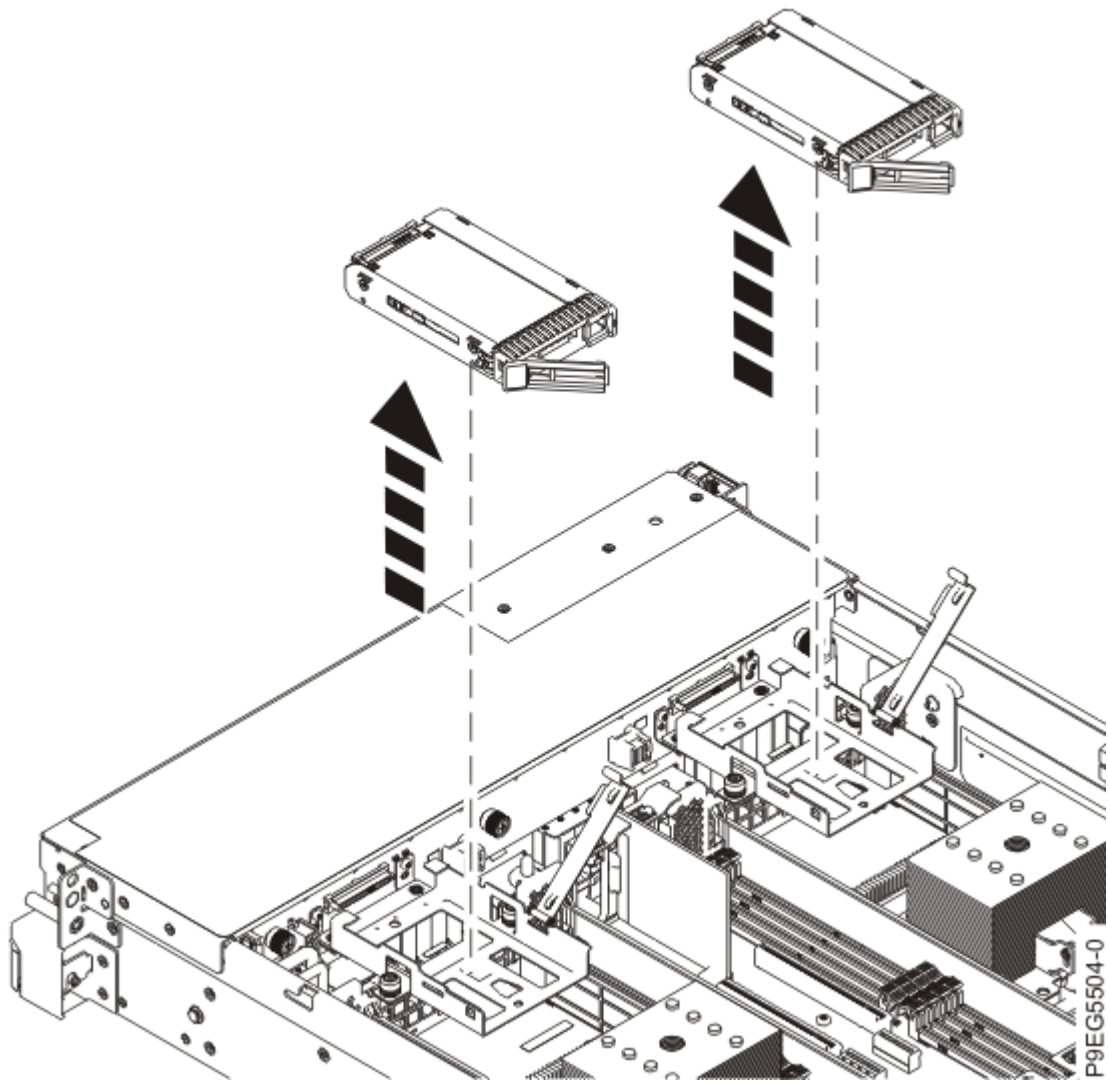
*Figure 85. Opening the drive holder lever*

- b) Unlock the drive handle (**B**) by pressing the handle release latch (**A**) in the direction that is shown, and pulling out the handle toward you.



*Figure 86. Unlatching the drive handle*

- c) Using the drive handle, pull the drive about 2.5 cm (1 in.) from the disk drive backplane.
- d) Lift the drive from the system as shown.



*Figure 87. Lifting the drive*  
4. Close the drive holder lever **(A)**.

