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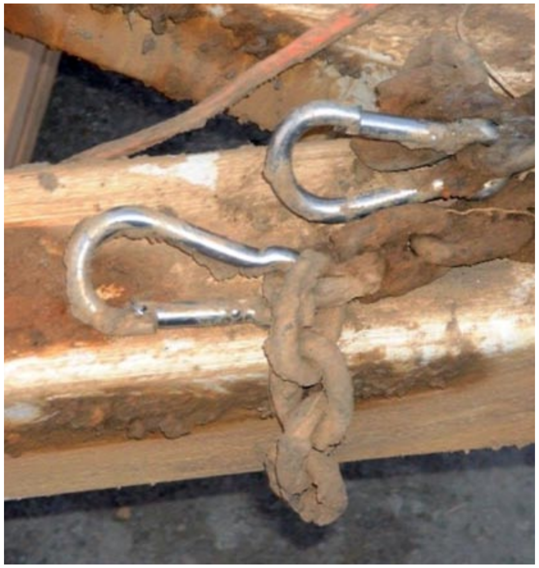
OPERATING EXPERIENCE SUMMARY



OE SUMMARY 2005-09

Unsafe Handling of Breathing Air Cylinder Results in Near Miss

1

On May 4, 2005, at the Hanford Site Tank Farms, a self-contained breathing apparatus (SCBA) accidentally slipped from the hands of a subcontractor rigger, causing a valve on the cylinder to open, propelling the cylinder 10 feet into the air. The airborne cylinder cleared a parked truck, then fell and struck the concrete base of a stadium light 35 feet away. The cylinder was not connected to a mask when the uncontrolled release of air pressure occurred. There were no injuries as a result of this near-miss event. (ORPS Report RP--CHG-TANKFARM-2005-0020)

The rigger was outside of the C-Farm change trailer when the incident occurred. He was carrying the fiberglass SCBA cylinder (which has a 1-hour capacity when charged to 4,500 psi) by the top of the valve handle when it slipped from his hand and the valve opened. Compressed air being expelled through the valve assembly caused the cylinder to slowly spin on the ground. The rigger attempted to close the valve but the cylinder spun faster, probably because the valve opened further as it rotated in contact with the ground. Suddenly, the cylinder went airborne. In all, the event lasted only about 5 seconds. No one was in the path of the cylinder or at the impact area.

Facility managers issued a stop work order on the use of SCBA air cylinders and initiated a fact-finding meeting. Investigators inspected the cylinder and found that the valve handle and stem were broken, but the valve had remained in the body (i.e., the neck did not break off the cylinder). Managers approved a briefing that outlined the event and clarified expectations for safe handling of SCBA cylinders, and workers were required to attend it before they were permitted to handle SCBA cylinders. The briefing specifically addressed handling cylinders in a manner to prevent contact with the valve handwheel. Figure 1-1 is from the briefing and shows both the incorrect and correct way to handle compressed air cylinders. Management also initiated research into long-term corrective measures for preventing recurrence of this type of event.

The facility safely handles upwards of 50 cylinders a day and has never had a mishap like this one. The rigger's handling of the cylinder was careless and could have resulted in worker injury. Safe handling of SCBA cylinders should include using cylinder storage racks to protect the cylinders from casual damage and thread protectors to prevent damage to the valve threads and to keep foreign materials from entering the valve orifices.

Figure 1-1. The incorrect and correct method for handling an SCBA cylinder

Additional information on compressed gas cylinder safety, including good practices for cylinder storage and use, can be found in Operating Experience Summary 2004-12.

This event is a reminder that a lack of attention or a moment of carelessness can quickly result in an accident that could have serious consequences. Compressed air cylinders used for self-contained breathing apparatus contain pressures ranging from 2,200 to 4,500 psi. An unintentional release of compressed air from these cylinders could easily result in a missile hazard.

KEYWORDS: *Compressed air, cylinder, SCBA, near miss, missile, bottle*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

Safe Handling of SCBA Cylinders

- Never carry a cylinder by the valve handwheel. The handwheel is only used to open or close the valve.
- Always handle the cylinder by grasping or cradling the cylinder body or the valve body, but not by contacting the valve handwheel.
- Avoid dropping a cylinder or bumping the handwheel.
- Be careful not to overtighten the valve. When closing the valve, close to snug-tight only. Overtightening can damage the valve seat.

