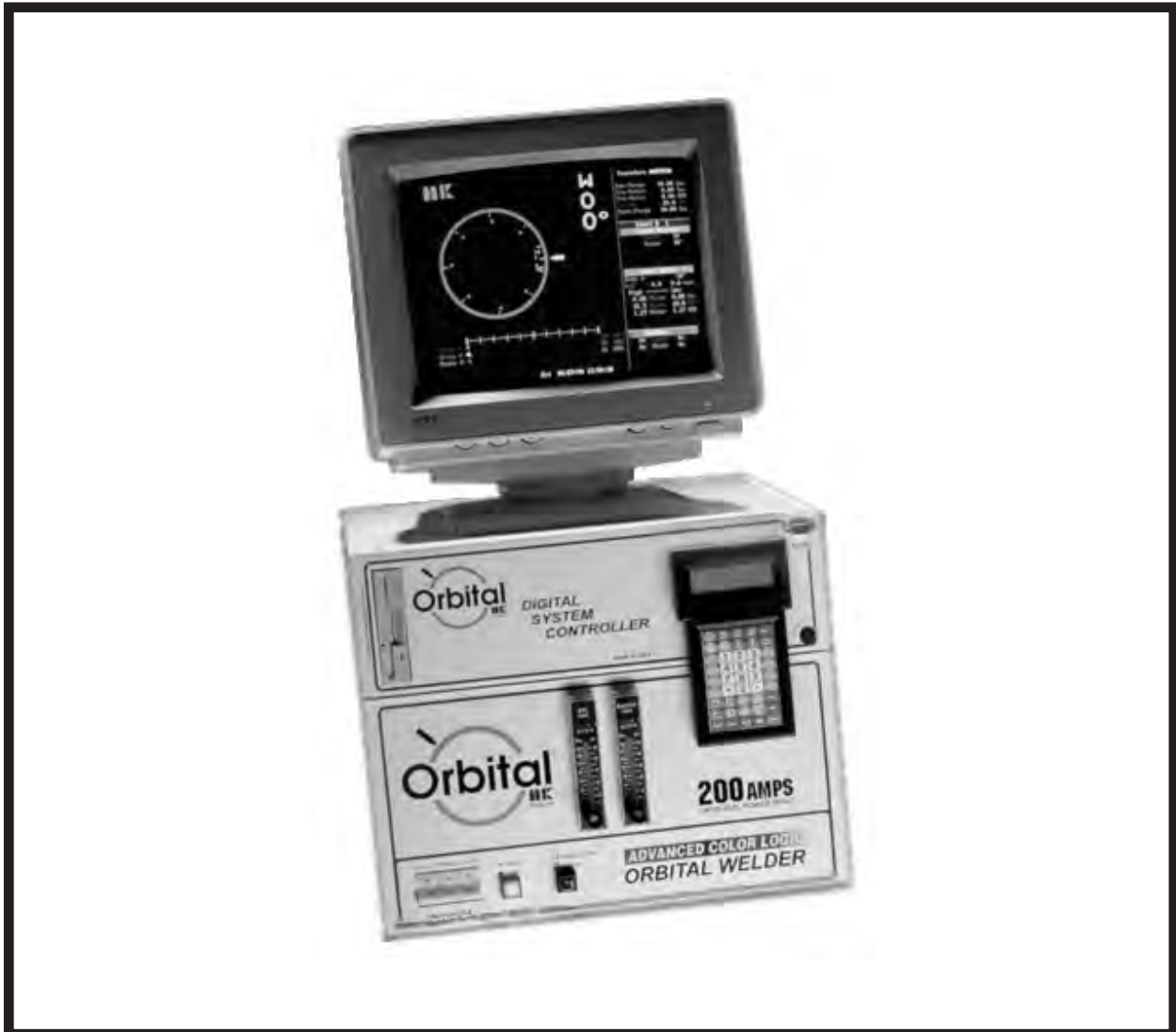




Product Description	Power Supply
MK Manual Part Number	091-0345
MK Form Number	ACL/OM
NWSA Form Number	550
Effective with Serial Number	101
Voltage Rating	120/208/240 VAC
Printing Date & Revision	October 2001 C
This manual applies to the following model numbers	ACL

Advanced Color Logic[®]



SAFETY CONSIDERATIONS

ELECTRIC ARC WELDING EQUIPMENT

CAUTION : READ BEFORE ATTEMPTING INSTALLATION, OPERATION OR MAINTENANCE OF THIS EQUIPMENT

1-1 INTRODUCTION

This equipment is intended for ultimate application by commercial/industrial users and for operation by persons trained and experienced in the use and maintenance of welding equipment. Operation should not be undertaken without adequate training in the use of such equipment. Training is available from many public and private schools or similar facilities.

Safe practices in the installation, operation and maintenance of this equipment requires proper training in the art, a careful study of the information provided with the equipment, and the use of common sense. Rules for safe use are generally provided by suppliers of welding power sources, compressed gas suppliers, and electrode suppliers. Careful compliance with these rules will promote safe use of this equipment.

The following Safety Rules cover some of the more generally found situations. READ THEM CAREFULLY. In case of any doubt, obtain qualified help before proceeding.

1-2 GENERAL PRECAUTIONS

A. Burn Prevention

ELECTRIC ARC WELDING PRODUCES HIGH INTENSITY HEAT AND ULTRAVIOLET RADIANT ENERGY WHICH MAY CAUSE SERIOUS AND PERMANENT EYE DAMAGE AND WHICH MAY DAMAGE ANY EXPOSED SKIN AREAS.

Wear helmet with safety goggles or glasses with side shields underneath, appropriate filter lenses or plates (protected by clear cover glass). This is a must for welding or cutting (and chipping) to protect the eyes from radiant energy and flying metal. Replace cover glass when broken, pitted, or spattered.

Medical first aid and eye treatment. First aid facilities and a qualified first aid person should be available for each shift unless medical facilities are close by for immediate treatment of flash burns of the eyes and skin burns.

Wear protective clothing - leather (or asbestos) gauntlet gloves, hat, and high safety-toe shoes. Button shirt collar and pocket flaps, and wear cuffless trousers to avoid entry of sparks and slag.

Avoid oily or greasy clothing. A spark may ignite them.

Flammable hair preparations should not be used by persons intending to weld or cut.

Hot metal such as electrode stubs and work pieces should never be handled without gloves.

Ear plugs should be worn when working on overhead or in a confined space. A hard hat should be worn when others work overhead.

B. Toxic Fume Prevention

WARNING: The use of this product may result in exposure to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Adequate ventilation. Severe discomfort, illness or death can result from fumes, vapors, heat, or oxygen enrichment or depletion that welding (or cutting) may produce. Prevent them with adequate ventilation. NEVER ventilate with oxygen.

Lead-, cadmium-, zinc-, mercury-, beryllium-bearing and similar materials, when welded or cut, may produce harmful concentrations of toxic fumes. Adequate local exhaust ventilation must be used, or each person in the area, as well as the operator, must wear an air-supplied respirator. For beryllium, both must be used.

Metals coated with or containing materials that emit toxic fumes should not be heated unless coating is removed from the work surface, the area is well ventilated, or the operator wears an air-supplied respirator.

Work in a confined space only while it is being ventilated and, if necessary, while wearing an air-supplied respirator.

Gas leaks in a confined space should be avoided. Leaked gas in large quantities can change oxygen concentration dangerously. Do not bring gas cylinders into a confined space.

Leaving confined space, shut OFF gas supply at source to prevent possible accumulation of gases in the space if downstream valves have been accidentally opened or left open. Check to be sure that the space is safe before reentering it.

Vapors from chlorinated solvents can be decomposed by the heat of the arc (or flame) to form PHOSGENE, a highly toxic gas, and other lung and eye irritating products. The ultraviolet (radiant) energy of the arc can also decompose trichloroethylene and perchloroethylene vapors to form phosgene. DO NOT WELD or cut where solvent vapors can be drawn into the welding or cutting atmosphere or where the radiant energy can penetrate to atmospheres containing even minute amounts of trichloroethylene or perchloroethylene.

C. Fire and Explosion Prevention

Causes of fire and explosion are: combustibles reached by the arc, flame, flying sparks, hot slag, or heated material, misuse of compressed gases and cylinders, and short circuits.

BE AWARE THAT flying sparks or falling slag can pass through cracks, along pipes, through windows or doors, and through wall or floor openings, out of sight of the goggled operator. Sparks can fly many feet.

To prevent fires and explosion:

Keep equipment clean and operable, free of oil, grease, and (in electrical parts) of metallic particles that can cause short circuits.

If combustibles are in area, do NOT weld or cut. Move the work if practicable, to an area free of combustibles. Avoid paint spray rooms, dip tanks, storage areas, ventilators. If the work cannot be moved, move combustibles at least 35 feet away, out of reach of sparks and heat; or protect against ignition with suitable and snug-fitting, fire-resistant covers or shields.

Walls touching combustibles on opposite sides should not be welded on (or cut). Walls, ceilings, and floor near work should be protected by heat-resistant covers or shields.

Fire watcher must be standing by with suitable fire extinguishing equipment during and for some time after welding or cutting if:

1. Appreciable combustibles (including building construction) are within 35 feet.
2. Appreciable combustibles are further than 35 feet, but can be ignited by sparks.
3. Openings (concealed or visible) in floors or walls within 35 feet may expose combustibles to sparks.
4. Combustibles adjacent to walls, ceilings, roofs, or metal partitions can be ignited by radiant or conducted heat.

Hot work permit should be obtained before operation to ensure supervisor's approval that adequate precautions have been taken.

After work is done, check that area is free of sparks, glowing embers, and flames.

An empty container that held combustibles, or that can produce flammable or toxic vapors when heated, must never be welded on or cut, unless container has first been cleaned in accordance with industry standards.

This includes: a thorough steam or caustic cleaning (or a solvent of water washing, depending on the combustible's solubility), followed by purging and inerting with nitrogen or carbon dioxide, and using protective equipment.

Water-filling just below working level may substitute for inerting.

A container with unknown contents should be cleaned (see paragraph above). Do NOT depend on sense of smell or sight to determine if it is safe to weld or cut.

Hollow castings or containers must be vented before welding or cutting. They can explode.

Explosive atmospheres. NEVER weld or cut where the air may contain flammable dust, gas, or liquid vapors (such as gasoline).

D. Compressed Gas Equipment

The safe handling of compressed gas equipment is detailed in numerous industry publications. The following general rules cover many of the most common situations.

1. Pressure Regulators

Regulator relief valve is designed to protect only the regulator from overpressure; it is not intended to protect any downstream equipment. Provide such protection with one or more relief devices.

Never connect a regulator to a cylinder containing gas other than that for which the regulator was designed.

Remove faulty regulator from service immediately for repair (first close cylinder valve). The following symptoms indicate a faulty regulator:

Leaks - if gas leaks externally.

Excessive Creep - if delivery pressure continues to rise with downstream valve closed.

Faulty Gauge - if gauge pointer does not move off stop pin when pressurized, nor returns to stop pin after pressure release.

Repair. Do NOT attempt repair. Send faulty regulators for repair to manufacturer's designated repair center, where special techniques and tools are used by trained personnel.

2. Cylinders

Cylinders must be handled carefully to prevent leaks and damage to their walls, valves, or safety devices:

Avoid electrical circuit contact with cylinders including third rails, electrical wires, or welding circuits. They can produce short circuit arcs that may lead to a serious accident. (See 1-3C)

ICC or DOT marking must be on each cylinder. It is an assurance of safety when the cylinder is properly handled.

Identifying gas content. Use only cylinders with name of gas marked on them; do not rely on color to identify

gas content. Notify supplier if unmarked. NEVER DEFACE or alter name, number, or other markings on a cylinder. It is illegal and hazardous.

Empties: Keep valves closed, replace caps securely; mark MT; keep them separate from FULLS, and return promptly.

Prohibited use. Never use a cylinder or its contents for other than its intended use, NEVER as a support or roller.

Locate or secure cylinders so they cannot be knocked over.

Passageways and work areas. Keep cylinders clear of areas where they may be stuck.

Transporting cylinders. With a crane, use a secure support such as a platform or cradle. Do NOT lift cylinders off the ground by their valves or caps, or by chains, slings, or magnets.

Do NOT expose cylinders to excessive heat, sparks, slag, and flame, etc. that may cause rupture. Do not allow contents to exceed 55° C (130° F.) Cool with water spray where such exposure exists.

Protect cylinders, particularly valves from bumps, falls, falling objects, and weather. Replace caps securely when moving cylinders.

Stuck valve. Do NOT use a hammer or wrench to open a cylinder valve that cannot be opened by hand. Notify your supplier.

Mixing gases. NEVER try to mix any gases in a cylinder.

NEVER refill any cylinder.

Cylinder fittings should never be modified or exchanged.

3. Hose

Prohibited use. Never use hose other than that designed for the specified gas. A general hose identification rule is: red for fuel gas, green for oxygen, and black for inert gases.

Use ferrules or clamps designed for the hose (not ordinary wire or other substitute) as a binding to connect hoses to fittings.

No copper tubing splices. Use only standard brass fittings to splice hose.

Avoid long runs to prevent kinks and abuse. Suspend hose off ground to keep it from being run over, stepped on, or otherwise damaged.

Coil excess hose to prevent kinks and tangles.

Protect hose from damage by sharp edges, and by sparks, slag, and open flame.

Examine hose regularly for leaks, wear, and loose connections. Immerse pressured hose in water; bubbles indicate leaks

Repair leaky or worn hose by cutting area out and splicing. Do NOT use tape.

4. Proper Connections

Clean cylinder valve outlet of impurities that may clog orifices and damage seats before connecting regulator. Except for hydrogen, crack valve momentarily, pointing outlet away from people and sources of ignition.

Wipe with a clean, lintless cloth.

Match regulator to cylinder. Before connecting, check that the regulator label and cylinder marking agree, and that the regulator inlet and cylinder outlet match. NEVER Connect a regulator designed for a particular gas or gases to a cylinder containing any other gas.

Tighten connections. When assembling threaded connections, clean and smooth seats where necessary. Tighten. If connection leaks, disassemble, clean, and retighten, using properly fitting wrench.

Adapters. Use a CGA adapter (available from your supplier) between cylinder and regulator, if one is required. Use two wrenches to tighten adapter marked RIGHT and LEFT HAND threads.

Regulator outlet (or hose) connections may be identified by right hand threads for oxygen and left hand threads (with grooved hex on nut or shank) for fuel gas.

5. Pressurizing Steps:

Drain regulator of residual gas through suitable vent before opening cylinder (or manifold valve) by turning adjusting screw in (clockwise). Draining prevents excessive compression heat at high pressure seat by allowing seat to open on pressurization. Leave adjusting screw engaged slightly on single-stage regulators.

Stand to side of regulator while opening cylinder valve.

Open cylinder valve slowly so that regulator pressure increases slowly. When gauge is pressurized (gauge reaches regulator maximum) leave cylinder valve in following position: for oxygen and inert gases, open fully to seal stem against possible leak; for fuel gas, open to less than one turn to permit quick emergency shut-off.

Use pressure charts (available from your supplier) for safe and efficient recommended pressure settings on regulators.

Check for leaks on first pressurization and regularly thereafter. Brush with soap solution. Bubbles indicate leaks. Clean off soapy water after test; dried soap is combustible.

E. User Responsibilities

Follow all Safety Rules.

Remove leaky or defective equipment from service immediately for repair. Read and follow user manual instructions.

F. Leaving Equipment Unattended

Close gas supply at source and drain gas.

G. Rope Staging-Support

Rope staging-support should not be used for welding or cutting operation; rope may burn.

1-3 ARC WELDING

Comply with precautions in 1-1, 1-2,

and this section. Arc Welding, properly done, is a safe process, but a careless operator invites trouble. The equipment carries high currents at significant voltages. The arc is very bright and hot. Sparks fly, fumes rise, ultraviolet and infrared energy radiates, weldments are hot, and compressed gases may be used. The wise operator avoids unnecessary risks and protects himself and others from accidents.

A. Burn Protection

Comply with precautions in 1-2.