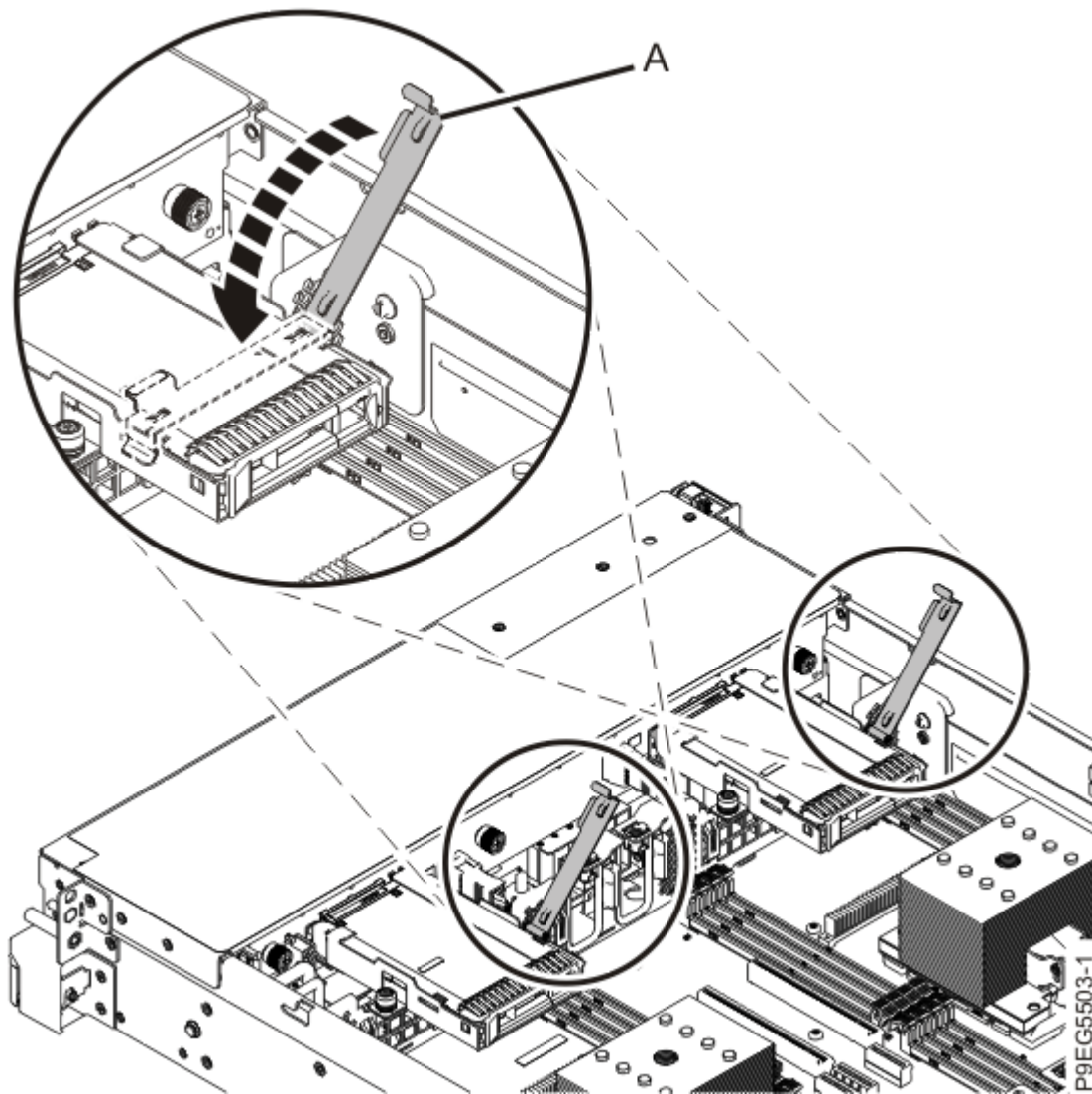
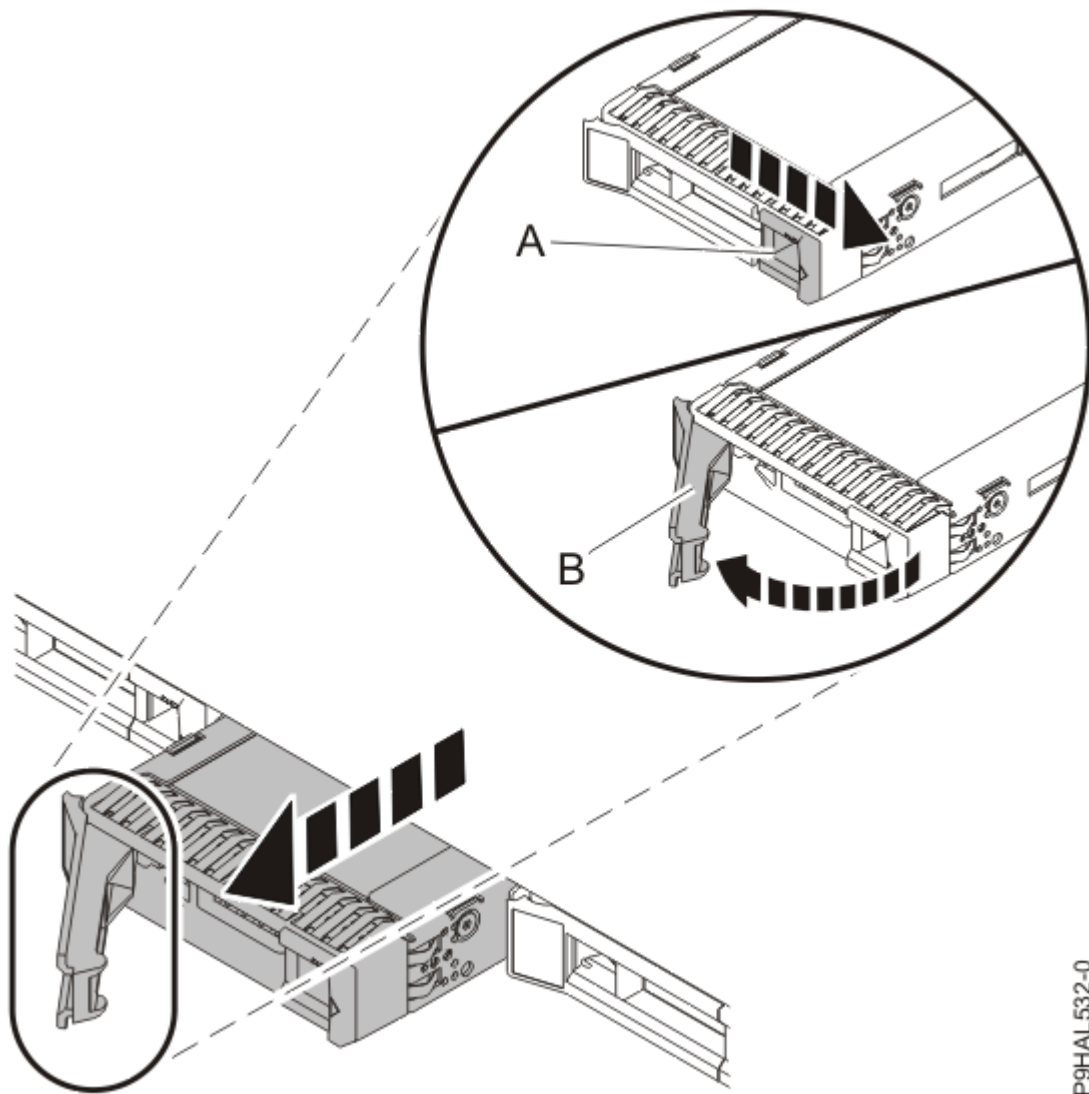


Figure 88. Closing the drive holder lever

5. Continue with step [“8”](#) on page 111.
6. To permanently remove a drive from the front of the system with the system power turned off, complete the following steps:
  - a. Unlock the drive handle **(B)** by pressing the handle release latch **(A)** in the direction that is shown, and pulling out the handle toward you. If the handle is not all the way out, the drive cannot slide out of the system.



