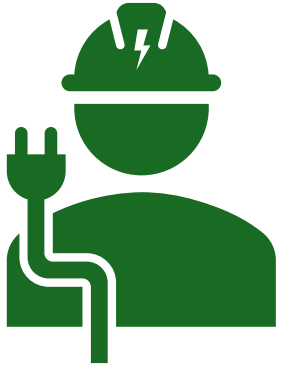
Welding

Welding Definition

- According to American Weld Society (AWS), a welding process is defined as "a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the application of pressure or by the application of pressure alone and with or without the use of filler material”

Principles

Sources of heat for welding or cutting is either an open flame or an electric arc between two electrically conducting materials



The welding arc is made by an electrical circuit between the electrode and the work piece and creates heat energy from electrical energy

Practical Applications of Welding

Welding has been employed in industry as a tool for:

Regular fabrication of cars, trucks, trailers aircrafts, bridges, buildings, pipelines, machines, and household equipment, refrigerators.

Repair and maintenance work, e.g., joining broken parts, rebuilding worn out components, and more.

Welding is used in a variety of industries from Boeing(large) to Mom-and-Pop Shops.

Fabrication shops-railings, fireplaces, fire pits, etc.

Truck and automotive shops

Wrecking yards

Shielded Metal Arc Welding (SMAW)-Stick Welding

- **Shielded metal arc welding (SMAW)** evolved from the metal arc process and is defined as "an arc welding process which produces coalescence of metals by heating them with an arc between a covered metal electrode and the work-piece. Shielding is obtained from decomposition of the electrode covering. Pressure is not used, and filler metal is obtained from the electrode.

SMAW Advantages

Lower equipment costs compared to other processes including: TIG, MIG, and Flux Core processes (no gas bottles, hoses, or wire feeders needed).

Quick and easy transition from one material to another.

The process lends itself to welding in confined spaces and various positions with few problems.

Deposition rates faster than GTAW Manual welding.

Easy to move from one location to another. No Wire Feeder and Bottle.

Requires no outside shielding gas and can be used outdoors in light to medium wind.

The ability to bend the electrode and the small space the electrode takes allows the process to be used in comparatively tight spaces.

SMAW Disadvantages

- Low deposition (filler material deposit) rate compared to GMAW/FCAW.
- Filler metal cost per weld can be greater due to a low deposition efficiency that can vary greatly with stub length.
- Production factor is typically lower due to rod changes and chipping slag (unless welding on various materials).
- This type of welding needs more hand-eye coordination than GMAW/FCAW.
- Slag removal is necessary, unlike MIG or TIG welding processes.

