TVET CERTIFICATE IV IN WELDING

SPOT WELDING

WELDSW 401 Perform SPOT Welding

Competence

Credits: 7 **Learning hours:70**

Sector: Mining and Manufacturing.

Sub-sector: Welding.

Module Note Issue date: June, 2020

Purpose statement

This specific module describes the performance outcomes, skills and knowledge required to correctly use the spot-welding machine on the different types of sheet metals.

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Learning Unit 1 – Analyze the spot-welding work.

LO 1.1 - Identify the work.

Content/Topic 1: Principles of spot welding.

The resistance spot welding (RSW) processes differ from arc welding in that pressure is used but filler metal or fluxes are not. Four factors involved in making a resistance weld.

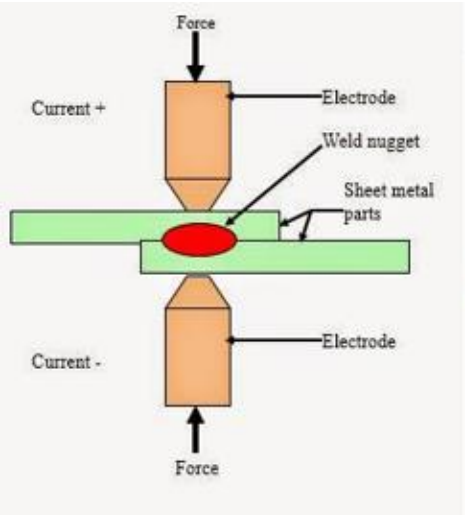
1. The current passes through the work.
2. The pressure that the electrodes transfer to the work.
3. The time the current flows through the work.
4. The area of electrode tip in contact with the work.

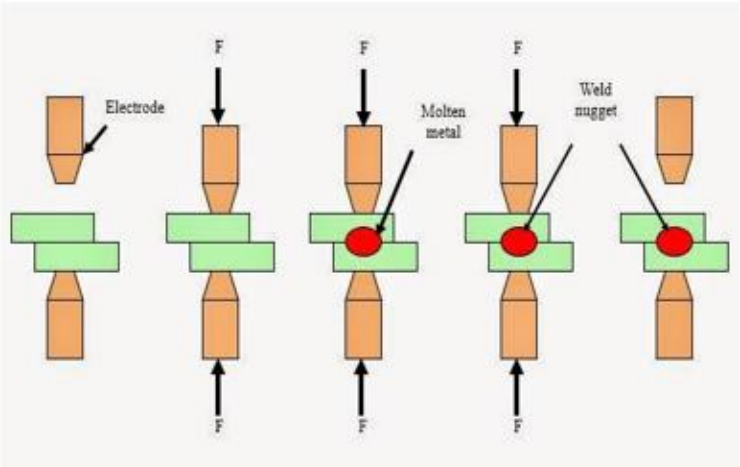
Resistance spot welding is one of the resistance welding (RW) processes, Spot welding was invented and patented in 1885 by an American named Elihu Tompson. The discovery was made while giving a lecture and demonstration on the exciting new field of electricity in 1884.

In response to a question from the audience, Tompson created an experiment and produced the first spot weld. To put the date into perspective, the incandescent light bulb was patented in 1880 by Thomas Edison. The two men, Edison and Tompson, merged their companies, i.e. Edison Electric and Tompson Electric into one company in 1895. They called it General Electric, a company you may have heard of today. Tompson was a prolific inventor with over 700 patents to his credit, Edison never made 700 patents. As a footnote, arc welding was invented in 1885 by a Russian and was based on the carbon arc method.

A spot-welding system needs at least the following components:

1. Welding transformer for supplying power.
2. A means of applying pressure.
3. A controller / contactor.
4. Electrode tips for conducting welding current to the work.





Content /Topic 2: Advantages and disadvantages of Resistance spot welding.

Advantages	Disadvantages
- Spot welding is quick and easy. - There is no need to use any fluxes or filler metal to create a join by spot welding, and there is no dangerous open flame. - Spot welding can be performed without any special skill. - Automated machines can spot weld in factories to speed up production. - The machines used in car factories produce as many as 200 spot welds in six seconds. - Spot welding can be used to join many different metals, and can join different types to each other. - Sheets as thin as 1/4 inch can be spot welded, and multiple sheets may be joined together at the same time. - Comparatively Low cost. - Resistance Spot Welding (RSW) method doesn't need highly skilled worker. - Distortion or warping of parts is eliminated though it leaves some depressions or indentation. - The joint made is highly uniform. - Automatic or semi-automatic operation both can be done. - There is no need for edge preparation. - Welding can be done in quick succession. It just needs a few seconds to make the joint.	- The electrodes have to be able to reach both sides of the pieces of metal that are being joined together. - A particular spot-welding machine will be able to hold only a certain thickness of metal--usually 5 to 50 inches--and although the position of the electrodes can be adjusted, there will be only a limited amount of movement in most electrode holders. - The size and shapes of the electrodes will determine the size and strength of the weld. - The join forms only at the spot where the electrodes are in contact with the metal. - If the current is not strong enough, hot enough or the metal is not held together with enough force, the spot weld may be small or weak. - Warping and a loss of fatigue strength can occur around the point where metal has been spot-welded. - The appearance of the join is often rather ugly, and there can be cracks. The metal may also become less resistant to corrosion. - The equipment cost is high so it can have an effect on the initial cost. - Skilled welders or technicians are needed for the maintenance and controlling. - Some metals need special surface preparation for making the RSW a success. - The thick jobs are not easy to weld.

Content /Topic 3: Application of spot welding.

Spot welding process present many applications, some of them are:

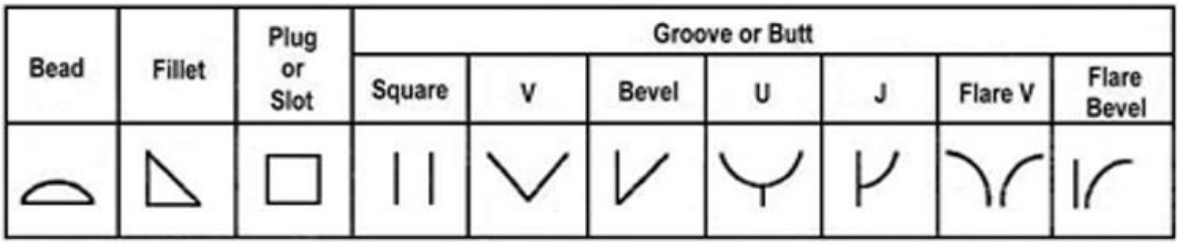
a. Spot welding of thick steel plates has been done and it has replaced the need for riveting.
b. The welding of two or more sheet metals can be joined by mechanical means more economically by using the spot-welding methods. We don't need gas tight joints.
c. Spot welding can be used for attaching braces, pads or clips with cases, bases and covers which are mainly product of sheet metal forming.
d. Automobile and aircraft industries relies greatly of spot welding these days.
e. RSW is commonly used for medical devices and electronic components.
f. Resistance welding is a far more flexible method of joining metals, and it is applicable to a greater range of sizes, shapes and materials than is generally appreciated.
g. Resistance welding is used extensively in the manufacture of composite products. For instance, two steel castings may be flash welded together to form a part that cannot be molded into a single casting.
h. Dissimilar metals are resistance welded to provide, in a single piece, the best characteristics for differing purposes.
i. In the manufacture of railroad cars, the field of application for resistance welding is constantly increasing.

LO 1.2 – Perform hand draft drawing.

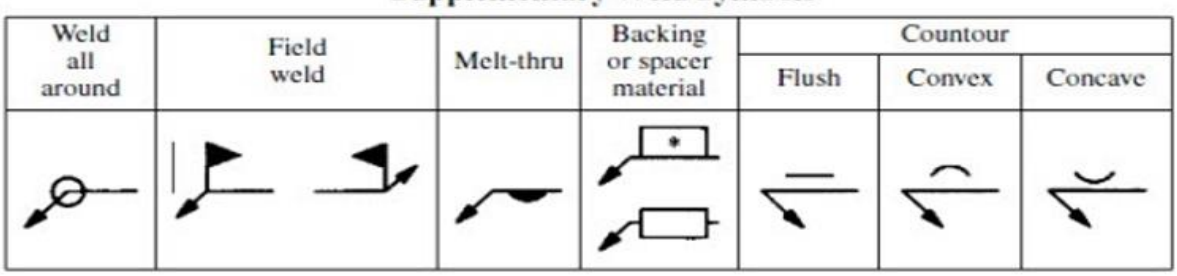
Content/Topic 1: Welding symbols.

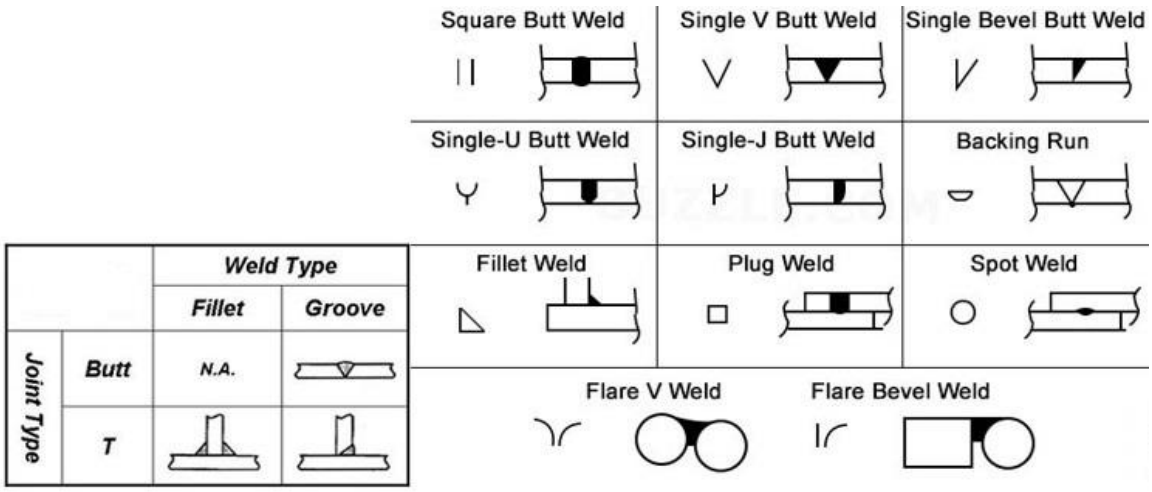
Arrow points to the line or lines on drawing which clearly identify the proposed joint or weld area. The tail of the welding symbol is used to indicate the welding or cutting processes, as well as the welding specification, procedures, or the supplementary information to be used in making the weld.

