An approach to Best Welding Practice : Part – I

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"AN APPROACH TO BEST WELDING PRACTICE : Part - I" is the First Detail Part of the **"AN APPROACH TO BEST WELDING PRACTICE"** which was written as a General and Overall approach to the subject matter. This is particularly focused to the Operational Aspects and at the first phase relate to

i. Welding Equipment, Standardization, Calibration,

ii. Set-up of Machinery & Equipment for Productivity.

iii. Regular Maintenance, Pre-production Preparation, Post-production Check-ups and Setting up.

Present Scenario in any Welding Process Dependent Manufacturing Plant.

Manufacturing Organizations regularly producing welded products small or large, components or assembled structures like Blowers, Bridge Structures, Railway Engine Bodies on Underframes, Wagons, Coaches, Containers, using more than 200 numbers of Welding Machines have more or less the following common features.

Variety of Welding machines for Manual welding, MIG/MAG welding, SAW and other processes in production - Operation. These welding sets have different makes, have different Ratings, Current and Voltage capacities, AC/DC types manufactured and supplied by at least four different Vendors. Consumables vary from Sticks of different sizes and different specifications, Flux Cored or Solid Wires. MIG/MAG Wire Feeders and Welding Torches may have variety of designs, operating and control systems. Gases used will vary three to four combinations supplied by again separate Vendors. The Gas Regulators, Heaters, Flow Meters will vary again.

Procurement decisions for such a mix of machineries and equipment are made over a period of time depending on specific use, vendor/ purchaser influence, cost and payment factor, availability - immediate/ late, etc.

The main reasons creating such chaotic conditions as stated above can be summarized as :

- Large varieties of Welding Machines types and Accessories at the shop floor in use - Transformers, Rectifiers, Inverters etc
- These Machines are of different Makes - minimum three to four Brands, of different designs and capacities
- Suppliers of these Welding Machines are mainly Distributors or Dealers, again more than three to four.
- Spare Parts for Machines / Accessories under breakdown are assessed first for the requirement of spares and then ordered for procurement.
- Spare Parts are supplied by Retailers or Traders, numbering more than five to six, dominant factor being Price not Genuinness of the part.
- Welding Sets are placed in haphazard manner and moved as and when needed from one Work Center to another.
- Input Power to the Welding Sets is provided through individual Switch Box mounted on the, Columns of the Workshop Shed or on Pedestals at the welding work Center.
- For the Output Power from the Power Source variety of Cables - Copper or Aluminum of different lengths often joined by twisting the ends of the cables together are used (exceptions of the use single copper wire with proper connecters are there, but rare).
- Earthing of the Power Source is done most casually by connection to the Columns mainly.
- Return Leads are anything - angles, channels, rods sometimes even the Jigs and Fixtures.
- Calibration of the Power Sources is normally ascertained by a Sticker mounted on it with details. Missing at some power Sources.
- Layers of Dust and Dirt accumulated on the Power Sources indicating ZERO Maintenance.
- No Records of Maintenance, No Preventive Maintenance.
- Gas Regulators / Pressure Gauges Not Working / Leaking / Not Calibrated.
- Wire Feeder Units are of various makes and capacities, may not always be compatible to different brands and models of Power Sources in use.

- Discarded / partly used spools of MIG wire and end cuttings are scattered all over the work place.

As a result

1. Welding Sets are not often interchangeable from one work center to another thereby creating production bottleneck.
2. Wire Feeder Units are to be moved along with the shifting of the machine as and when required - not being interchangeable.
3. Deployment of Operators is not flexible from one to another work center, from one job to another, from one machine to another.
4. Critical work centers either provided with additional welding sets or allowed to go idle till similar Capacity sets are moved in.
5. Spare Parts for Machines / Accessories under breakdown are assessed first for the requirement of spares and then ordered for procurement from the Welding set manufacturer or his dealer. But Spare Parts are supplied by any one of the Retailers or Traders, numbering more than five to six
6. High failure rate of Machinery and Equipment.
7. Delayed or no maintenance due to delay in spare part availability. Procurement dominant factor being Price not Genuinness of the part attending for repair maintenance of the Welding set and putting it back into operation is delayed - often takes more than a week.
8. Unbalanced production at different work centers causes disruption in assembly line production.
9. Idle workforce and Low utilization of machinery, equipment and manpower - Low Productivity.
10. High Cost of Capital, High Cost of Production and High Quality Cost
11. Generation of higher rate of Rejects, Scraps and Rework.
12. Customer Dissatisfaction. Loss of Market Share.

