Welding Hazards
Mitigating the Risk

Presented by Dave Hisey to the WMEA Conference
June 12, 2003
Welding Hazards
Mitigating the Risk

- Electric shock
- Stray welding currents
- Welding fume
- Mobile Gas Welding Systems
Welding Hazards

Electric Shock

- Electric Shock from welding will kill
- Province of Ontario Stats
  - August 15, 1988
  - Sept. 15, 1993
  - August 04, 1994
  - Nov. 02, 2001
- Each date represents a fatality involving electric welding
Welding Hazards

Electric Shock

- Electric Shock from welding will kill
- Recent US Mining Fatalities
  - August 30, 2000
  - Sept. 16, 2002
- Both fatalities involved stick welding in confined work areas while the welder was lying on the base metal
Welding Hazards
Electric Shock

- Welding machines can and do operate at up to 100 VDC
- We must prevent the welder from receiving electric shock
- John Richards is going to explain how this device works
Shock Stop Design Criteria

- Reduce the OCV when the welder is not in use and return power the instant an arc is stuck.

- Seamless operation for welder no impact on quality.
Shock Stop Components

- MicroProcessor Based.
- Solid State Switching up to 720 Amps.
- Powered by the available OCV.
- Mounted in a Fibreglass Enclosure.
Shock Stop Theory of Operation

- The human body normally provides a high resistance value.
- A number of factors reduce the effective resistance.
  - Temperature
  - Humidity/Moisture
  - Distance
  - Surface Area
Shock Stop Theory Of Operation

- Shock Stop measures the resistance of the welding circuit.
- The Threshold Resistance is in the Range of 40-50 Ohms.
- When the electrode is struck on the work the resistance drops below the threshold level and Shock Stop output is energized.
Shock Stop Theory Of Operation

- To allow the weld to be established, the output is energized for a minimum of 3 seconds.
- The microprocessor is fast enough that the turn on and off time is not noticeable to the user.
Shock Stop Diagnostics

- **Internal**
  - SCR, Trigger Devices, MPU
- **External**
  - Welding Cables, Ground Path
- **Shock Stop is an additional Safety device to be used with existing safety practices.**
Shock Stop Summary

- Welders accept electric shock as part of their job.
- The risks associated with shock are not known by welders nor their supervisors.
- Technology is available to reduce risk and improve working conditions.
Stray Welding Currents

- Cause damage to
  - Pins and bushings
  - Bearings
  - Building structure
  - Building electrical systems
    - Conduits
    - Ground/Bond wires
    - Tech cable jackets
    - Bonding screws
- Electronics – computer driven equipment
- People
Stray Welding Currents

- Responsible for fatalities
  - Nov. 02, 2001
    - Cambridge Ontario
Electrical service was diagonally opposite welding location.

Proof of multiple current paths – this circuit was not involved in powering welder.
Worker suffers fatal shock when opening a 600 volt attachment device.
The connector which the victim was attempting to open when he died.

Connection to Splitter

EMT Connector which failed
Burn marks where welding machine was located
Worker suffers fatal shock when opening a 600 volt attachment device.
Condition of Welding Cables is Important

Unacceptable damage

Unacceptable risk!
Examples of Welding Current Damage
Examples of Welding Current Damage
Costs of Welding Current Damage

- Engine overhaul costs can be as high as $350,000.00
- Destroy that engine due to welding damage
- Costs can be as high as $600,000.00
Why Do Stray Welding Currents Occur

- Because multiple parallel current paths exist
TYPICAL WELDER CIRCUIT

600V POWER OUTLET

POWER SUPPLY
600V, 3PHASE CABLE

3 POWER + GRND CONDUCTORS

STRUCTURAL GROUND

MACHINE FRAME GROUND

WORK LEAD TERMINAL

DC OUTPUT

WELDER

ELECTRODE TERMINAL

ELECTRODE

WORKPIECE

FLOOR/GROUND

DC WELDING CURRENT FOLLOWS CONTROLLED PATH THRU THE CABLES
FAULT CONDITION DC WORK LEAD TERMINAL

(WELDING IN PROGRESS)

IF WORK CLAMP IS NOT IN PLACE OR HIGH RESISTANCE

CURRENT THRU GROUND COND. OF POWER TOOL & GROUND SYSTEM OF BLDG OR EQUIP

POWER TOOL
FAULT CONDITION DC ELECTRODE TERMINAL
(NO WELDING IN PROGRESS)

NOTE: ELECTRODE NOT IN USE

POWER TOOL
When Using Steel as Current Path

- The multiplier is \( \times 7 \)

- 4/0 welding cable = 1 \( 5/8 \) round bar
This Major Company Experienced Serious Stray Welding Current Problems
This flat bar is only 22 gauge material – it got very hot!
These mats were melted by the heat generated from welding current passing through 22 gauge sheet metal strip.
Clamp used here only amplifies the problems.