Basic welding symbols



Supplementary Weld Symbols





LO 1.3 – Estimate the cost.

A cost estimate is the approximation of the cost of a program, project, or operation. The cost estimate is the product of the cost estimating process. The cost estimate has a single total value and may have identifiable component values.

Content/Topic 1: Elements of Bill of quantity.

A. **Types of materials**: is the king or categories of the material.
B. **Quantity of materials**: is the total of materials in number.
C. **Unit price**: the cost of a single material, good or service.
D. **Tax:** a compulsory contribution to state revenue, levied by the government on workers' income and business profits, or added to the cost of some goods, services, and transactions.
E. **Labor cost:** is the cost payed for the worker (who's working).
F. **Overhead cost**: In business, overhead or overhead expense refers to an ongoing expense of operating a business. Overheads are the expenditure which cannot be conveniently traced to or identified with any particular cost unit, unlike operating expenses such as raw material and labor.
G. **Depreciation of equipment:** a statement or account giving the characteristics of someone or something.
H. **Transports:** is the money given for taking goods from one location to another.
I. **Total Cost**: is the total amount of all activity in money, is the total economic cost of production and is made up of variable costs, which vary according to the quantity of a good produced.

Bill of quantity (BOQ) sample.

S. N	*Description*	*Unit*	*Quantity*	*Rate per unit*		*Tax*	*Labor cost*	*Transport*	*Total cost*	*Remark /Depreciation*
				In figure	In words					
1	Angle iron	pc	4	7,300	Seven thousand and three hundred.	3% (21.9)	30	90	7,441.9	
2	Electrode	pck	3	2,400	two thousand and four hundred.	1.5% (3.6)	10	70	2,483.6	
3	Cement	sac	10	6,000	six thousand	3% (180)	40	60	6,280	
4	Sheet metal	pc	5	11,000	eleven thousand	3% (330)	25	40	11,395	
5	Gloves	pair	3	120	One hundred twenty	1% (1.2)	5	7	133.2	
6	…. …… …..	…. …… …..	…. …… …..	…. …… …..	…. …… …..	…. …… …..	…. …… …..	…. …… …..	…. …… …..	
Total				26,720	Twenty-six thousand, seven hundred and twenty.	536.2	110	267	27,733.7	

Learning Unit 2 – Organize the workplace.

LO 2.1 – Arrange the workplace.

Content/Topic 1: Workplace arrangement.

The philosophy of **5 S** represents a way of focusing and thinking in order to better organize and manage workspace, specifically by eliminating the 8 Wastes whose are: *Defects, Overproduction, Waiting, Non-utilized talent, Transportation, Inventory, Motion and Extra processing.*

A. **Sort** – This step focuses on the elimination of any unnecessary workplace clutter (a collection of things lying about in an untidy state). In a process called "red tagging," all workplace items are sorted through, with a red tag placed on any that are not absolutely necessary for completing a task. Once tools, supplies, materials and equipment have been tagged, they are then relocated to a holding area for a follow up evaluation. Items that are only seldom used can be stored closer in proximity to the workspace, while obsolete clutter. a more effective use of space, simplified tasks, a reduction in hazards, and a significant decrease in distracting clutter.

B. **Set in Order** – The goal of this step is to examine methods of storage that are effective and efficient, sometimes referred to as "visual management," and then create a work environment that is organized, ergonomic, uncluttered and easily navigable. Some questions to ask during this step might be: Which specific items are needed to perform a task? How many items need to be readily accessible and where should they be located?

C. **Shine** – With the clutter gone and the storage organized, the next step is to properly and thoroughly clean the work area every day. This step is critical as a way of sustaining the improvements begun in the Sort and Set phases. All storage areas, machines, equipment, tools and work surfaces must be cleaned and checked regularly.

Employees will feel more comfortable in this clean and uncluttered environment, which could also lead to increased ownership of the organization's goals and vision.

D. **Standardize** – Now that the first three steps are in play, it's time to standardize these new practices. All employees need to be included in the creation of a set of standards that will become the new norm for the workspace. When these new standards and best practices are implemented, the old habits will soon die out and be replaced by the more efficient patterns of behavior. New standards, however, will probably require some oversight and enforcement until they are habitual; reminders such as visuals and emails are effective tools to help these new standards become set in stone.

E. **Sustain** – The final step of 5S is certainly the most challenging: remaining disciplined enough to sustain the positive changes made in the first three steps. It is critical that the new system be maintained or the efforts and costs put into developing the new system will be pointless. By putting a formal system in place that includes regular training and communication, employees will be able to comfortably conform to the company's 5S procedures.

The ***5S system*** is not complicated to understand; the challenges lie in successfully implementing the steps and sustaining the practices. Among other things, a successful 5S implementation will improve workplace safety, develop self-esteem among employees and reduce training time for new employees.

Content/Topic 1.1: Workplace layout.

A. **Cleaning of the workplace**: A clean workplace means more than just having a fresh building. A clean workplace also ensures the safety and health of employees, workers and visitors. Here are five reasons why a clean workplace also means a safe workplace:
    1. Clean, dry floors to prevent slips and falls.
    2. Disinfectants prevent the spread of germs and illness, including the flu (influenzas/ a highly contagious viral infection of the respiratory passages causing fever).
    3. Proper air filtration lowers employee exposure to hazardous substances.
    4. Clean light fixtures improve lighting efficiency.
    5. Proper disposal of waste and recyclable materials keeps work areas clutter-free.

B. **Firefighting equipment arrangement**: the following are majors' points to be considered when dealing with firefighting equipment's;
    1. Fire-fighting equipment must be in place for employees to use, without exposing themselves to danger, to extinguish a fire in its early stages.

2. The equipment must be suitable to the risks and appropriate staff will need training and instruction in its proper use.
3. In small premises, having one or two portable extinguishers may be all that is required.
4. Signboards or a safety color (or both) shall be used to mark permanently the location and identification of fire-fighting equipment.
5. Fire safety measures and equipment in the workplace must be kept in effective working order. This includes all fixtures and fittings such as fire doors, staircases, corridors, fire detection and alarm systems, fire-fighting equipment, notices and emergency lighting.
6. Regular checks, periodic servicing and maintenance must be carried out, whatever the size of the workplace. Any defects should be put right as quickly as possible.

In larger or more complex premises, a greater number of portable extinguishers, strategically sited throughout the premises, are likely to be the minimum required. Other means of fighting fire may need to be considered.

LO 2.2 – Select the tools, materials and equipment.

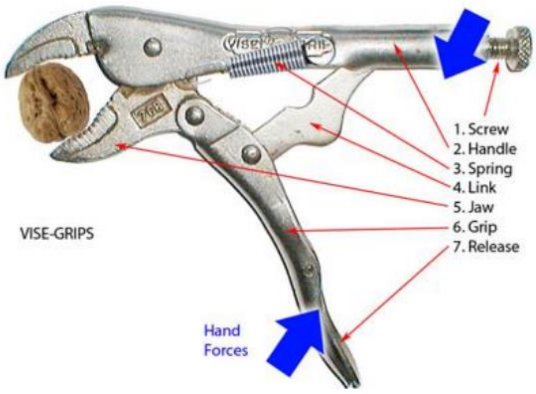
Content/Topic 1: Tools, materials and equipment for spot welding:

A. Tools:

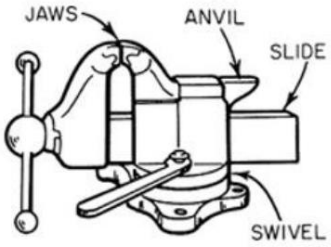
1. Clamping tools

i. **Gripping pliers**: Combination pliers are heavy-duty, side-cutting pliers, also known as lineman pliers or side cutters, which are designed for all regular wire-cutting needs.

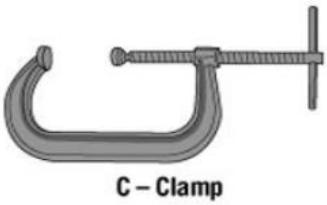
They have gripping jaws, a cutting edge, and insulating handle grips that reduce (but don't eliminate) the risk of electric shock from contact with live wires.

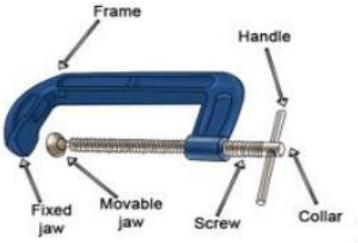


ii. **Vices**: Any of various devices, usually having two jaws that may be brought together or separated by means of a screw, lever, or the like, used to hold an object firmly while work is being done on it.



iii. **Clamps**: A device designed to bind or constrict or to press two or more parts together so as to hold them firmly. And is any of various instruments or appliances having parts brought together for holding or compressing something.