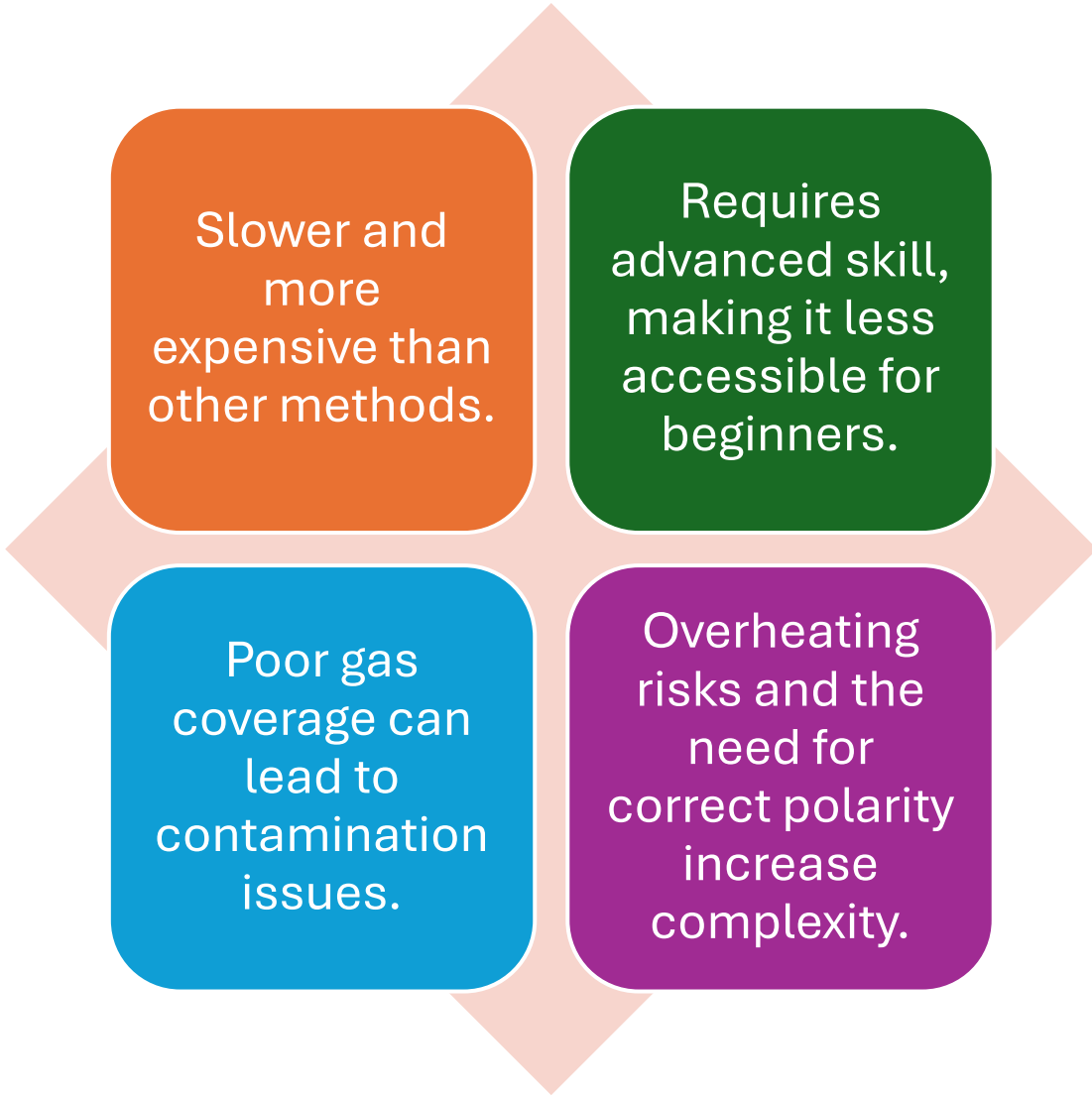
Gas Tungsten Arc Welding (GTAW)- TIG welding

- **Gas tungsten arc welding (GTAW)** was developed to address the challenge of welding non-ferrous metals like magnesium and aluminum. It is defined as "an arc welding process which produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work piece. Shielding is obtained from a gas or gas mixture."

GTAW Advantages

- Provides exceptional precision and quality, making it ideal for intricate projects.
- Suitable for a wide range of metals, including aluminum, stainless steel, and exotic alloys like titanium and gold.
- Minimal fumes and cleaner operation compared to other methods.
- Uses argon shielding gas, simplifying gas requirements.
- Offers flexibility with precise amperage adjustments for different applications.

GTAW Disadvantages



Gas Metal Arc Welding (GMAW)- MIG(metal inert gas) & MAG (Metal Active Gas)

- **Gas metal arc welding (GMAW)**, developed in the late 1940s for welding aluminum, has become extremely popular. It is defined as "an arc welding process which produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work piece. Shielding is obtained entirely from an externally supplied gas or gas mixture."