The welding arc is intense and visibly bright. Its radiation can damage eyes, penetrate lightweight clothing, reflect from light-colored surfaces, and burn the skin and eyes. Skin burns resemble acute sunburn; those from gas-shielded arcs are more severe and painful. **DON'T GET BURNED; COMPLY WITH PRECAUTIONS.**

1. Protective Clothing

Wear long-sleeve clothing in addition to gloves, hat, and shoes. As necessary, use additional protective clothing such as leather jacket or sleeves, flameproof apron, and fire-resistant leggings. Avoid outer garments of untreated cotton.

Bare skin protection. Wear dark, substantial clothing. Button collar to protect chest and neck, and button pockets to prevent entry of sparks.

2. Eye and Head Protection

Protect eyes from exposure to arc. Eyes may be damaged by radiant energy when exposed to the electric arc, even when not looking in the direction of the arc. Never look at an electric arc without protection.

Welding helmet or shield containing a filter plate shade no. 12 or denser must be used when welding. Place over face before striking arc.

Protect filter plate with a clear cover plate.

Cracked or broken helmet or shield should NOT be worn; radiation can be passed through to cause burns.

Cracked, broken, or loose filter plates must be replaced IMMEDIATELY. Replace clear cover plate when broken, pitted, or spattered.

Flash goggles with side shields MUST be worn under the helmet to give some protection to the eyes should the helmet not be lowered over the face before an arc is struck. Looking at an arc momentarily with unprotected eyes (particularly a high intensity gas-shielded arc) can cause a retinal burn that may leave a permanent dark area in the field of vision.

3. Protection of Nearby Personnel

Enclose the welding area. For production welding, a separate room or enclosed bay is best. In open areas, surround the operation with low-reflective, noncombustible screens or panels. Allow for free air circulation, particularly at

floor level.

Viewing the weld. Provide face shields for all persons who will be looking directly at the weld.

Others working in area. See that all persons are wearing flash goggles.

Before starting to weld, make sure that screen flaps or bay doors are closed.

B. Toxic Fume Prevention

Comply with precautions in 1-2B.

Generator engine exhaust must be vented to the outside air. Carbon monoxide can kill.

C. Fire and Explosion Prevention

Comply with precautions in 1-2C.

Equipment's rated capacity. Do not overload arc welding equipment. It may overheat cables and cause a fire.

Loose cable connections may overheat or flash and cause a fire.

Never strike an arc on a cylinder or other pressure vessel. It creates a brittle area that can cause a violent rupture or lead to such a rupture later under rough handling.

D. Compressed Gas Equipment

Comply with precautions in 1-2D.

E. Shock Prevention

Exposed electrically hot conductors or other bare metal in the welding circuit, or in ungrounded, electrically-HOT

equipment can fatally shock a person whose body becomes a conductor. **DO NOT STAND, SIT, LIE, LEAN ON, OR TOUCH** a wet surface when welding without suitable protection.

To protect against shock:

Keep body and clothing dry. Never work in damp area without adequate insulation against electrical shock. Stay on a dry duckboard, or rubber mat when dampness or sweat cannot be avoided. Sweat, sea water, or moisture between body and an electrically HOT part - or grounded metal - reduces the body surface electrical resistance, enabling dangerous and possibly lethal currents to flow through the body.

1. Grounding the Equipment

When installing, connect the frames of each unit such as welding power source, control, work table, and water circulator to the building ground. Conductors must be adequate to carry ground currents safely. Equipment made electrically HOT by stray currents may shock, possibly fatally. **DO NOT GROUND** to electrical conduit, or to a pipe carrying ANY gas or a flammable liquid such as oil or fuel.

Three-phase connection. Check phase requirement of equipment before installing. If only three-phase power is available, connect single-phase equipment to only two wires of the three-phase line. **DO NOT** connect the equipment ground lead to the third (live) wire, or the equipment will become electrically HOT - a dangerous condition that can shock, possibly fatally.

Before welding, check ground for continuity.

Be sure conductors are touching bare metal of equipment frames at connections.

If a line cord with a ground lead is provided with the equipment for connection to a switch box, connect the ground lead to the grounded switch box. If a three-prong plug is added for connection to a grounded mating receptacle, the ground lead must be connected to the ground prong only. If the line cord comes with a three-prong plug, connect to a grounded mating receptacle. Never remove the ground prong from a plug, or use a plug with a broken ground prong.

2. Connectors

Fully insulated lock-type connectors should be used to join welding cable lengths.

3. Cables

Frequently inspect cables for wear, cracks, and damage. **IMMEDIATELY REPLACE** those with excessively worn or damaged insulation to avoid possibly lethal shock from bared cable. Cables with damaged areas may be taped to give resistance equivalent to original cable.

Keep cable dry, free of oil and grease, and protected from hot metal and sparks.

4. Terminals and Other Exposed Parts

Terminals and other exposed parts of electrical units should have insulating covers secured before operation.

5. Electrode Wire

Electrode wire becomes electrically HOT when the power switch of gas metal-arc welding equipment is ON and welding gun trigger is pressed. Keep hands and body clear of wire and other HOT parts.

6. Safety Devices

Safety devices such as interlocks and circuit breakers should not be disconnected or shunted out.

Before installation, inspection, or service of equipment, shut OFF all power, and remove line fuses (or lock or red-tag switches) to prevent accidental turning ON of power. Disconnect all cables from welding power source, and pull all 115 volts line-cord plugs.

Do not open power circuit or change polarity while welding. If, in an emergency, it must be disconnected, guard against shock burns or flash from switch arcing.

Leaving equipment unattended. Always shut OFF, and disconnect all power to equipment.

Power disconnect switch must be available near the welding power source.

Please Examine Carton and Equipment For Damage Immediately

When this equipment is shipped, title passes to the purchaser upon receipt by the carrier. Consequently, claims for material damaged in shipment must be made by the purchaser against the transportation company at the time the shipment is received.

Please record your equipment identification information below for future reference. This information can be found on your machine nameplate.

Model Name & Number: _____

Code & Serial Number: _____

Date of Purchase: _____

Whenever you request replacement parts for r information on this equipment, always supply the information you have recorded above.

Read this Owner's Manual completely before attempting to use this equipment. Save this manual and keep it handy for quick reference. Pay particular attention to the safety instructions we have provided for your protection.

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Section A

Installation

1. Technical Specifications

Electrical Characteristics:

Line Power:	120 VAC ($\pm 10\%$), 50/60 Hz 208/240 VAC ($\pm 10\%$), single phase, 50/60 Hz. 208/240 VAC ($\pm 10\%$), three phase, 50/60 Hz.
Output Current:	1 to 200 amps ($\pm 0.5\%$), constant or pulsed.
Pulse Rate:	0.01 to 9.99 seconds per pulse.
Arc Voltage:	80VDC open circuit, up to 20VDC during welding
Loop Response:	3KHz
Current Regulator Frequency:	18KHz
Motor Control:	24V, 2 amp maximum, DC tachometer feedback or back EMF (optional).

Mechanical Characteristics:

Width:	16.75 inches
Height:	14.75 inches
Depth:	27.5 inches
Weight:	110 lbs. (ACL only)
Shipping Weight:	350 lbs. (includes ACL, monitor, printer, keyboard, power cable and Customer Start-Up Kit; palletized)

Computer Control System:

Microcomputer Architecture:	Proprietary embedded multi-tasking operating system using Intel 80486 CPU.
Computer Memory:	4MB RAM. Up to 1MB of nonvolatile flash memory for weld program. Up to 1MB static RAM for weld procedure storage. 3.5", 1.44MB floppy diskette for procedure backup, transfer of real time logging data and program upgrades.
Program storage:	1000 weld procedures (1K average size) in 1MB static RAM.
Main Frame Networking:	RS232 serial interface port.

Software Options:

PC Development	Software for use on personal computers to develop weld procedures and perform file management of procedure library for later use on ACL.
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2. Machine Grounding

The ACL is grounded through the input power cord. Consult local and national electrical codes for proper grounding methods.

3. Machine Location

The ACL should be placed in a location where it can be protected from damage. Lead lengths and accessibility must also be considered when installing the ACL. The rear of the ACL must be a minimum of three inches so that clean cooling air can circulate through the machine. Dirt, dust, or any foreign material that can be drawn into the welder should be kept at a minimum.

Section A (Cont.)

Keep the ACL in a dry, sheltered area, since a wet environment is a possible safety hazard and may cause improper operation.

4. Input Power Connections

The Input Power Cord has a standard 120 VAC power plug on one end and a 37-pin Amphenol connector on the other end.

The Input Power Cord is wired for the voltage and phase which was specified when the ACL was ordered.

If a different value input power voltage is required after the initial setup, a different power cord will have to be ordered (Reference Section C - Accessories.) The wiring of the power cord determines the input power and phase.

Section B

Operation

1. Power Source Startup

This section describes the different sequence of screens at startup for the ACL. When the power is turned on, a short series of automatic self-tests take place. These tests are necessary to ensure that the ACL, which includes the computer, keyboard, HHC (Hand Held Control), interface connections, and the program are all compatible and in proper working order.

During this start-up sequence, the system checks for any failures. If there are any failures of any component or programs, they will be reported on the monitor and the HHC. If all the tests pass, without a failure found or reported, the system will continue on to the next step of the program.

The ACL system start-up sequence goes through the following steps:

- 1.1 Power Up - when power is applied to the system.
- 1.2 Self-Check - series of self-checks verifies readiness.
- 1.3 Logo Screen - displays logo for MK Products, Inc.
- 1.4 Identification - displays model/serial numbers and software revision.

1.1 Power-Up

The start-up and shutdown procedures are the same for the Teach and the Production Modes. Before attempting to power up the ACL, the operator should become thoroughly familiar with this section of this manual. Follow this procedure to assure power-up and self-diagnostic sequences occur:

Prior to connecting to AC input power; plug the factory supplied power cord into the rear panel receptacle of the ACL (making sure the keying lines line up for both plug and receptacle).

DO NOT USE FORCE TO INSERT PLUG.

If it doesn't slide in easily - it probably isn't aligned properly.

Turn the tightening ring on the plug to lock in place.

Plug the ACL power cord into the appropriate AC power outlet.

WARNING

Be sure the AC voltage matches the voltage shown on the factory supplied power cord. Using a power cord on the wrong voltage may cause serious damage to the unit, as well as exposing the operator to potential electrical injury.

Connect the weldhead cables to the rear of the ACL.

Connect the factory-supplied gas regulator to an inert gas source. Connect the shield gas input gas line coming from the gas regulator to the gas connector at the rear panel of the ACL. The factory-supplied regulator is preset, regardless of the input, to insure proper output flow and pressure.

Section B (Cont.)

Power-up the ACL by turning the POWER ON/OFF rocker switch to ON. The following power-up messages appear on the monitor.

1.2 Self Check

Once the system has completed the power-up diagnostics, it then performs a program self test. The purpose of this is to ensure that the welding system is functional before proceeding on with the welding. If there are any failures detected by the ACL, the monitor and the HHC will display the fault and error messages warning the operator of the pending and potential problems.

1.3 Logo Screen

The ACL self-test sequence is completed when the MK Products logo appears on the monitor. This screen will remain for approximately 5 seconds; it can be paged to the next screen by pressing any key on the keyboard or on the HHC.

After pressing any key or letting the screen time out, the ACL will go into the self-identification sequence.

1.4 Identification

In the self-identification sequence the ACL displays its identification information, on both the monitor and the HHC. This information is similar for each and every ACL; it shows the name of the company and the welding system, the model and serial numbers, software program revision, and phone numbers for service and assistance.

At the bottom of this screen are the words "Hit Any Key". This is a prompt for the operator to touch any key on the keyboard or on the HHC, to page to the next screen and the next sequence. After pressing any key or letting the screen time out, the ACL will go to the MAIN MENU screen.

2. Main Menu Operations

This section will explain how to view the library of procedures, select a saved procedure, weld with that procedure, modify and override during welding and setting deviation and abort limits on the welding parameters.

There are two welding modes in the ACL unit: Production and Teach. Both of these are obtainable by turning the key switch on the front panel of the ACL. The Teach Mode (key switch in vertical position) is used primarily for weld procedure development and editing, whereas the Production Mode (key switch in horizontal position) is used for welding. The key switch is a method of "locking" the operator into the Teach Mode, so that he does not inadvertently modify, erase or copy.

While in the Teach Mode, all options on the MAIN MENU are available, unless deemed disabled when highlighted in red. In Production Mode, only those options needed by the operator are available. All the development and modifying types of options are now out of the operators' control, and he is responsible only for choosing the correct procedure and pressing the [START] button.

Unless otherwise stated, all operations discussed in this manual are from the standpoint of being in the Teach Mode, since this is where all the developing, editing, saving, erasing and copying of procedures occurs.

2.1 Selecting Weld Procedures

Once the ACL unit has completed its Power Up, Self Check, Logo Screen, and Identification, the next visible screen is the MAIN MENU. From here, the operator has a variety of options to choose from: anything from welding, printing, erasing, saving, and even setting the time and date in the ACL computer.

To view the library and select a procedure, from the MAIN MENU, press [2 Select Saved Procedure]. This will show the titles of any and all weld

Section B (Cont.)

procedures present in the library. Along with the title, or name of the procedure, in the highlighted cursor box at the top or in the middle of the screen, its description will appear across the bottom of the screen.

Using the cursor buttons on the HHC [PAGE UP], [PAGE DOWN], [↑SYMBOLS], [CASE↓], [←], and [→], or the arrow keys on the computer keyboard [←, →, ↑, ↓], the operator can move the highlighted cursor box to the weld procedure he requires.

Once the cursor box is on the procedure of choice press [ENTER], either on the HHC or the keyboard, to accept this procedure.

The screen will now revert back to the MAIN MENU with the chosen weld procedure ready for welding or modifying. Options [1 Weld with Procedure ———] and [5 Modify Procedure ———], now have the name of the procedure where once the blank lines were.

2.2 Setting Default Procedures

The ACL has a software feature that will allow the most common weld procedure used, to be set as the default procedure. The default procedure is the one most used when other procedures are cycled through the ACL in a given days work.

To set the default procedure, choose the weld procedure from the library as described in **SELECTING WELD PROCEDURES** above, then press [3 Select Default Procedure ———]. This will allow the operator to enter the chosen procedure as the 'Default Procedure'.

Should a different procedure be needed during the day, and not selected to be the 'Default Procedure', option [3 Select Default Procedure ———] will still show the previously chosen procedure. To retrieve the 'Default Procedure' for welding, press [3 Select Default Procedure ———], then press [ENTER]. This will automatically move the chosen 'Default Procedure' to the [1 Weld with Procedure ———] option.

2.3 Welding and Testing Weld Procedures

Once a weld procedure has been loaded into the [1 Weld with Procedure ———] option, the operator may now choose this option and begin welding, or testing.

Depending on the enabled options of the weld procedure (see **MODIFYING WELD PROCEDURES**), the ACL will ask for some data entry: Name & Headings, Serial Numbering and Serialization.

2.3.1 Name & Two Headings

These three data lines can be used for the operators' name or identification number, any information that describes that particular weld and/or application, or the operator may press [ENTER] three times to accept blank lines.

All this extra information can be used to identify the operator and a series of welds to be performed.

2.3.2 Serial Numbers

Press [ENTER] to accept the value shown. This option is used for serializing each individual weld with its own unique number; even test welds can be serialized. Any number, up to four digits, can be entered and used as the Serial Number.

2.3.3 Sequential Serialization

Once the Serial Number is entered, the ACL will ask if the operator would like the serial numbers to become sequential. If [ENTER] or [NO] is pressed, then each weld or test weld, will have the same Serial Number. If [YES] is pressed, this will cause the serial number to be automatically incremented by one after each weld or test weld.

Section B (Cont.)

Regardless, if a series or the same serial number or if ten different serial numbers are programmed, each will be displayed on the screen for Performance Logging and on printouts for Deviation Reports.

The information above will not become an integral part of the procedure, since it will not be saved when the procedure is saved.

This information will repeat for each and every procedure loaded that has similar enabled options or, until the operator changes the data on these lines.

Even though the information is not saved with the procedure, it is however printed on the Deviation Report and Saved to diskette as the current Weld Log.

After all the data has been entered, the next screen will be the Weld Screen. Once at the weld screen, the operator is ready to start welding.

2.3.4 Modes

On the front panel of the ACL, next to the key switch, is a green lighted-push button switch. The label for this switch is Weld (button in) and Test (button out). The operation of this push button switch does not change whether in Production or Teach Mode.