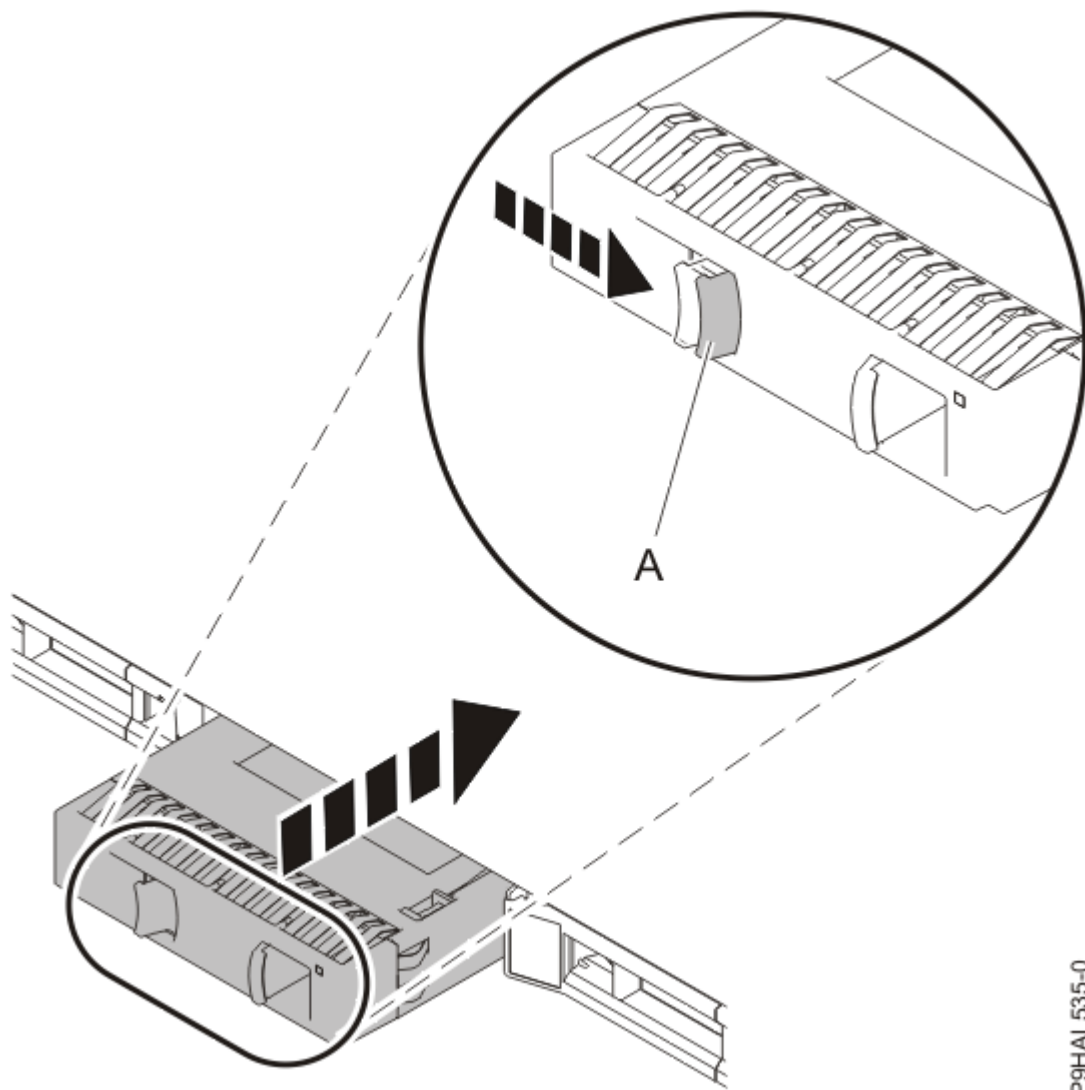


P9HAL532-0

*Figure 89. Unlocking and removing the drive*

- b. Support the bottom of the drive as you slide it out of the system.
- 7. To install a filler to ensure proper air flow for cooling, complete the following steps:
  - Note:** If your system has internal slots, they do not require a filler.
  - a. Press the lock **(A)** on the handle of the filler in the direction that is shown.
  - b. Align the filler with the drive slot and push the filler all the way into the system until it locks.





P9HAL535-0

Figure 90. Installing a drive filler in a system

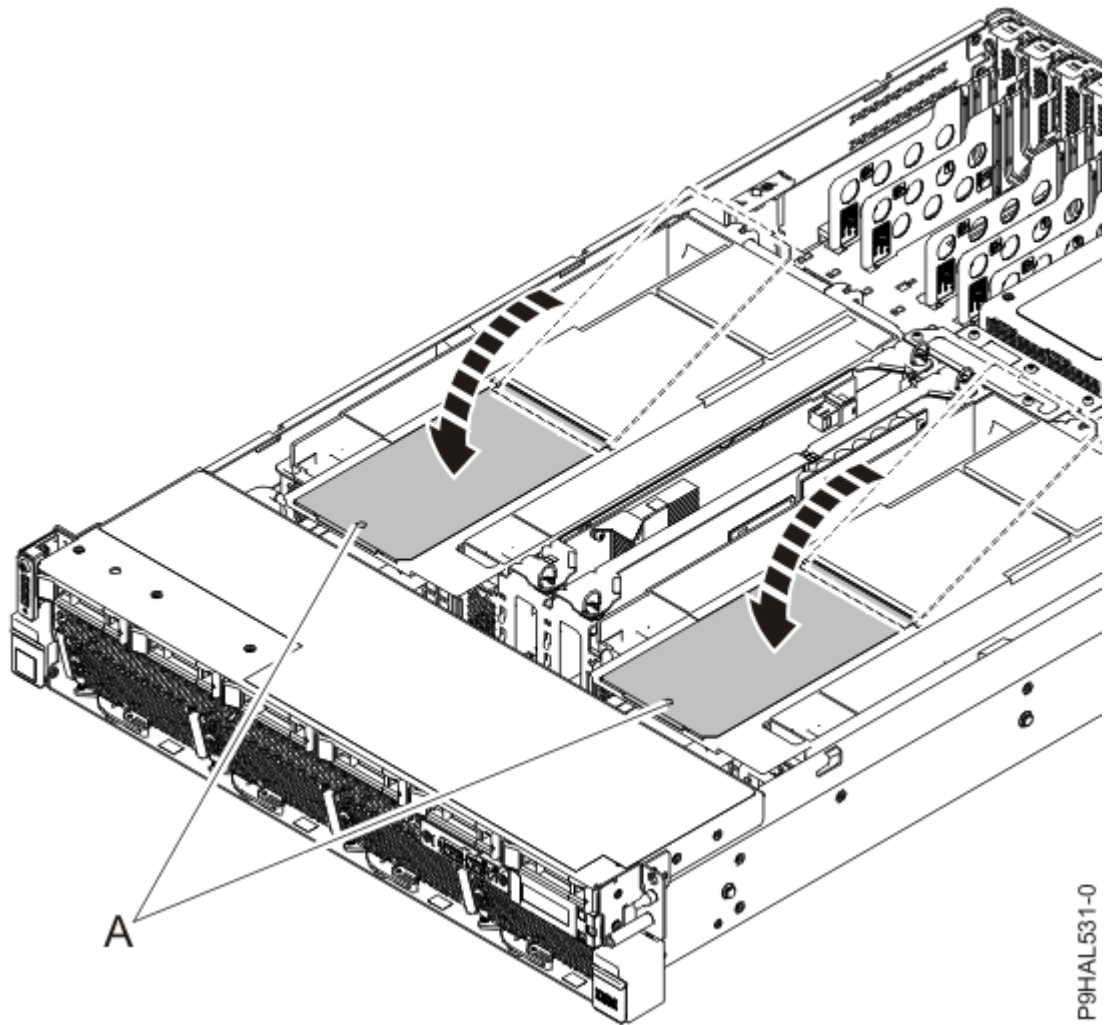
8. If you want to permanently remove another drive, repeat this procedure.