Proper Selection and Use of Electrical Connectors Can Prevent Electrical Shocks

2

On April 14, 2005, at Sandia National Laboratory–Albuquerque, a researcher received an electrical shock when he accidentally touched the energized (100 volts) center pin of a cable connector. The cable was still connected to an energized power supply. The shock was mild; however, higher voltages can result in severe shocks, burns, and electrocution. (ORPS Report ALO-KO-SNL-1000-2005-0005; final report filed May 16, 2005)

The researcher was troubleshooting a sample fixture using a Keithley, Model 2410, SourceMeter® DC power supply, which provides up to 1,000 volts with a current limit of 100 microamps. The researcher disconnected the BNC (Bayonet Neill-Concelman) connector from the test fixture equipment while trying to determine if the sample holder was working properly. He inadvertently touched the end of the BNC connector (Figure 2-1) and received approximately 100 volts to a fingertip on his right hand. The electrical path was from the center pin of the cable through the finger and to the outside of the BNC connector.

Investigators determined that the researcher received the shock because he failed to turn the power supply off before disconnecting the BNC connector from the test equipment and that the design of the connector allowed for easy finger contact with the center pin. They also determined that the BNC coaxial cable was less than adequate for the application in that it was rated for only 500 volts (the power supply could provide up to 1,000 volts).

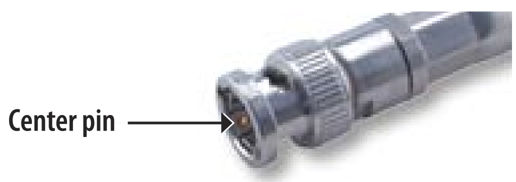


Figure 2-1. Typical BNC connector for coaxial cable

As a corrective action, management directed all laboratory personnel using BNC connectors on equipment that could be powered over 50 volts to replace them with Safe High Voltage connectors, which are rated for 3,500 volts and have a recessed center pin that is more difficult to inadvertently touch (Figure 2-2).

Figure 2-2. Typical SHV connector for coaxial cables

Management also directed that all banana plugs (Figure 2-3) used in the same voltage applications (over 50 volts) were to be replaced with retractable-sheath type banana plugs (Figure 2-4) or shielded banana plugs.

Figure 2-3. Typical banana plug

Figure 2-4. Typical retractable-sheath banana plug

A review of the ORPS database identified the following events that involved the use of BNC connectors.

- At the National Synchrotron Light Source, a post-doctoral scientist received a shock while removing a connector from a multimeter. The shell of the BNC connector was energized to 1,000 VDC from a power supply connected in series with the multimeter. Investigators learned that the scientist had used coaxial cables, BNC connectors, alligator clips, and a banana plug, which are appropriate for low-voltage and low-current applications into a high-voltage circuit. (ORPS Report CH-BH-BNL-NSLS-2002-0001)
- At the Ames Laboratory, a graduate student received a second-degree burn from an electrical arc while attempting to connect a male BNC connector to a female BNC connector that was energized to 1,000 volts. The student knew the connector was energized, but took the risk and proceeded with the connection anyway. (ORPS Report CH--AMES-AMES-1994-0005)
- At Sandia National Laboratory–Livermore, a contractor calibration technician received an electrical shock and slight burn to his finger while disconnecting a BNC connector from the front panel of a high-voltage power supply. The technician was fully aware that there were 2,000 volts at the connector, but he was unaware that he was acting unsafely by not removing the power. (ALO-KO-SNL-LVMRSITE-1992-0010)

The following events involved the use of banana plugs.

- At Sandia National Laboratory–Albuquerque, a technologist received a shock from 120 volts at 200 milliamps while inserting a banana plug into an output jack on a variac controller, which provides a variable source of AC voltage. The technologist had turned the variac on and did not realize that the output jacks had been energized. (ORPS Report ALO-KO-SNL-2000-2002-0001)
- At Sandia National Laboratory–Albuquerque, a metrologist removing test leads from a voltage monitor was shocked when his left hand touched a banana plug that was still energized to 1,000 VAC. He failed to reduce the power to zero or turn off the test equipment as required by procedure. (ORPS Report ALO-KO-SNL-4000-1993-0003)

The following events involved the use of adapters or transition-type connectors (e.g., banana plug to BNC).