When pushed in (green light on), the Weld Mode is enabled. This will allow welding to occur during the operation of the procedure.

When pushed out (green light off), the Test Mode is enabled. In the Test Mode, the entire weld procedure can be operated **without** welding occurring.

In the top-middle of the Weld Screen, either a "W" or a "T" will appear, depending which mode (Weld or Test) is selected.

2.4 Start Weld

A Weld and a Test Weld operate in the same manner except that in the Test Mode the welding arc is not initiated. Otherwise, the Test sequence performs in the same way as a weld sequence including weldhead rotation, system timing and display.

Once at the weld screen, the operator may press [START] either on the HHC or at the weldhead control. This will start the procedure:

The first part of the weld program is the gas Pre-Purge. At this point the gas solenoid will turn on and gas will begin to flow.

If the Home Pre-Weld option is enabled, the rotor will complete two revolutions at the higher Calibration Speed (see **MOTOR CALIBRATION**), and then stop at home, prior to starting the Pre-Purge. This is done to update the calibration of the motor. If the rotor was already at the home position, it will back up slightly then begin its two revolutions.

If a Flying Start time value is given for the procedure, it will start during the Pre-Purge time and end at the same time (see Flying Start).

At the end of the Pre-Purge time, the arc will initiate. At the bottom of the monitor screen, the Voltage Bar Graph will show a bright yellow bar all the way across the graph (this is the high voltage needed to start the arc). The amount of current used in establishing the arc is set by Strike Current parameter in the Pre-Purge Information Section.

Once the arc voltage and current feedback sense that the arc has been initiated and is established, the weld procedure will start Level 1 (Up-slope).

In this Level current and rotor speed will initiate and start the welding arc, commence rotation of the rotor and take the procedure to its programmed welding parameters.

The actual welding portion of the procedure takes place between the last

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half of the Up-slope level and the Final Slope level. This is called the Welding Sequence.

As the weld progresses through the weld levels, the screen shows the parameter values for the current welding level, including; time left and/or degrees left in the level, degrees left in the full rotation of the tungsten around the part, the pulsing current, the resultant pulsing voltage, and the motor speed value all of which show on their respective bar graphs.

Once the welding sequence is complete, the program will finish in the Final Slope level.

This level will tail out and taper the weld so that there is no cratering effect left at the end of the weld, once the arc is extinguished.

Typically, when designing a procedure using APG, the Final Slope current will slope down while the motor will slope up.

The gas Post-Purge will start immediately after the arc is extinguished at the end of the Final Slope. It will stay on for as long as programmed.

At the end of the Post-Purge time, the rotor will then rotate in the normal direction until it reaches home position. This will only occur if the Post-Weld Home option is enabled for the procedure. When designing a procedure from APG, this option is enabled by default.

To keep extra gas flowing, the ACL program is designed to keep gas flowing until the rotor reaches home position. If the Post-Weld Home option is not enabled, then the gas will stop flowing at the end of the time period.

2.5 Deviation Screen, Report & Log

Once the weld finishes, the rotor returns to home position and the gas has stopped flowing, the weld log will appear on the screen; and if enabled it will also print and/or save to diskette.

This weld log contains all needed information concerning the status of the completed weld. When used in conjunction with the Data Monitoring option (see **MODIFYING WELD PROCEDURES**) this log will produce a report on the screen showing all the deviations that occurred during the entire Weld, or Test operation.

A weld log will appear on the screen after each and every weld. A printout of the weld log, a Deviation Report will generate only if either the Print All Logs or Print On Error options are enabled.

The weld log consists of several items of pertinent information: Procedure Name and Description; Name & Two Headings; Applied Current and/or Motor Scaling; Weld Serial Number; Total Number and Type of Deviations Detected; Procedure and Abort Limit Values (if programmed).

The number of deviations may be large or small, depending on the type of deviation detected. Both the screen and the printout will show the first fifteen deviations, and the absolute last one.

If an Abort Limit caused the last deviation, the top of the deviation report would show that the weld was aborted. The last deviation, if it greater than the sixteenth, would show exactly what type of deviation occurred to abort the weld.

Each procedure can be modified to not only print, but also save the weld log at the completion of the weld.

In order to save each and every weld log, or just the weld log of those that had deviations, at the options screen for the procedure enable either of the two Save Log functions.

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Saving a weld log requires the operator to insert an already formatted diskette (1.44MB) into the floppy disk drive.

When the weld finishes, and during the time the weld log appears on the screen, the information will also be transferred to the diskette.

During this transfer, you will notice, at the bottom of the weld log screen a prompt informing of the drive reading the diskette and storing the information of the weld log:

* Updating Disk *

If there is no diskette in the drive, the drive will continue to spin, in order to save the log, at which time the following prompt will appear:

* DISK: Time-out *

- Hit Any Key -

At this point, if saving the information is still required, revert to the LOG MENU and save the current weld log from there (see **LOG MENU OPERATIONS**). If it is not required to save this weld log, the operator may start another weld, at which point the current weld log will be erased in order to make room for the next weld log.

2.6 Auto-Procedure Generation (APG)

The Auto-Procedure Generation (APG) option enables the operator to utilize the ACL to generate a weld procedure from a description of the weld to be performed. This weld procedure, which is usually very close to the ideal procedure, may then be adjusted and/or modified to obtain optimum welding performance.

Prior to using this option, determine whether the procedure is to be designed using either Standard (SAE) or Metric (SI) Units. The Auto-Procedure Generation Information Screen is the only screen that utilizes either units of measure. While the parameters and resultant procedure variables are ultimately the same, it is the description that varies with the units selected.

The only method in which to select between SAE and SI Units is to use the keyboard. The Metric Units are not obtainable using the HHC.

While at the MAIN MENU, press [Alt + U]. When pressed, this will list the word "METRIC" across the top of the MAIN MENU panel. Thus, when the APG option is selected, the units of measure will be in mm. Otherwise, there is no indication when using SAE units for APG.

The APG option, which is available by pressing [4 Auto-Procedure Generation] from the MAIN MENU, is enabled only in the Teach Mode. If a weld procedure is already loaded, the next question asks if that procedure should be discarded. The next two questions on the ACL have to do with the structure of the procedure to be generated: the first asks if the current is to be sloped and the second asks if it's to be a procedure based on degrees.

2.6.1 Sloping Current

A sloping current procedure is designed to allow for heat input, starting from the beginning of the weld and going to the last level before the final slope.

If a sloping current procedure is chosen, the ACL computer will automatically calculate how much heat is needed at the beginning and end of the weld. It will then assign decreasing current values for all levels of the procedure as well as a current slope for each level, meaning that each level has a different starting and ending current.

Without current sloping, the ACL will assign one constant set of current values for the entire procedure, except for the final slope.

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2.6.2 Degree Procedure

A degree procedure is one based on a circumference of degrees and not inches or millimeters. Each level is exactly a certain number of degrees and not a certain number of seconds. Similarly, each level is programmed to end at a set degree and not when time runs out.

If a degree procedure is chosen, certain conventions must be remembered when modifying and developing; such as motor speed scaling versus rotational travel and level jumping versus level termination (see **MODIFYING WELD PROCEDURES**).

Declining a degree procedure will default the APG to make a standard time based procedure.

The next screen is the Auto-Procedure Generation Information screen. It is at this screen that all pertinent variables are inputted and used for weld procedure generation. In order, from top to bottom they are, Tube O.D. (up to 5.5"), Wall Thickness (up to 0.200"), Number of Tacks (up to 8), Number of Levels (up to 90), and Travel Speed (ipm - maximum based on tube diameter).

2.6.3 Tube O.D.

This maximum is based on the largest sized weldhead available. The ACL unit does not need to know the size of the weldhead it welds uses; it uses a correlation between tube diameter and travel speed (ipm) to calculate a rotational speed (rpm) of the tungsten.

2.6.4 Wall Thickness

The maximum output of the ACL Welding Power Supply is 200 amps; the ACL is programmed to give one-amp for every one-thousands material thickness. For these reasons, the maximum wall thickness input possible is two hundred thousands.

2.6.5 Tacks

When this option is utilized, the ACL program will generate a current value and a length of time for each tack, which is in relation to the tube diameter and wall thickness. For thicker materials, longer and hotter tacks while thinner materials get a shorter and colder tack.

All tacks programmed from this auto tacking function, will occur at opposing intervals around the tube. These tacks are not programmed into the procedure as levels, but exist as opposing intervals of degrees, occurring after the Pre-Purge and prior to initial arc strike.

2.6.6 Levels

Whether designing a regular procedure or a degree procedure, the circumference of the tube will be evenly cut into slices that correlate to the number of levels chosen, excluding the Up Slope and Final Slope levels.

2.6.7 Travel Speed

This is the only screen in which you will see the travel speed with a value of inches-per-minute (ipm). All other travel speed values in this program use rpm. The travel speed in rpm is derived by dividing the travel speed in ipm, by the circumference (which is calculated from the tube diameter).

When all the values for the weld procedure have been entered, the program will return to the MAIN MENU. Options [1 Weld With Procedure *TRIAL*] and [5 Modify Procedure *TRIAL*] will contain the name "*TRIAL*" where the once empty blanks were.

Since this procedure has just been made, the program gives it the name *TRIAL*. At this point the operator may choose to save this procedure with a valid name, using option [6 Save Modified Procedure], or continue with modification, editing, testing and/or welding and save at a later time in the program.

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2.7 Saving Weld Procedures

Once a weld procedure has been designed, tested welded and modified to exact standards as required by either the Welding Engineer, the Operator and/or the Customer and his specification, it is generally a good idea to save the procedure for future use.

2.7.1 Saving to Library

The first step in saving a procedure is to name it. At the MAIN MENU, use option [6 Save Modified Procedure]. This will highlight the seven character spaces in which to name the procedure. The procedure name can be one character or seven characters long.

Both numbers and letters (only upper case) can be used to name the procedure. **DO NOT USE SYMBOLS.**

Enter the desired name for the procedure, then press [ENTER]. Once entered, the procedure name in option [1 Weld with Procedure *TRIAL*] will change and show the new procedure name in place of the name “*TRIAL*”.

If the procedure to be saved is given a name of an already existing procedure, when [ENTER] is pressed the program will notify the operator. At the bottom of the MAIN MENU screen, the prompt will show the description of the existing procedure with this statement below:

_____ Used -

Replace It?

Answering [YES] will override the existing procedure with the new procedure.

2.7.2 Saving to Disk

When saving procedures to diskette, save a procedure as described above then use option [T Copy Procedure To Disk]. This will command the drive to spin and attempt to save the selected procedure to a diskette. Be certain to have a formatted diskette in the drive prior to performing this operation.

When saving a procedure to a diskette for the first time, using this option will command the drive to spin with this prompt below:

Reading disk...

Once this prompt disappears, the procedure has been successfully saved to a diskette.

If attempting to save a procedure to a diskette under a name that already exists, the following prompt will appear:

* DISK: _____

OK to Overwrite?

Answering [YES] will override the existing procedure with the new procedure.

2.8 Erasing Weld Procedures

When a weld procedure is no longer used and necessitates being erased, use option [7 Erase Saved Procedures]. This option will erase any and all the procedures currently saved in either the library or on the diskette.

Erasing from Library

When this option is selected, the name of the procedure that is loaded will be highlighted at the end of this line.

Press [ENTER] to erase this particular procedure. Or, if the name of the procedure is known, type it in followed by pressing [ENTER]. If the name is not known, return to the Library thru option [2 Select Saved Procedure], and select the procedure to be erased.

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When [ENTER] is pressed, a description of the procedure will appear at the bottom of the MAIN MENU screen, followed by this prompt:

OK to Erase?

Answering [YES] will erase the procedure and leave a procedure called *TRIAL*.

2.8.1 Erasing From Disk

In order to erase procedures that are saved on a diskette, use option [E Erase Procedure on Disk]. Be certain to have a diskette in the drive prior to performing this operation.

When this option is selected, the drive will spin and read the diskette. If there are no procedures on the diskette, the following prompt appears:

* Disk: No File

- Hit Any Key -

If there are procedures on the diskette, the screen will show the "Library" of procedures that are on the diskette. Use the cursor keys to highlight the procedure to be erased, and press [ENTER].

At the bottom of the screen, just below the procedure description, this prompt will appear:

OK to Erase?

Answering [YES] will erase the procedure from the diskette and the Library. Use the cursor keys to highlight the next procedure to be erased or, [ESCAPE] to return to the MAIN MENU.

2.9 Modifying Weld Procedures

This section details the steps by which to create a new weld procedure or modify an existing procedure, save a new or modified procedure into memory, and erase a saved procedure from memory. The functions are only accessible while in the TEACH MODE.

A pre-programmed weld procedure is a sequence of welding functions performed over a synchronized time schedule or segmented degrees. With an automatic weld procedure the ACL can weld with a given current and weldhead rotor speed over a period of time, or for a given number of degrees. The ACL software will also allow the operator to program a procedure with multiple time levels or levels of a certain number of degrees.

Within these levels the current and weldhead rotor speed can be made to pulse between high and low values and to slope over a given range. Additionally, the operator can specify the homing characteristics of the rotor both before and after the weld, whether data monitoring should be performed and to what tolerances, whether a starting point should be defined, how reports are to be printed, and whether AC welding is to be performed.

Option [5 Modify Procedure ———] allows the operator to change all the parameters and variables in a weld procedure or create a new procedure altogether. When creating a new procedure, select one that is most like it, and substitute new values for those already present, or start with the basic procedure (————) and start from scratch.

When modifying a procedure, the following screens will allow modification and editing:

All references to entered values in this section will pertain to a time based weld procedure. A description of a degree based weld procedure will immediately follow this section.

2.9.1 Procedure Identification Screen

A total of four lines, sixteen characters per line, are available for weld procedure identification, instructions, or messages. Even though data is not

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required, the operator could leave these lines blank if he chooses, they are to help identify and describe each and every procedure. They will not affect the operational ability or performance function of the weld procedure, but they will show on all printouts.

Pressing [ENTER] will move the cursor box to the next line, top to bottom, accepting either a blank line or the typed information.

Should one line contain more than the sixteen characters, the text will automatically wrap and jump to the next lower line. Once all the lines are filled, or entered and accepted, pressing [ENTER] once again will change to the next screen.

2.9.2 Procedure Options Screen

This screen displays a list of enabled options that are unique to each and every procedure. The options that appear in GREEN are the currently selected options for the procedure being modified. Refer to the Option Code table on the following page.

At the bottom of this screen under the list of options, is the question "Change Options?" The operator may press either [YES] or [NO]: pressing [NO] will advance the program to the next screen, pressing [YES] will move the cursor to the top of the screen, and begin the modification of this information.

As each option is displayed it is highlighted with a question mark following. To enable that particular option press [YES], this will leave that option highlighted in green. If that option is not enabled, by pressing [NO], it will remain in RED.

Once all the applicable options have been enabled, the screen will show all enabled options highlighted, again with the question at the bottom of the screen "Change Options?".

2.9.3 Procedure Pre-Purge Information Screen

This screen is used to enter and modify the pre- and post-weld parameters for each weld procedure. These features include Pre-Purge gas time, Flying Start values (time and speed of rotation), Strike Current value, number and intensity of tacks, Start Position degree setting (only if the Start Position option is enabled in the Procedure Options screen) and Post-Purge gas time.

2.9.3.1 Pre-Purge Time

This is the amount of time that the purge gas will flow prior to starting the welding arc. Valid values are from 0.02 to 300.00 seconds.

2.9.3.2 Flying Start

Pre-Motor Run Time

This is the amount of time the rotor will rotate prior to striking the arc, also known as a "Flying Start". This time value cannot be longer than the Pre-Purge time, and the ACL program will prevent a higher value from being entered.

A positive value will cause the rotor to slope up to the Pre-Motor Speed, while a negative value will delay the rotor by the time value and then cause it to proceed at the Pre-Motor Speed. Valid values are from 0.00 to 99.00 seconds.

Pre-Motor Run Speed

This speed is what the rotor is to run at before striking the arc. It is used in conjunction with the Pre-Motor Run Time. If the Pre-Motor Run Time is zero the Pre-Motor Run Speed is not available.