Set-up of Machinery & Equipment for Productivity

- Welding Sets are placed in haphazard manner and moved as and when needed from one Work Center to another without conspiring compatible application of the replacing unit.
- Input Power to the Welding Sets is provided through individual Switch Box mounted on the, Columns of the Workshop Shed or on Pedestals at the welding work Center.
- For the Output Power from the Power Source variety of Cables - Copper or Aluminum of different lengths often joined by twisting the ends of the cables together are used (exceptions of the use of single copper wire with proper connecters are there, but rare).
- Earthing of the Power Source is done most casually by connection to the Columns mainly.
- Return Leads are anything - angles, channels, rods sometimes even the Jigs and Fixtures.

As a result

1. Welding Power Sources are subjected to Input and Output Power Fluctuation.
2. Output Power at the point of welding is different from the Meter Readings at the Power Source.
3. Loss of Power (Electrical Energy) from point of supply to the point of Welding.
4. Hazardous and unsafe Welding Environment - chances of receiving Electric Shocks are HIGH.
5. High rate of Machinery Failure and Breakdown.
6. Welding Parameters specified in WPSs cannot be maintained at the point of welding.
7. Welding quality is poor causing high rejection and repair work.
8. Low Production and Low Productivity.

It appears from the above mentioned cause and effect analysis of the dismal state of affairs prevalent in most of the production set ups where Welding is the main process of manufacturing, that possibly there is no solution to come out of the problems!

BUT THERE IS A SOLUTION. The Best Approach to improve the Performance Level of Welding Equipment and Accessories is by adopting **"Lean Welding"**.

CONCEPT OF "LEAN WELDING"

"Lean" is a manufacturing concept designed to provide the optimum framework for efficient and effective production. The lean production system focuses on the reduction of waste from the value stream in order to remain competitive. Lean manufacturing is lean because it provides a way to do more and more with less and less-less labor, less equipment, less

time, and less space- while coming closer to providing customers with exactly what they want.

Standard, Uniform and Single Welding Process

The Approach to Best Welding Practice for the lean journey may start with lean welding becoming the Focal Point when the organization may commit to using a Single Process for all of its production welding.

Welding is to be done according to certain specifications, otherwise the as-welded properties of some components may be undesirable for subsequent operations, such as machining or anodizing. This is the reason why it is very difficult to include welding in a production system that relies on the uniform flow of components with uniform standards, as they do in a lean manufacturing environment.

The only way in which lean manufacturing can be applied to manufacturing operations that include welding is to ensure that all the prior operations that could influence the welding quality or productivity are controlled carefully so the components presented to the welding cell are as uniform as possible. Likewise, the welding operation must be controlled to a degree that the resulting condition of the weld metal and weldment is as uniform as possible, in other words Standardized so that subsequent operations are not adversely affected.

Organization's first step in lean welding must be standardizing it to one process (may be solid wire pulsed gas metal arc welding, or pulsed MIG) for all production welding, reducing the number of Welding Machine Brands and Models to maximum two and standardizing all consumables including Gases.

As welding is standardized through standard fit ups, single process with single type of Power Packs, Wire Feeders, Torches and Gases, in standard positional set ups on new welding technology, numerous process-related benefits are generated, such as:

- Eliminating variability in primary power fluctuation (with Grouping as in Auto-Line technology).
- Ability to limit or "lock-in" functionality within scope of specific requirements.
- Multi-MIG process capability using one wire and one gas.
- Ability to weld thick or thin metal with same set up.
- Improved travel speed with lock in function.
- Less heat input through pulse operation.
- Better puddle control with locked in current and voltage.
- Reduced distortion due to low heat input.
- Less spatter with current control.
- Improved arc stability through reduction of controlled parameters locked in.
- Operators are confident to produce high quantity weldment with quality.