MIG Equipment

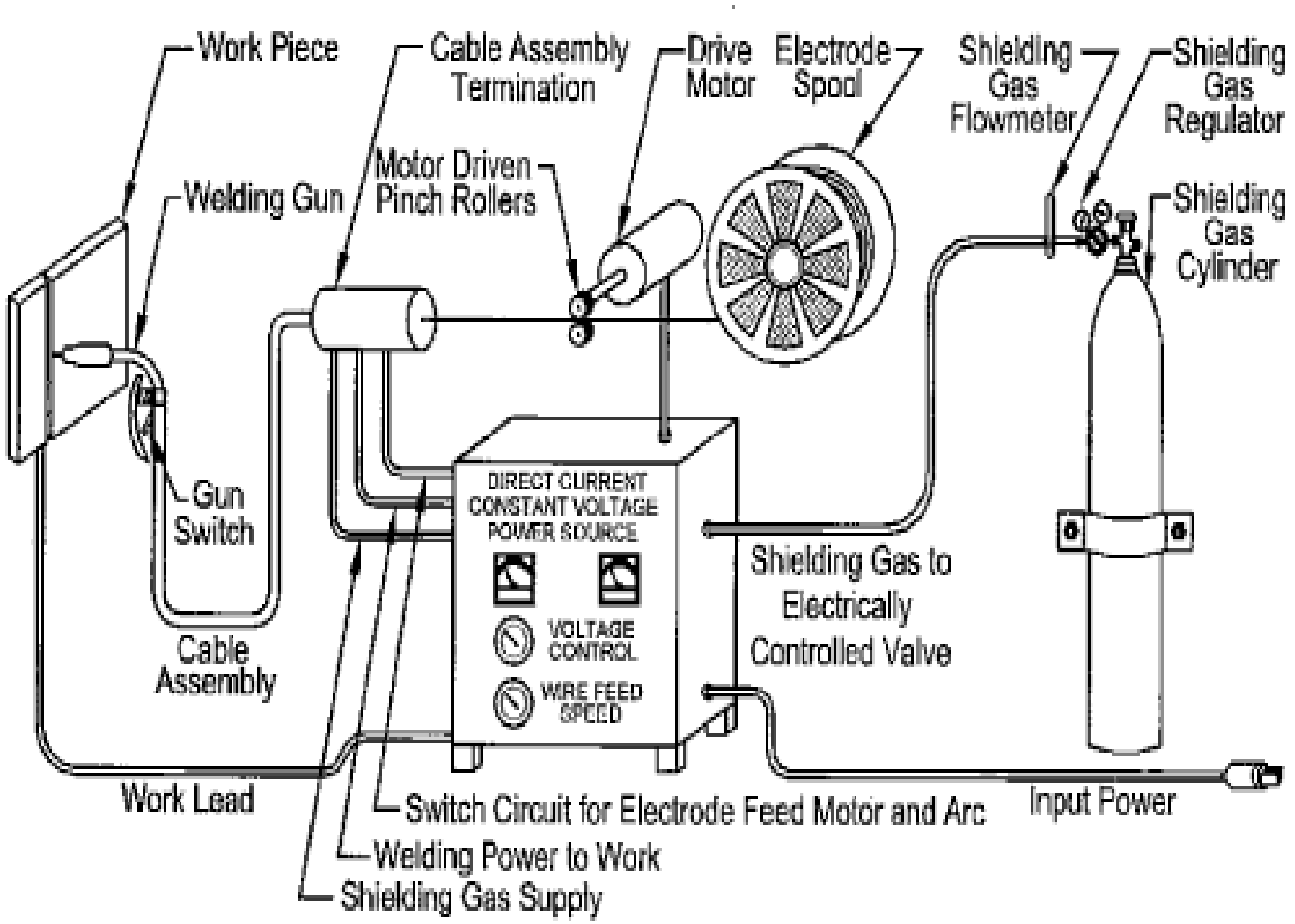


Figure 6–1. GMAW welding outfit.

GMAW Advantages

- High deposition efficiency when used in certain transfer modes.
- No slag to chip, unlike SMAW and FCAW.
- If properly set, the process can be used on thin materials relatively easily.
- Lower hydrogen weld deposit with all electrodes.
- High production factor since no slag is required to be removed, and the process uses a continuous electrode.
- With the parameters properly set for the application, most people can weld after a very short amount of practice.
- One given electrode size can be used on various thicknesses of materials productively, as compared to SMAW and GTAW.