Option Code

Monitor	HHC	Meaning
Home-pre-weld	HW	Prior to the start of Pre-Purge, this command rotates the rotor to the home position, if it is not already at home. This also invokes the MOTOR CAL update before the Pre-Purge of each weld.
Post-Weld-Home	WH	Prior to the start of Pre-Purge, this command rotates the rotor to the home position, if it is not already at home. This also invokes the MOTOR CAL update before the Pre-Purge of each weld.
Deg. Procedure	OP	After the Post-Purge time has expired, this command rotates the rotor back to home position. This function will not occur if the weld was aborted by a system fault detection or by operator initiation (any [STOP] switch). Pressing [FINAL SLOPE/HOME] will not affect the post-weld-home function, as this does not constitute an abnormal stop.
Repeat Weld	RW	This option allows the operator to program each level of the procedure by definite degree values, instead of a time base. ¹
Repeat Weld	RW	This feature causes the ACL to cycle to the "Ready to Weld" screen and prompt after a weld has been completed (after Post-Purge and post-weld-home) so that another weld can be started. This will only occur after a deviation-free weld, if a deviation does occur the program stops at the Deviation Report screen and forces the operator to look at the screen and physically clear the display before proceeding to the next weld. By performing this action, the operator will see what deviations have occurred and been detected by the ACL If this option is not enabled, the program will always stop at the Deviation Report screen and clear each display.
Data Monitor	DM	This enables the Data Monitoring feature of the ACL program. The Performance Monitoring feature is always activated and will always result in a weld log report. The Data Monitoring checks the actual weld data against predetermined limits for deviations whereas Performance Monitoring just checks against fault conditions. Enabling this option will allow for tolerances on the weld procedure parameters. These are available in the Procedure Limit Information Screen.
Print All Logs	PL	This causes the weld report to be printed after each and every weld or test weld sequence, whether the sequence finished normally or abnormally. When enabled, additional text lines and weld serialization will prompt prior to starting a weld. By selecting this option, the Print On Error option will not allow itself to become enabled.
Print On Error	PE	This causes the weld report to be printed only after the ACL program, Data Monitoring and Performance Logging features have detected a deviation in a weld or test weld. When enabled, additional text lines and weld serialization will prompt prior to starting a weld. This option will only highlight if Print All Logs has not been enabled.
Short Log File	SF	When used with Save All Logs or Save On Error, this option will store ACL identification, weld procedure identification, parameter information, procedure limit and abort limit deviation values. When enabled, the saved information will use the least amount of memory space on a diskette, while saving pertinent information.
Start Position	SP	This option allows the Start Position of the weld, with respect to the home position, to be specified and controlled. When the Start Position is enabled, an additional parameter will be requested as the procedure is selected and readied to start. This parameter, "Weldhead Angle?", is an additional angle added to the Start Position. ²
Save All Logs	SL	This causes the weld report to be saved on a diskette after each and every weld or test weld sequence, whether the sequence finishes normally or abnormally. When enabled additional text lines and weld serialization will prompt prior to starting a weld. By selecting this option, the Save On Error option will not allow itself to become enabled.
Save on Error	SE	This causes the weld report to be saved only after the ACL program, Data Monitoring and Performance Logging features have detected a deviation in a weld or test weld. When enabled, additional text lines and weld serialization will prompt prior to starting a weld. This option will only highlight if Save All Logs has not been enabled.
A/C Welding	AC	When used in conjunction with the Variable Polarity-Alternating Current (VPAC) unit, this option allows programming of the time intervals, for both straight and reverse polarities in milliseconds. ³

1. Degree Procedure.

2. See Start Position Procedure Pre-Purge information.

3. A/C Welding.

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2.9.3.3 Strike Current

This is the current value at which the arc will strike and initiate an arc. Valid values are from 5.0 to 25.0 amps.

2.9.3.4 Tacks

Number

This value determines how many tacks are required around the circumference of the item to be welded. Multiple tacks will occur at opposing points with the last tack opposite Home or the programmed Start Position. Valid values are from 0 to 8 tacks.

Time

This value defines the duration of each tack. Valid values are from 0.5 to 5.0 seconds. If no tacks are requested the tack time will not be available.

Current

This value defines the heat intensity of the tack. Valid values are from 1.0 amp to the maximum amp value in the procedure. If no tacks are requested the tack current will not be available.

2.9.3.5 Start Position

This value defines the position, in degrees clockwise (normal forward rotating direction of the rotor) from the Home position, that the procedure will start welding. This assumes the weldhead is held in the vertical position with the rotor opening at the top and the tungsten at about the three o'clock position.

If the welding is to start at Home, the Start Position value should be zero. If the welding is to start at the bottom of the weldhead, a value of ninety should be entered.

When Start Position is enabled, the ACL program requests an additional parameter as the [1 Weld with Procedure ——] option is selected from the MAIN MENU. This additional parameter, "Weldhead Angle", is the degree angle of the weldhead from the vertical.

When the procedure is started, following the Pre-Purge, the rotor will move to the specified Start Position plus the added Weldhead Angle value. When used with the tacking feature, the final tack will occur opposite the Start Position, the added Weldhead Angle simply adjusts for the orientation of the weldhead position

This feature is available with, and only if the Start Position option has been enabled at the Procedure Options screen.

2.9.3.6 Post-Purge Time

This is the amount of time that the purge gas will flow once the welding arc has extinguished, regardless if the procedure has fully completed or whether the operator has prematurely halted the procedure by pressing [STOP]. Valid values are from 0.02 to 300.00 seconds.

2.10 Procedure Up-Slope Information Screen

This section of the program is used to set values for Level 1 of the procedure. Level 1 of each procedure is considered the Up Slope Level; in this Level current and rotor speed will initiate and start the welding arc, commence rotation of the rotor and take the procedure to its programmed welding parameters.

When the cursor box is at the Level Number the parameters for that Level will show underneath. Changing Levels can be done in several ways: enter the number of the Level to be viewed then press [ENTER], or press [PAGE DOWN] to scroll to the next Level or [PAGE UP] to scroll to the previous Level.

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Using the cursor buttons on the HHC [PAGE UP], [PAGE DOWN], [↑SYMBOLS], [CASE↓], [←], and [→], or the arrow keys on the computer keyboard [←, →, ↑, ↓] or [ENTER] on either, the operator can move the highlighted cursor box to enter and/or modify each and every procedure parameter, such as Level Time, Current Slope and Motor Slope, as well as Pulse Times, Current and Motor Speeds for both High and Low values.

2.10.1 Level Time

This is the total length of time for the Level. Valid values are from 0.00 to 300.00 seconds. If 0.00 is entered, no other values will be allowed and the Level will be deleted when exiting the modification option.

2.10.2 Current Slope

This is the time the Current will take to slope from the Strike Current to the current value in this Level. Valid values are from 0.00 to 300.00 seconds. The Current Slope time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.10.3 Motor Slope

This is the time the Motor will take to slope from zero (or the Pre-Motor Speed) to the Motor Speed value in this Level. Valid values are from 0.00 to 300.00 seconds. The Motor Slope time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.10.4 High Pulse Time

This time specifies the length of time each high pulse value in this Level. Valid values are from 0.00 to 9.99 seconds. If 0.00 seconds is entered, the Low Pulse values will not be available and this Level will not pulse. The High Pulse time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.10.5 High Current

This is the constant current value of this Level if there is no Current Slope Time or no pulsing. If sloping exists, then this value is the final High Pulse Current value for this Level at the end of the Current Slope Time. If there is current pulsing, then this is the High Pulse Current value of the Level. Valid values are from 0.00 to 200.00 amps.

2.10.6 High Motor Speed

This is the constant value of the motor speed in this Level if there is no Motor Slope Time or no Step-Pulsing. If sloping exists, then this value is the final High Motor Speed value for this Level at the end of the Motor Slope Time. If there is Motor Step-Pulsing, then this is the value associated with the High Pulse value of the current. Valid values are from 0.00 to 10.00 rpm.

If the A/C Welding option is enabled, in the Procedure Options Screen, the cursor box will move from the weld procedure parameters to the A/C (Reverse and Straight) weld parameters.

2.11 Straight Polarity

Normal welding of the ACL is done using Straight Polarity: when the electrical current flow is from the tungsten electrode (positive) to the work piece (ground). Valid values are from 0.1 milliseconds to 400.0 milliseconds.

2.12 Reverse Polarity

When using Reverse Polarity, the electrical current flow is from the work piece (ground switched to positive) to the tungsten electrode (positive switched to ground). Valid values are from 0.1 milliseconds to 200.0 milliseconds.

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With a pulsing procedure (High Pulse is not zero), the cursor box will move from the High values to the Low values, then down to the A/C values. This will cause the ACL to alternate polarities from reverse to straight, while the whole time pulsing the current.

With a non-pulsing procedure (High Pulse is zero), the Low values disappear and the cursor moves from the High values to the A/C values. This will cause the ACL to only alternate polarities from reverse to straight.

The Low values of the weld procedure parameters are requested only if there is pulsing (High Pulse is not zero). The following Low Pulse values are requested.

2.12.1 Low Pulse Time

This time specifies the length of time each high pulse value in this Level. Valid values are from 0.00 to 9.99 seconds. The Low Pulse time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.12.2 Low Current

This is the constant current value of this Level if there is no Current Slope Time or no pulsing. If sloping exists, then this value is the final Low Pulse Current value for this Level at the end of the Current Slope Time. If there is current pulsing, then this is the High Pulse Current value of the Level. Valid values are from 0.00 to 200.00 amps.

2.12.3 Low Motor Speed

This is the constant value of the motor speed in this Level if there is no Motor Slope Time or no Step-Pulsing. If sloping exists, then this value is the final Low Motor Speed value for this Level at the end of the Motor Slope Time. If there is Motor Step-Pulsing, then this is the value associated with the Low Pulse value of the current. Valid values are from 0.00 to 10.00 rpm.

Once the Procedure Up-Slope Information is complete, the ACL program will automatically jump to the Procedure Weld Level Information Screen.

2.13 Procedure Weld Level Information Screen

Level 2 and subsequent Levels' hereafter, are considered Weld Levels. The previous Up-Slope Level simply initiated and started welding; these next Levels will be programmed to perform the actual welding of the tubes, fittings, and parts. Up to 99 levels are available (excluding the Final Slope Level) for entering and modifying welding parameters. The welding parameter values have the same function as in Level 1.

When the cursor box is at the Level Number the parameters for that Level will show underneath. Changing Levels can be done in several ways: enter the number of the Level to be viewed then press [ENTER], or press [PAGE DOWN] to scroll to the next Level or [PAGE UP] to scroll to the previous Level.

Using the cursor buttons on the HHC [PAGE UP], [PAGE DOWN], [↑SYMBOLS], [CASE↓], [←], and [→], or the arrow keys on the computer keyboard [←, →, ↑, ↓] or [ENTER] on either, the operator can move the highlighted cursor box to enter and/or modify each and every procedure parameter, such as Level Time, Current Slope and Motor Slope, as well as Pulse Times, Current and Motor Speeds for both High and Low values.

2.13.1 Level Time

This is the total length of time for the Level. Valid values are from 0.00 to 300.00 seconds. If 0.00 is entered, no other values will be allowed and the Level will be deleted when exiting the modification option.

2.13.2 Current Slope

This is the time the Current will take to slope from the current in the previous Level to the current value in the next Level. Valid values are from

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0.00 to 300.00 seconds. The Current Slope time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.13.3 Motor Slope

This is the time the Motor will take to slope from the speed in the previous Level to the Motor Speed value in the next Level. Valid values are from 0.00 to 300.00 seconds. The Motor Slope time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.13.4 High Pulse Time

This time specifies the length of time each high pulse value in this Level. Valid values are from 0.00 to 9.99 seconds. If 0.00 seconds is entered, the Low Pulse values will not be available and this Level will not pulse. The High Pulse time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.14.5 High Current

This is the constant current value of this Level if there is no Current Slope Time or no pulsing. If sloping exists, then this value is the final High Pulse Current value for this Level at the end of the Current Slope Time. If there is current pulsing, then this is the High Pulse Current value of the Level. Valid values are from 0.00 to 200.00 amps.

2.14.6 High Motor Speed

This is the constant value of the motor speed in this Level if there is no Motor Slope Time or no Step-Pulsing. If sloping exists, then this value is the final High Motor Speed value for this Level at the end of the Motor Slope Time. If there is Motor Step-Pulsing, then this is the value associated with the High Pulse value of the current. Valid values are from 0.00 to 10.00 rpm.

If the A/C Welding option is enabled, in the Procedure Options Screen, the cursor box will move from the weld procedure parameters to the A/C (Reverse and Straight) weld parameters.

2.14 Straight Polarity

Normal welding of the ACL is done using Straight Polarity: when the electrical current flow is from the tungsten electrode (positive) to the work piece (ground). Valid values are from 0.1 milliseconds to 400.0 milliseconds.

2.15 Reverse Polarity

When using Reverse Polarity, the electrical current flow is from the work piece (ground switched to positive) to the tungsten electrode (positive switched to ground). Valid values are from 0.1 milliseconds to 200.0 milliseconds.

With a pulsing procedure (High Pulse is not zero), the cursor box will move from the High values to the Low values, then down to the A/C values. This will cause the ACL to alternate polarities from reverse to straight, while the whole time pulsing the current.

With a non-pulsing procedure (High Pulse is zero), the Low values disappear and the cursor moves from the High values to the A/C values. This will cause the ACL to only alternate polarities from reverse to straight.

The Low values of the weld procedure parameters are requested only if there is pulsing (High Pulse is not zero). The following Low Pulse values are requested.

2.15.1 Low Pulse Time

This time specifies the length of time each high pulse value in this Level. Valid values are from 0.00 to 9.99 seconds. The Low Pulse time cannot be

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longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.15.2 Low Current

This is the constant current value of this Level if there is no Current Slope Time or no pulsing. If sloping exists, then this value is the final Low Pulse Current value for this Level at the end of the Current Slope Time. If there is current pulsing, then this is the High Pulse Current value of the Level. Valid values are from 0.00 to 200.00 amps.

2.15.3 Low Motor Speed

This is the constant value of the motor speed in this Level if there is no Motor Slope Time or no Step-Pulsing. If sloping exists, then this value is the final Low Motor Speed value for this Level at the end of the Motor Slope Time. If there is Motor Step-Pulsing, then this is the value associated with the Low Pulse value of the current. Valid values are from 0.00 to 10.00 rpm.

Once the Weld Level data has been entered and/or modified, the ACL program will automatically move to the next subsequent Level. Upon reaching Level 99, the program will advance to the Final Slope Level. If there are only five Levels in the weld procedure, the Final Slope Level can be obtained by moving the cursor box to the Weld Level Number, and pressing [FINAL SLOPE/HOME]. This will show the Final Slope Information Screen.

2.16 Procedure Final Slope Information Screen

The Final Slope Level is considered part of the weld procedure, but it does not perform any welding. The function of the Final Slope Level is to slope the welding current and travel speed in order to eliminate detrimental effects produced by the heat of the welding arc, and to leave a weld bead which is visually more appealing to inspectors and other first line inspection personnel.

Using the cursor buttons on the HHC [PAGE UP], [PAGE DOWN], [↑SYMBOLS], [CASE↓], [←], and [→], or the arrow keys on the computer keyboard [←, →, ↑, ↓] or [ENTER] on either, the operator can move the highlighted cursor box to enter and/or modify each and every procedure parameter, such as Level Time, Current Slope and Motor Slope, as well as Pulse Times, Current and Motor Speeds for both High and Low values.

2.16.1 Level Time

This is the total length of time for the Level. Valid values are from 0.00 to 300.00 seconds. If 0.00 is entered, no other values will be allowed and the Level will be deleted when exiting the modification option.

2.16.2 Current Slope

This is the time the Current will take to slope from the current in the last Weld Level to the current value in this Level. Valid values are from 0.00 to 300.00 seconds. The Current Slope time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.16.3 Motor Slope

This is the time the Motor will take to slope from the speed in the last Weld Level to the Motor Speed value in this Level. Valid values are from 0.00 to 300.00 seconds. The Motor Slope time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.16.4 High Pulse Time

This time specifies the length of time each high pulse value in this Level. Valid values are from 0.00 to 9.99 seconds. If 0.00 seconds is entered, the Low Pulse values will not be available and this Level will not pulse. The High Pulse time cannot be longer than the total Level Time, if a longer time

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is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.16.5 High Current

This is the constant current value of this Level if there is no Current Slope Time or no pulsing. If sloping exists, then this value is the final High Pulse Current value for this Level at the end of the Current Slope Time. If there is current pulsing, then this is the High Pulse Current value of the Level. Valid values are from 0.00 to 200.00 amps.