- At Sandia National Laboratory–Albuquerque, a technician received an electrical shock while attaching a BNC to banana plug adapter to the output of an amplifier that was energized to 200 VDC. (ORPS Report ALO-KO-SNL-15000-2000-0003)
- At Sandia National Laboratory–Albuquerque, a technician received an electrical shock to the fingers and thumb on the left hand while removing a banana plug from a voltmeter that was being used to check the output of a high-voltage power supply. The technician had no experience in making high-voltage measurements, and the banana plug-to-BNC connector allowed contact with the exposed prongs. (ORPS Report ALO-KO-SNL-2000-2000-0001)

These events underscore the importance of giving careful attention to the selection of electrical connectors and cable configurations for proper application and electrical rating. Care must be exercised when handling banana plugs and BNC-type connectors because of the potential for contact with the exposed conductors. Consideration should be given to using plugs and connectors that are specifically designed to eliminate contact hazards. In addition, users of power supplies, amplifiers, and electrical test equipment should make a practice of reducing or removing output power before making or breaking connections and handling cables.

KEYWORDS: *Electrical shock, burn, connector, plug, adapter, energized*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

Near Miss When Trailer Hitch Detaches from Truck

3

On March 2, 2005, at the Savannah River Site, subcontractors were relocating a flatbed trailer onsite when the trailer hitch detached from the truck. The trailer veered to the opposite side of the road, went down an embankment, and came to rest in a nearby stream (see Figure 3-1). No other vehicles were involved in the incident, no one was injured, and there was no damage to either the truck or the trailer. However, the trailer crossed into the path of an oncoming car that was about 100 yards away, creating the potential for a serious accident. (SR--WSRC-CMD-2005-0002; final report issued April 20, 2005)

Figure 3-1. Trailer near stream post-accident

The truck driver and a passenger were traveling between 40 and 45 mph and heard a noise just as they drove over a dip in the road. As the driver began pulling off the road to check for the source of the noise, the passenger noticed that the trailer had separated from the truck. The trailer traveled about 300 or 400 yards, crossing the road, before it went down the embankment and stopped. Fortunately, the oncoming driver was alert, saw the trailer moving into his lane, and stopped his car until the trailer passed by and came to a stop.

On the day after the incident, critique members learned that the truck had hauled approximately six trailers during the week in which the incident occurred. The same hitch assembly was used in each case—a trailer hitch with a cotter pin and a safety pin (Figure 3-2).

Figure 3-2. Trailer hitch assembly

The driver said he thought that the safety pin was installed, but he did not check to be sure it was there when the trailer was hooked up to the truck. Critique members believe that someone stepped on the safety pin before transit and inadvertently dislodged it or that it was somehow dislodged during transit. The cotter pin was found beside the road the day after the incident, but the safety pin has not been located.

Safety chains would have provided a secondary connection between the vehicle and the trailer and would have helped retain the connection when the trailer coupling separated, but photos taken after the incident show that they were never attached between the truck and the trailer (Figure 3-3).

Figure 3-3. Post-accident photo showing unattached safety chains

As a result of this event, the subcontractor was required to inspect all towing equipment before using it and to report any deficiencies. They were also required to revise their Observation Checklist to include inspections of trailer hitch attachment devices and safety chain attachments and to use a positive locking-style safety pin rather than a cotter pin. All drivers will be required to inspect the attachment from truck to trailer before moving the trailer.

This event could have had much more serious consequences. Five years ago, two contractors at Oak Ridge National Laboratory were killed and a third employee was hospitalized for 7 days with internal injuries when an empty utility trailer struck several cars. The trailer separated from a vehicle traveling eastbound on a public road about a mile east of the site, collided with one vehicle and continued into the path of a second vehicle, hitting the left front side. The trailer tongue continued through the vehicle, killing the two contractors inside and injuring the third, before coming to a stop when it hit and damaged another car. (ORO--WSOR-FEDBUILDGS-2000-0002)

The police officer who arrived on the scene after the accident reported that the trailer had been secured to the vehicle pulling it with a ball hitch and safety chains, but the chains had snapped. The officer noticed that the locking mechanism on the tongue was also missing; the missing pieces were later found inside the vehicle in which the passengers were killed. The direct cause of the accident was identified as failure of the trailer hitch assembly, with failure of the safety chains as a contributing cause.