### Preparing the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system for operation after permanently removing a disk drive or solid-state drive

To prepare the system for operation after you permanently remove a disk drive or solid-state drive (SSD), complete the steps in this procedure.

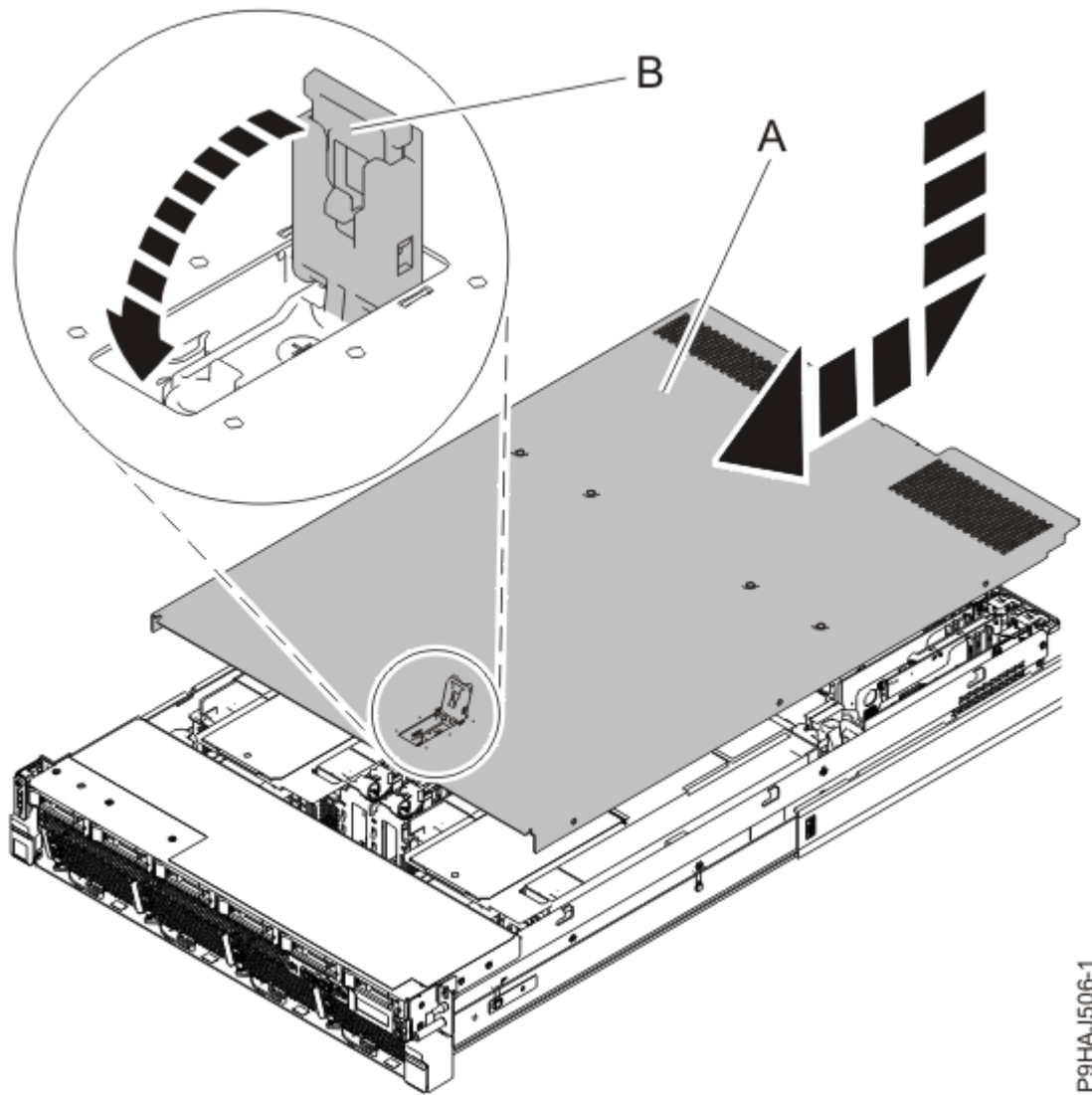
#### Procedure

1. Ensure that you have the electrostatic discharge (ESD) wrist strap on and that the ESD clip is plugged into a ground jack or connected to an unpainted metal surface. If not, do so now.
2. Choose from the following options:
  - If you permanently removed a drive from inside the system, continue with step “3” on page 111.
  - If you permanently removed a drive from the front of the system, continue with step “4” on page 114.
3. If you permanently remove a drive from inside the system, complete the following steps:
  - a) Close any open hinged access doors (**A**) on the air baffles.



*Figure 91. Closing the hinged access doors on the air baffles in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system*

- a) Slide the service access cover **(A)** onto the system unit.
- b) Close the release latch **(B)** by pushing it in the direction shown.