2.16.6 High Motor Speed

This is the constant value of the motor speed in this Level if there is no Motor Slope Time or no Step-Pulsing. If sloping exists, then this value is the final High Motor Speed value for this Level at the end of the Motor Slope Time. If there is Motor Step-Pulsing, then this is the value associated with the High Pulse value of the current. Valid values are from 0.00 to 10.00 rpm.

If the A/C Welding option is enabled, in the Procedure Options Screen, the cursor box will move from the weld procedure parameters to the A/C (Reverse and Straight) weld parameters.

2.16.7 Straight Polarity

Normal welding of the ACL is done using Straight Polarity: when the electrical current flow is from the tungsten electrode (positive) to the work piece (ground). Valid values are from 0.1 milliseconds to 400.0 milliseconds.

2.16.8 Reverse Polarity

When using Reverse Polarity, the electrical current flow is from the work piece (ground switched to positive) to the tungsten electrode (positive switched to ground). Valid values are from 0.1 milliseconds to 200.0 milliseconds.

With a pulsing procedure (High Pulse is not zero), the cursor box will move from the High values to the Low values, then down to the A/C values. This will cause the ACL to alternate polarities from reverse to straight, while the whole time pulsing the current.

With a non-pulsing procedure (High Pulse is zero), the Low values disappear and the cursor moves from the High values to the A/C values. This will cause the ACL to only alternate polarities from reverse to straight.

The Low values of the weld procedure parameters are requested only if there is pulsing (High Pulse is not zero). The following Low Pulse values are requested.

2.16.9 Low Pulse Time

This time specifies the length of time each high pulse value in this Level. Valid values are from 0.00 to 9.99 seconds. The Low Pulse time cannot be longer than the total Level Time, if a longer time is entered, the program will automatically adjust the entry to match that of the total Level Time.

2.16.10 Low Current

This is the constant current value of this Level if there is no Current Slope Time or no pulsing. If sloping exists, then this value is the final Low Pulse Current value for this Level at the end of the Current Slope Time. If there is current pulsing, then this is the High Pulse Current value of the Level. Valid values are from 0.00 to 200.00 amps.

2.16.11 Low Motor Speed

This is the constant value of the motor speed in this Level if there is no Motor Slope Time or no Step-Pulsing. If sloping exists, then this value is the final Low Motor Speed value for this Level at the end of the Motor

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Slope Time. If there is Motor Step-Pulsing, then this is the value associated with the Low Pulse value of the current. Valid values are from 0.00 to 10.00 rpm.

When the last weld procedure parameters have been entered in the Final Slope Level, the ACL program will advance to the Procedure Limit Information Screen. This value can be found at the bottom of the screen under the title "Max. Scale Change".

2.17 Procedure Limit Information Screen

This screen is used to set a value on the amount of scaling allowed to the operator during a weld, as well as setting deviation logging and abort tolerances on the weld procedure parameters; high and low values for current, voltage, and motor speed.

2.17.1 Maximum Scale Change

This value limits the amount, by percentage, by which both the Current and Motor Speed may be scaled, either up or down. This value should be large to allow for compensations of expected variations in material and welding conditions, but not so large that control of the welding process is lost.

This value has no effect unless the ACL system is in Production Mode (see WELDING OPERATIONS in this section).

2.17.2 Current Limit (Tolerance)

These are limits (tolerances) set on the high and low current pulse values of the weld procedure. Limits are set as a percentage of the actual demand value along with an amount of time allowed for the current to exceed the limit.

If the current and time feedback from the welding arc should exceed the limit, then a deviation will be logged and printed, if the procedure is programmed to do so.

2.17.3 Voltage Limit (Tolerance)

These are absolute limits (tolerances) set on the welding arc voltage. The limits that exist on the maximum and minimum voltage values are allowed.

If the voltage and time feedback from the welding arc should exceed the limit, then a deviation will be logged and printed, if the procedure is programmed to do so.

2.17.4 Motor Speed Limit (Tolerance)

These are limits (tolerances) set on the high and low motor speed values of the weld procedure. Limits are set as a percentage of the actual demand value along with an amount of time allowed for the motor speed to exceed the limit.

Should the motor speed and time feedback from the motor tachometer feedback exceed the limit, then a deviation will be logged and printed, if the procedure is programmed to do so.

2.17.5 Current Abort (Abort Tolerance)

These are abort limits (tolerances) set on the high and low current pulse values of the weld procedure. The abort limits are set as a percentage of the actual demand value along with an amount of time allowed for the current to exceed the limit. Typically these abort limits are greater than those of the current limits, thus extending or allowing more of a deviation before aborting the weld.

Should the current and time feedback from the welding arc exceed the abort limit, the weld will automatically abort and an abort deviation will be logged and printed, if the procedure is programmed to do so.

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2.17.6 Voltage Abort (Abort Tolerance)

This is an absolute abort limit (tolerance) set on the welding arc voltage. The abort limits exists on the maximum and minimum voltage values allowed.

If the voltage and time feedback from the welding arc should exceed the abort limit, then a deviation will be logged and printed, if the procedure is programmed to do so.

2.17.7 Motor Speed Abort (Abort Tolerance)

These are limits (tolerances) set on the high and low motor speed values of the weld procedure. The abort limits are set as a percentage of the actual demand value along with an amount of time allowed for the motor speed to exceed the limit. Typically these abort limits are greater than those of the motor speed limits, thus extending or allowing more of a deviation before aborting the weld.

Should the motor speed and time feedback from the motor tachometer feedback exceed the abort limit, the weld will automatically abort and an abort deviation will be logged and printed, if the procedure is programmed to do so.

3. Hand Held Control (HHC) Operation

3.1 Menu Buttons

Across the top of the HHC keypad, there are separate buttons for each of the MENUs in the ACL. Pressing the corresponding button on the HHC, or on the factory supplied computer keyboard can bring each MENU forward.

Using the HHC, to access the "MAIN MENU", the "PRINT MENU" and the "LOG MENU", press one of the blue buttons across the top of the HHC.

Using the keyboard, press the corresponding button that matches the requested MENU, as seen at the bottom of each of the MENU screens.

The MAIN MENU can be accessed by pressing either [MAIN MENU] at the top, or [ESCAPE] at the bottom of the HHC.

3.2 Welding Function Control Buttons

These are the buttons that control the welding program operations prior to and during welding or testing, and during weld procedure editing/modifying.

The red [START/STOP] button first starts the program. If pressed a second time, it will stop the program.

The [FINAL SLOPE/HOME] button in orange, if pressed during the welding or testing of the welding program, will skip all levels and initiate the final slope. If pressed at any time, the rotor will move (jog) to its home position at the high calibration speed value. If the rotor is already at home position, the rotor will then backup several degrees, then forward again to home.

If using a Degree procedure, pressing the [FINAL SLOPE/HOME] button will immediately start this level and will not finish until it reaches the programmed end.

The [NEXT LEVEL/GAS] button in orange, if pressed during the welding or testing of the welding program, will jump from its current program level to the next program level. Subsequent pressing of this button will continue to jump to the next levels of the program.

If using a Degree procedure, pressing the [FINAL SLOPE/HOME] button will immediately start this level and will not finish until it reaches the programmed end.

If pressed at any other time, the gas function is enabled: if pressed once, the gas will 'flow' (assuming the inert gas supply and the weldhead gas lines are connected to the ACL), if pressed again the 'flow' of gas will stop.

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The inert shielding gas will automatically turn on ('flow'), when the program is started by pressing the [START/STOP] button.

The two green buttons [\uparrow JOG] and [\downarrow JOG], are used to jog the rotor either prior to starting the program for setup, or after running the program.

To jog the rotor in the normal welding direction (clockwise direction), press [\uparrow JOG]. To jog the rotor in the opposite direction, press [\downarrow JOG].

Either button will jog the rotor in their respective directions, at a speed of 5 rpm.

3.3 Acceptance Buttons

The five buttons at the bottom of the HHC keypad are primarily used to affirm, negate, select and accept data that has been entered.

The [CLEAR] button in blue is used to remove an entered value, which has not yet been accepted. Once a value has been entered, but not 'accepted' at the active highlighted field, the operator may 'clear' the entry simply by pressing [CLEAR]. In the welding and testing mode, pressing the [CLEAR] button will zero all the Scale factors applied to the procedure, so the procedure runs as programmed.

The [ESCAPE] button in blue has primarily the same functions the [Esc] button has on a standard PC keyboard. As described above, while at the weld screen, in the editing/modifying mode or, at any other screen, pressing this key will return to the MAIN MENU.

Both the [YES] and [NO] buttons which are blue, are used to confirm and accept, or decline and negate any values in the highlighted field. They will also answer questions prompted on the screen during the program.

The [ENTER] button in green, is used similarly as the [YES] and [NO] buttons. This button will accept any values entered and those, which are defaulted. When answering questions, this button will perform the same functions as [NO], thus declining to change what the questions ask to change.

3.4 Scaling Buttons

During the welding and testing mode, the operator may scale both the current and rotor speed values as the procedure allows. This can be accomplished with the four buttons described below.

The two red buttons labeled [\uparrow %CURRENT] and [\downarrow %CURRENT], when pressed, will increase or decrease the amperage value, before or during the welding and testing, by one percent (1%) of the current level value.

For example: If the amperage value for the current level is 50 amps, and the [\uparrow %CURRENT] is pressed five times to increase the amperage five percent (5%), then the actual current value at the arc will be:

$$50 + 5\%(50) = 52.5 \text{ amps}$$

$$50 + 2.5 = 52.5 \text{ amps}$$

The two green buttons labeled [\uparrow %MOTOR] and [\downarrow %MOTOR], when pressed, will increase or decrease the rotor speed value, before or during the welding and testing, by one percent (1%) of the current level value.

For example: If the rotor speed value for the current level is 5 rpm, and the [\downarrow %MOTOR] is pressed five times to decrease the rotor speed five percent (5%), then the actual rotor speed value at the tube surface will be:

$$5 - 5\%(5) = 4.75 \text{ rpm}$$

$$5 - 0.25 = 4.75 \text{ rpm}$$

If any these buttons are held down continuously, the percentage value will climb, or fall, as long as the button is held. Each procedure has a

Section B (Cont.)

Maximum Scale Change Limit that was programmed when the procedure was developed. The program will not let you exceed that Scale Limit while in the 'Production Mode'.

3.5 Cursor Buttons

These six buttons will help move through the program during editing/modifying of procedures.

When editing a weld procedure in the [5 Modify Procedure —] option, the [PAGE UP] and [PAGE DOWN] both in orange, will move the cursor to the next section of values to be entered or edited. These buttons will also scroll through the editing screens forward or backward, except when editing text entries. Then [PAGE UP] and [PAGE DOWN] from the HHC keypad will accept the text characters assigned to each button. When using the keyboard, there is no conflict with these buttons.

While editing a weld procedure, the arrow buttons [↑SYMBOLS], [CASE↓] in orange, and [←], [→] in blue, will move the cursor to the next available field for data entry or edit.

3.6 Text/Symbol Buttons

There are sections of the program that will require or request text to be entered. This will range from a weld procedure name (either to be saved or recalled) to a procedure description. The program will show a line of text by displaying the length of the text available on this line. This is shown with underlines (_) on the HHC display. This function can be easily performed using the factory supplied PC computer keyboard, however; this exact same function can also be performed using the HHC. This may be preferable, in that the keyboard does not need to be connected for the system to operate, and it can be stored out and away from the work environment. For others, the keyboard is a much easier and faster method of entering text and symbols.

Unlike a standard PC computer keyboard, every button on the HHC is used for entering, editing and/or deleting text (both upper and lower case) and text symbols, known as punctuation marks and mathematical signs. Those buttons with a white letter in a black box, at the upper left-hand corner of each button on the HHC, are used to enter text. Opposite these letters, in the upper right-hand corner are the available text symbols.

To maximize the usage of the keypad, many buttons have a single- or dual-function program button, as well as a text and symbols function. The text buttons will not become active unless the highlighted cursor box is within a field that will accept text and/or a symbol.

For example: If when in the editing/modifying mode, the cursor box is located at a weld parameter field, none of the text characters will be active. If one of the text buttons is pressed, only the other function of the button will occur.

However, if at a text line, only the text characters will be active. The text buttons are now active, and once pressed will 'type' that text character or symbol.

All text is defaulted to be upper case, should a lower case letter be required on the text line, simply press the [CASE↓] button once. After pressing this button, all text characters entered will be lower case. To return to the upper case letters, press the [CASE↓] button once again, this will toggle the lower case letters to the upper case letters.

For example: If typing the word "Weld" at a text line, follow this procedure... Press the 'W' [↓%MOTOR], followed by [CASE↓] (for lower case letters) then finish with the letters 'E' [HELP], 'L', and 'D' [PRINT MENU], then press [ENTER]. This will complete the line and look like this... Weld.

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The next subsequent line will start of with upper case letters, since it is a new line of text.

In order to place a space between words or symbols is to press [→], then continue typing. This will add a space as the text is being typed on the line.

If the [→] was not pressed and a space is required, there is no 'Backspace' or 'Delete' button on the HHC. The [→] button will not add a space, or over-type a letter with a space. The simplest method to add a space to the already typed text, is to clear the line using [CLEAR], then re-type the line.

If any of the text symbols need to be placed on a text line, either as part of the weld procedure name or procedure description, this too is easily done with the HHC keypad. Many of the same text buttons used for typing also contain a symbol character; these are obtainable by first pressing [↑SYMBOLS] followed by the required button.

For example: If a '#' symbol needs to be added to the line developed above, move the cursor to the end of the word using [ç] button. Followed by [↑SYMBOLS] **once**, then by '#' [↑%CURRENT], then [ENTER]. This will finish the line... Weld#.

All text buttons are defaulted to the available text character; should a series of text symbols be required on the text line, simply press the [↑SYMBOLS] button once. After pressing this button, all text symbol buttons pressed will type that symbol. To return to the text characters, press the [↑SYMBOLS] button once again, this will toggle from the text symbols to the text characters.

3.7 Numeric Buttons

The white buttons in the middle of the HHC keypad, are used for numerical data entry. These buttons are active any time the highlighted cursor box is on a text line field, weld procedure parameter line, or at any other point in the program which requires a number value or numerical identification.

These buttons are single function only, meaning that there are no other functions connected to these buttons, which may confuse or distract the operator.

3.8 Service Buttons

In the upper right-hand corner of the HHC keypad are two blue buttons, these are [HELP] and [PRINT SCREEN].

The [HELP] button will aid the operator in giving an explanation, on screen, of exactly the field or section the operator is working in.

For example: If the operator is editing a weld procedure, and he is at the point of choosing procedure options, such as pre- and post-weld homing, he may press the [HELP] button to get a summary of the options available to him.

The [PRINT SCREEN] button will allow the operator to produce, on the factory-supplied printer, a hard copy printout of exactly what is on the screen. This button can be pressed at any time during the welding and testing operation in order to produce this printout.

4. Keyboard Functions

Like using the HHC, the factory supplied PC keyboard can be used to fully operate the ACL welding program. Not only are the keys on the keyboard used for entering text and numbers but many are also utilized as program function commands.

Described in the next section are the many keystrokes used on the keyboard in order to achieve the exact commands as found on the HHC.

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4.1 Text, Symbol & Numeral Keys

There are sections of the ACL program that will require or request text, symbols and/or numerals to be entered. This will range from a weld procedure name (either to be saved or recalled) to a procedure description to weld parameters.

Several keys have a single- or dual-function; depending on which part of the ACL program screen is currently showing.

The text keys are only active when the cursor box lies within a text line.

For example: If the MAIN MENU is showing, and the operator is attempting to save a procedure, the highlighted character spaces after the save procedure option will show and await the operator to type in a procedure name. At this screen, all the text and numeral keys are active. If at the weld screen, the text keys will become ACL program function keys.

When modifying a procedure, and the cursor box is located at the weld procedure description, all key functions are in text entering mode only.

All text typed from the keyboard is defaulted upper case. If a lower case letter is required on the text line, it is only available using the HHC.