Tack weld will not carry the current.
Stopping the Damage

- **Work Lead Position is Key**
  
  - W117.2-01  S 5.3.2.4 ..... The work lead shall be connected as close as practicable to the location being welded upon
  
  - to ensure welding current returns directly to the source *through the work lead*
The work lead shall be of the same cross-sectional area as the greater portion of the electrode cable.

Damaged cables shall be replaced.

Cable length shall not exceed that specified by the welding equipment manufacturer.
Electrical grounds connected to a building framework or other locations remote from the work area increase the possibility of output current passing through lifting chains, crane cables, or other electrical paths.

This passage of current through building systems can cause extensive damage to equipment and electrical circuits if the work lead isn’t properly installed.
From This — To This

Frayed section of cable
Correct Work Lead Connections

- Note the amount of steel contained in the designed for purpose 600 amp welding clamp when compared with the standard “C” clamp.
ELECTRICAL SAFETY

Welding machines can kill! Extra care required

By David Hisey

November 01, 2001 started out like any other Thursday morning for the young Millwright/welder in southern Ontario. Thoughts of the weekend coming and what that might bring may have been in the back of his mind, but for now he was intent on finishing his current welding assignment. Things were not going well with the welding task and his welding machine had finally quit completely. While investigating the cause, the worker died.

August 04, 1994, was a very hot day in the Toronto suburb. The welder, who had recently immigrated to Canada, was working above a suspended ceiling and the air temperature and humidity were taking their toll. Sweat beads rolled down his face and wetted his clothing. The shock he felt was brutal and took his breath away. He struggled to get up but the welding current locked him in place. Somehow, as he struggled to free himself, the circuit was broken and he found himself on the floor, alive, but barely. Exhausted and in medical difficulty, he later died at the scene.

August 15, 1988; September 15, 1993; are dates, which commemorate similar circumstances for other Ontario welders - these are the dates workers died as a result of the welding they were doing. August 30, 2000 and September 16, 2001 have similar relationships, they represent fatality dates in USA Mining. Both of the US workers died while lying on the bed of a mine crusher with a welding electrode in contact with their body.

Were these workers aware of the hazards of the workplace? Were they provided with all of the knowledge that exists to prevent this type of accident? Did their employers provide all of the safety equipment that was available? Were the standards that were already in place followed? I have just described the dates that 6 workers died, in North America, unnecessarily and from only two causes, both very much preventable through safe work procedures and now through the availability of new safety equipment.

Stick welders (SMAW) and stray welding currents from these machines account statistically, for a high percentage of fatalities involving welding. The first incident was the extreme result of stray welding current and a couple of pictures typical for this type of event are included. The two incidents from the USA were a direct result of the welders allowing the electrode to come in contact with their bodies (information on these incidents is available at www.msha.gov). For the remaining workers described here, who died, the actual causes are unclear. As the CSA technical committee on W117.2 Safety in Welding, Cutting and Allied Processes we were asked to review and comment on one of the incidents, however, we were not provided sufficient information to understand the direct cause.

Welders must understand that the work lead (commonly called "The Ground") is not ground, but a very important part of the welding circuit. The work lead must be connected as close as possible to the work location. The insulation on both leads must be complete - all of the welding current must return through the work lead. This concept and other controls necessary to prevent these fatalities are clearly described in CSA Standard W117.2-01 Safety in Welding, Cutting and Allied Processes. Welders must take extra precautions when changing electrodes in confined workspaces as fatalities often occur during this task. Holding the electrode holder under an armpit while repositioning in difficult locations, a common practice by some welders, is a sure way to become a victim.

Welding units are designed as an isolated power source, but this concept is difficult to maintain in the workplace. The work lead must flow the same current as the welding electrode lead, and when it does not, the remaining current must flow back to the welding unit via some other path. In most cases this is the building wiring, the bench grinder cord or work light cord. The final current path to the welding unit, is often through the primary ground in the power supply cord. Visible arcing between the grinder and the workbench or between the crane hook and the load, are signs that welding current is damaging your property and endangering your workers.

Occasionally, as in the first incident, welding current flows through electrical service conduits, system grounds and possibly phase conductors. This can occur anytime the welding circuit and the electrical ground circuit becomes connected. My employer, Syncreude Canada Ltd., a long time promoter of welding safety, has produced a video - "Welding Electrical Hazards" - that also explains these concepts visually.

