DEPARTMENT OF FINANCE (DOF)
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS (DPWH)
DEPARTMENT OF INTERIOR AND LOCAL GOVERNMENT (DILG)
THE REPUBLIC OF THE PHILIPPINES

THE URGENT DEVELOPMENT STUDY ON THE PROJECT ON REHABILITATION AND RECOVERY FROM TYPHOON YOLANDA IN THE PHILIPPINES

FINAL REPORT (II)

APPENDIX

TECHNICAL SUPPORTING REPORT 3 (VOLUME 2)

FEBRUARY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS GLOBAL CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.
PACIFIC CONSULTANTS CO., LTD.
YACHIYO ENGINEERING CO., LTD.
PASCO CORPORATION

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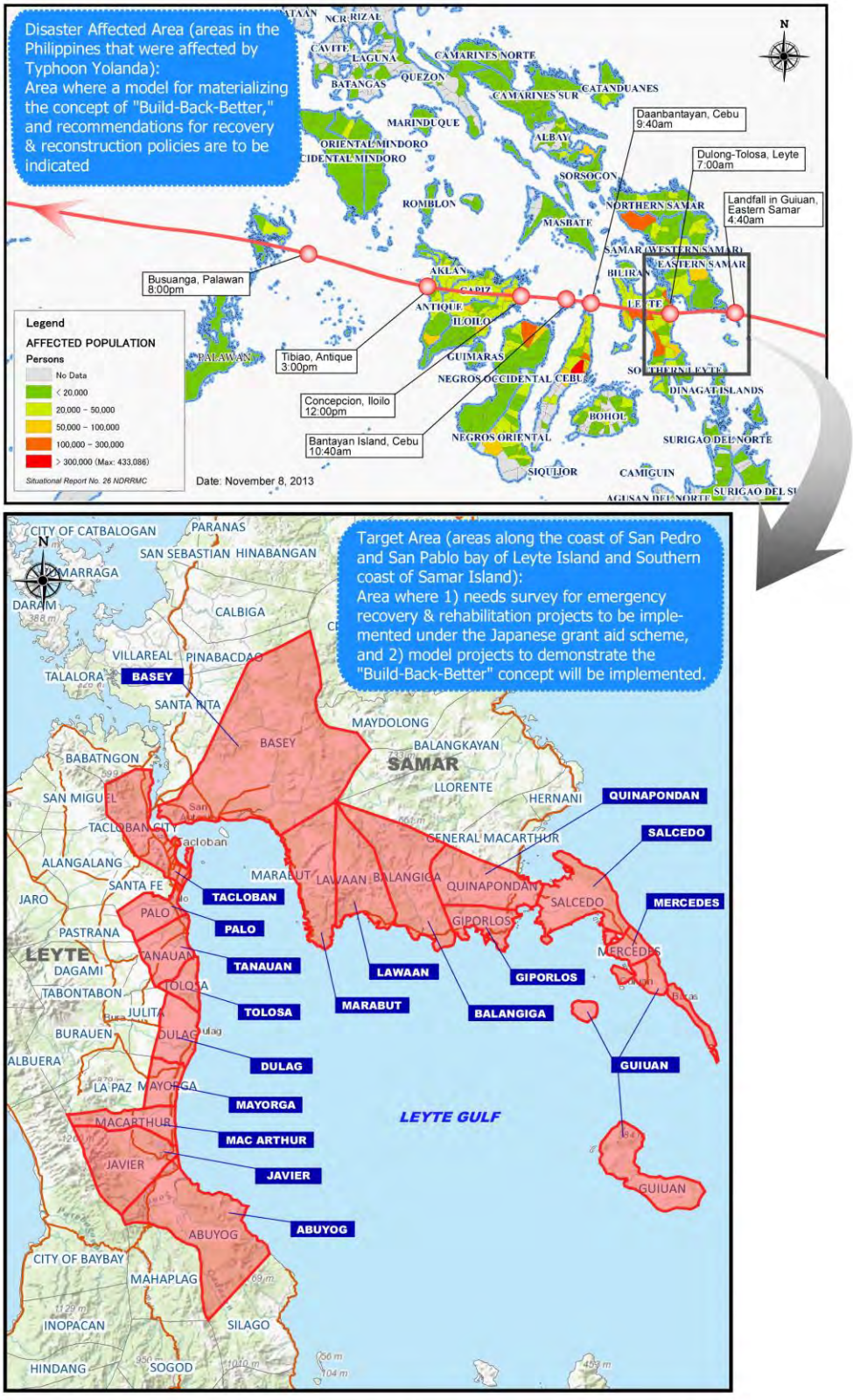
Composition of Final Report (II)