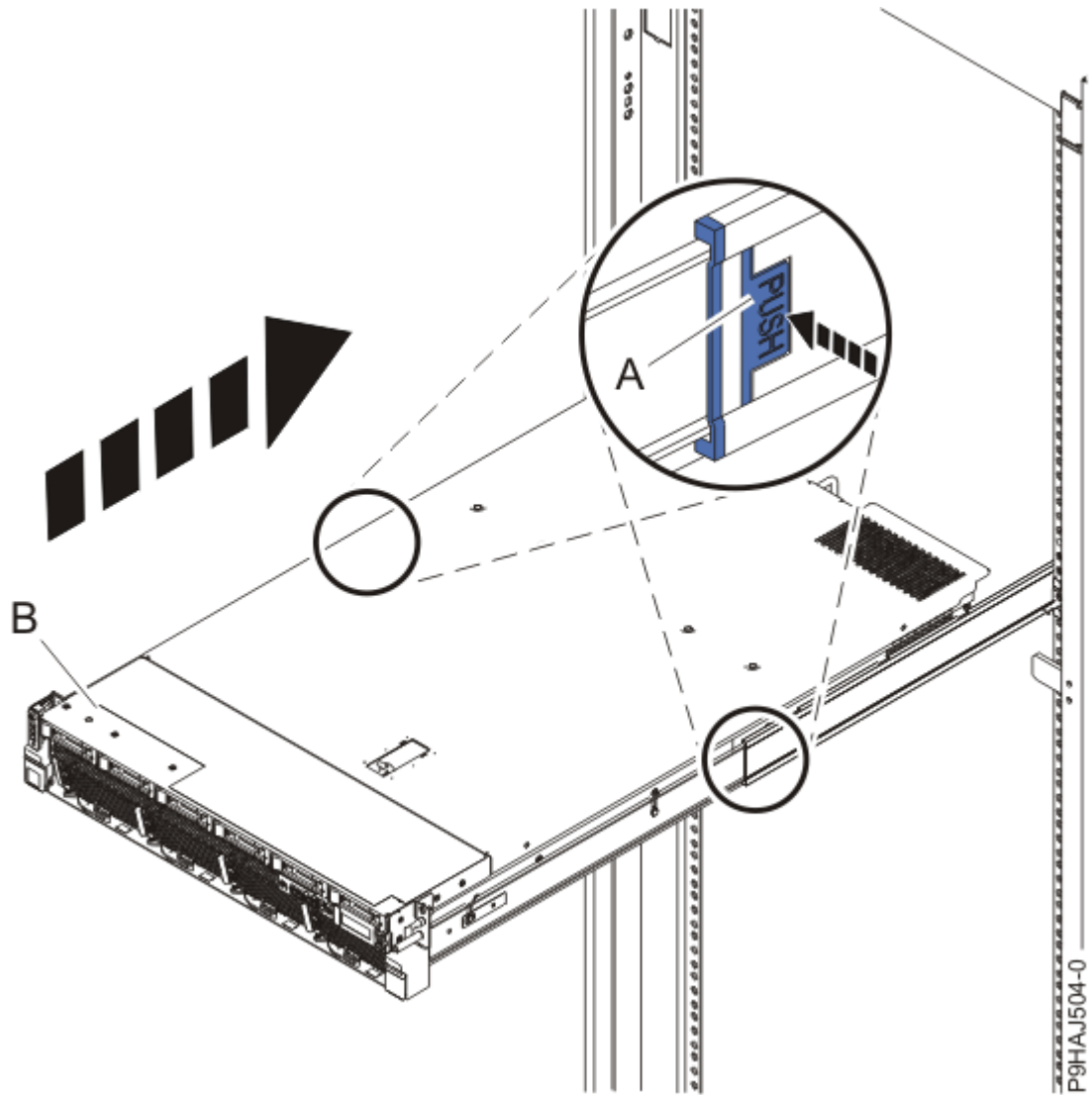


P9HAJ506-1

*Figure 92. Installing the service access cover*

- c) Unlock the blue rail safety latches **(A)** by pushing them inward.
- d) Push the system unit **(B)** back into the rack until both release latches of the system unit lock into position.

Ensure that the cable management arms can move freely. Ensure that the cables at the rear of the unit do not catch or bind as you push the unit into the operating position.



*Figure 93. Placing the system into the operating position*

4. Using your labels, reconnect the power cords **(A)** to the system unit.

Fasten the power cords to the system using the hook-and-loop fasteners **(B)** as shown in [Figure 94 on page 115](#).