2. Common tools:

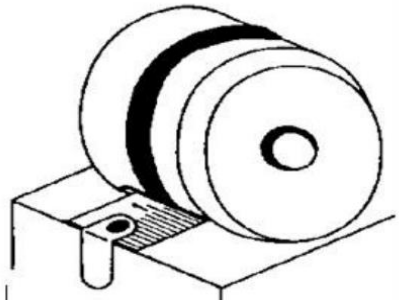
i. **Screw drivers**: A hand tool for turning a screw, consisting of a handle attached to a long, narrow shank, usually of metal, which tapers and flattens out to a tip that fits into the slotted head of a screw. Examples from the Web for screwdriver. It was a tool you used to perform a function, like a screwdriver.

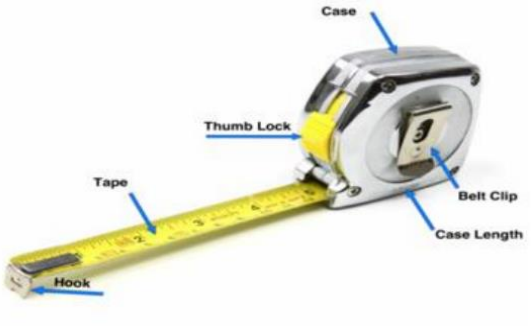
ii. **Spanner:** A wrench is a tool used to provide grip and mechanical advantage in applying torque to turn objects usually rotary fasteners, such as nuts and bolts or keep them from turning.

iii. **Pliers**: Pliers are a hand tool used to hold objects firmly, possibly developed from tongs used to handle hot metal. They are also useful for bending, cutting and compressing a wide range of materials.

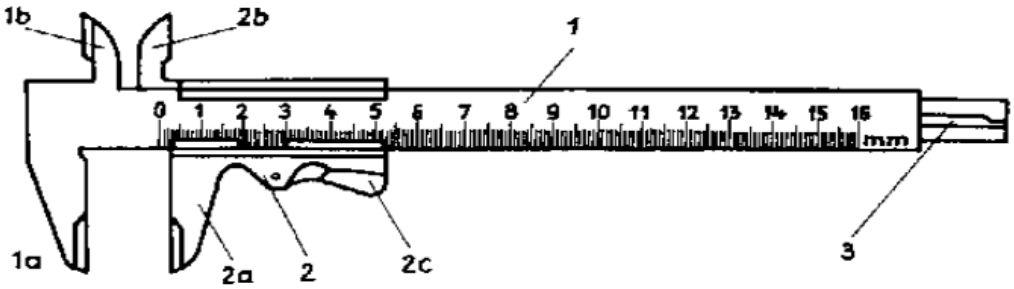
3. Measuring tools

i. **Tape measure**: Steel tape measure rules have often a small sheet-metal angle which makes it easy to apply it at the work piece edge (fig. below).





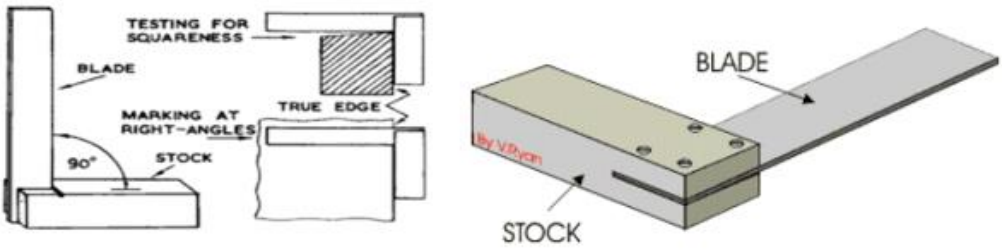
ii. **Vernier caliper:** Is a device used to measure the distance between two symmetrically opposing sides. A caliper can be as simple as a compass with inward or outward-facing points. The tips of the caliper are adjusted to fit across the points to be measured, the caliper is then removed and the distance read by measuring between the tips with a measuring tool, such as a ruler.



iii. **Steel rule**: For making marking out, measuring is required in short lengths; the steel rule is given preference in metalworking. It is handier and its graduation is precise than steel tape rule. The simplest length measuring tools are steel rule and steel tape rule. The steel rule (fig. below) has a length of 300 mm or 500mm.

Steel rule, 300 mm long

iv. **Square**: It is used for checking the straightness and the squareness of a work piece. It can also be used for marking perpendicular lines onto a work piece.



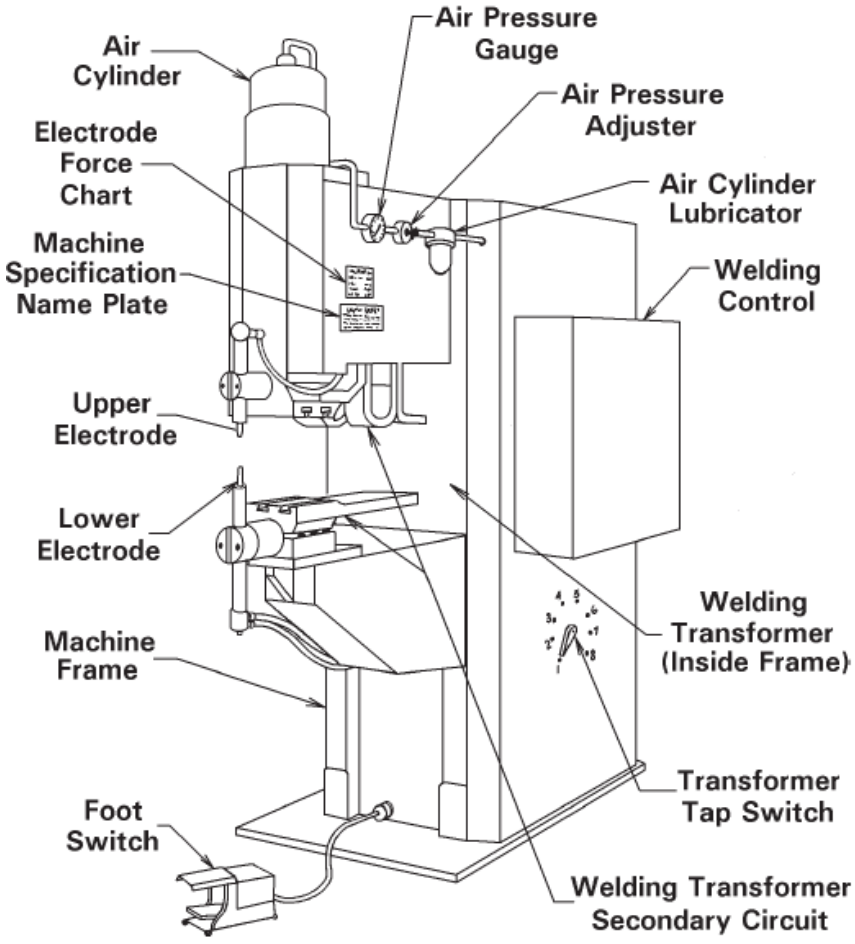
v. **Protractor:** Protractors are used for measuring or constructing angle which cannot be obtained by set squares. Protractor can be flat, circular or semicircular. Protractor is usually made from box wood or ivory.

4. **Cleaning tools**: Broom, Dustpan and Mop: This is obvious. Bucket: A nice sized bucket can not only stow your cleaning supplies, but also be used for mopping, or any other of a multitude of household tasks. 9. Scrub Brush: A sponge or cloth isn't always going to work, so keep a bristle scrub brush on hand to use on tough stains.

B. Equipment:

1. Spot welding machine and accessories

a) Spot welding machines are available in two categories: *single-point or single spot machines and multiple-point machines.* The single spot machine is manual operated, rated at 2Kva with a short circuit current of 6,000 A and capable of welding 20-gauge and thinner carbon steel.


Air Cylinder
Air Pressure Gauge
Air Pressure Adjuster
Electrode Force Chart
Air Cylinder Lubricator
Machine Specification Name Plate
Welding Control
Upper Electrode
Lower Electrode
Welding Transformer (Inside Frame)
Machine Frame
Transformer Tap Switch
Foot Switch
Welding Transformer Secondary Circuit

b) The accessories: A successful resistance spot welding process generally requires a welding power supply, a spot-welding head, and a weld monitor or weld checker. Selecting the right accessories for these critical components can enhance and improve your results, and provide additional safety for your operators. In the following datasheet you will find:

i. Handpieces: Generally speaking, welding handpieces should be used only when it is impractical to use a welding head. Their relative ease of use, combined with low maintenance and flexibility, make them well suited for small batch production.

The Model GHP and HDHP are switch fired handpieces and can be used to weld or tack materials that don't require stringent force control.

ii. Optic Accessories: The Model SMZ-660 Stereo ***Zoom Optic Pod (1*)** is supplied with 10X Eyepieces and a 0.5X Objective Lens. It provides magnification which is adjustable from 4.0-25X and a working distance of 211 mm. Its lightweight housing is airtight, anti-mold and anti-electrostatic.

The Model OMA optic mounting assembly (2) provides the posts and hardware required to support the optic pod. ***The Model BPTL, Thin-Line base plate (3)*** is drilled to accept all TL-080B Thin-Line weld heads and the optic mounting assembly. ***The BLFOI fiber optic illuminator system (4)*** transmits light through bifurcated, fiber optic light guides to produce cool, flicker-free, high-intensity light at the worksite.

iii. **Chillers, Fume Extractors, Pull Tester:** Water chillers are necessary for cooling higher powered welders.

They control the temperature of the water to keep condensation from building when facility water cannot. The following chillers provide the necessary cooling capacity for the approximate kVA Rating running at full power and duty cycle.

Fume extractors are necessary to remove harmful airborne particles so that operators and engineers are not exposed.

These sometimes-toxic fumes need to be collected and properly filtered.