Summary		
Main Report	Volume 1	Recovery and Reconstruction Planning
	Volume 2	Quick Impact Projects
Appendix	Technical Supporting Report 1 (Volume 1, Chapter 2)	
	Technical Supporting Report 2 (Volume 1, Chapter 3 and 4)	
	Technical Supporting Report 3 (Volume 2)	

US$ 1.00 = Phillipines Peso (PHP) 49.68 = Japanese Yen ¥ 117.38

(January, 2017)



Map of the Disaster Affected Area and Target Area

Republic of the Philippines
The Urgent Development Study on
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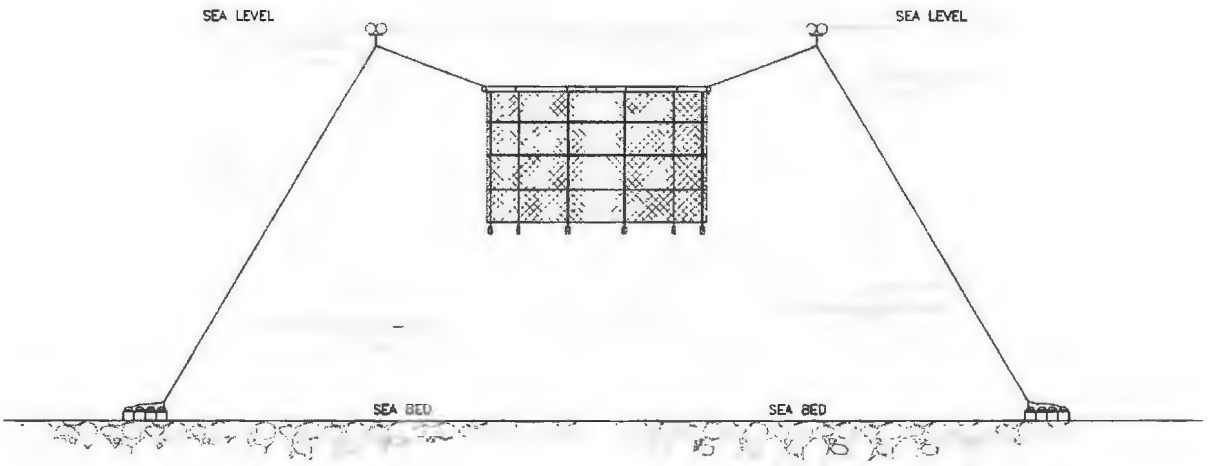
ø10M SUBMERSIBLE CIRCULAR CAGE