But, these will be just the beginning. Standardizing on one process for one product would also be achieving these benefits in the end:

- Welding Training will be simplified and of shorter duration on knowledge and use of limited brand machines and accessories focusing more on techniques and productivity.
- Provide flexibility to deploy welders with Standard productivity in different Work Stations having Standardized Set Ups.
- Immediate improvement of operator performance (higher production rates with fewer errors and better morale).
- Eliminate sources of variability in quality and productivity between welding stations in different shifts.
- Maintenance planning and execution is greatly simplified and streamlined by drastically reducing parts count; maintaining 200 to 300 Welding Sets of the same design enables maintenance to become very proficient.
- Change the typical vendor-supplier relationship into a vendor-partner relationship where each party contributes more to the value chain and benefits accordingly.

Vendor - Partner Relationship.

The traditional relationship between a Manufacturer and the suppliers of Machineries, Accessories and Consumables is just a buyer and a seller for a particular transaction. The main interest common to both the parties is the PRICE and the payment. Instead, understanding each other's needs, goals and long-term objectives must be given priority over price and delivery.

For an example, to select a new Welding Machine, engineers, operators, area managers and maintenance managers must evaluate several different systems and suppliers over a period of months on such traditional criteria as arc performance, reliability/robustness of design, ease-of-use, ease-of-maintenance and flexibility for future enhancements.

There are differences between various welding systems on all of these criteria. Some differences are small, others are much larger and there may be solid reasons to select one particular product over another. In fact, the newest generation of welding technology can potentially save manufacturers substantially by solving productivity and quality issues that have not previously been solvable by either party all alone.

Once such a relationship starts it should develop into a joint venture of Lean Journey to include :

- Supplier-managed inventory for accessories and spares at Vendor's stores.
- Planning and building Inventory to customer requirement for a long span, rather than to a short forecast.
- Daily on-line inventory replenishment for delayless supply.
- Ability to build and ship even customer specific products in one day.
- Same-day shipping of replacement parts.
- Building facilities for some circuit boards to be built in-house.
- A flat, responsive and reactive organizational structure.
- Employees at supervisory levels empowered to make decisions.
- Line employees / operators engaged in production, inspection and maintenance empowered to manage their own business areas.

Welding system performance is important, but more value should be placed on finding a responsive welding partner with similar organizational philosophies, structures, objectives and goals. This type of relationship, where both parties are aligned for mutual success, enables the parties to manage better the challenges that arise with any product's use.

CALIBRATION

Output of Machines and equipment diminishes with use and age; meters on the machines and the Regulating Knobs will not indicate correct setting of parameters. Such a condition impedes productivity quality, and operator's morale, increases degree of supervision, delivery period and cost. Outputs of all the Welding Sets in terms of steady current and voltage is essential. Any fluctuation or variation in these parameters will adversely affect quality production and productivity. Even a skilled worker working with such variations will not be able to produce a good weld.

Authentic calibration conducted by an external agency is an essential step in the process of Standardization of Welding Sets, Equipment and Accessories. Each and every Welding Set, Wire Feeder Unit, Gas Regulators, Flow Meters, Electrode Ovens must be calibrated every 12 months if not every 6 months. The Calibrated Charts must be pasted on the machine or accessory for the knowledge of the operator, supervisor and the inspectors for application. Any observed fluctuation of current, voltage or speed of wire feeder must be repaired to remove the flaw.

WELDING SET LAYOUT AND SET UP

The most common arrangement of placing Welding Sets is in between Workshop Shed Columns. The input terminals of the machines are connected to individual main switches mounted on the columns. Each main switch is in turn connected to the incoming cable branch outs. Earthing of the machine is accomplished by connecting cables, rods, torn / twist jointed wires to a bolt welded to the base or side of the column. Nothing is wrong in such set ups till a fatal electrocution occurs when EARTHING and installation of MCB and RCCB are thought of. In such a set up there is no control to limit the current used in welding by the operator.