GMAW Disadvantages

- Requires a wire feeder, which is difficult to move and can sometimes be a maintenance/repair burden.
- Needs shielding gas, making welding in windy conditions difficult. Generally, it is not suitable for windy conditions.
- Out-of-position welds are sometimes more difficult.
- Increased chance of lack of fusion if parameters and welding technique are not controlled.
- The gun is difficult to get into tight places.

Flux Cored Arc Welding (FCAW)

- **Flux-cored arc welding (FCAW)**, a variation of GMAW, uses a tubular electrode containing flux for shielding. Additional shielding may be obtained from an externally supplied gas or gas mixture.

FCAW Advantages

- There is a high deposition rate and deposition efficiency as compared to SMAW in all positions. Compared to GMAW, there is a greater deposition rate when used in positions other than flat.
- With some process variations, welding can be performed in mild, windy locations.
- Low hydrogen weld deposit with most electrodes.
- It has a higher production factor than SMAW and GTAW since the process uses a continuous electrode.
- With the parameters properly set for the application, most people can weld after less training than some other types of welding, making for an excellent welding style to train newer welders on.
- One given electrode size can be used productively on various thicknesses of materials compared to SMAW and GTAW.

FCAW Disadvantages

- It requires a wire feeder, which is difficult to move and can sometimes be a maintenance and repair burden.
- It needs shielding gas with some wires, so welding in windy conditions can be difficult.
- Slag must be removed.
- Increased chance of lack of fusion if parameters and welding technique are not controlled. It is very easy to carry a very large puddle, which can greatly increase the chances of a lack of fusion.
- The gun is difficult to get into tight places.
- Some of the self-shielded electrodes have limited deposit thicknesses due to the flux and electrode composition.
- Not very suitable for precision type work as compared to GTAW

Types of cutting

- Torch
- Plasma
- Laser
- Carbon arc gouging (highest airborne exposure hazard of any process addressed in this presentation and the nosiest)

Types of cutting

- **Air carbon arc cutting** previously known as **air arc cutting**, is an arc cutting process where metal is cut and melted by the heat of a carbon arc. Molten metal is then removed by a blast of air. It employs a consumable carbon or graphite electrode to melt the material, which is then blown away by an air jet. It is very smoky and very noisy.

Other Activities to consider

- Needle guns and hammers to knock off slag and spatter
- Grinding.

Hazards in the smoke

- Welding fume-(PEL & STEL to consider)
  - ❖ Iron
  - ❖ Manganese
  - ❖ Chromium
  - ❖ Copper
  - ❖ Zinc
  - ❖ Nickel
  - ❖ Cadmium
  - ❖ Lead
  - ❖ Cobalt
  - ❖ Total Particulate
- Chrome VI-Welding on stainless also in some filler material but typically not an exposure concern

Sources of hazard in the smoke

Base metal

Coatings-Impacts weld quality as well

Filler material (minimal)

Controls for weld fume

- VENTILATION VENTILATION, VENTILATION!!
  - ❖ Position within 1.5 duct diameter of the weld
    - ❑ Mobility
    - ❑ Impact on shield gas

Other hazards

Noise-especially when carbon arcing

UV-which can give the skin a serious sunburn and permanently damage eyes

Burns-from sparks and molten metal

Fires-from sparks and molten metal as well as oxygen and fuel gas cylinders stored together when not in use