Pull tester is one method to test the strength of a weld is to pull the two joined materials apart. The 200 lbF pull tester can be configured for tension or compression testing applications up to 200 lbF (890 N) for laboratory and production needs.

iv. **Footpedals and Footswitches:** The Model FS2L two-level footswitch is intended for use with all AMADA WELD TECH power supplies. The first level actuates the weld head via the air valve driver of the power supply; the second level, along with the force firing switch in the weld head, initiates the welding current.

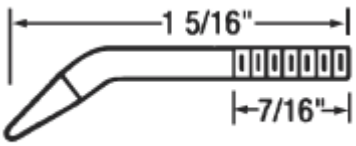
The Model FS1L one-level footswitch also may be used with all AMADA WELD TECH power supplies. The single level switch actuates the weld head and initiates the welding current simultaneously (when the firing switch closes).

The MODEL FS Single level Firing Switch without safety guard. Used to fire power supplies immediately upon initiation.

The Model CP cable pedal pivots under the heel for optimum force control. It is equipped with an adjustable down-stop which prevents the application of excess force, it is rated at 25 pounds.

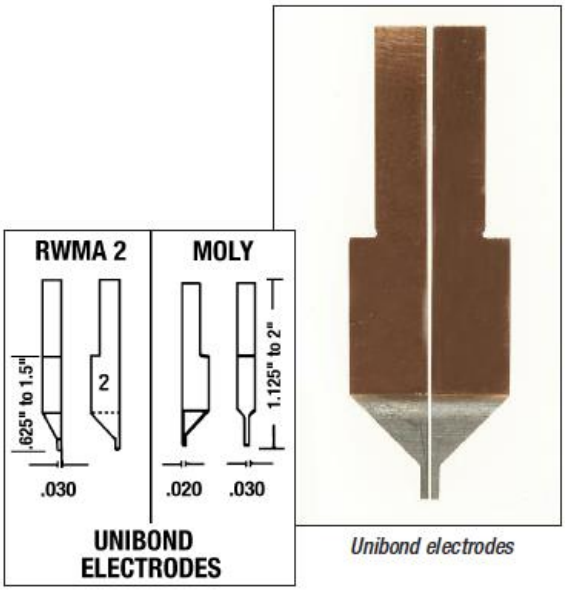
v. **Electrode Force Gauges:** Electrode force gauges are used to establish weld schedules and to calibrate weld heads and handpieces. They are color coded to indicate the usable force range. The accuracy is ±2% of full scale.

vi. **Electrode Material and Electrodes:**



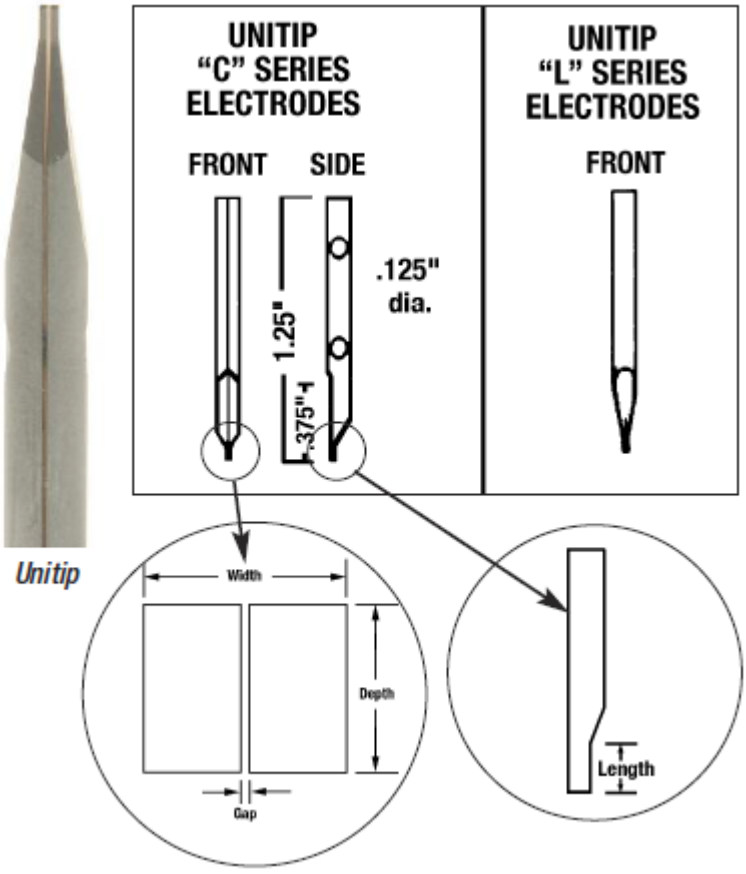
EP0400 Series Electrodes

vii. **Unibond and Unitip Electrodes:** Unibond electrodes are used for parallel gap bonding and reflow soldering. Generally, RWMA2 copper Unibond electrodes are used with resistive and/or hard materials such as gold plated kovar and nickel. Molybdenum Unibond electrodes are used for bonding conductive or soft materials such as copper or gold.



Unibond electrodes

Unitips are electrodes for parallel gap bonding of gold plated kovar, copper, or gold ribbons (wires) which are smaller than 0.010 in (0.25 mm). They are made from two pieces of molybdenum, which are permanently bonded to an insulating spacer. This fixed gap and bonded construction results in a tip which wears uniformly when properly dressed.



Unitip

viii. **Polishing Disks, Tab Material:** Model PD Polishing Disks, 600 and 1000 grit silicon carbide, 1.5 in diameter, Package of 50.
Model CPD Ceramic Polishing Disks,1 in square x .025 in thick. Package of 20.

1 ½ in dia, polishing disk

1 in square ceramic polishing disk

ix. **Cables, Terminals and Connectors:** Our connectors for primary circuit lines guarantee reliable power supply to welding units.

The Welding Cables are used for the transmission of high currents from the electric welding machine to the welding tool.

In order to weld wires and components to terminal connectors, we adapt tools to your application or re-design them.

Connectors

cables

terminals

x. **Electrode Holders and Adapters:** Electrode Adapters are used to improve electrode holder life and flexibility by allowing the adapter to be replaced when the taper wears out. The standard electrode adapters are made from RWMA Class 2 alloy. Other Alloys are available upon request.

Electrode Adapters can mount to a holder via threads or RWMA tapers.

Electrode holder

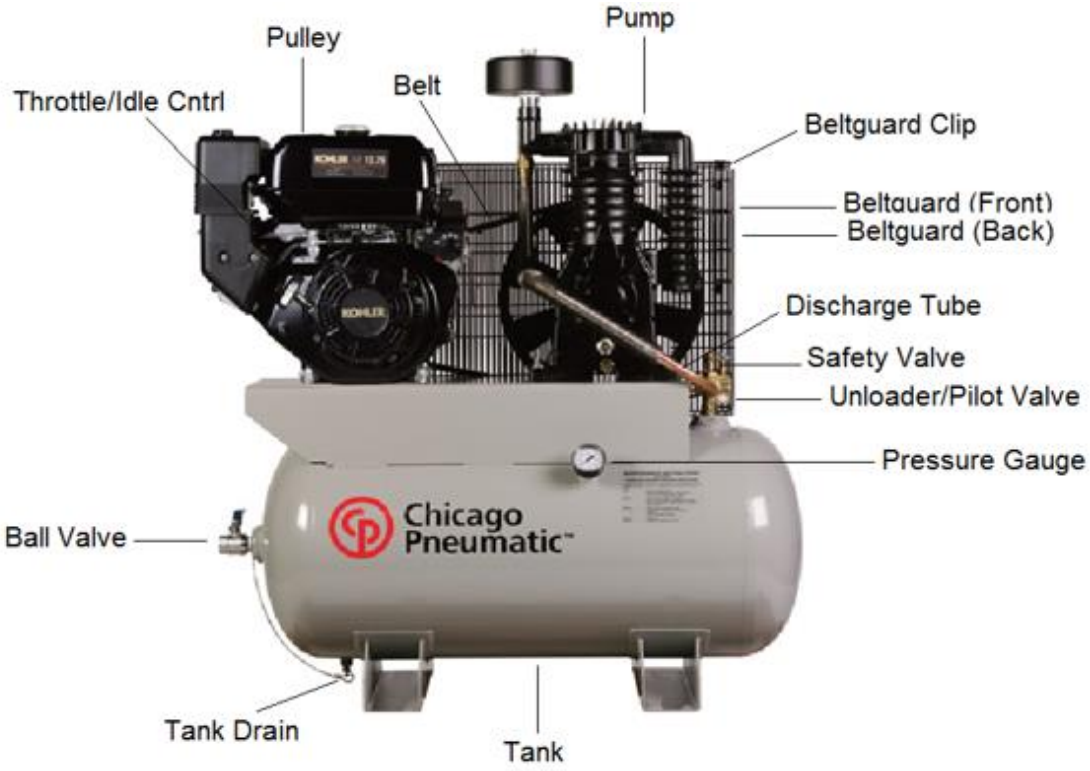
electrode adapter

xi. **Starter and Calibration Kits:** Starting new welding project can seem daunting at first. Not only do you need to purchase the welding equipment, but also need to consider peripheral equipment to ensure that the process is successful