More recently, on September 10, 2004, at the Nevada Test Site, a pickup truck/trailer combination crossed a dip in the road, causing the trailer to move vertically and disengage from the trailer hitch ball. The driver was able to keep the vehicle under control and stopped on the side of the highway. Damage included a broken safety chain. Investigators determined that this incident was caused by the latch assembly (safety tongue) of the trailer hitch being wedged into the upper part of the hitch housing, which prevented the latch from performing its safety function. Corrective actions included developing options to confirm hitch engagement before towing. (NVOO--SN-NTS-2004-0001)

Trailer separation often occurs because of improper hitching or inadequate or damaged equipment. For example, pin-type hooks and ball hitches can uncouple if they are improperly latched, and hitch mounts may separate if damaged or not properly maintained. Because safety chains help retain the connection between the towing vehicle and the trailer long enough to bring the vehicles to a stop, it is important to ensure that they are installed and are in good condition.

To prevent accidents involving trailer separation, the Department of Transportation, Federal Motor Carrier Safety Administration (FMCSA), suggests that managers/supervisors and drivers consider the following.

Managers/Supervisors

1. Are towing vehicles and trailers equipped with properly rated ball hitches/pin[type] hooks?
2. Are appropriate safety devices, such as chains and breakaway brakes, available and installed?
3. Are hitches and safety devices being properly maintained?
4. Are drivers trained in and knowledgeable about proper use of hitching equipment?

Drivers

1. Have hitch components been checked to ensure that they are in good condition?
2. Has the coupler been adjusted, if necessary?
3. Is the hook/ball hitch properly locked?
4. Are safety chains properly connected?

The FMCSA trailer inspection requirements are detailed in *Federal Motor Carrier Safety Regulation 393*. Section 393.70, “Coupling Devices,” states that [devices] “shall be adequate to support and maintain control of the towed vehicle and shall not have cracks or excessive wear”; section 393.71(h) 10 and 11 address safety chains, requiring them to “be adequate to maintain attachment if the attachment device fails” and state that two chains are required to be crossed under the hitch. Additional inspection requirements for trailers can be found on the FMCSA website.

These events illustrate the potential for disastrous results if a trailer separates from the tow vehicle. Drivers who are towing trailers need to verify that trailers are properly secured to the hitch before driving away and make sure that trailers are never towed until safety chains are in place. Using a positive locking-style pin provides more assurance that the trailer will remain attached to the towing vehicle. It is also important to note that trailer hitches vary in size, and the hitch or ball must match in size to tow a trailer safely. Supervisors should ensure that personnel are trained properly in all aspects of towing and on the importance of inspecting hitching equipment before driving. Preventive maintenance is also essential to ensure that all components used in towing activities are in good condition and are unlikely to fail.

KEYWORDS: *Trailer, trailer hitch, safety chains, pin hook*

ISM CORE FUNCTIONS: *Analyze the Hazard, Develop and Implement Hazard Controls, Perform Work within Controls*

Best Practice: Use a Voltmeter to Verify a De-Energized Condition

4

On December 15, 2004, at the Savannah River Site, electricians from the Site Utilities Department discovered unexpected voltage on several conductors in a multi-conductor control circuit cable while performing electrical isolation work. The voltages ranged from 4 to 69 volts and had been verified as de-energized with a proximity (non-contact) voltage tester. Work was stopped immediately, and the area was placed in a safe condition. There were no injuries. (ORPS Report SR--WSRC-SUD-2004-0009; final report filed January 5, 2005)

The primary electrical power feeds for the facility had been removed in the early 1980s; therefore, a lockout/tagout was not initiated for the work. However, the electricians were wearing the proper electrical PPE to protect them from an electrical shock hazard when the incident occurred. During the causal analysis, investigators determined that the proximity voltage tester was not effective in identifying the low voltage present in the armored cable.

The following three events are examples of incidents reported in ORPS regarding problems associated with the use of proximity voltage detectors.