In Standardized Welding Set Up (Lean Welding), every Work Station and Welding Center must have the following arrangement:

- Input Power Connection from the Feeder Cable should be made to a Master Panel for four to six Welding sets for every Work station or Work Center.
- Each Master Panel should be housed in between Workshop Shed Columns.
- For each welding set one MCB, one RCCB and a Fuse Box should be housed in the Master Panel.
- An Auto Controller for Current which can be set and locked for maximum value must be housed in the Master Panel for each Welding Set.
- Arrangement for locking the doors of every Master Panel to be made.
- Earthing of each machine and the job must be made through copper cable lines connected to the Earthing Pits.

Safety, Maintenance and Inspection of Arc Welding Equipment in Use

Standardized Welding Machinery, Equipment and Accessories

after calibration needs regular inspection and maintenance to sustain exposure to optimum uses with minimum probability of failure. In addition, the health and safety of the operators are ensured by this process of inspection and maintenance.

Inspection of Work Equipment

1. It must be ensured that that the work equipment has been installed correctly and is operating properly. It shall be subject to an initial inspection (after installation and before first being put into service) and an inspection after assembly at a new site or in a new location by competent person.
2. It must be ensured that work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is subject to:
   - periodic inspections and, where appropriate, testing by competent persons,
   - special inspections by competent persons each time on exceptional circumstances which are liable to jeopardize the safety of the work equipment have occurred, such as modification work, accidents, natural phenomena or prolonged periods of inactivity, to ensure that health and safety conditions are maintained and that the deterioration can be detected and remedied in good time.
3. Inspection and Tests must be conducted on Daily, Weekly and Monthly break ups.
4. The results of inspections must be recorded and kept at the disposal of the authorities concerned. They must be kept for a suitable period of time.

Inspection and tests are of two types:

1. Partial tests
2. Complete test

Normally Complete test are performed by the manufacturer or a company recommended by the manufacture and normally performed after repair.

Partial tests are regular and a sequence has to be maintained which is given below. Any of the tests shall be passed before starting the next test.

If defects are detected during a test, and repaired, (e.g. by changing parts such as lamps, circuit breakers, actuators, connecting cables with coupling plugs, plugs etc.), the entire test sequence shall be carried out after repair.

Partial Test and Sequence

e. Visual inspection

f. Electrical test, measurement of the protective conductor resistance

g. Functional test

d) Documentation

e) Protection against electrical shock

Power source, ancillary equipment, torch, cables and harness shall be visually inspected. Visual inspection shall be carried out in accordance with the conditions of use of welding equipment and the manufacturer's instructions.

Items for the Visual Inspection

A. Torch/electrode holder, welding current return clamp.
   - Missing or defective insulation at the torch/electrode holder.
   - Defective connections at the electrode holder/torch or at the welding current return clamp.
   - Defective, damaged switches (torch)
   - Blocked, burnt out nozzle (torch)
   - Worn contact tube (torch)
   - Signs of overload and improper use
   - Other damages

B. Cables, including plugs and couplers,(Mains supply-, welding current- and -return cable, cable hose assembly, supply conductors for remote control or external wire feeder etc.)
   - Deformed and/or faulty plug/coupler enclosures
   - Used, broken or thermally damaged plug pins
   - Corroded, deformed or broken protective contacts
   - Ineffective cable anchorage
   - Defective bending and buckling protection
   - Unsuitable cable guiding
   - No compliance between protection class and connecting cable / plug, coupler, if relevant
   - Cables and plugs unsuitable for the intended use and performance
   - Defects at the welding current appliance inlets

C. Enclosure (welding power source, wire feeder, cooling system ...)

- Incompleteness
- Ineffective contact protection, minimum degree of protection IP 2x
- Inadmissible interventions and modifications, strong fissures/wear
- Impairment of the degree of protection by destruction and/or indentation at the enclosure or casing
- Rupture damages at insulating material and cast iron enclosures
- Excessive pollution and corrosion, conductive deposits, humidity
- Cooling openings not free, missing of required air filters
- Signs of overload and improper use
- Burnings/welding points caused by electrode holder or welding current return cable put down on the enclosure (danger of PE overload)
- Missing or bad condition of protective devices, such as gas cylinder holder
- Missing or bad condition of transport rolls, rope eyes, holder etc.
- Failings at the wire reel fixing (e.g. destroyed insulation material, reel fixing does not operate properly, traces of sliding/contact
- Conductive objects placed in the enclosure