4.2 Menu Keys

Pressing the corresponding key on the factory supplied computer keyboard can bring each MENU forward.

To access the "MAIN MENU", the "PRINT MENU" and the "LOG MENU", press the corresponding key that matches the requested MENU, as seen at the bottom of each of the MENU screens.

Using [Esc] on the keyboard is the only way the "MAIN MENU" can be accessed.

Use [P] for the PRINT MENU.

Use [L] for the LOG MENU.

4.3 Welding Function Control Keys

These are the keys that control the welding procedure operations prior to and during welding or testing, and during weld procedure editing/modifying.

Use the [S] key to [START/STOP] the procedure.

When pressed, while viewing the Weld Screen, the loaded procedure will start.

If pressed during the welding or testing of the welding procedure, the procedure will stop.

Use the [Home] or [F] keys for [FINAL SLOPE/HOME] functions.

If pressed during the welding or testing of the welding procedure, all levels will skip and initiate the Final Slope.

If pressed at any other time while at the Weld Screen, the rotor will move (jog) to its home position at the high calibration speed value. If the rotor is already at home position, the rotor will then backup several degrees, then forward again to home.

If using a Degree procedure, pressing the [Home] or [F] keys will immediately start the next level and will not finish until it reaches the programmed end of that level.

Use the [N] key for [NEXT LEVEL/GAS] functions.

If pressed during the welding or testing of the welding procedure, the procedure will jump from its current procedure level to the next procedure level.

Subsequent pressing of this key will continue to jump to the next levels of the procedure until the Final Slope is reached.

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If using a Degree procedure, pressing the [N] key will immediately start the next level and will not finish until it reaches the programmed end of that level.

Pressing this key prior to starting the procedure will cause the Arc Gas and Backup Gas (if connected) to start flowing. The gas will not turn off until this, or another gas key is pressed again.

If the gas flow is off, the inert shielding gas will automatically turn on ('flow') once the procedure is started by pressing the [S] key.

In order to jog the rotor, either prior to or after running the procedure, use the combination of [Alt + 6] or [Alt + 7] for forward or reverse rotation, respectively.

To jog the rotor in the normal welding direction (clockwise direction), press [Alt + 6]. To jog the rotor in the opposite (counter-clockwise) direction, press [Alt + 7].

Either key will jog the rotor in their respective directions, at a speed of 5 rpm.

4.4 Acceptance Keys

The five buttons at the bottom of the HHC keypad are primarily used to affirm, negate, select and accept data that has been entered. Similarly, on the keyboard there are keys that perform the same function.

Once a value has been entered, but not 'accepted' at the active highlighted field, the operator may 'clear' the entry by pressing [Ctrl + L]. Using this combination will also clear a line of text prior to typing.

As described above, while at the weld screen, in the editing/modifying mode or, at any other screen, pressing [Esc] will return to the MAIN MENU.

Use the [Y] and [N] keys to confirm and accept, or decline and negate any values in the highlighted field. They will also answer questions prompted on the screen during the program.

The [Enter] or [Return] key, is used similarly as the [Y] and [N] keys. This key will accept any values entered and those that are defaulted. When answering questions, this key will perform the same functions as [N], thus declining to change what the questions ask to change.

4.5 Scaling Keys

During the welding and testing mode, the operator may scale both the current and rotor speed values as the procedure allows. This can be accomplished using the cursor keys.

The up [↑] and down [↓] arrow keys, when pressed, will increase or decrease the amperage value, before or during the welding and testing, by one percent (1%) of the current level value.

For example: If the amperage value for the current level is 50 amps, and the [↑] is pressed five times to increase the amperage five percent (5%), then the actual current value at the arc will be:

$$50 + 5\%(50) = 52.5 \text{ amps}$$

$$50 + 2.5 = 52.5 \text{ amps}$$

The left [←] and right [→] arrow keys, when pressed, will increase or decrease the rotor speed value, before or during the welding and testing, by one percent (1%) of the current level value.

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For example: If the rotor speed value for the current level is 5 rpm, and the [←] is pressed five times to decrease the rotor speed five percent (5%), then the actual rotor speed value at the tube surface will be:

$$5 - 5\%(5) = 4.75 \text{ rpm}$$

$$5 - 0.25 = 4.75 \text{ rpm}$$

If any these keys are held down continuously, the percentage value will climb, or fall, as long as the key is held.

Each procedure has a Maximum Scale Change Limit that was programmed when the procedure was developed (see **MODIFYING WELD PROCEDURES**). The procedure will not let you exceed that Scale Limit while in the 'Production Mode'.

At the Weld screen, pressing the [Ctrl + L] key will zero all the Scale factors applied to the procedure, so the procedure runs as programmed.

4.6 Cursor Keys

These four keys will help move through the procedure during editing/modifying of procedures.

When editing a weld procedure in the [5 Modify Procedure —] option, the [Page Up] and [Page Down] keys will move the cursor to the next section of values to be entered or edited. These keys will also scroll through the editing screens forward or backward, except when editing text entries.

While editing a weld procedure, the cursor keys [←, →, ↑ and ↓], will move the cursor to the next available field for data entry or edit.

5. Print Menu Operations

To access the printing function of the ACL Orbital Tube Welding System, be certain to have the factory supplied Dot Matrix 9-Pin printer connected to the ACL, and simply press the [PRINT MENU] button on the HHC or the "P" on the keyboard. This will shift the PRINT MENU on the screen to the front of the others and allow full viewing of all options and functions.

Those options in green are active and fully functional. Those option numbers which are red are either not available from the factory, or are not yet active while still within the welding program. All printouts can be found in the APPENDIX.

In order to utilize any one of the options shown on this menu, use either the HHC number buttons or the number keys on the keyboard. Of the ten options in the PRINT MENU, only eight have active choices. Even then, if certain steps are not taken prior to reaching this screen, some of the eight may not yet be active. This will be discussed in the following:

Option [1 Procedure — & Weld Data] will print out the weld procedure with full heading, which currently loaded and active. The name of this procedure will appear after the word "Procedure" in the title of this option.

The full heading is useful for documenting production welds and can be utilized as a quality control document. The information contained as part of the form above the parameters of the weld procedure listing contains most of the data necessary to properly track and document a weld for future analysis, job costing, and quality assessment.

Option [2 Procedure —] provides the same stored weld procedure parameter data as the first option, [1 Procedure — & Weld Data], but does not include the printing which provides operator input for weld information. The name of this procedure will appear after the word "Procedure" in the title of this option.

This printout is useful for situations that are not linked to production welding where quality control is accountable. This would include

Section B (Cont.)

situations where a quick printout is necessary to inspect the weld procedure parameters verification prior to performing a series of welds. Another application may be during weld procedure development or modification.

Option [3 Printer Headings: Full / Brief] is used as a toggle between two different types of heading on each printout: Full or Brief.

The Full heading provides information such as the ACL's identity: name, model number and serial number. This is especially useful in multi-machine job situations where it is important to track the welds not only by part serial number but also by which machine has performed the weld.

The Brief heading shows only the title of the printout without any of the ACL identification. This print out heading is useful for situation where the ACL information is not necessary such as in weld procedure development.

Option [4 List of Saved Procedures] provides a directory of the saved weld procedures residing on the memory of the ACL. This provides a quick reference to the user for finding an applicable weld procedure without having to load and view each procedure, or having to print out each individual procedure.

The first column is the procedure name. A procedure with a “/#” after it indicates a revision. The revisions will show as “/A”, “/B”, and so on.

The second column consists of the four identification lines appearing at the beginning of the weld procedure modification (MAIN MENU Option 5).

The third column shows the last date and time the weld procedure was modified and saved.

Option [5 Calibrate Data] provides the Motor Calibration results of the latest calibration sequence.

This result is either from initial Motor Calibration at ACL startup or by choosing MAIN MENU Option 8 or by modifying the weld procedure to perform a home pre-weld calibration update prior to each weld.

This printout gives all pertinent data of the last Motor Calibration, Motor and Tachometer Gain Errors, as well as the last date and time of the Motor Calibration.

Option [6 Scaled Procedure Print Enabled] provides a printout of the weld procedure with updated scaled parameters for both the Current and Motor.

Choosing this option will toggle the cursor box around the word “Enabled”, this will convert the scaled parameters to their scaled values without changing the original values in memory. This can be accomplished even without performing a weld, either in WELD or TEST Mode.

While at the Weld Screen, adjust either the Current or Motor by scaling either up or down. Press [PRINT MENU] on the HHC, select this option to “Enable”, and then select Option [2]. This will give a printout of the scaled parameters, while maintaining the integrity of the original parameters.

This is useful when needing to see how apparent scale changes will affect either current or motor speed without actually doing it.

Option [7 Print Strip Chart] will print out the resultant strip chart from the alternate Strip Charting screen.

Section B (Cont.)

Whether in TEST or WELD Mode this function will printout the entire length of the printout from the screen. With every length of strip chart on the screen being equal to eight seconds of the weld procedure, a large diameter weld could easily use five screens or more. Printouts in this option will give one sheet of tractor paper for every screen of weld from the procedure.

This option is quite useful when tracking individual welds, as their pulsing values for current and voltage are kept on hard copy. For production purposes, especially on larger diameter welds, individual printouts from this option would not be recommended since the speed of the printer is limited.

Option [8 Print Deviations] provides a printout of all weld procedure deviation that occurred during the weld.

Whether Data Monitor values are used or not, a deviation is also registered as the pressing of a button on the HHC or on the weldhead handle. Once the weld is finished, given there are no deviations, a screen will appear showing that there were no deviations during the procedure.

When a deviation is registered it will show exactly when it occurred: in which Level, what time in the Level, what degree of rotation the deviation occurred at, and the type of deviation.

This printout can be beneficial when a hard copy of all deviations is needed for weld tracking and evaluation of integrity.

6. Log Menu Operations

Option [1 Print Strip Chart] will print out the resultant strip chart from the alternate Strip Charting screen.

Whether in TEST or WELD Mode this function will printout the entire length of the printout from the screen. With every length of strip chart on the screen being equal to eight seconds of the weld procedure, a large diameter weld could easily use five screens or more. Printouts in this option will give one sheet of tractor paper for every screen of weld from the procedure.

This option is quite useful when tracking individual welds, as their pulsing values for current and voltage are kept on hard copy. For production purposes, especially on larger diameter welds, individual printouts from this option would not be recommended since the speed of the printer is limited.

Option [2 Print Deviations] provides a printout of all weld procedure deviation that occurred during the weld.

Whether Data Monitor values are used or not, a deviation is also registered as the pressing of a button on the HHC or on the weldhead handle. Once the weld is finished, given there are no deviations, a screen will appear showing that there were no deviations during the procedure.

When a deviation is registered it will show exactly when it occurred: in which Level, what time in the Level, what degree of rotation the deviation occurred at, and the type of deviation.

This can be beneficial when a hard copy of all deviations is needed for weld tracking and evaluation of integrity.

Option [3 Display Deviations] provides on-screen evaluation of any deviations that may have occurred during the weld.

Whether Data Monitor values are used or not, a deviation is also registered as the pressing of a button on the HHC or on the weldhead handle. Once

Section B (Cont.)

the weld is finished, given there are no deviations, a screen will appear showing that there were no deviations during the procedure.

When a deviation is registered it will show exactly when it occurred: in which Level, what time in the Level, what degree of rotation the deviation occurred at, and the type of deviation.

Once the deviation screen reverts back to the weld screen, the only way to view the procedure deviations is to return to the LOG MENU and select this option. This will then show the deviations from the previous weld.

At the operator's discretion, he may decide to print these deviations using option [2 Print Deviations] from the LOG MENU or option [8 Print Deviations] from the PRINT MENU.

Option [0 Erase Log on Disk] allows the operator to erase any saved logs, which are on the diskette.

When selected, the library of logs that are on the diskette will appear; this will appear similar to the procedure library.

Use the cursor keys to highlight the log to be erased.

Pressing [ENTER] will prompt to erase the highlighted log, with the command:

OK to Erase?

Press "Y" or [YES] to erase. Press "N" on the keyboard, or [NO] on the HHC to keep. If it is the last log to be erase, once the "Y" or [YES] is pressed, a DISK prompt will appear:

* DISK: No File

- Hit Any Key -

This means there are no more logs in the library.

Option [T Copy Log to Disk] allows the operator to save the current weld log to a diskette.

This diskette with the saved weld log can now be utilized on any PC that has Microsoft Excel[®] loaded. In this program, the results from the weld log (deviations, amps, volts and motor speed) can be examined and plotted to resemble the Strip Chart printout.

This is especially useful when either of the save options are not enabled, but the operator needs to save a particular log.

When doing so, the Short Log File function still applies. Meaning if Short Log File is enabled, then when the log is copied to the diskette, only the procedure parameter information will copy and not the weld performance data.

7. Personal Computer (PC) Development

The operation of the ACL software under the PC Development Operations is essentially the same as for a standard ACL System (consult ACL Operating Systems Manual-Welding Operations), except that the availability of functions on the PC are considered "enabled" and "disabled". For example: with no weldhead connected to the PC, no motor calibration can be performed.

No provision is made for the HHC, so all operator input is via the keyboard and displays to the operator are via the monitor.

If there is a printer connected, it must be LPT1 and operate in the Epson-compatible mode, because of this; it is recommended that only Dot Matrix type printers be used to print from the program while using the PC Development software.

Section B (Cont.)

7.1 Minimum System Requirements

IBM compatible, DOS 5.0 or higher, VGA card, 80386 or better.

7.2 Prior To Loading Software

The ACL software can be run either one of two ways: copied to C: drive and run from it, or run from the floppy diskette provided.

7.3 Operating Software

To run from the hard drive, both files must be copied ACL.EXE and GO32.EXE.

To start the program, you must have both files in the default drive and directory. For example:

If copied to "C" drive and "FILES" directory, you must be at the following prompt:

```
C:\FILES\>
```

The program will only run from DOS, not DOSSHELL nor Windows.

If an error message appears that you are not in the REAL MODE, you must edit the CONFIG.SYS file. Simply add the following, "rem (space)" to the front of the line containing EMM386 driver. Then reboot the computer.

Type ACL and press [ENTER] to start the program.

7.4 Keyboard Notes

Press Alt + A, to exit the program from the MAIN MENU to DOS.

Press Alt + P, to print screen only to Epson compatible printers. If this does not work, you may use the "Print Screen" key, and only if you install the GRAPHICS.COM program (see DOS Manual) prior to running the ACL program.

The LOG MENU is present, but is not active at this time.

The PRINT MENU and MAIN MENU are active and have all options available, except ones involving reading, writing, and printing procedures from battery backed memory of the ACL machine.

7.5 To Enter Data from Previous Procedure Printout

At the MAIN MENU, press [5 Modify Procedure ——].

Enter the Procedure Description. This screen gives you four lines in order to type out information regarding the weld procedure. To add/change description text lines:

Press [ENTER] to move from one text line to the next. Pressing [ENTER] does not change the existing text on the line.

Enter the new text. As one enters the first character, the entire text line is erased and a block appears to show how many spaces are left to complete the entry.

If more than 16 characters are entered, the cursor automatically moves to the next line.

Press [PgDn] to accept the screen and advance to the next screen.

Select the applicable options regarding the weld procedure. To change the options listed, follow the following procedure:

Answer [N] to the prompt to advance to next screen. This will accept all options as they first appeared.

Section B (Cont.)

Answer [Y] to the prompt, "Change Options?". This will show each option highlighted with a question mark after it. Answering [N] will advance to the next option, and leave it red (disabled). Answering [Y] will select that option in green (enabled). Options in red are considered OFF, while options in green are ON.

NOTE

For the Option called "Deg. Procedure" answer [N], unless the previous procedure is written in degree form.

After all the options have been selected, press [ENTER] or [N] at the prompt "Change Options?", this will advance to the next screen.

7.5.1 Procedure Purge

For the next sections that involve entering numerical data the following applies:

The arrow keys [←, →, ↑, ↓] on the keyboard will move the purple cursor box up, down, left and right, as the fields permit.

The [PgUp] [PgDn] keys will move from section to section, level to level, and advance screens forward and backwards.

This section is the **Procedure Purge Information** screen. Enter all pertinent data from the previous procedure into the applicable boxes, as the prompt box moves from field to field. The values for this section are the same values from Level 0 in the ATW program.