USER MANUAL

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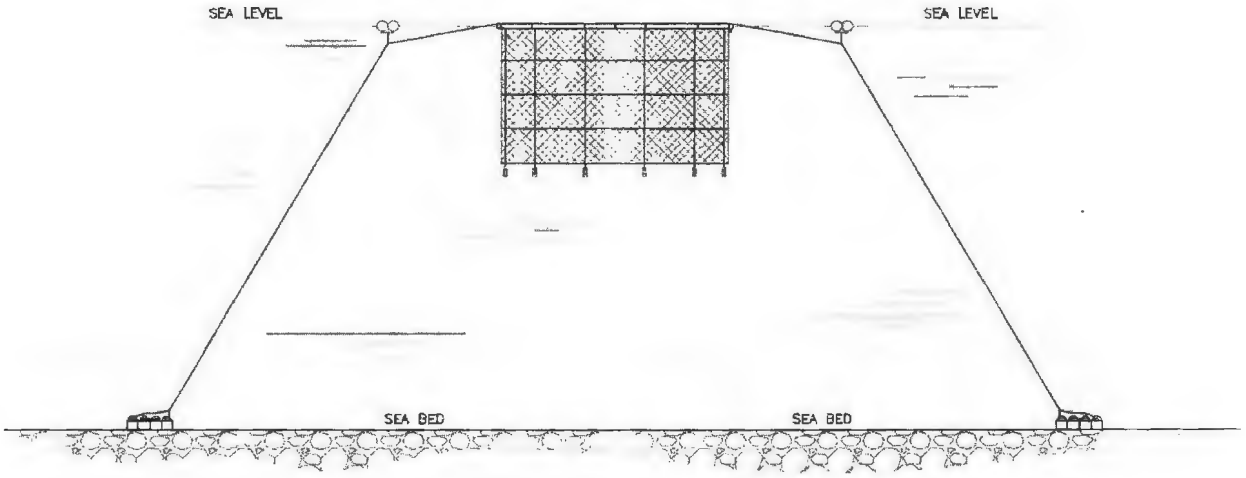
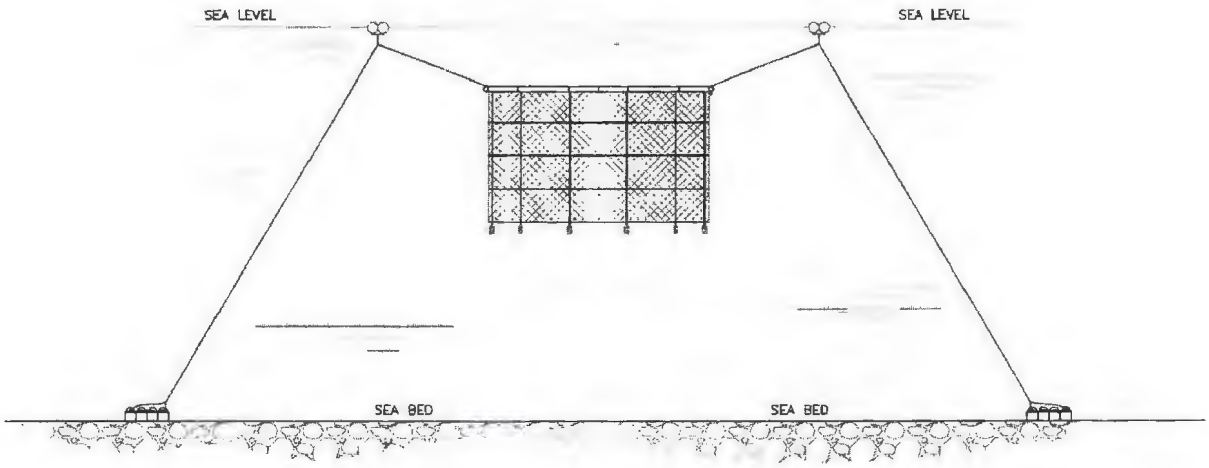
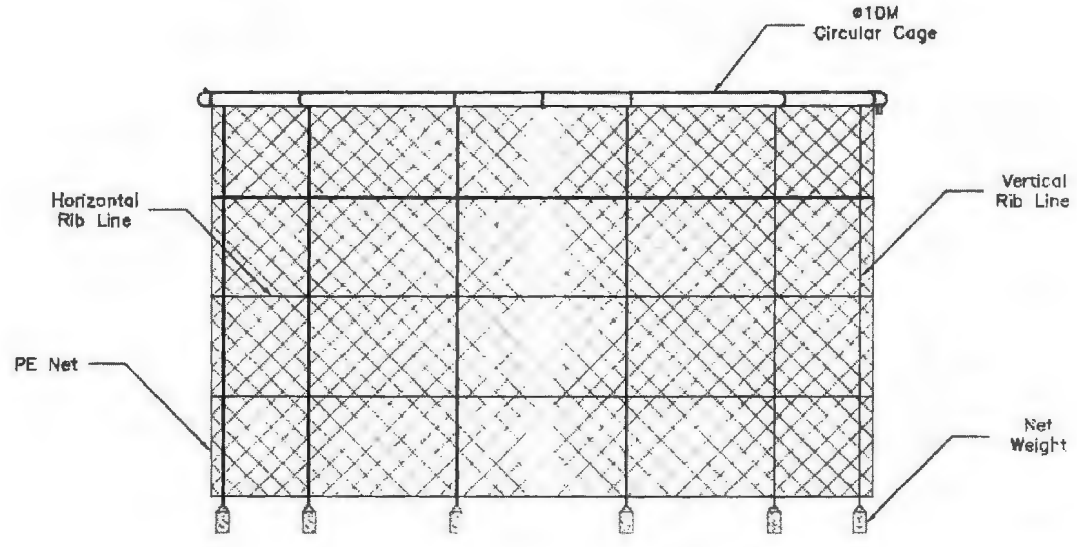
SUBMERSIBLE CAGE PLAN and LAYOUT