D. Insulation resistance - Only checked by measurement

E. Leakage current - Only checked by measurement

F. No-load voltage (UO) - Only checked by measurement

G. Functional test - Where a selector switch or a control device is fitted, this shall operate correctly. Conformity shall be checked by operating the device and by checking whether the welding power source operates correctly.

H. Supply circuit on/off switching device - Where an integral supply circuit on/off switching device (e.g. switch, contactor or circuit-breaker) is fitted, this shall:

a. open or close all ungrounded mains conductors, and

b. clearly indicate whether the circuit is open or closed.

I. Magnetic gas valve - Where a magnetic gas valve is fitted (e.g. TIG, MIG/MAG, PLASMA power sources), this shall operate properly.

Conformity shall be checked by visual inspection and the following operations:

a) Function - Operate the trigger of the torch and check by means of the gas flow, whether the magnetic gas valve operates.

b) Leakage:

i. Connect the power source to the shielding gas supply (e.g. gas cylinder) and set maximum admissible operating pressure by means of the pressure regulator;

ii. Operate the trigger of the torch and put it then into the OFF position;

iii. Stop gas supply by means of the pressure regulator;

Warning : Attention shall be paid to the fact that also flexible gas tubes and their connections may leak.

J. Signal and control lamps - Where a signal or control lamp is fitted, this shall operate properly.

Conformity shall be checked by visual inspection.

K. Welding Gas equipment

a. Pressure regulator

Visual examination of:

- Good state of threads, gaskets, manometers, hose assemblies, hose clamps
- Absence of grease
- Tightness test at service pressure
- Verification or replacement at least after five years quick-action coupling with

b. Shut-off valve

- Verification of good functioning of locking
- Tightness test at service pressure

c. Systematic replacement if malfunction assembled hoses

- Verification of hoses colour in function of gases
- Visual examination to be sure of good state and cleanness of hoses
- Visual examination on bended hose to verify absence of failures, cracks, inflating, injury

- Replacement if visual examination discovered a defect
- at least three years after put into service if intensive service
- at least five years after put into service in every case
- Note: date on hose is fabrication date and not date of put into service non-return valve

d. Flame arrestor

- verification that they are in place
- Verification of their colour in function of gases
- Visual examination and tightness test
- Replacement in case of backflow, backfire or at least three years after put into service

e. Blowpipes

- Visual examination of good state of nozzles
- Full visual examination and tightness test

L. Test or inspection report - The tests shall be reported to include

a. the identification of tested arc welding equipment;

b. the date of testing and the date of future tests;

c. the test results;

d. the name of the technician; can be clearly identified and reconstructed.

The list is exhaustive and the selection and Visual Inspection and Maintenance schedule should be made on Daily, Weekly and Monthly basis. Major overhauling of Machinery, Equipment and accessories can be made annually, but in a staggered basis so that the maintenance load is evened out throughout the year.

A check list for daily, weekly and monthly Inspection and maintenance schedule must be made. The visual inspection should be the joint responsibility of Operator and Maintenance Mechanic and the check list must be critically checked by Shop Floor Supervisor for effective Standardization Process.

CONCLUSION

- Most of the persons working at the shop floor level are aware of the losses incurred in Production due to delay in Scheduling Work, Deployment of Operators, Mobilizing Machineries and Equipment, Downtime, but never keep an account in totality.
- ON TOTALITY, IT IS ABOUT 37%.
- Any organization in a condition stated as above may conduct an Industrial Study and ascertain the current trend of such losses.
- If the organization HONESTLY takes up "Lean Welding" approach to cut down the losses an initial preparedness and investment have to be planned and the financial impact has to be absorbed.
- THE RESULTS WILL SHOW UP WITHIN THREE MONTHS.