As a value is typed in, press [ENTER] to accept. This will then move the prompt box to the next available field.

7.6 Procedure Up-Slope

Once all the values for this section are typed and entered, the cursor box will move to the next section, which is **Procedure Up-Slope Information**. To add/change data in this and previous section is as follows:

The cursor is now in the field showing Level# 1. Press [ENTER] to accept and add data to this Level, or enter another Level # to change Levels.

Pressing the [PgUp] [PgDn] keys will advance Levels, while using the arrow keys [←, →, ↑, ↓] will advance the cursor box through the available fields in each Level.

For each level enter the Level time, Current Slope, Motor Slope, High Pulse Time/Current/RPM, and Low Pulse Time/Current/RPM.

If the AC Welding option is enabled, enter only the High Pulse Time/Current/RPM, followed by the AC Fwd and Rev Pulse Time.

7.7 Procedure Weld Level

Levels 2 through 90 is the section called **Procedure Weld Level Information**. To add/change data in this and previous section is as follows:

The cursor is now in the field showing Level# 2. Press [ENTER] to accept and add data to this Level, or enter another Level # to change Levels.

Pressing the [PgUp] [PgDn] keys will advance Levels, while using the arrow keys [←, →, ↑, ↓] will advance the cursor box through the available fields in each Level.

For each level enter the level time, Current Slope, Motor Slope, High Pulse Time/Current/RPM, and Low Pulse Time/Current/RPM.

If the AC Welding option is enabled, enter only the High Pulse Time/Current/RPM, followed by the AC Fwd and Rev Pulse Time.

NOTE

*The sequence for adding and changing values in this section is identical to that of the **Procedure Up-Slope Information** section.*

Section B (Cont.)

7.8 Procedure Final Slope

The last section, known as the **Procedure Final Slope Information** is obtained by pressing "F". To add/change data in this and previous section is as follows:

The cursor is now in the field showing Level# ***. Press [ENTER] to accept and add data to this Level, or enter another Level # to change Levels.

Pressing the [PgUp] [PgDn] keys will advance Levels, while using the arrow keys [←, →, ↑, ↓] will advance the cursor box through the available fields in each Level.

For each level enter the level time, Current Slope, Motor Slope, High Pulse Time/Current/RPM, and Low Pulse Time/Current/RPM.

If the AC Welding option is enabled, enter only the High Pulse Time/Current/RPM, followed by the AC Fwd and Rev Pulse Time.

NOTE

*The sequence for adding and changing values in this section is identical to that of the **Procedure Up-Slope and Procedure Weld Level Information** sections.*

7.9 Maximum Scale Change

Once the last value of the Final Slope is added, the cursor will move to the bottom of the screen, into the Scales field. This field shows "Max. Change" with the cursor directly behind it.

Enter a percent value for Maximum Scale Change. Upon pressing [ENTER], the screen will advance back to the MAIN MENU; this procedure can now be saved.

7.10 To Save A Procedure

The last three options available on this software indicate editing functions, to and from a 'Disk'. When using this software on a PC, the 'Disk' is not the diskette inserted into either disk drive, rather, it is the RAM space of the drive and directory where the ACL software is loaded.

In order to actually have these procedures on a diskette, it is best to use DOS or Windows application to copy the procedures from their drive and directory to the diskette. Then insert the diskette into the ACL and use option [F Copy Procedure From Disk] at the MAIN MENU, to copy those procedures into the ACL.

To save this procedure, you must first name it.

At the MAIN MENU, press [6 Save Modified Procedure] to name this procedure. Enter up to 7 characters for the name.

Next, press [T Copy Procedure To Disk]. There is no indication to tell you that this has been done, but it has saved the procedure. If the [T Copy Procedure To Disk] is pressed a second time, it will bring up a prompt at the bottom of the screen "DISK: _____ OK to Overwrite?". Answer [Y] to this prompt. You have now saved this procedure under the name given.

WARNING

If the procedure is not copied to a diskette using [T], and another procedure is copied from the diskette using [F], the last named procedure will be lost.

7.11 Using Procedures From ATW Software Versions 3.0 and Later

If you have a floppy diskette containing previously saved procedures, you may recall them on this new system without having to re-enter all data. Note that only procedures developed and saved on previous systems using software revision 3.0 or later can be recalled in this manner.

Section B (Cont.)

Simply follow the procedure below:

Copy the existing procedures to the drive and directory containing the ACL program.

At the MAIN MENU, use option [F Copy Procedure From Disk] to recall the saved procedures. Press [ENTER] to select highlighted procedure.

At the prompt "_____ Procedure OK to Discard?" answer [Y]. This will return you to the MAIN MENU.

7.12 Using Procedures From ATW Software Versions Prior To 3.0

In order for the system to recognize information developed and saved on versions prior to revision 3.0, you must save them on a version later than 3.0. You need not re-develop each procedure, as long as you want all aspects of the procedure maintained.

To save procedures from an old version to a new version, simply copy the procedures from the old version diskette onto the new version diskette. Install the diskette into the ATW welder and modify and rename as needed and re-save onto the diskette. This process will save procedure using "new" format.

Refer to the prior section on copying procedures for using these procedures on the ACL.

Section C

Accessories

Weldheads

005-0212 Start-up kit, Domestic

005-0217 Start-up kit, International

Alternative or Additional Input Power Cords:

843-0359 120 VAC, Single Phase

843-0360 208/240 VAC, Single Phase

843-0361 208/240 VAC, Three Phase

843-0362 220 VAC, Single Phase, Euro

843-0392 Universal 120 VAC, 30 A UL

Transformer:

001-1230 480/240VAC, 3 Phase, Stand Alone Transformer

ACL Tools and Accessories:

005-0251 Calibration Kit

005-0347 ACL Diagnostic & Troubleshooting Kit

005-0348 Protective Welding System Enclosure (ACL only)

005-0620 ACL Adapter Kit for Astro Arc Weldhead

005-0252 Helium Arc Start Kit

001-1280 Variable Polarity AC Adapter

001-1251 Dual Weldhead Adapter

Recirculators

001-3693 Water Recirculator, 120 VAC

001-3709 Water Recirculator, 230 VAC

Section D

Maintenance

Setting Time & Date

To change the Time & Date, which shows on the bottom of the screen, as well as on all printouts and saved Weld Logs, use option [0 Time & Date].

When this option is selected, the clock at the bottom of the screen stops counting, and at the end of this text line, all the essential settings appear:

MM DD YY HH MM SS

The cursor box can be moved from one set of settings to the next, either by using the cursor keys or, pressing [ENTER] to accept the settings highlighted.

To change the settings, move the cursor box to the settings to be changed and type in the changes. While all the settings are standard, the hour setting (HH) uses 24-Hour Time.

Once the last set of changes is accepted, the date and time at the bottom of the screen instantly change to reflect the modifications made.

Calibration/Verification Procedure

The ACL Calibration Software provides the user a means of calibration the ACL welder parameters: Current (AMPS), Arc Voltage (VOLTS) and Rotor Speed (RPM).

In the ACL welder Main Menu, menu selection [9 Calibrate Analog Input/ Output] will setup a built-in Weld Calibration Procedure **ANA_CAL**. This procedure is part of the ACL program... it **CANNOT** be edited, modified and/or erased. This procedure consists of 13 levels, each of which increases in both AMP and RPM values: from 5.0 to 200.0 Amps and from 1.00 to 10.00 RPM.

Each level in this procedure is 300.0 seconds (5 minutes) long. This enables the Calibration Technician more than enough time to measure, evaluate and adjust ACTUAL and FEEDBACK AMP values and ACTUAL and FEEDBACK RPM values.

The [NEXT LEVEL/GAS] button in orange, if pressed during the welding or testing of the welding program, will jump from its present level to the next level. Subsequent pressing of this button will continue to jump to subsequent levels of the program. While changing from one level to the next, both the AMP and RPM values increase to the value of that level.

Once the last level has been reached, if the [NEXT LEVEL/GAS] button is pressed, the program will start over again at Level 1. This will cause the program to Loop through procedure **ANA_CAL** again.

By using this procedure and the setups in the following sections, the user will step through the **ANA_CAL** weld procedure and adjust the weld parameters at each level of the procedure by pressing the indicated keys of the HHC. All final data can be recorded neatly and completely on the calibration data form provided.

CAUTION

*Before beginning final calibration **VERIFY THAT ALL TEST EQUIPMENT USED FOR MEASURING HAS A CURRENT UNBROKEN CALIBRATION SEAL.***

Use of uncalibrated test equipment will invalidate the calibration you are about to perform.

Section D (Cont.)

Required Test Equipment

- 4 1/2 Digit DMM, with varied leads.
- 20VDC adjustable power supply, with varied leads.
- Calibration Kit (P/N 005-0251)

Calibration Kit

In order for the calibration procedure to be successfully performed, the Calibration Kit must first be connected and adjusted. The Calibration Kit consists of a general purpose air-cooled handheld TIG torch rated at 150 amps, a calibrated current shunt (50mV/200A) in a fixture with standard dual female banana plug connectors and leads, all of which are mounted within an adjustable fixture for calibration purposes.

Adjustment of the Calibration Kit requires the use of standard feeler gauges and an adjustable end wrench. Turn the copper block counter-clockwise so that it is approximately 1/4" from the bottom of the torch cup (nozzle), spin the hex-nut up to and against the bottom of the block. Holding the nut with the wrench, turn the copper block clock-wise and down against the nut, thus in effect "jamming" the block and nut against each other.

NOTE

Positive and tight surface contact between the copper block and the "jam" nut on the stud is absolutely essential in order to maintain a consistent and stable arc.

Once the block is secured against the nut, remove the black cap from the top of the torch. Place a feeler gauge (0.035" - 0.045") under the cup and drop the tungsten down through the collet in the torch (collet and collet body for holding 3/32" diameter tungsten are standard), so that it stops on the feeler gauge. Replace the cap onto the torch and tighten to hold the tungsten from moving.

If adjusted properly, this will assure a consistent tungsten-arc-gap for performing the Current Calibration portion of this procedure.

Arc Voltage Calibration

The weldhead control connector on the weldhead cable should be plugged into the ACL. Be certain there is no obstruction in the weldhead - **the rotor must turn for this test to work.**

Connect the DC power supply to the ARC VOLTAGE side of the shunt box, positive-to-positive, and negative-to-negative. Then connect the DMM either at the power supply or across the power supply leads at the shunt box, and set the DMM to read up to 20 VDC.

If the leads in this operation are reversed, the arrows on the Voltage bar graph will point in the reverse direction and the power supply may "fold back" on itself.

This will cause the voltage from the power supply to drop and the current will peak to maximum. When this occurs, turn the power supply and the ACL off, check polarity connection from the power supply to the shunt box, and restart this calibration.

A negative reading on the DMM means the leads between the DMM and the shunt box or power supply are reversed. To correct this simply reverse the reading leads either at the DMM or at the shunt box.

Once connected, with the ACL in TEST Mode, press [START/STOP] on the HHC. The **ANA_CAL** procedure will enter Level 1 and the rotor will start rotating.

Input each of the Voltage levels that are listed on the attached calibration data sheet. At each input voltage, if needed, adjust the displayed

Section D (Cont.)

FEEDBACK VOLTS (to the right of the Voltage Bar Graph on the bottom of the monitor screen) by pressing the PAGE UP or PAGE DOWN buttons on the HHC, until the values equals that which is shown on the DMM. Each button press is equal to 1/100 V scale adjustment.

Record each of the final display values on the data sheet.

Press [START/STOP] on the HHC when complete. Repeat if necessary.

Verify that each of the recorded values equal = Input Voltage \pm 0.2VDC.

Rotor Speed Calibration

The weldhead control connector on the weldhead cable should be plugged into the ACL. Be certain the there is no obstruction in the weldhead - **the rotor must turn for this test to work.**

Once connected, with the ACL in TEST Mode, press [START/STOP] on the HHC. The **ANA_CAL** procedure will enter Level 1 and the rotor will start rotating.

Press [NEXT LEVEL/GAS] on the HHC to jump to the next level, thus changing the rotor speed to the next RPM value. This will occur whenever the [NEXT LEVEL/GAS] button is pressed.

At each DEMAND RPM (which is that RPM value in the **ANA_CAL** procedure), adjust the ACTUAL RPM of the weldhead rotor (displayed to the right and below of the RPM Bar Graph at the bottom of the monitor screen) by pressing the RIGHT ARROW or LEFT ARROW on the HHC, until the ACTUAL RPM equals that of the DEMAND RPM. Each button press is equal to 1/200 RPM output adjustment.

Once an adjustment is made to the ACTUAL RPM, wait until the rotor makes two complete revolutions before making secondary adjustments to the ACTUAL RPM. The ACTUAL RPM is updated after the second rotor revolution and every subsequent revolution past the "Home" position.

Once the ACTUAL RPM value is set equal to the DEMAND RPM value, the FEEDBACK RPM (displayed just to the right of the RPM Bar Graph at the bottom of the monitor screen) must be adjusted to equal that of the ACTUAL RPM value. Pressing the % MOTOR SCALE UP or % MOTOR SCALE DOWN on the HHC accomplishes this. Each button press is equal to 1/200 RPM feedback adjustment.

Record each of the final display values on the data sheet.

Verify that each of the recorded values = (DEMAND RPM \pm 0.5 RPM) or (DEMAND RPM \pm 1%), whichever is greater.

Press [START/STOP] on the HHC when complete. Repeat if necessary.

Current Calibration

From the Calibration Kit to the ACL; connect the torch lead to the BLACK connector, the ground lead to the GREEN connector and the torch purge gas connector to the ARC GAS port on the rear panel of the ACL. The weldhead control connector on the weldhead cable should be plugged into the ACL. Be certain the there is no obstruction in the weldhead - **the rotor must turn for this test to work.**

Connect the DMM to the CURRENT SHUNT side of the shunt box, positive-to-positive and negative-to-negative. Set the DMM to read up to 50 mVDC.

If the leads between the DMM and the shunt are reversed, the readout on the DMM will show negative mV values. To correct this; simply reverse the leads either at the DMM or at the shunt.

Section D (Cont.)

CAUTION

***REMOVE ALL TEST EQUIPMENT FROM THE
ARC VOLTAGE SIDE OF THE SHUNT BOX PRIOR
TO STARTING THE CURRENT CALIBRATION.***

Once connected, with the ACL in WELD Mode, press [START/STOP] on the HHC. The **ANA_CAL** procedure will initiate and establish an arc within the tungsten arc gap, then enter Level 1 and the rotor will start rotating.

CAUTION

***PROLONGED EXPOSURE TO THE WELDING ARC
MAY RESULT IN INJURY TO THE EYES AND/OR SKIN.
PROTECT ALL PERSONNEL FROM ALL ARC FLASHES.***

***Unnecessary extended time in each level of calibration,
or performing repeated calibrations will cause all fixturing
(torch, block and cables) to become very hot.***

***EXPOSURE TO THESE VERY HOT ITEMS
WILL RESULT IN INJURY TO THE SKIN.
USE CAUTION WHEN HANDLING VERY HOT FIXTURING.***

Press [NEXT LEVEL/GAS] on the HHC to jump to the next level, thus changing the current to the next AMP value. This will occur whenever the [NEXT LEVEL/GAS] button is pressed.

At each DEMAND AMPS (which is that AMPS value in the **ANA_CAL** procedure), adjust the ACTUAL AMPS of the welding arc (displayed on the DMM (mV x 4 = ACTUAL AMPS)) by pressing the UP ARROW or DOWN ARROW on the HHC, until the ACTUAL AMPS equals that of the DEMAND AMPS. Each button press is equal to 1/10 A output adjustment.

Once the ACTUAL AMPS are set equal to the DEMAND AMPS, the FEEDBACK AMPS (displayed just to the right of the AMPS Bar Graph at the bottom of the monitor screen) must be adjusted to equal that of the ACTUAL AMPS value. Pressing the % CURRENT SCALE UP or % CURRENT SCALE DOWN on the HHC accomplishes this. Each button press is equal to 1/10 A feedback adjustment.

NOTE

***Once all the necessary measurements and assessments
have been made for each level, it is **HIGHLY ADVISABLE**
to change levels and not remain in any one level
for the entire 300.0 seconds.***

Record each of the final display values on the data sheet.