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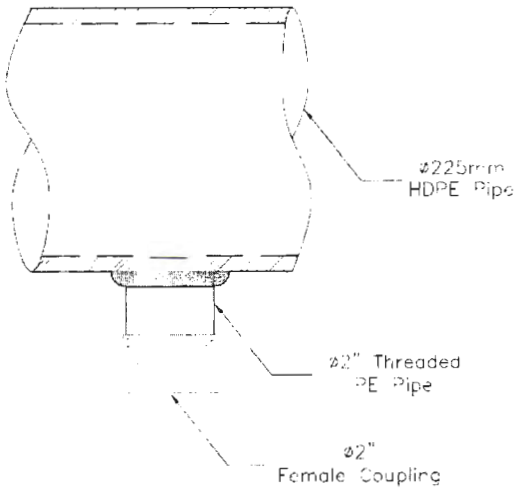
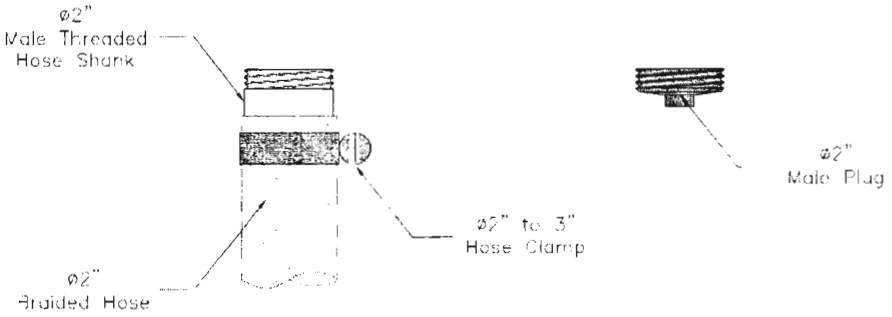
SUBMERSIBLE CAGE FITTINGS AND ACCESSORIES DETAILS

A. FOR WATER CONNECTION

- **All Fittings and accessories used for water connections are ø2" Stainless Steel.**
- **This connection is located at the bottom of the HDPE Pipe allowing the water to enter freely during submerged and can easily be pumped out during floating procedure.**
- **Threaded PE Pipe is fully welded at the bottom of the HDPE Pipe.**
- **Female Coupling are fixed at the threaded PE Pipe.**





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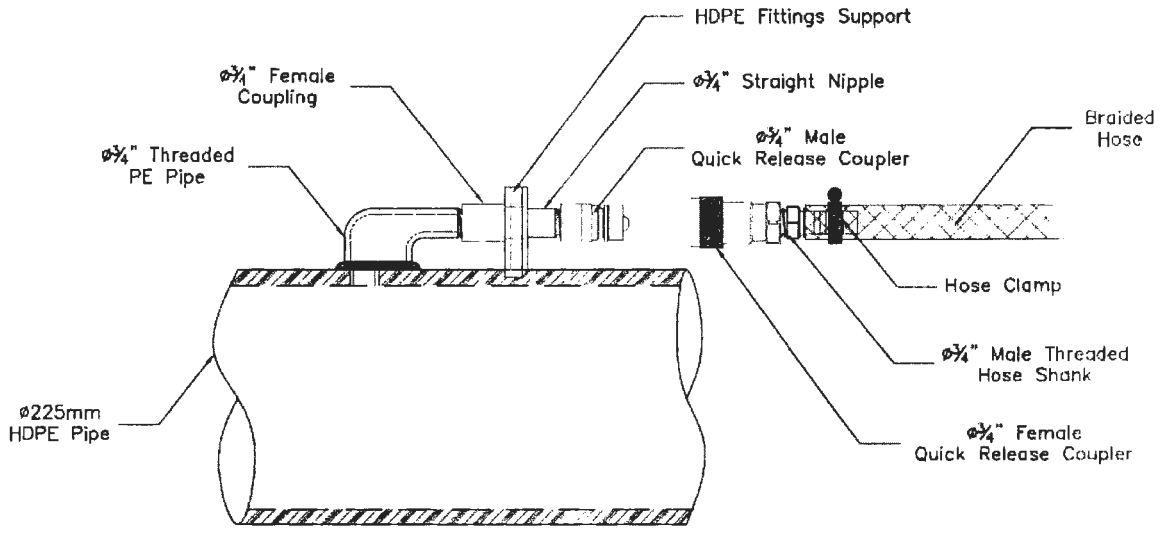
B. FOR AIR CONNECTION