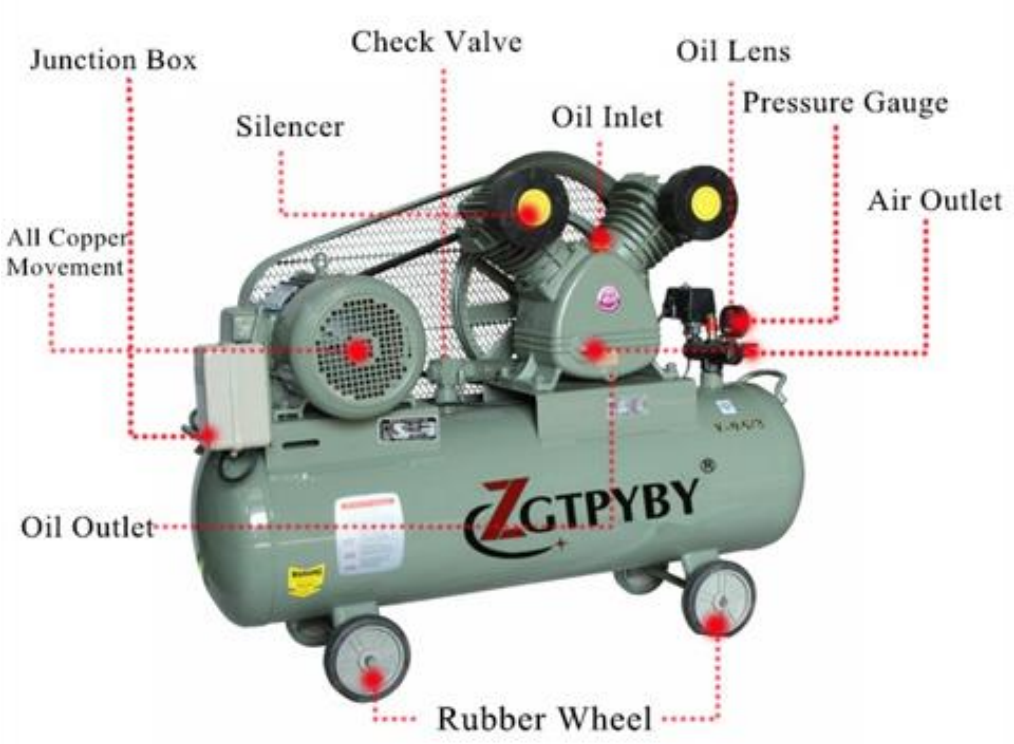
and safe. We have created start-up kits for the different products to help you get started.

Calibration of your equipment is essential to maintain proper operation, calibration should be done on an annual basis. These kits include everything needed to calibrate the UB/DC25 or HF-2500A/HF-2700A power supplies. Choose the kit with or without oscilloscope depending on your needs.

2. **Air compressor:** An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When the tank's pressure reaches its engineered upper limit, the air compressor shuts off. The compressed air, then, is held in the tank until called into use.



diesel or gasoline engine air compressor



electric motor air compressor

C. Materials:

1. **Mild steel:** Carbon Steel can be segregated into three main categories: Low carbon steel (sometimes known as mild steel); Medium carbon steel; and High carbon steel.
    i. **Low Carbon Steel (Mild Steel):** Typically contain 0.04% to 0.30% carbon content. This is one of the largest groups of Carbon Steel. It covers a great diversity of shapes; from Flat Sheet to Structural Beam. Depending on the desired properties needed, other elements are added or increased. For example: Drawing Quality (DQ) – The carbon level is kept low and Aluminum is added, and for Structural Steel the carbon level is higher and the manganese content is increased.
    ii. **Medium Carbon Steel:** Typically has a carbon range of 0.31% to 0.60%, and a manganese content ranging from .060% to 1.65%. This product is stronger than low carbon steel, and it is more difficult to form, weld and cut. Medium carbon steels are quite often hardened and tempered using heat treatment.
    iii. **High Carbon Steel:** Commonly known as “carbon tool steel” it typically has a carbon range between 0.61% and 1.50%. High carbon steel is very difficult to cut, bend and weld. Once heat treated it becomes extremely hard and brittle.

2. **Stainless steel**: Stainless steel is a steel alloy with increased corrosion resistance compared to carbon/alloy steel. Common alloying ingredients include chromium (usually at least 11%), nickel, or molybdenum. Alloy content often is on the order of 15-30%.

Common applications include food handling/processing, medical instruments, hardware, appliances, and structural/architectural uses.
Stainless Steel can be purchased online and at any Metal Supermarkets location. It is available in a wide variety of shapes such as bar stock, channel, beam, angle and more. It can be cut to your exact specifications.

3. **Steel alloys:** Alloy steel is a steel that has had small amounts of one or more alloying elements (other than carbon) such as such as manganese, silicon, nickel, titanium, copper, chromium and aluminum added. This produces specific properties that are not found in regular carbon steel. Alloy steels are workhorses of industry because of their economical cost, wide availability, ease of processing, and good mechanical properties. Alloy steels are generally more responsive to heat and mechanical treatments than carbon steels.
   The heat-treated type is available in both Annealed and Normalized. To learn more about Annealing and Normalizing, visit our Metal Glossary, Alloy Steel can be purchased online and at any Metal Supermarkets location. It can be cut to your exact specifications.

4. **Aluminium**: Aluminum is a silver-colored, low density metal. It finds use in a huge variety of commercial applications. The Unalloyed type is ductile, exhibits moderate strength, and is very resistant to corrosion under most circumstances. Aluminum can be dramatically strengthened by the addition of appropriate alloying elements (Cu, Mg, Mn, Si, etc.) and subsequent heat/work treatments. It is commonly used in both wrought and cast forms.
   The low density of this metal results in its extensive use in the aerospace industry, and in other transportation fields. Its resistance to corrosion leads to its use in food and chemical handling (cookware, pressure vessels, etc.) and to architectural uses. Aluminum can be purchased online and at any Metal Supermarkets location. It can be cut to your exact specifications.

LO 2.3 – Set up spot welding machine.

Content/Topic 1: Assemble the equipment.

As with all machinery, a safety inspection should be made to assure proper installation and use of the welder.
Operators must wear suitable eye protection and shop clothing. The manufacturer's operating manual should be reviewed to familiarize operating personnel with the functioning of the welder as well as any special features.

The following procedures are based on use of a pneumatically operated, single-phase AC spot welder

1. Turn on the compressed air and water to the welder. Check for adequate water flow and air pressure, then turn on the electrical power to the welder.
   ***NOTE*:** Air and water should be turned on before power.
   Some installations may incorporate an electronically operated solenoid valve which turns on the water only when the power to the welder has been turned on.
2. Adjust the air pressure regulator to the required air pressure to obtain the desired electrode force.
3. Energize the welder control panel if a separate switch was provided for this purpose.
4. Set "Squeeze" time to the maximum setting.
5. Adjust "Weld" time (also referred to as weld count or heat time) sequence to the recommended setting for the type and thickness of material to be welded.
6. Set "Hold" time sequence to provide adequate time for the hot weld nugget to cool while held under the electrode force.
7. Set "Repeat" switch to non-repeat position.
8. Consult welder operating manual or specification sheet to determine nominal maximum weld current which can be produced at the throat depth you are using.
9. If the welder transformer is equipped with a tap switch, adjust the tap to the position which approximates the required weld current output and set phase shift at 50%.
10. Place the "Weld/No Weld" switch into the "No-Weld" position.
11. If so equipped, use the electrode alignment valve to bring the electrodes together without air pressure. Check the electrode alignment and stroke.
12. If applicable, place the welders "Run/Set-up" switch in the "Run" position.
13. Initiate and operate the welder through a complete sequence with parts between the electrodes. Check tip alignment, downstroke and upstroke speeds and adjust the speed control valve if necessary.
14. Place the "Weld-No Weld" switch in the "Weld" position.
15. Place a sample workpiece between the electrodes, exercising care to keep fingers, clothing, etc. in the clear.
16. Initiate and sequence the welder. Check the weld current and time analyzer to determine actual current and time. If the analyzer shows a lower or higher current than desired, adjust the phase shift accordingly
17. Remove and examine welded sample. Indentation should not exceed 10% of the material thickness.
18. If testing discloses a weak weld or a no weld condition, it will be necessary to increase weld current intensity as in step #16. If, on welders having transformer taps and phase shift, and 99%/100% is reached before a good weld is obtained.
19. When satisfactory welds have been made, the squeeze and hold sequence times may be adjusted to optimum settings. Consult weld schedules for recommended hold times.

20. If automatic repeat welding is required, place the “Repeat/Non-Repeat” switch into the “Repeat” mode and adjust the “Off or Interval” time sequence to a sufficient length of time to permit the workpiece to be moved into position for the next weld.

Content/Topic 2: Electrode.

Our welding electrodes made of tungsten, molybdenum and their alloys are particularly suitable for welding highly conductive materials such as copper. They are used in the following processes: Spot welding, Roller welding, Projection welding, Upset welding.