Verify that each of the recorded values = DEMAND AMPS ± 2.0 Amps.

Press [START/STOP] on the HHC when complete. Repeat if necessary (read CAUTION statement for Current Calibration).

ACL CALIBRATION DATA SHEET

UNIT S/N _____ WELDHEAD S/N _____ SOFTWARE REV. _____

CURRENT CALIBRATION

#	Actual AMPS (mV x 4)	Feedback AMPS (A)	Demand AMPS (A)	Actual AMPS (mV x 4)	Feedback AMPS (A)
10	_____	_____	_____	_____	100
20	_____	_____	_____	_____	120
40	_____	_____	_____	_____	150
60	_____	_____	_____	_____	180
80	_____	_____	_____	_____	200

ARC VOLTAGE CALIBRATION

Input Voltage (V)	2	4	6	8	10	12	14	16	18	20
Feedback Volts (V)	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

ROTOR SPEED CALIBRATION

Demand (RPM)	Actual (RPM)	Feedback (RPM)	Demand (RPM)	Actual (RPM)	Feedback (RPM)
0.5	_____	_____	6	_____	_____
1	_____	_____	7	_____	_____
2	_____	_____	8	_____	_____
3	_____	_____	9	_____	_____
4	_____	_____	10	_____	_____
5	_____	_____			

Technician _____

Date _____

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Section E Troubleshooting

Fault Messages

MESSAGE	DESCRIPTION
* Printer Bad * - Hit Any Key -	ACL not reading printer. <u>Probable Cause:</u> Printer not connected, not turned on, not on-line, or there is no paper loaded. <u>Corrective Action:</u> Connect printer, turn printer on, load paper and press on-line button.
* STATUS: Gas Fault *	Arc Gas not flowing in Weld Mode. <u>Probable Cause:</u> Gas cylinder empty or manifold turned off. Gas connections not secure. Knob on flow tube turned off. <u>Corrective Action:</u> Check gas supply, connection and adjustments.
* STATUS: Arc Fault *	No arc established during High Voltage arc strike. <u>Probable Cause:</u> Weldhead leads not connected. Arc strike current set too low. Poor quality or dirty tungsten electrode. Poor grounding of workpiece through collets and cartridge. Dirty or misaligned workpiece. Tungsten arc gap not properly set. Arc Gas flow set too low or poor quality. <u>Corrective Action:</u> Check weldhead connections and grounding through collets and cartridge. Inspect, clean and refurbish tungsten electrode geometry. Replace with better quality tungsten electrode. Clean and re-align workpiece, adjust tungsten arc gap and Arc Gas flow.
* STATUS: Motor Stall *	ACL indicates weldhead rotor is not turning. <u>Probable Cause:</u> Weldhead Amphenol not properly connected. Tungsten welded to workpiece, keeping rotor from turning. Foreign substance jammed in weldhead gears. Coupler shaft and/or shear pin(s) damaged. Motor/Tach mechanism not functioning. <u>Corrective Action:</u> Reconnect weldhead Amphenol. Dismantle, inspect and clean weldhead, gears, rotor and Motor/Tach mechanism. Replace failed components.
* Disk: Timeout * - Hit Any Key -	Error reading disk. <u>Probable Cause:</u> No diskette in drive or bad diskette. <u>Corrective Action:</u> Insert diskette prior to performing disk drive function. Use formatted diskette.
* DISK: WritePrct * - Hit Any Key -	Error writing to disk. <u>Probable Cause:</u> Write Protect tab on diskette is set to protect (Read Only). <u>Corrective Action:</u> Move Write Protect tab on diskette to Write Mode.
* DISK: No File * - Hit Any Key -	Drive not finding proper files on diskette. <u>Probable Cause:</u> Targeted files cannot be found on diskette. <u>Corrective Action:</u> Locate files prior to erasing from or copying from diskette.
* DISK: No Disk * - Hit Any Key -	Not reading diskette in drive. <u>Probable Cause:</u> No diskette in drive when saving to or erasing from diskette. <u>Corrective Action:</u> Insert diskette in drive prior to performing disk functions.
* DISK: WrongDisk * - Hit Any Key -	Using wrong size disk in drive. <u>Probable Cause:</u> Diskette in drive not formatted to 1.44 Mb. <u>Corrective Action:</u> Remove diskette from drive and use only formatted 1.44 Mb sized diskette.

Section E Troubleshooting

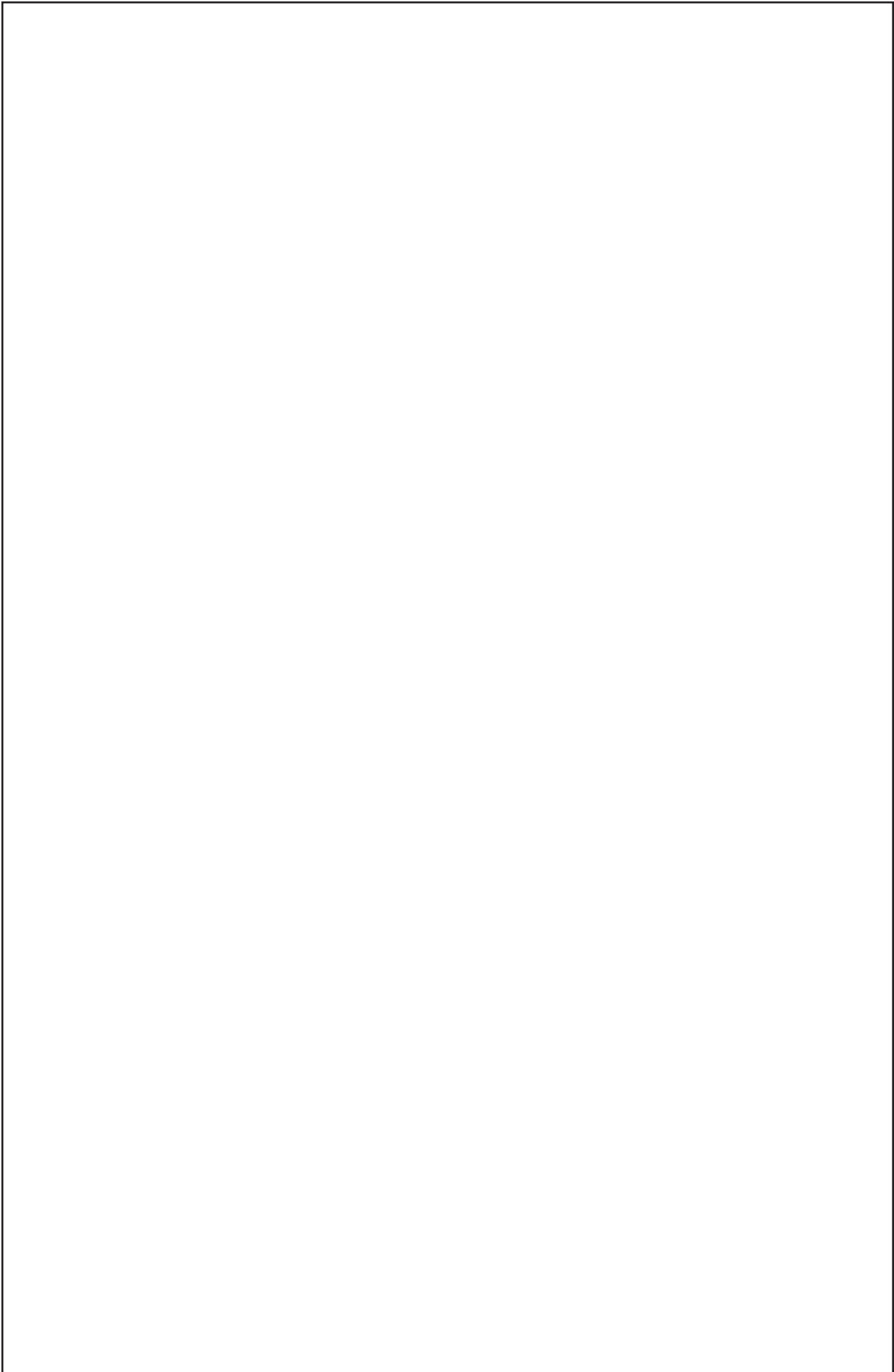
(Continued) Fault Messages

MESSAGE	DESCRIPTION
* Battery Low *	<p>Voltage not within specification.</p> <p><u>Probable Cause:</u> Battery voltage on Memory Board (P/N 003-1806) under 2VDC, minimum.</p> <p><u>Corrective Action:</u> Check battery voltage and replace if below specification.</p>
No power to system . when switched to "ON"	<p><u>Probable Cause:</u> Power cables not properly connected. No line voltage at power outlet. Main breaker and electrical panel tripped.</p> <p><u>Corrective Action:</u> Check main breaker at electrical panel. Check line voltage at outlet. Reconnect power cable plugs at both outlet and ACL.</p>
No power to monitor.	<p>No information on screen.</p> <p><u>Probable Cause:</u> Monitor not turned on. Power/interface cables not properly connected.</p> <p><u>Corrective Action:</u> Turn monitor switch "ON". Inspect and reconnect power/interface connections at monitor and ACL.</p>
* Hand Held Bad *	<p>No communication with HHC.</p> <p><u>Probable Cause:</u> Poor connection at ACL or HHC. Damaged HHC or cable.</p> <p><u>Corrective Action:</u> Reconnect cable at ACL and HHC. Inspect and replace faulty components.</p>
Rotor does not home.	<p>When rotor is commanded to return home, it does not stop and continues to spin.</p> <p><u>Probable Cause:</u> Faulty or mis-aligned reed switch in weldhead. Poor wiring connections in weldhead handle.</p> <p><u>Corrective Action:</u> Inspect and re-align reed switch. Reconnect wiring harness in weldhead handle. Replace faulty connectors and/or reed switch..</p>
** Cal: TIME ** ** DO NOT WELD ** - Hit Any Key -	<p>Weldhead can not be calibrated.</p> <p><u>Probable Cause:</u> Weldhead Amphenol not properly connected. Rotor and/or gears jammed. Motor/Tach mechanism not functioning.</p> <p><u>Corrective Action:</u> Reconnect weldhead Amphenol. Inspect and clear jammed rotor and/or gears and Motor/Tach mechanism. Replace failed components.</p>
* FAULT: WPS Hot * -Hit Any Key	<p>Interface between computer and weld power supply faulty. Opened thermal inside weld power supply.</p> <p><u>Probable Cause:</u> Power supply is hot. Faulty interface boards and/or ribbon cable connections. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Turn ACL off, let power supply cool and try again later. Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>
* DISCR I/O Bad * - Hit Any Key -	<p>Digital interface between computer and weld power supply faulty.</p> <p><u>Probable Cause:</u> Analog self calibration failed. Faulty interface boards and/or ribbon cable connections. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>
* ADC Cal Error * - Hit Any Key -	<p>Analog interface between computer and weld power supply faulty.</p> <p><u>Probable Cause:</u> Analog self-calibration failed. Faulty interface boards and/or ribbon cable connections. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>

Section E Troubleshooting

(Continued) Fault Messages

MESSAGE	DESCRIPTION
+5V Fault ** - Hit Any Key -	<p>Voltage not within specification or faulty. Interface between computer and weld power supply faulty.</p> <p><u>Probable Cause:</u> Faulty power supply or interface. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>
** +24V Fault ** - Hit Any Key -	<p>Voltage not within specification or faulty. Interface between computer and weld power supply faulty.</p> <p><u>Probable Cause:</u> Faulty power supply or interface. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>
** +15V Fault ** - Hit Any Key -	<p>Voltage not within specification or faulty. Interface between computer and weld power supply faulty.</p> <p><u>Probable Cause:</u> Faulty power supply or interface. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>
** -15V Fault ** - Hit Any Key -	<p>Voltage not within specification or faulty. Interface between computer and weld power supply faulty.</p> <p><u>Probable Cause:</u> Faulty power supply or interface. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>
** DAC Cal Error ** - Hit Any Key -	<p>Analog loop test failed. Interface between computer and weld power supply faulty.</p> <p><u>Probable Cause:</u> See ADC Cal Error. Loose ribbon cable connections.</p> <p><u>Corrective Action:</u> Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connection. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>
** FATAL FAULT ** - Hit Any Key -	<p>One or more of the previous FAULTS has occurred to prevent reliable system operation.</p> <p><u>Probable Cause:</u> Previously displayed FAULT.</p> <p><u>Corrective Action:</u> DO NOT WELD. Eliminate cause of previously displayed FAULT. Analyze components using ACL Diagnostic Test Kit (P/N 005-0347). Inspect and reconnect ribbon cable connections. Inspect and replace faulty interface boards, components and/or ribbon cables.</p>



Section F

Diagrams/Parts Lists

List of Schematics

Please contact MK Products at 16882 Armstrong Ave. Irvine, CA (949) 863-1234 for a copy of one of the following schematics:

071-0300	003-1421, WPS Driver Card
071-0301	003-1420, WPS Servo Card
071-0304	003-1369, Base Drive Supply
071-0317	003-1841, TIG ARC PS
071-0318	003-1821, WPS Support Circuitry
071-0319	003-1828, WPS Card Cage
071-0320	003-1878, Test Board
071-0337	003-1806, Memory
071-0338	003-1807, System Interface
071-0339	003-1808, Isolation
071-0341	003-1838, Power Supply Triple Output
071-0344	003-1871, Motor Controller
071-0345	003-1872, System Interface
071-0346	003-1873, Mother Controller
071-0347	001-1225, 254-200 ACL Block Diagram
071-0348	003-1829, Digital Controller
071-0349	003-1836, Block Diagram Power Supply Chassis

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LIMITED WARRANTY

Effective March 1, 2001

This warranty supersedes all previous MK Products warranties and is exclusive, with no other guarantees or warranties expressed or implied.

LIMITED WARRANTY - MK Products, Inc., Irvine, California warrants that all new and unused equipment furnished by MK Products is free from defect in workmanship and material as of the time and place of delivery by MK Products. No warranty is made by MK Products with respect to trade accessories or other items manufactured by others. Such trade accessories and other items are sold subject to the warranties of their respective manufacturers, if any.

MK Products' warranty does not apply to components having normal useful life of less than one (1) year, such as relay points, wire conduit, tungsten, and welding torch parts that come in contact with the welding wire, including gas cups, gas cup insulators, and contact tips where failure does not result from defect in workmanship or material.

In the case of MK Products' breach of warranty or any other duty with respect to the quality of any goods, the exclusive remedies therefore shall be at MK Products' option:

- (1) repair
- (2) replacement
- (3) where authorized in writing by MK Products, the reasonable cost of repair or replacement at our Irvine, California plant; or
- (4) payment of or credit for the purchase price (less reasonable depreciation based upon actual use) upon return of the goods at customer's risk and expense. Upon receipt of notice of apparent defect or failure, MK Products shall instruct the claimant on the warranty claim procedures to be followed.

As a matter of general policy only, MK Products may honor an original user's warranty claims on warranted equipment in the event of failure resulting from a defect within the following periods from the date of delivery of equipment to the original user:

1. **Torches, Weldheads and Water Recirculators** 1 year
2. **All Other Equipment**..... 3 years
3. **Repairs** 90 days

Classification of any item into the foregoing categories shall be at the sole discretion of MK Products. Notification of any failure must be made in writing within 30 days of such failure.

A copy of the invoice showing the date of sale must accompany products returned for warranty repair or replacement.

All equipment returned to MK Products for service must be properly packaged to guard against damage from shipping. MK Products will not be responsible for any damages resulting from shipping.

Normal surface transportation charges (both ways) for products returned for warranty repair or replacement will be borne by MK Products, except for products sold to foreign markets.

ANY EXPRESS WARRANTY NOT PROVIDED HEREIN AND ANY IMPLIED WARRANTY, GUARANTY, OR REPRESENTATION AS TO PERFORMANCE, AND ANY REMEDY FOR BREACH OF CONTRACT WHICH, BUT FOR THIS PROVISION, MIGHT ARISE BY IMPLICATION, OPERATION OF LAW, CUSTOM OF TRADE, OR COURSE OF DEALING, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR PARTICULAR PURPOSE, WITH RESPECT TO ANY AND ALL EQUIPMENT FURNISHED BY MK PRODUCTS, IS EXCLUDED AND DISCLAIMED BY MK PRODUCTS.

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DATE : March 1, 2001



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