- **All Fitting and accessories used for air connections are ø3/4" Stainless Steel.**
- **This connection is located at the top of the HDPE Pipe.**
- **Threaded PE Pipe is fully welded at the top of the HDPE Pipe.**
- **The Fixed air connection are supported with welded HDPE Sheet.**
- **Female Coupling and Male Quick Release Coupler are fixed at the threaded PE Pipe.**
- **There are two Female Quick Release Coupler with Braided Hose Attachment. One, open end hose attachment and Two, compressed air hose attachment.**



COMPLETE LIST OF PARTS AND ACCESSORIES

A. Water Connection
   1. Ø2" Threaded PE Pipe
   2. Ø2" Stainless Steel Female Coupling
   3. Ø2" Male Threaded Hose Shank with Braided Hose Attachment (male threaded hose shank, braided hose and hose clamp)
   4. Ø2" Stainless Steel Male Plug

B. Compressed Air Connection
   1. Ø3/4" Threaded PE Pipe
   2. Ø3/4" Stainless Steel Female Coupling
   3. Ø3/4" Stainless Steel Straight Nipple
   4. Ø3/4" Stainless Steel Male Quick Release Coupler
   5. Ø3/4" Open End Hose Attachment (female quick release coupler, male threaded hose shank, hose clamp, braided hose and floater to be attached at the end)
   6. Ø3/4" Compressed Air Hose Attachment (female quick release coupler, male threaded hose shank, hose clamp, braided hose and air compressor)

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CIRCULAR CAGE FLOATATION PROCEDURE

To make the circular cage floats, compressed air is pumped inside the HDPE Pipe through the air connection located on the top of the pipe. First, we need to connect the ø3/4" Compressed Air Hose Attachment to the male quick release coupler which is fixed at the top connection (see Figure 1). This procedure will open up the way for the air from the compressor to enter the circular cage. The compressed air builds up inside the circular cage and slowly pushing the water out of the HDPE Pipe. The removal of water inside the pipe and the buildup or trapping of compressed air will cause the circular cage to float. The procedure will takes around 10 – 20 minutes to completely filled the cage with compressed air and make it float. A large air flowing out the water connection will cause bubbles to the water surface indicating that the pipe is completely filled with compressed air. Connect the male plug to the water connection to avoid water from entering the pipe (see Figure 2) and unplug the compressed air hose attachment.

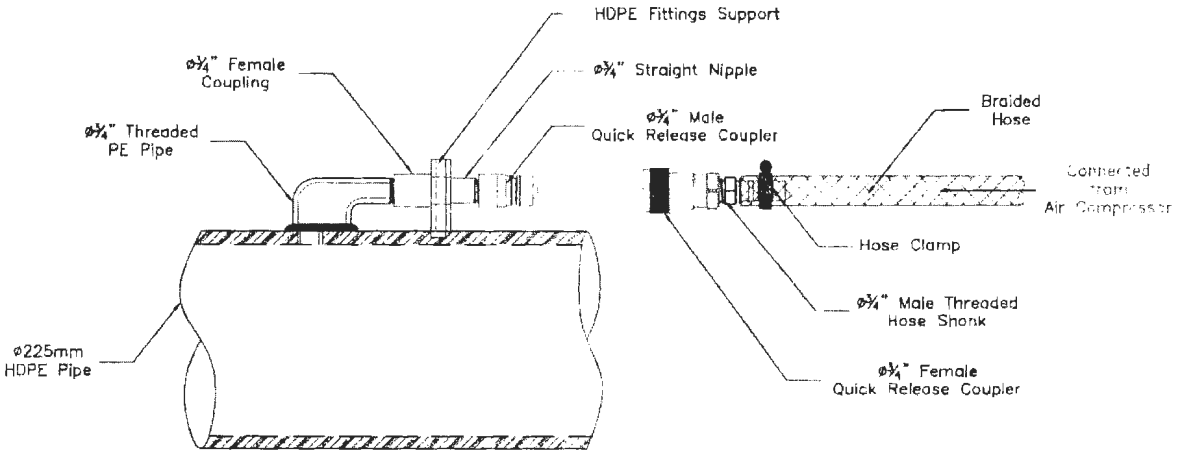

Figure 1

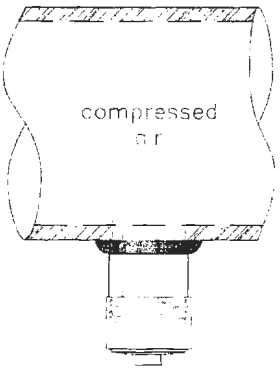

Figure 2

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CIRCULAR CAGE SUBMERGED PROCEDURE

To submerge the circular cage, release the air contained inside the circular cage PE pipe by connecting the ø3/4" Open End Hose Attachment to the male quick release coupler which is fixed at the top connection (see Figure 3). Remove the ø2" stainless steel male plug which is located at the bottom connection/ water connection and connect the ø2" x 2 meters male threaded hose shank. The hose will ensure the water filling the PE pipe even when the circular cage tilt above the water level. This will allow the sea water to enter the HDPE Pipe freely, filling the pipe with water until it is fully submerged. This procedure takes around 10 – 20 minutes in order for the circular cage to be fully submerged.