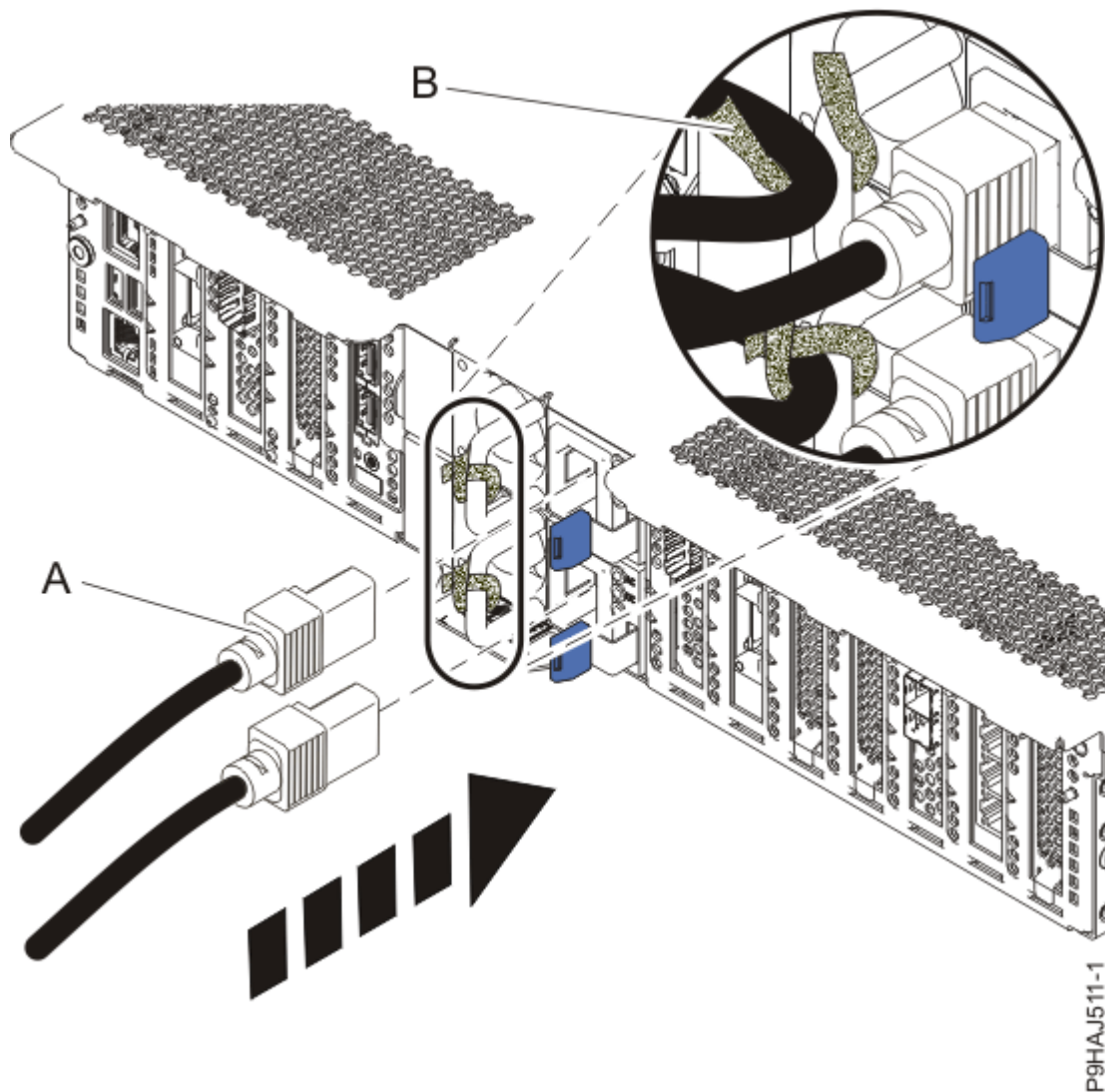


Figure 94. Connecting the power cords

5. Close the rear rack door.
6. Start the system. For instructions, see [Starting a system](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm) ([www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm](http://www.ibm.com/support/knowledgecenter/POWER9/p9haj/crustartsys.htm)).
7. Store the drive or drives that you permanently removed in a safe place.

## Related procedures for installing, removing, and replacing disk drives or solid-state drives

Find procedures that are related to installing, removing, and replacing disk drives or solid-state drives in an 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system.

### Internal drive sharing on a 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system

Learn how to split the internal drives in the system into groups, which you can manage separately.

#### Before you begin

PCIe3 x8 SAS RAID internal adapter 6 Gb (FC EJIH or FC EL68; CCIN 57D7) is used to split the disk drive backplane in the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9223-22H, or 9223-22S system. Installing

two CCIN 57D7 adapters enables the split mode on the disk drive backplane. The eight short-form factor (SFF) disks can be split into two sets of four SFF disks. The drives can be configured for RAID 0, 10, 5, and 6.

For more information about the SAS Subsystem, see [SAS subsystem](#).

For more information about installing FC EJ1H or FC EL68, see [Installing the PCIe3 x8 SAS RAID internal adapter 6 Gb](#).

**Note:** The FC EJ1H and FC EL68 must be installed while the system power is turned off.

The split drive mode can be useful for partitioning. If you set up two distinct logical partitions (LPARs), the resources that are associated with FC EJ1H or EL68 can be assigned to two distinct partitions. To learn about a partitioned environment, see [Logical partitioning](#).

### **What to do next**

You can now manage the drives as you would manage any other drives.

## **Mainstream solid-state drives**

Learn about the differences between enterprise solid-state drives (SSDs) and mainstream SSDs (previously called read intensive SSDs).

Traditionally, enterprise SSDs are built on high-endurance multi-level cell (MLC) flash and can handle up to 10 drive writes per day. These SSDs are referred to as *enterprise SSDs* in this document (previously called eMLC). Now, because of software advances and industry demands, less write intensive SSDs can be used with applications where write operations are less frequent. IBM offers several 4 K mainstream SSDs, including feature codes (FCs) ES8Y, ES8Z, ES96, ES97, ESE7, ESE8, ES83, ES84, ES92, ES93, ESE1, and ESE2.

### **Differences between mainstream and enterprise SSDs**

Mainstream SSDs are less expensive to use, but also have lower endurance and random write performance.

#### **Lower endurance for mainstream drives**

The NAND flash used in mainstream drives tend to be of lower endurance than the NAND flash used in SSDs that are targeted for more write intensive workloads. Therefore, the number of write operations to a mainstream drive is limited (typically, one drive write per day (DWPD) versus 10 DWPD on an enterprise drive).

A *drive write per day* writes the entire capacity of the drive in 24 hours. For example, a DWPD for a 387 GB drive writes 387 GB of data on the drive in 24 hours. You can write more data in a day, but the DWPD is the average usage rate by which the life span of the drive is calculated. Since many applications require only about 1 DWPD, these drives are the most commonly used drives in the industry and thus used for mainstream applications. Only applications that require high endurance or the highest random write performance need enterprise drives.

#### **Lower over-provisioning for mainstream drives**

SSDs have more NAND flash capacity than the rated user capacity of the drive. This extra capacity, called *over-provisioning*, is used by the SSD controller during the operation of the drive. When more over-provisioning is available, the controller extends the life of the flash more effectively. NAND flash can be written (programmed) and read in small units that are called *pages*, individually, but to rewrite that page, the page must first be erased and then programmed again.

Due to the architecture of NAND flash, erase operations are completed on the block level and not the page level. Each block contains hundreds to thousands of pages. Therefore, to erase a block, all of the valid data must first be transferred to another block and then you can erase the block. The SSD controller then searches for blocks with large proportions of pages that have data that can be erased. Then, the SSD controller moves and combines the pages of data that must be retained to previously erased blocks, which then frees these new blocks for erasing.



This process of moving data to free up blocks for erasing is called *garbage collection*. Increasing the over-provisioning of an SSD enables the controller to be more efficient in garbage collection and minimizes extra read and program operations.

All of these background operations result in more data that is written to the flash than what is written to the drive. The ratio of data that is written to flash and the data that is written to the drive is referred to as the *write amplification*. All else being equal, write amplification is greater for drives with lower over-provisioning.

### **Lower cost for mainstream drives**

The cost per GB of a mainstream drive is typically less than the cost per GB of an enterprise drive. The cost is low because the amount of over-provisioning is less and almost all the flash memory in the drive is available for storing data.

### **Lower write operation performance for mainstream drives**

Mainstream drives are similar to enterprise drives in terms of read performance. However, because of the lower over-provisioning of the mainstream drives, the random write performance is reduced because of the higher number of background operations that are needed for garbage collection and associated write amplification. Thus, lower over-provisioning decreases both performance and endurance. Read performance is not impacted.

### **No mixing of mainstream drives with enterprise drives in disk arrays**

Endurance differences imply that when you form disk arrays, you must not mix mainstream drives with enterprise drives because the PCIe SAS adapter stripes data across drives, thus sending equal data to each drive. The IBM PCIe SAS adapters do not allow mixing of mainstream drives with enterprise drives when you create RAID arrays.