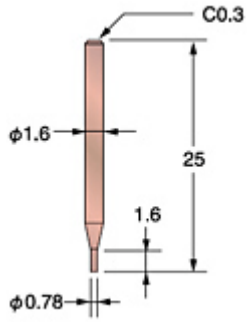
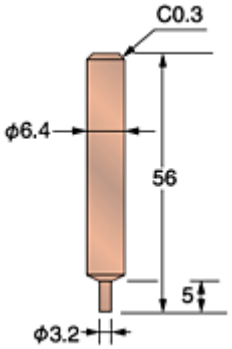
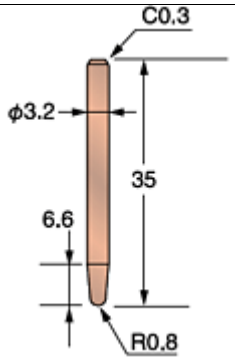
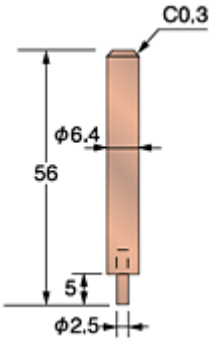
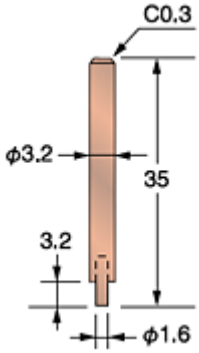
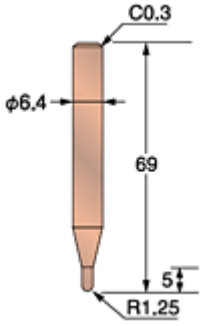
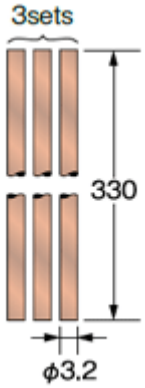
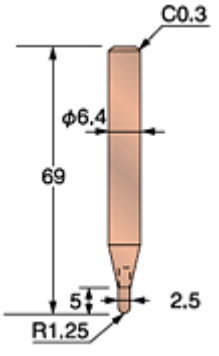
Electrode tips are made of copper alloys and other materials. The Resistance Welders Manufacturing Association (RWMA) has classified electrode tips into two groups:

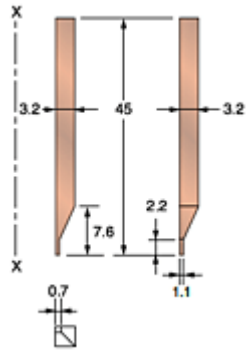
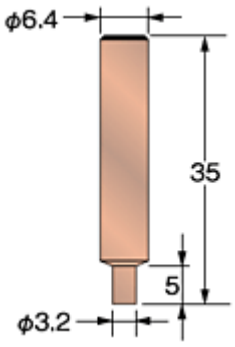
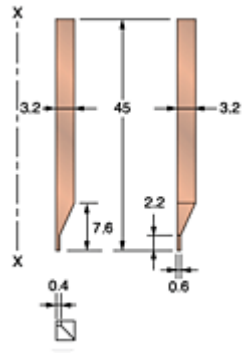
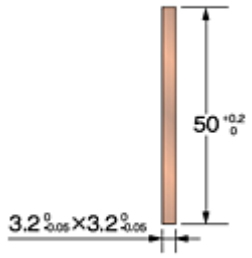
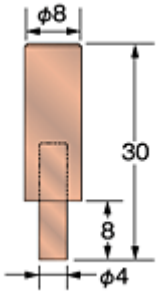
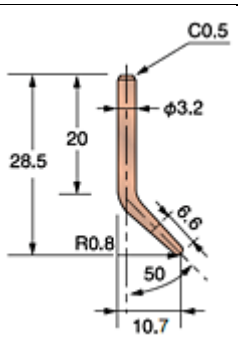
i. Copper based alloys
ii. Refractory metal tips.

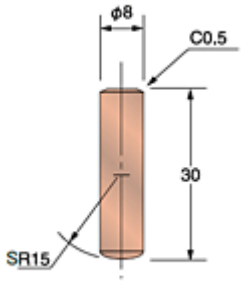
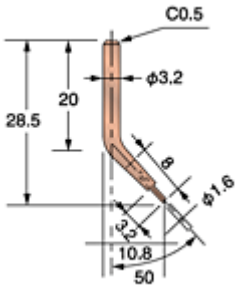
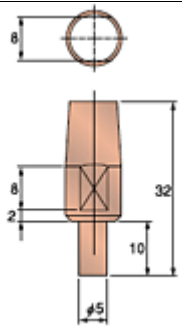
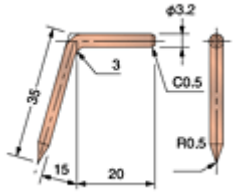
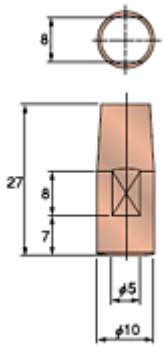
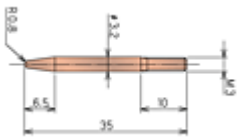
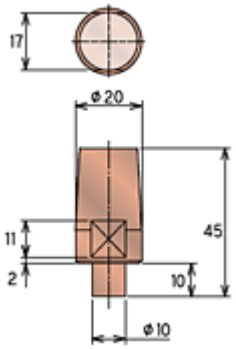
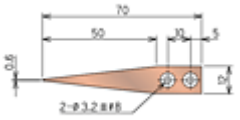
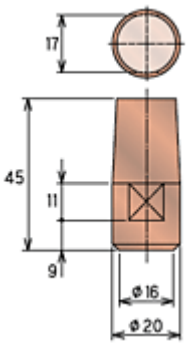
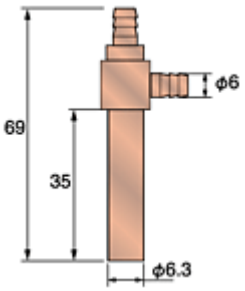
Diameter of the electrode contact surface used to determine the weld diameter. Weld diameter is a measure of weld quality. As the welding progresses the diameter of the electrode will change due to effect of wear. Weld diameter (*nugget diameter*) is determined based on the number of spot welds that has been made with the electrode. Generally, the nugget diameter is slightly less than the contact electrodes diameter.

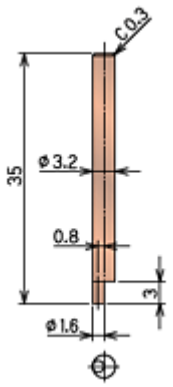
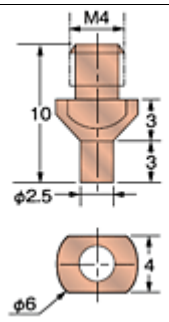
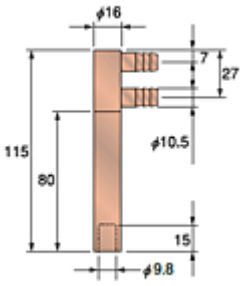
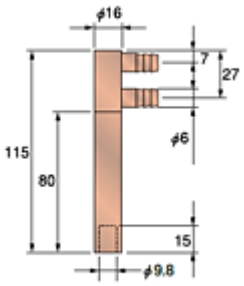
Welding Electrode

Electrode Number	**Alloy Components**	**Electric Conductivity (IACS%)**	**Applicable Metal**
02(equivalent to RWMA-2)	Cu-Cr-Zr	around 80%	iron, nickel, chrome and their alloys
03(equivalent to RWMA-3)	Cu-Ni-Be	around 50%	phosphor bronze, brass
00	pure Mo	around 31%	tinned copper wire, solder plating copper wire
11 (equivalent to RWMA-11)	Cu (30%) -W (70%)	around 46%	noble metal
13 (equivalent to RWMA-13)	pure W	around 32%	copper
20	Cu-Al_2O_3	around 80%	Battery Tab

Electrode Number	Shape	Applicable Weld Head	Electrode Number	Shape	Applicable Weld Head
EH-062-02A		NA-121 NA-141	EH-250-02A EH-250-03		NA-122 NA-123 NA-124 NA-142 NA-143 NA-60A NA-43
EH-125-02A EH-125-03 EH-125-20		NA-121 NA-122 NA-123 NA-141 NA-142 NA-143 NA-60A	EH-250-00A EH-250-11A EH-250-13A		
EH-125-00A EH-125-11A EH-125-13A			EO-250-02A EO-250-03		
CC Alloy (3.2ϕ)			EO-250-00A EO-250-11A EO-250-13A		

EP−711−00F EP−711−02F				EH-250-02S		
EP-406-00F EP-406-02FA						
Molybdenum Square Bar		NA−131 NA−132 NA−141 NA−142				
EH-80-00		NA-124		EL-125-02A EL-125-03		NA-54A

EH-60C			EL-125-00A EL-125-11A EL-125-13A		
EH-F-00		NA-125 NA-72	EL-54LA		NA-54LA
EH-F-02			EH-57A-02A		NA-57A
EH-200-00A		NA-126	EH-58A-02		NA-58A
EH-200-02A			EHC-250M4		NA-60A Water Cooling Shank

EH-125-02E EH-125-20E		NA-141 NA-142 NA-143	WT-M25M4-00 WT-M25M4-02		
			EHC-F		NA-72 Water Cooling Shank
			EHM-72		NA-72 Water Cooling Shank Set

A. Preparation of spot electrode: Spot welding even with the advent of "smart" welders is a complicated process, here I list five (**5**) things to do before you weld.

1) Clean the electrodes: Sounds easy but you would be amazed how many people do not understand the importance of electrode shape. This was chosen so that large spot weld diameter could be achieved without indenting into the steel too much and thinning it out in the HAZ (heat affected zone) area.

2) **Carry out a test tag:** Always carry out a test tag prior to welding on the vehicle, this is important even if you have a "smart" welder. The reason for the weld tag is 2-fold:

I. To ensure you have the correct setting for the panel you want to weld on the vehicle.

ii. To ensure you have the correct nugget diameter.

3) **Observe manufacturers methods:** Some manufacturers methods sheets are excellent, Vauxhall and Peugeot being good examples as they either give you a set programmed for the panel to be welded or the correct welding

parameters. Some are very vague though giving little information apart from a few dots on a drawing.

4) **Prepare spot weld areas:** Explosions are not the fault of the welder, they are the fault of joint preparation or electrode preparation.

5) Observe your weld: Welds will alter a little according to the type of stack you are welding (resistance of the joint) so observing the weld appearance as you weld will vastly improve your weld quality. Many welders have indicators when a weld has finished, green lights, beeps, OK on display and many more. These do not mean you have performed a good weld, they just mean the welder has met its programmed criteria.

B. **Care of spot electrode:** Electrode life is defined by a limiting nugget size or the insufficient resulting mechanical properties of the joint, in general. In case of bare steel sheets, nugget size is mainly limited due to a mechanical deformation of the welding electrode. This decreases the current density necessary for the formation of a sufficient large lens diameter.
In addition, factors limiting electrode life welding bare steel sheets are based on the chemical composition of the steel sheet, e.g., silicon or carbon contents. Electrode cap surface will be changed due to element diffusion during welding and electrical as well as mechanical properties will be changed. Thus, chemical composition of steel sheets is limited for certain elements that are known to directly negatively influence resistance welding (e.g., silicon and carbon).