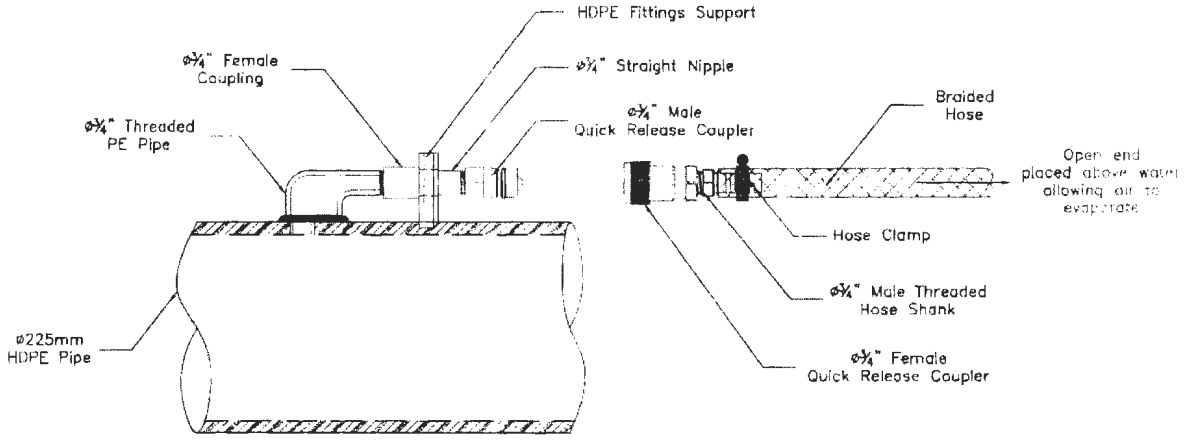


Figure 3

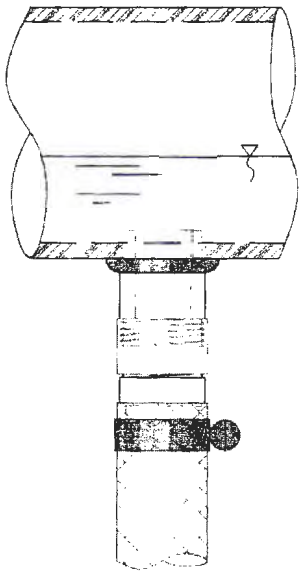
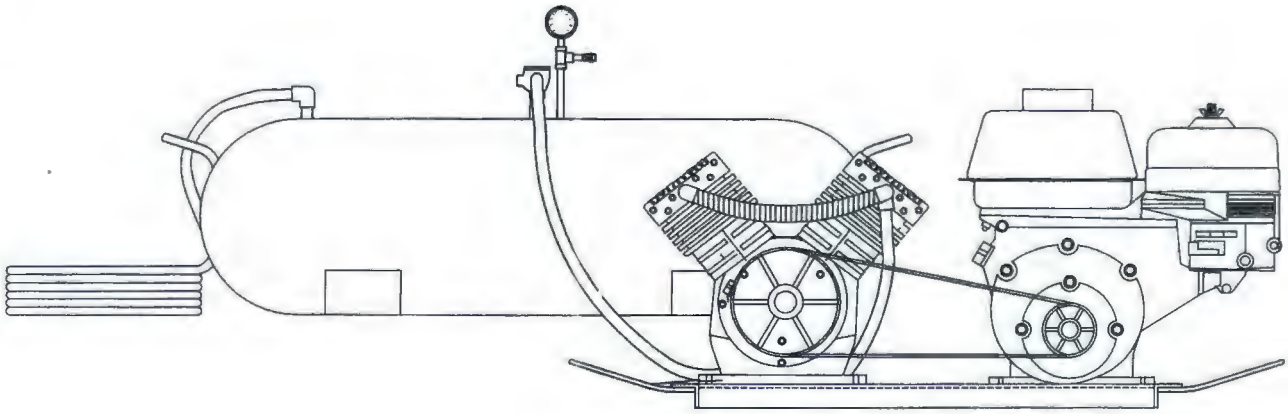