### **Monitoring end of life for mainstream drives**

You must monitor end of life symptoms for mainstream drives because of their endurance limitations. Internally, when the drive nears the end of life, a predictive failure analysis (PFA) trip is generated and an operating system message is logged. When this trip is generated, the drive continues to run but it must be replaced as soon as possible. The PFA trip code for end of life is the same as the PFA trip code for thermal failures. Therefore, you can determine the root cause of a failure by using operating system support that is provided by a fuel gauge command.

### **Warranty and maintenance information for mainstream SSDs**

A mainstream drive is not suitable for write intensive workloads. Assuming a typical heavily random workload, at about 3394 TB of write operations to a 1.9 TB mainstream drive, the drive is at its maximum projected write capability. If the write operations exceed the drive's maximum write capacity, the write operation takes more time to complete. A predictive failure analysis (PFA) message indicates that you must replace the drive.

If you ignore the PFA message and if you continue to send the write operation requests to the drive, the drive is unable to accept write commands and accepts only read commands for some time. A failed to write operation results in a more serious error message that indicates that the drive must be replaced.

The nature of the workload impacts the maximum write operation capacity. For example, if a high percentage of sequentially oriented write operations is used instead of random oriented write operations, the maximum write operation capacity increases. You must periodically check the percentage of the drive's remaining write life, and if necessary, adjust the workload or reassign the drive. Check the remaining life on each of the mainstream drives individually, even if all of the drives are in the same array.

Failure of IBM mainstream SSD devices is covered in the standard warranty and only mainstream SSD devices that have not reached the maximum number of write cycles are covered during the maintenance period. Mainstream SSD devices that reach this limit might fail to operate according to specifications and must be replaced. This replacement cost is not covered under the standard warranty or during the maintenance period.

### **Using the fuel gauge command**

The fuel gauge command is an operating system command that you can use to determine the amount of life in a drive. When a PFA trip is reported by the drive, you can use the fuel gauge command to determine the remaining life on the mainstream drive. Then, you can decide whether the drive reached end of life or if the PFA trip occurred for another reason.

For instructions about using the fuel gauge command, select the option for the operating system you are using:

- [Using the AIX fuel gauge command](#)
- [Using the IBM i fuel gauge tool](#)
- [Using the Linux fuel gauge command](#)

### Using the AIX fuel gauge command on a mainstream SSD

Learn how to use the AIX operating system fuel gauge command to find the amount of remaining life in a mainstream solid-state drive (SSD).

#### About this task

To use the fuel gauge tool for the AIX operating system, complete the following steps:

#### Procedure

1. If the system has logical partitions, complete this procedure from the logical partition that owns the SSD.
2. From the AIX command line, type the following command and press Enter:  
`/usr/lpp/diagnostics/bin/pdiskfg -d pdiskX`, where *X* is the physical disk (pdisk) number of the mainstream SSD.
3. Is the value in the **Life Remaining Gauge** field less than or equal to 2 percent?
  - **Yes:** Continue with the next step.
  - **No:** The mainstream SSD is not reporting a change in status for the number of write operations available.
4. Is the value in the **Life Remaining Gauge** field 0 percent?
  - **Yes:** Continue with step “5” on page 118.
  - **No:** Continue with step “6” on page 118.
5. The mainstream SSD reached the limit for the number of write operations that are supported. Write operations to the SSD become slower over time, and at some point the SSD becomes a read-only drive. When the operating system writes to the read-only drive, the write operations are rejected, and the operating system considers the drive as if a failure occurred. For example, if the operating system writes to a drive that is in a RAID array and if the write operations are rejected, the array becomes exposed. To support normal write operations, the drive must be replaced.

Replacement of the mainstream SSD might not be covered by the system's level of service entitlement, depending on the terms and conditions of the system. For more information about mainstream SSDs, see [“Mainstream solid-state drives” on page 116](#). **This ends the procedure.**

6. The mainstream SSD is nearing the limit for the number of write operations that are supported. No service action is required currently.

**Note:** After the mainstream SSD reaches the limit for the number of write operations that are supported, write operations to the SSD become slower over time, and at some point the SSD becomes a read-only drive. To support normal write operations, the drive must be replaced. Replacement of the mainstream SSD might not be covered by the system's level of service entitlement, depending on the terms and conditions of the system. For more information about mainstream SSDs, see [“Mainstream solid-state drives” on page 116](#). **This ends the procedure.**

## Using the IBM i fuel gauge tool on a mainstream SSD

Learn how to use the IBM i operating system fuel gauge tool to find the amount of remaining life in a mainstream solid-state drive (SSD).

### About this task

To use the fuel gauge tool for the IBM i operating system, complete the following steps:

### Procedure

1. If the system has logical partitions, complete this procedure from the logical partition that owns the SSD.
2. Sign on to an IBM i session with the QSECOFR user profile.
3. To create a report in a spool file, type the following command at the XPF command line and press Enter.

```
CALL PGM(QSMGSSTD) PARM('SSDGAUGE' X'00000008' 'SSTD0100' X'00000000')
```

4. Display the contents of the spool file. The spool file contains a report for mainstream SSDs. For each of the SSDs in the report, continue with the next step.
5. Is the value in the **Life Remaining Gauge** field less than or equal to 2 percent?
  - **Yes:** Continue with the next step.
  - **No:** The mainstream SSD is not reporting a change in status for the number of write operations available.
6. Is the value in the **Life Remaining Gauge** field 0 percent?
  - **Yes:** Continue with step “7” on page 119.
  - **No:** Continue with step “8” on page 119.
7. The mainstream SSD reached the limit for the number of write operations that are supported. Write operations to the SSD become slower over time, and at some point the SSD becomes a read-only drive. When the operating system writes to the read-only drive, the write operations are rejected, and the operating system considers the drive as if a failure occurred. For example, if the operating system writes to a drive that is in a RAID array and if the write operations are rejected, the array becomes exposed. To support normal write operations, the drive must be replaced.

Replacement of the mainstream SSD might not be covered by the system's level of service entitlement, depending on the terms and conditions of the system. For more information about mainstream SSDs, see [“Mainstream solid-state drives” on page 116](#). **This ends the procedure.**
8. The mainstream SSD is nearing the limit for the number of write operations that are supported. No service action is required currently.