C. **Positioning spot electrode:** The pieces to be processed must be positioned on a solid, non-deformable surface in order to ensure that the gun and the welded pins are perpendicular. moreover, a solid surface will prevent deformation, which is especially important if the piece in question is of limited thickness.

- First of all, select the pin holder that most closely matches the diameter of the pin to be welded (ϕ 4 mm).
- Then adjust the overhang of the pin beyond the copper pin holder by around 2 - 3 mm by moving the limit screw, which will then be blocked by the counter nut.
- It is then necessary to insert the adjusted pin holder into the gun, tightening the nut using the box spanner while also ensuring that the tripod feet are stable.
- Move the pin into the desired position by applying light vertical pressure on the gun.

- The pre-compression of the spring can be adjusted by turning the ring nut on the gun clockwise to increase or anticlockwise to decrease.
- The level of pre-compression is shown by the indicator on the left--hand side. adjusting the pre-compression changes the speed at which the pin is immersed into the welding bath, thus ensuring optimum results.
- While maintaining the chosen gun position, pull the trigger to initiate the welding cycle and then remove it from the welded pin vertically, without twisting the gun, which could damage the pin holder.
- It is good practice to ensure that the pin holder is properly attached to the pin in order to avoid damage to the external surface of the pin and electrode.

Content/Topic 3: Current setting timing.

Many methods have been used to control the time of a resistance weld. Even some mechanically controlled machines are still operating quite well, when less control sophistication is required. Weld controls can be grouped as three basic types:

1) mechanical and electro-mechanical timers;
2) analog, both vacuum tube and solid-state timers; and
3) digital timers, both discrete component and microprocessor-based (including mini-computers).

Timing was also controlled by one of several mechanical or electro-mechanical means. Rotary, split cam timers were used, as well as pneumatic timers, springs and manually operated switches. These types of timers are seldom seen in production today.

With the introduction of analog, resistor-capacitor (RC) time controls, users eventually gained the ability to provide better timing adjustment of the welding current. The time duration could be adjusted by a front panel switch or potentiometer, calibrated in cycles of the line frequency.

There are four (4) basic types of power supplies used in Resistance Spot Welding (RSW).

A. **Direct Energy / Inventor (AC) Power Supply,** which provides alternating current (AC) of the same frequency as the input power line;
   i. High Output Power - Delivers 16,000 Amperes Maximum Current
   ii. Store Up to 255 Welding Conditions for Multiple Welding Applications
   iii. Easy to Control Welding Conditions (Welding Waveform Display, Memory Function)
   iv. Multiple Safety Features (Detection of Overcurrent, Overheating, No Current, etc.)
   v. Monitor Important Functions (Current, Voltage, Power, Resistance, Trace)

B. **Capacitor Discharge (CD)** Power Supply, which provides the weld current by discharging the energy stored in a capacitor bank; **Suitable for Welding of Battery Tab, Aluminum and Copper.** Using large-capacity energy storage, with quick release of weld energy (discharge time on the order of a few ms).

C. **Mid Frequency Inverter (MFDC)** Power Supply, which controls the weld energy by means of mid frequency switching technology; This product is High reliability inverter type resistance welding power supply which realizes high definition control. Free inverter frequency selection type and 127 step free style welding profile which realize high reliability welding in variety welding scenes. By Program Box that remote control is possible, it will improve more freedom in terms of arrangement of welding power supply in an automated system. Automation machine type welding power supply which equipped high dustproof.

i. Selectable frequency (2k, 4k, 5kHz)
ii. 127 steps (Slope, weld, cool) parameter setting
iii. Variation of weld stop: Less than 1ms
iv. Enhanced dust-proof structure (Dust, oil mist)
v. Remote control by program box

vi. Multiple power source 3-phase AC200V to 480V
vii. Ethernet Connection.

D. **Direct Current (Linear DC)** Power Supply, which provides pure DC weld current through power transistors working in their linear range. Transistor type welding power supply is suitable for precise welding of superfine wires and micro components.

i. Consistent and precise welding by high speed linear control
ii. 3 control modes: constant current, voltage, and power
iii. High productivity by high speed welding: 5 shots / sec
iv. Pre-weld check function reduces spark problem
v. Simultaneous graphic display of V, I and W waveform.

Most large -scale resistance spot welding (LSRSW) systems use direct energy (AC) power supplies. Downsized welder power supplies are used for small -scale resistance spot welding SSRSW systems.

Content/Topic 4: Setting pressure and adjustment.

The effect of pressure on the resistance spot weld should be carefully considered. The primary purpose of pressure is to hold the parts to be welded in intimate contact at the joint interface. This action assures consistent electrical resistance and conductivity at the point of weld.
The tongs and electrode tips should not be used to pull the workpieces together. The resistance spot welding machine is not designed as an electrical "C" clamp! The parts to be welded should be in intimate contact before pressure is applied.

Investigations have shown that high pressures exerted on the weld joint decrease the resistance at the point of contact between the electrode tip and the workpiece surface. The greater the pressure the lower the resistance factor.
Proper pressures, with intimate contact of the electrode tip and the base metal, tend to conduct heat away from the weld. Higher currents are necessary with greater pressures and, conversely, lower pressures require less amperage from the resistance spot welding machine. This fact should be carefully noted, particularly when using a heat control with the various resistance spot welding machines.

Learning Unit 3 – Perform spot welds.

LO 3.1 – Prepare work pieces.

Well it really depends on the situation in which the weld is needed, but pulser (a machine that produces pulses. a device to produce pulsation in a liquid). nailed it for a general answer as far as cleaning the steel. Depending on the situation you may need to bevel a plate edge or gouge a crack. If this is just for practice and its new metal just run over it with a grinder to knock the mill scale off and go to work. Also, what type of welding will you be performing? I thought you just crank up the amps a little more to burn thru the rust and dirt.

Content/Topic 1: Positioning the work pieces.

Welding positioner also named as welding rotating worktable, which is mainly used for welding and assembling parts, it makes the workpiece in the best welding or assembly position through the turning over of the mechanism for welding and assembly. It is widely used in the welding of flange and pipe fitting joints, as well as the inversion of construction machinery and the position conversion of various welding structures. It can also be used as robot peripheral equipment to realize welding automation. It greatly improves the quality of welding, at the same time can reduce the number of work handling, reduce the labor intensity of workers, quickly improve the labor efficiency.

The welding positioner series are side tipping type, head and tail rotation type, head and tail lifting rotation type, head and tail inclined type and double rotation type, etc. Special customized welding rotating worktable are available to meet clients' different requirement.

Different welding positioner with load capacity from 50kg to 200Ton, with electric type or hydraulic type, to meet client’s different requirement for welding positioner.

The welding positioner with pedestal structure, and the worktable adopts AC frequency conversion stepless speed regulation, with uniform rotation speed and no crawling, meet the requirement of welding workpiece for the speed of rotation.

The frame is made of section steel and steel plate, with reasonable structural design and good bending and torsion resistance.

The work table surface is a circular structure, which is processed with equidistant concentric circles. The radial T-slot (T-bolt) is processed on the table, which is convenient for alignment of workpiece and easy to install all kinds of positioning and clamping tools.

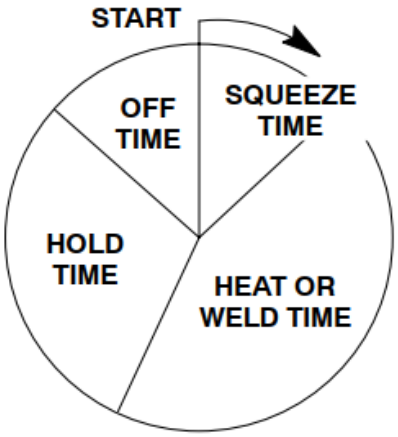
The tilting mechanism adopts worm reducer with self-locking function and brake motor to realize double braking function to ensure the safe and stable operation of the reducer in the tilting process.

A conductive device is installed under the work table to form a good conductive circuit of welded ground wire, so as to avoid over-electricity of rotary support, which will affect its

service life. Equipped with different control modes: electric control cabinet, pendent control or remote control.

LO 3.2 – Perform Spot welds.

Content/Topic 1: Spot welding time cycle.



A. **Squeeze time:** Is the time between pressure application and weld, Squeeze time is the period of time programmed into the weld controller, typically between the command to close the electrode and the beginning of weld time (sometimes referred to as the programmed squeeze time).
B. **Weld/ heat time:** Is a weld time in cycles, Post Weld Heat Treatment (PWHT) is a controlled process in which a material that has been welded is reheated to a temperature below its lower critical transformation temperature, and then it is held at that temperature for a specified amount of time.
C. **Hold time:** Time that pressure is maintained after weld is made, hold time is defined as the minimum amount of time after the clock's active edge during which data must be stable
D. **Off time**: Electrodes separated to permit moving of material for next spot.

Content/Topic 2: Time factor.

Resistance spot welding depends on the resistance of the base metal and the amount of current flowing to produce the heat necessary to make the spot weld. Another important factor is time. In most cases several thousand amperes are used in making the spot weld. Such amperage values, flowing through a relatively high resistance, will create a lot of heat in a short time.
To make good resistance spot welds, it is necessary to have close control of the time the current is flowing. Actually, time is the only controllable variable in most single impulse resistance spot welding applications. Current is very often economically impractical to control. It is also unpredictable in many cases.

Most resistance spot welds are made in very short time periods. Since alternating current is normally used for the welding process, procedures may be based on a 60-cycle time (sixty cycles = 1 second).
Previously, the formula for heat generation was used. With the addition of the time element, the formula is completed as follows:
$H = I^2RTK$, H = Heat, I^2 = Current Squared, R = Resistance, T = Time, K = Heat Losses.