Voltage reducing devices (VRDs) are available for welders as field installed devices. These lower the electrode voltage to negligible levels, when the stick machine is not welding, reducing the opportunity for the worker to receive electrical shock as electrodes are changed or when the electrode accidentally contacts the workers body. One unit manufactured in Canada has a test feature, which in effect, will check the contact insulation quality of the welding leads. Will a VRD with this feature prevent stray welding currents and the damage, worker shock, and potential fatalities they produce? Recent testing in progress by my employer Syncreude Canada Ltd suggests it will.

Dave Hisey works for Syncreude Canada Ltd. as an advisor on mining electrical issues as well as welding safety issues, at the Mildred Lake Plant site. Dave is the current chair for CSA Standard W117.2. He can be reached at his office 780-790-5282 or email hisey.dave@syncreude.com. Syncreude Canada Ltd has a workplace injury target of zero lost time injuries for 2003. CSA is available online at www.csa.ca or by phone at 416-757-0066 or 1-800-463-2742.
Welding Fume Disease

- Manganese Issue
  - Relationship to Parkinson’s

- Pregnant Welder Concerns
  - No published studies
Welding Fume Disease

- ACGIH reduced Manganese TLV to 0.2mg/m³ in 1996
- Notice of Change to 0.03mg/m³
  - How it is measured has also changed
- Relationship of manganese to Parkinson's under study at Harvard - AWS
- 2 year study Dr. Joseph Brain
What’s wrong with this picture?
The Female Welder

*Alberta Statistics*

- 3.67% of all licensed welders female
- Over 200 welders - female
- 59 steamfitters - female (additional) plus apprentices
- 13.37% of apprentice welders female
- Currently there are over 5000 apprentice welders in Alberta – 670 female
February 22, 2000 seemed like just another clear, cold day.
The safety meeting had just concluded, and several workers had received awards for their efforts in working safely. At 6:30 a.m., outside the work tent, a loud explosion and a hail of flame interrupted the quiet winter darkness.

**Mobile menace**

by David Hisley

Two workers lay on the ground, one dead and another with life-threatening injuries. The truck body was damaged and the cab was on fire, fed by escaping acetylene. The pickup truck, equipped with a mechanic style service body, contained an oxygen-acetylene cutting set inside a locked cabinet. The truck was clean, having been washed the night before, but the cabinet door lock was frozen solid in the minus 35°C temperature. A small propane torch was found nearby.

How could this have happened? Had it happened before?

The morning of May 14, 1993 was hot and dry as the two welders worked to modify a mine conveyor section. The sparks from the arc air electric torch streamed across the 22 feet separating the welders from the vented cabinet containing an oxygen-acetylene set. The explosion was deafening, and the workers instinctively ran for cover.

The truck was not damaged but the cabinet was destroyed and the cabinet door blown several feet away. (Yes, it did happen before.) These workers at a different mine site were fortunate; they were more than 22 feet away and not in line with the burst. They returned to their families uninjured that night with only a story to tell. Nearly seven years later, two others would not be so lucky.

**Explosion-prone truck-mounted welding systems are subject to new standards**

At a meeting of the Northern Institute of Occupational Health in Edmonton, Alberta on February 23, 2002, Dr. Sam Shaw welcomed 20 people assembled in the boardroom, including both the chair and vice-chair of CSA W172.2 - 00, what he termed was a very important meeting. The reason, as Shaw described it, contained both the “why” and the “where.” Nevertheless, this was a safe place to meet for this event organized by a CSA representative. They were assembled not to talk about bids, but to make recommendations that would become the basis for the new Alberta Regulation: Welding: Review, Prevented From Volatility and an addendum to CSA Standard W172.2 Safety in Welding, Cutting and Allied Processes: Mobile Gas Welding Systems (Gas Welding Systems Mounted on Vehicles).

The “vamps” were the Alberta occupational health and safety officers with Alberta Human Resources and Employment, Workplace Health and Safety, responsible for bringing the initial charges under the Alberta OHSA Act following their investigation of the incident on February 22, 2000.

The “vamps” were employers, manufacturers, and other interested parties who had agreed to attend at least one session and work together. They were there to discuss, to learn, and to help prevent future tragedies at welding sites.

On the evening of Sunday morning, moderated with a firm hand, in the end, recommendations were made, and we parted company knowing that much work remained to be accomplished. Changes that were once easy to the mobile welding industry.

**Positive afterthock:**

**How regulations are born**

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**Mobile Gas Welding Systems (Gas Welding Systems Mounted on Vehicles):**

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- Syncrude Canada Ltd., CSA, The LAC, & Keyano College are working together to make this a reality.
Thank You

Are there any questions for myself or John Richards?