**Note:** After the mainstream SSD reaches the limit for the number of write operations that are supported, write operations to the SSD become slower over time, and at some point the SSD becomes a read-only drive. To support normal write operations, the drive must be replaced. Replacement of the mainstream SSD might not be covered by the system's level of service entitlement, depending on the terms and conditions of the system. For more information about mainstream SSDs, see [“Mainstream solid-state drives” on page 116](#). **This ends the procedure.**

## Using the Linux fuel gauge command on a mainstream SSD

Learn how to use the Linux operating system fuel gauge command to find the amount of remaining life in a mainstream solid-state drive (SSD).

### About this task

To use the Linux operating system fuel gauge command, complete the following steps:

## Procedure

1. If the system has logical partitions, complete this procedure from the logical partition that owns the SSD.
2. Choose from the following options:
  - To use the **iprconfig** command, continue with step “3” on page 120.
  - To use the **ssd-report** command in the **iprutils** command-line interface, continue with step “4” on page 120.
3. To use the **iprconfig** command, complete the following steps:
  - a) Type `$ iprconfig`
  - b) In the main menu, select the **Devices Statistics** option.
  - c) In the **Device selection** screen, select **Read Intensive SSD** (Mainstream SSD) by moving the cursor to the correct line and pressing **1**.
  - d) Press Enter to confirm. The statistics for the selected device is shown.
  - e) Review the information in the first block of information.
  - f) Continue with step “5” on page 120.
4. To use the **ssd-report** command in the **iprutils** command-line interface, complete the following steps:
  - a. Type `$ iprconfig -c ssd-report <dev>`  
Where <dev> is the device you want to use.
  - b. Review the information that is shown.
  - c. Continue with step “5” on page 120.
5. Interpret the statistics:
  - **Total Bytes Written:** Number of GB already written to the device
  - **Number of Bytes reported by Warranty:** Number of GBs that can be written according to the specification
  - **Life Remaining Gauge:** An estimate of how much of the device's life is consumed
  - **PFA Trip:** The device detected an issue that might lead to a failure
  - **Power-on Days:** Number of days since the last power-on
6. Is the value in the **Life Remaining Gauge** field less than or equal to 2 percent?
  - **Yes:** Continue with the next step.
  - **No:** The mainstream SSD is not reporting a change in status for the number of write operations available.
7. Is the value in the **Life Remaining Gauge** field 0 percent?
  - **Yes:** Continue with step “8” on page 120.
  - **No:** Continue with step “9” on page 120.
8. The mainstream SSD reached the limit for the number of write operations that are supported. Write operations to the SSD become slower over time, and at some point the SSD becomes a read-only drive. When the operating system writes to the read-only drive, the write operations are rejected, and the operating system considers the drive as if a failure occurred. For example, if the operating system writes to a drive that is in a RAID array and if the write operations are rejected, the array becomes exposed. To support normal write operations, the drive must be replaced.

Replacement of the mainstream SSD might not be covered by the system's level of service entitlement, depending on the terms and conditions of the system. For more information about mainstream SSDs, see “Mainstream solid-state drives” on page 116. **This ends the procedure.**
9. The mainstream SSD is nearing the limit for the number of write operations that are supported. No service action is required currently.

**Note:** After the mainstream SSD reaches the limit for the number of write operations that are supported, write operations to the SSD become slower over time, and at some point the SSD becomes a read-only drive. To support normal write operations, the drive must be replaced. Replacement of the mainstream SSD might not be covered by the system's level of service entitlement, depending on the terms and conditions of the system. For more information about mainstream SSDs, see [“Mainstream solid-state drives”](#) on page 116. **This ends the procedure.**





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## **Accessibility features for IBM Power Systems servers**

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Accessibility features assist users who have a disability, such as restricted mobility or limited vision, to use information technology content successfully.

### **Overview**

The IBM Power Systems servers include the following major accessibility features:

- Keyboard-only operation
- Operations that use a screen reader

The IBM Power Systems servers use the latest W3C Standard, WAI-ARIA 1.0 ([www.w3.org/TR/wai-aria/](http://www.w3.org/TR/wai-aria/)), to ensure compliance with US Section 508 ([www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-section-508-standards/section-508-standards](http://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-section-508-standards/section-508-standards)) and Web Content Accessibility Guidelines (WCAG) 2.0 ([www.w3.org/TR/WCAG20/](http://www.w3.org/TR/WCAG20/)). To take advantage of accessibility features, use the latest release of your screen reader and the latest web browser that is supported by the IBM Power Systems servers.

The IBM Power Systems servers online product documentation in IBM Knowledge Center is enabled for accessibility. The accessibility features of IBM Knowledge Center are described in the [Accessibility](http://www.ibm.com/support/knowledgecenter/doc/kc_help.html#accessibility) section of the IBM Knowledge Center help ([www.ibm.com/support/knowledgecenter/doc/kc\\_help.html#accessibility](http://www.ibm.com/support/knowledgecenter/doc/kc_help.html#accessibility)).

### **Keyboard navigation**

This product uses standard navigation keys.

### **Interface information**

The IBM Power Systems servers user interfaces do not have content that flashes 2 - 55 times per second.

The IBM Power Systems servers web user interface relies on cascading style sheets to render content properly and to provide a usable experience. The application provides an equivalent way for low-vision users to use system display settings, including high-contrast mode. You can control font size by using the device or web browser settings.

The IBM Power Systems servers web user interface includes WAI-ARIA navigational landmarks that you can use to quickly navigate to functional areas in the application.

## Vendor software

The IBM Power Systems servers include certain vendor software that is not covered under the IBM license agreement. IBM makes no representation about the accessibility features of these products. Contact the vendor for accessibility information about its products.

## Related accessibility information

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TTY service  
800-IBM-3383 (800-426-3383)  
(within North America)

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When attaching a monitor to the equipment, you must use the designated monitor cable and any interference suppression devices supplied with the monitor.

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This product may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

Warning: This equipment is compliant with Class A of CISPR 32. In a residential environment this equipment may cause radio interference.

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Armonk, New York 10504  
Tel: 914-499-1900

Der verantwortliche Ansprechpartner des Herstellers in der EU ist:  
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Technical Relations Europe, Abteilung M456  
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Tel: +49 (0) 800 225 5426  
email: HalloIBM@de.ibm.com

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New Orchard Road  
Armonk, NY 10504  
Contact for FCC compliance information only: [fccinfo@us.ibm.com](mailto:fccinfo@us.ibm.com)

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New Orchard Road  
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Generelle Informationen:

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- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult an IBM-authorized dealer or service representative for help.

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(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Responsible Party:

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