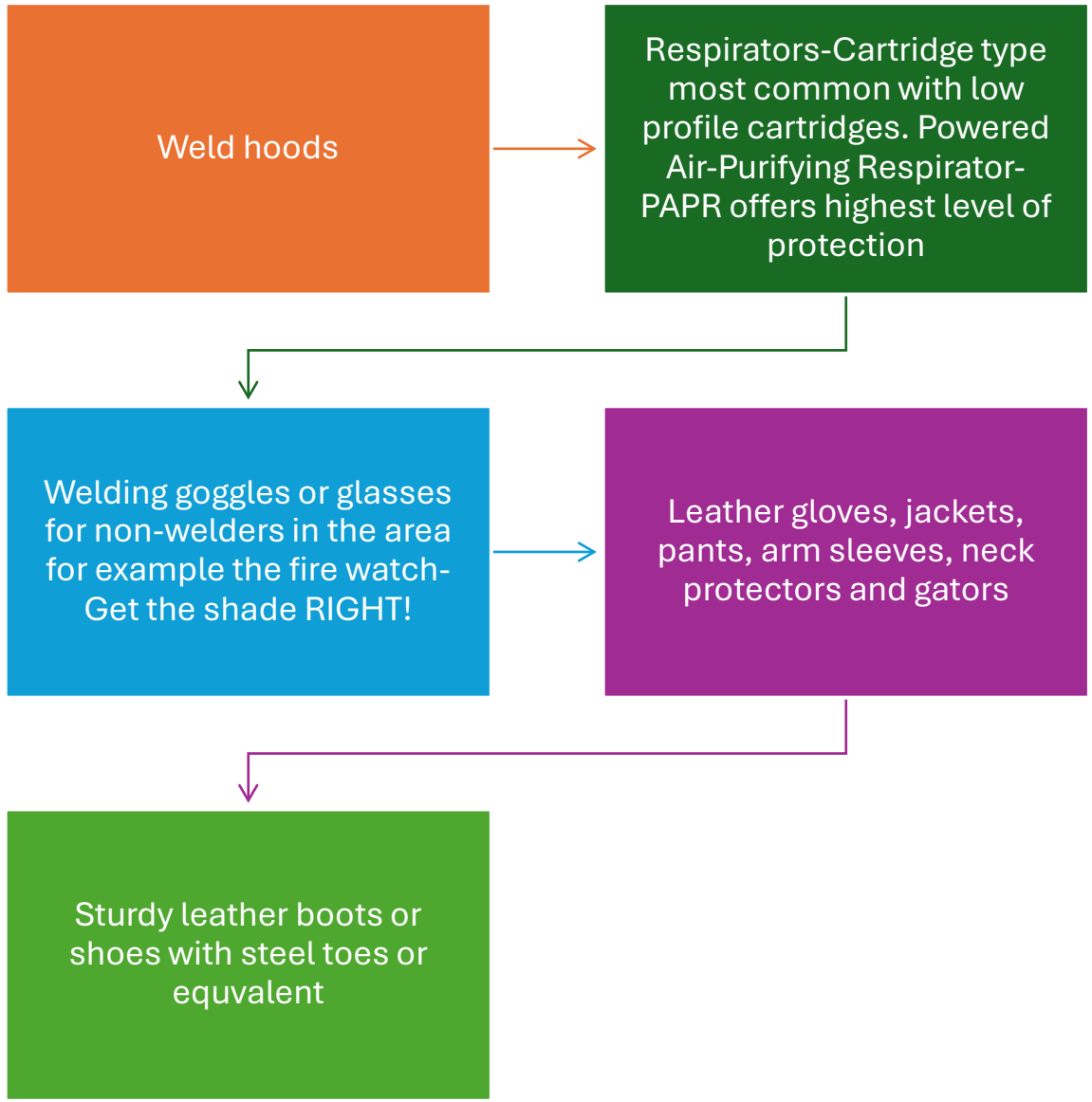
Electrical hazards from poorly maintained equipment

Projectile-from improperly secured cylinders

Controls for other hazards

- Weld screens-protective barriers made from durable material between the weld area and other workspaces maybe handheld or portable
- Flammable and combustible material removed paints, gas, paper, rags
- Well maintained equipment inspected prior to each use
- Secured cylinders separate fuel gas from oxygen by end of day
- Personal protective equipment (PPE) on next slide

Personal Protective Equipment



Things to look for:

- Accumulation of smoke –Is it visible and accumulating?
- Lack of PPE-Skin including neck area, eyes, ears, and lungs for both the welder and others in the work area
- Properly maintained and stored PPE including respirators
- Poorly maintained and stored equipment including ventilation systems. Are the filters changed routinely? Does some one check functionality before use?
- Gas cylinders secured or lain down
- Fuel gas separated from oxygen when not in use
- Inert shield gases not used near confined or enclosed areas