Figure 4

AIR COMPRESSOR USER'S MANUAL



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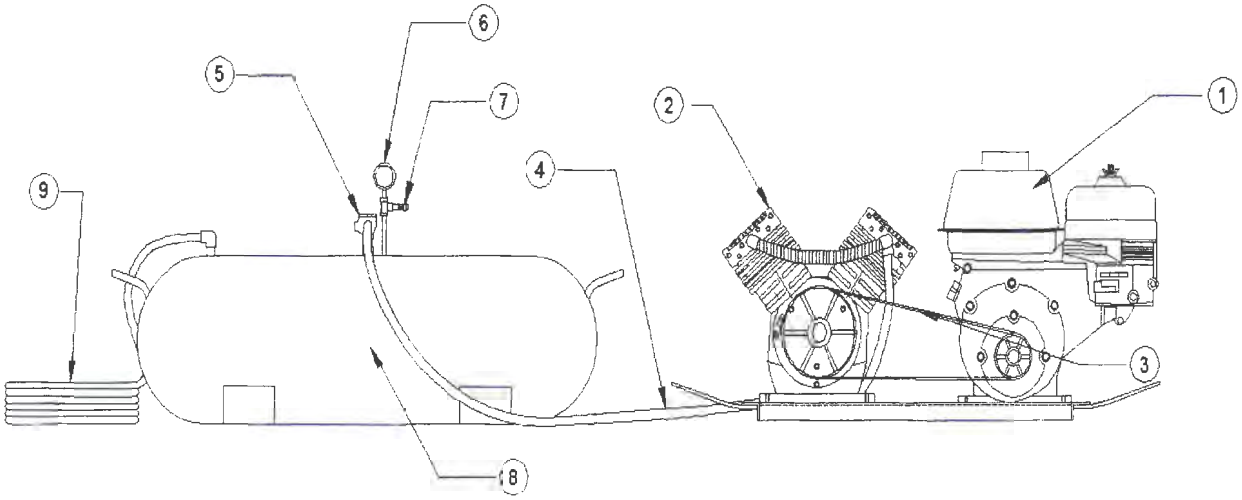
1. Air Compressor Parts and Accessories

1. Gas Engine
2. Twin Head Compressor
3. V-Belt
4. Discharge Hose to receiver
5. Check Valve
6. Pressure Gauge
7. Relief Valve
8. Air Receiver
9. Discharge Hose from receiver



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2. AIR COMPRESSOR SPECIFICATIONS

2.1 Engine

a. Honda Engine (GX 160)
b. Shaft ¾" dia. x 2 ½"L
c. Speed: 3600RPM
d. Pulley: 2 ½ "dia.
e. Fuel Capacity: 3.1L
f. Dry Weight: 33lbs. (15.1kg.)

2.2 Compressor Head

a. Displacement: 6CFM @90 PSI
b. Max. Pressure: 100 PSI
c. Shaft: 1" dia. x 2 ½ "L
d. Speed: 1800RPM
e. Pulley: 5" dia.
f. Cylinder Head Fittings: ½ "
g. Weight: 25.5 kg.

2.3 Belt

a. Type: V-Belt
b. Description: B35 Classical V-Belt

2.4 Air Receiver

a. Dimension: 230mm dia. x 780mm
b. Capacity: 30L
c. Discharge Fittings: ¼ "dia.
d. Pressure: (0-90)PSI
e. Check Valve: ½ "dia.

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3. OPERATION AND MAINTENANCE

3.1 Preparing to start

1. Remove all loose pieces and tools around the compressor installation.
2. Check oil level.
3. Check engine's fuel level.
4. Check motor and compressor pulley for alignment and tightness on shaft.
5. Be absolute sure that all mounting bolts are tight.
6. Manually rotate compressor through enough revolutions to be certain that there are no mechanical interferences.
7. Check belt tension, it should be neither too loose nor too tight.
8. Check all pressure connections for tightness.

NOTE: Failure to make these recommended checks could result in serious injury, property damage, and mechanical failure.