Control of time is important. If the time element is too long, the base metal in the joint may exceed the melting (and possibly the boiling) point of the material. This could cause faulty welds due to gas porosity.
There is also the possibility of expulsion of molten metal from the weld joint, which could decrease the cross section of the joint and weaken the weld. Shorter weld times also decrease the possibility of excessive heat transfer in the base metal.
Distortion of the welded parts is minimized, and the heat affected zone around the weld nugget is substantially smaller.

Content /Topic 3: Pressure or welding force.

The effect of pressure on the resistance spot weld should be carefully considered. The primary purpose of pressure is to hold the parts to be welded in intimate contact at the joint interface.

Spot Welding. Simply defined, spot welding is "the welding of overlapping pieces of metal at small points by application of pressure and electric current. “Electrodes seated in a weld head are brought to the surface of the parts to be joined and force (pressure) is applied.

Work-pieces are held together under pressure exerted by electrodes. The process uses two shaped copper alloy electrodes to concentrate welding current into a small "spot" and to simultaneously clamp the sheets together.

The pressure exerted by the tongs and the electrode tips on the workpiece has a great effect on the amount of weld current that flows through the joint. The greater the pressure, the higher the welding current value will be, within the capacity of the resistance spot welding machine.
Setting pressure is relatively easy. Normally, samples of material to be welded are placed between the electrode tips and checked for adequate pressure to make the weld. If more or less pressure is required, the operating manual for the resistance spot welding machine will give explicit directions for making the correct setting. As part of the equipment set-up, the tong and electrode tip travel should be adjusted to the minimum required amount to prevent “hammering” the electrode tips and tip holders.

Content /Topic 4: Spot welding on various metals

A. **Mild steel:** Typically contain 0.04% to 0.30% carbon content. This is one of the largest groups of Carbon Steel. It covers a great diversity of shapes; from Flat Sheet to Structural Beam.

   Mild steel Q235 were welded using resistance spot welding with an interlayer of Ni. The mechanical properties of the joint were examined, the effects of welding parameters on the nugget size and tensile shear strength were investigated. Both the tensile shear strength and nugget diameter increased with the increasing of welding current and welding time, whereas they decreased with the increasing of electrode pressure. The results indicate that the tensile shear strength of joint welded by resistance spot welding with a Ni interlayer is higher in comparison with that obtained by conventional resistance spot welding.

B. **Stainless steel**: Stainless steel is a steel alloy with increased corrosion resistance compared to carbon/alloy steel. Common alloying ingredients include chromium (usually at least 11%), nickel, or molybdenum. Alloy content often is on the order of 15-30%.

   Common applications include food handling/processing, medical instruments, hardware, appliances, and structural/architectural uses.

   Stainless steel SUS304 were welded using resistance spot welding with an interlayer of Ni. The mechanical properties of the joint were examined, the effects of welding parameters on the nugget size and tensile shear strength were investigated. Both the tensile shear strength and nugget diameter increased with the increasing of welding current and welding time, whereas they decreased with the increasing of electrode pressure. The results indicate that the tensile shear strength of joint welded by resistance spot welding with a Ni interlayer is higher in comparison with that obtained by conventional resistance spot welding.

C. **Steel alloys**: Alloy steel is a steel that has had small amounts of one or more alloying elements (other than carbon) such as such as manganese, silicon, nickel, titanium, copper, chromium and aluminum added. This produces specific properties that are not found in regular carbon steel.

   Since alloys steel cannot be readily fusion welded together due to their drastically different thermal physical properties, a cold-rolled clad material was introduced as a transition to aid the resistance welding process. The optimal welding parameters and electrode selections were established using experimental approaches. The welded samples' mechanical behaviors were then evaluated using static and dynamic weld strength tests as well as cyclic fatigue tests. The weld strength, failure mode, and fatigue life were then compared with self-piercing rivets of the same dissimilar metal's combination. Statistical analyses were also performed to analyze the effects of different failure modes on samples' peak strength and energy absorption.

D. **Aluminium**: Aluminum is a silver-colored, low density metal. It finds use in a huge variety of commercial applications. The Unalloyed type is ductile, exhibits moderate strength, and is very resistant to corrosion under most circumstances. Aluminum can be dramatically strengthened by the addition of appropriate alloying elements (Cu, Mg, Mn, Si, etc.) and subsequent heat/work treatments.

Since aluminum steel cannot be readily fusion welded together due to their drastically different thermal physical properties, a cold-rolled clad material was introduced as a transition to aid the resistance welding process. The optimal welding parameters and electrode selections were established using experimental approaches. The welded samples' mechanical behaviors were then evaluated using static and dynamic weld strength tests as well as cyclic fatigue tests. The weld strength, failure mode, and fatigue life were then compared with self-piercing rivets of the same dissimilar metal's combination. Statistical analyses were also performed to analyze the effects of different failure modes on samples' peak strength and energy absorption.

LO 3.3 – Check defects.

Content/Topic 1: Types of defects, causes and remedies:

A. **Distortion:** Distortion is a contraction of weld metal during welding that forces base metal to move. It is also defined as any permanent change in shape and size of joining pieces from the original caused during welding. These are the results of that Metals expand when heated and contracts when cooled. Due to localized uneven heating and cooling shapes and sizes of the joining pieces are changed.
B. **Crater:** Too much pressure may reduce weld heat, but too little pressure also creates problems. When there isn't enough pressure from the weld electrodes at the weld site, the welded joint may become porous or even show signs of cracking.
C. **Spattering:** While weld spatter is common for processes that rely on a separate substance to act as a bonding agent, in resistance welding, it's a sign of a defective weld. Splatter is often caused by the use of too strong a current to form the weld.

   Here, the spattered material is loose metal that was accidentally burned away by intense heat. The loss of material at the weld site can weaken the overall strength of the finished product.
D. Excessive weld: Expulsion, which refers to the ejection of molten metal, is a common phenomenon during resistance spot welding process. Due to the presence of expulsion, excessive electrode indentation, shrinkage voids and solidification cracks will be introduced into the weld nugget.
E. Electrode mushrooming: Electrode face mushrooming is the normal wear mechanism of a spot-welding electrode. Possible causes are,
   a. High Weld Currents and

b. Welding with a lot of power heats the electrodes and part and can lead to wear.
c. Small Electrode Face Area
d. Too much current or force for the surface area of the electrode to withstand.

F. **Electrode sticking**: Surface splash and electrode sticking are a result of excessive heating between the electrode and the sheet material being joined. The resistance of the surface or current concentration is likely to be too high.
G. **Indented Surfaces**: Creating consistent spot welds requires incredibly precise control over the pressure applied to the metal surfaces to be joined. When too much pressure is applied, resistance to electrical current decreases, keeping the metal from reaching proper welding temperature.

LO 3.4 – Finish the welded pieces.

Content/Topic 1: Methods of preventing corrosion:

A. **Red oxide painting:** Is a protection of metals where we use anti-corrosion paint(red-oxide) to avoid rust (corrosion resistance), For performing this work, we have to use a painting brush.
B. Keeping away from humidity: Use rods that have been left out and potentially exposed to **humidity** for a very short amount of time then, subsequently dried per the manufacturers recommendations and then stored in a rod oven. Use rods that have been stored in a dry, sealed container immediately **after** opening the original, sealed container.

Learning Unit 4 – Perform housekeeping.

LO 4.1 – Clean tools, equipment and workplace.

Content/Topic 1: Cleaning tools and materials:

A. **Brush**: It is used for cleaning the working surface prior to welding and general cleaning of the weldment.

B. **Cloth rug**: is the process of cleaning workplace (area) by using a rag, A rug is a small carpet made of old pieces of cloth stitched or woven together?

C. **Mop**: a tool for cleaning floors made of a bundle of cloth or yarn or a sponge fastened to a long handle, something that looks like a cloth or yarn mop. a mop of hair.

D. **Soapy water**: A metallic salt of a fatty acid, as of aluminum or iron, that is not water soluble and may be used as a lubricant, thickener, or in various coating applications, ointments, or disinfectants. 3. Slang Money, especially that which is used for bribery.
E. **Compressed air**: air that is at more than atmospheric pressure used to clean the workplace with equipment's and tools.

Content/Topic 2: Methods of cleaning:

A. **Dusting:** is the process of removing unwanted materials to the workplace by putting it the dust bin.
B. **Removal of dirt:** To aid in health and general hygiene, dusting is important. Dust can cause respiratory problems, and can also give your home a messy feel. Work on using the right tools for efficient dusting. A high-quality dusting cloth and wand are important. Make sure you dust hard-to-reach places, like behind appliances and in the

cracks and crevices of cabinets. Make efforts to make your environment less susceptible to dust. Regular cleaning and vacuuming can prevent dust from building up in your home.

C. **Chemical spraying**: Aerial release, or device for aerial release, of liquid war gas for casualty effect, or of liquid smoke for aerial smoke screens.

LO 4.2 – Store tools, equipment and materials.

Content/Topic 1: Care and storage procedures of tools, equipment and materials.

Cleaning of tools and equipment's is required, after that store them properly if there are not in use. Based on your needs, a simple toolbox will suffice. In case you own a big collection of tools or use them professionally, a great option is a metal cabinet. All tools must be sorted and organized and replaced in their stipulated storage area after use. This way you can not only access them quickly but also keep them safe. When storing those tools, we have to store;

A. **According to types:** when storing we have to consider the types of tools, materials and equipment's accordingly, for better not causing problems with other surrounding materials and environment by knowing which categories are specified in.

B. **According to size:** during storing make sure the all size materials, tools and equipment's are stored each category a part.

C. **According to shape:** even shape must be considered for better using the space perfectly otherwise saving it.

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