- On April 24, 2003, at the Savannah River Site, mechanics cut energized 120-volt wires while replacing a fan motor. Investigators determined that the mechanics had used a proximity voltage detector that was not approved for verifying the absence of voltage. Because the detector did not indicate an energized condition, the mechanics cut the wires, resulting in an exhaust failure alarm. (ORPS Report SR--WSRC-LTA-2003-0012)
- On September 29, 2001 at the Los Alamos National Laboratory, a sheetmetal worker decommissioning a radiological hood cut into a conduit containing an energized 110-volt conductor that supplied duplex outlets. The worker did not receive an electrical shock. Investigators determined that the electrician who removed electrical service to the hood failed to use a voltmeter to verify energized/de-energized status of the outlets as required. Instead, the electrician relied on an inductive pickup-type voltage tester to check the circuit. (ORPS Report ALO-LA-LANL-CMR-2001-0029)
- On May 23, 2001, at the East Tennessee Technology Park, workers in the K-33 Building produced an electrical arc when they cut a conduit containing an energized 120-volt wire. None of the workers received an electrical shock. Investigators determined that an electrician had attempted to verify that the wiring was not energized by using a proximity voltage detector instead of the voltmeter required by the procedure. Electricians may use proximity detectors to identify the presence of an energized alternating current circuit, but a voltmeter must be used to provide actual confirmation. (ORPS Report ORO--BNFL-K33-2001-0006)

There are many types of proximity voltage detectors available to electricians, mechanics, and electrical workers. When these detectors sense the presence of voltage, they can alert the user with an audible response, vibration, or a glowing lamp.

Inductive proximity testers and solenoid-type devices should not be used to test for the absence of alternating current voltage. These testers have a threshold voltage of approximately 60

DO NOT rely on proximity-type voltage testers to verify the de-energized condition of circuits and equipment.

BEST PRACTICE — Use a voltmeter to perform this verification and check test the voltmeter before and after use.

volts, and below that they cannot reliably detect a 60-hertz electromagnetic field. Even at higher voltages, shielding and insulation can block the electromagnetic field. These testers will not detect a constant direct-current voltage because they are sensitive only to the changing field.

Some proximity testers detect the difference in electrostatic potential between the circuit or object being tested and the detector. Therefore, it is important to ensure that the user is grounded and not in contact with whatever is being checked. Static electricity can also affect the response of the instrument. Metallic conduit can provide a false negative reading because it can bleed the voltage charge from the energized conductors to ground. Although useful on single-phase power, these detectors can be unreliable in three-phase applications that are clustered because the phase voltage flux can cancel the signal to the detector.

Non-contact-type voltage testers, which sense voltage based on capacitive coupling, are unable to detect direct current voltage or accurately indicate the magnitude of the voltage. The performance of these instruments can be affected by variations in the test circuit's capacitive coupling.

Proximity-type voltage detectors are useful tools for locating energized cables and devices; however, electrical workers should not rely on them to verify whether or not electrical equipment is de-energized.

These events illustrate the importance of using voltmeters to verify that electrical equipment is de-energized instead of relying on proximity-type testers. Proximity voltage detectors are good instruments for checking whether circuits are energized, but there are limitations to their use. These limitations must understood by users, not only for their own safety, but for the safety of others. The best practice is to always use a voltmeter to verify the absence of electrical energy and to check-test the meter before and after use.

KEYWORDS: *Electrical safety, proximity tester, detector, voltage, zero energy*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

Commonly Used Acronyms and Initialisms

Agencies/Organizations	
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
CPSC	Consumer Product Safety Commission
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
INPO	Institute for Nuclear Power Operations
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
SELLS	Society for Effective Lessons Learned

Units of Measure	
AC	alternating current
DC	direct current
psi (a)(d)(g)	pounds per square inch (absolute) (differential) (gauge)
RAD	Radiation Absorbed Dose
REM	Radiation Equivalent Man
v/kv	volt/kilovolt

Job Titles/Positions	
RCT	Radiological Control Technician

Authorization Basis/Documents	
JHA	Job Hazards Analysis
NOV	Notice of Violation
SAR	Safety Analysis Report
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question

Regulations/Acts	
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
RCRA	Resource Conservation and Recovery Act
D&D	Decontamination and Decommissioning
DD&D	Decontamination, Decommissioning, and Dismantlement

Miscellaneous	
ALARA	As low as reasonably achievable
HVAC	Heating, Ventilation, and Air Conditioning
ISM	Integrated Safety Management
MSDS	Material Safety Data Sheet
ORPS	Occurrence Reporting and Processing Syste
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control

EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health publishes a series of Just-In-Time reports on its Lessons Learned and Best Practices web site. These reports are targeted to work planners and workers and discuss safety topics relevant to the work they do. Each report presents examples of problems and mistakes encountered in actual reported cases and offers points to consider to avoid similar mistakes in the future.

EH plans to issue more Just-in-Times soon on other safety issues. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy complex by encouraging the exchange of lessons-learned information among DOE facilities.

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