3.2 Starting

1. Move the fuel valve lever to the ON position.
2. Move the throttle lever slightly to the left.
3. Move the choke lever to the CLOSED position.
4. Turn the engine switch to the ON position.
5. Pull the starter grip lightly until resistance is left, then pull briskly.
6. Move the choke lever to the OPEN position.
7. Set the throttle lever at the desired position
8. Watch for excessive vibration and noises. If either is present, stop compressor and correct.
9. Check air receiver pressure.
10. Observe general operation closely for first hour then frequently for the next few hours. If any abnormal conditions exist, stop the compressor and correct the problem.
11. After few days of operation, check belt tension, air and oil piping and crankcase oil level.

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4. GENERAL PREVENTIVE MAINTENANCE SCHEDULE

Procedure	Daily	Weekly	Monthly	Annually (200) hours)
Check low oil level. Maintain between high and mask level in gauge. CAUTION: Do not overfill.	X			
Oil leak inspection	X			
Drain water in tank	X			
Check for any unusual noise and vibration.	X			
Inspect all air leaks.	X			
Inspect belts	X			
Check air filters (clean or replace)		X		
Check belts if necessary			X	
Check and tighten all bolts			X	
Check connections for leaks			X	
Service pump or engine				X

5. TROUBLESHOOT

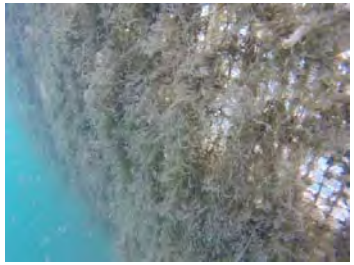
Trouble	Probable Cause
Low discharge pressure and air delivery.	Restricted air inlet filter or suction. Bad compressor valves or valve unloading mechanism. Drive belt slipping. Incorrect speed Worn piston rings or loose piston. Leaking head gasket. Drain valve open. Bad pressure gauge. Safety valve leaking. Loose compressor valves or leaking valve gaskets. Valves or piston rings not seated.
Rusty valves and/or cylinders.	Compressor operated too infrequently. Compressor does not run enough to get hot and vaporize the moisture squeezed out of the air during compression. Not properly processed for storage.
Excessive belt wear.	Pulleys out of alignment. Belt too loose or too tight. Belt slipping Pulley wobbling. Pulley groove damaged or rough.

Appendix-2: Cleaning and Tightening of Anchor Ropes

Method and Procedure for Tightening Ropes for the Submersible Cages

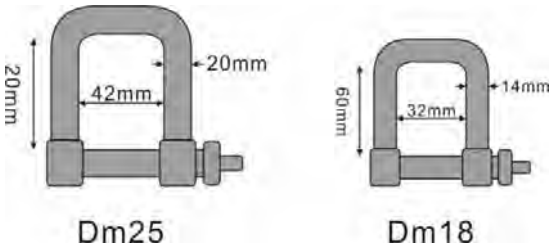
A. Cleaning of ropes

The ropes of grid mooring system are infested with algae, shells, barnacles and other organisms (called bio-fouling) as it is set underwater for a long period. They cause various problems for the operation of fish farming. Accidental net breakage occurred three times in the last 1 and 1/2 years with the submsersible cages since the introduction and were all caused by contact of the net with barnacles that grew on the grid frame ropes. They need to be removed regularly.



Coner metal ring (left) and cage net (rightI infested with bio-fouling

A recommended method of rope cleanig is explained below. This method uses galvanized metal shackle commonly avaible in hardware shops selling fishing gears. Type of shackle suitale for cleaning of the original anchor ropes and grid frame ropes are shown in the figure below.



Dimensions of the shackles used for cleaning.

<u>Procedure for cleaning rope:</u>

1. Set a raft near the corner of the grid by anchoring and lift the corner ring (metal ring set at every corner, suspended from float) of the grid frame to the surface. (Figure 1 ①).
2. A pulling rope for cleaning is passed through the corner ring and pulled along the anchor rope by a diver to the concrete anchor block, where the diver sets a shackle at the end of rope. The shackle is set to hold the anchor rope inside and the pulling rope is tied to the shackle rod. Figure 1 ②).
3. Another diver does the same for grid frame rope and is set in a smaller sized shackle.
4. The pulling rope for cleaning attached to the anchor rope is pulled from the raft so that the shackle gradually move along the rope while removing the bio-fouling materials grown on the rope because the inner size of shackle is just enough to pass the rope through. (Figure 1 ③).
5. After cleaning of the anchor rope is finished, the other rope with the shackle attached on the grid frame rope is pulled similarly to clean the grid frame rope.
6. Repeat the procedure for all ropes (both anchor ropes and grid frame ropes).

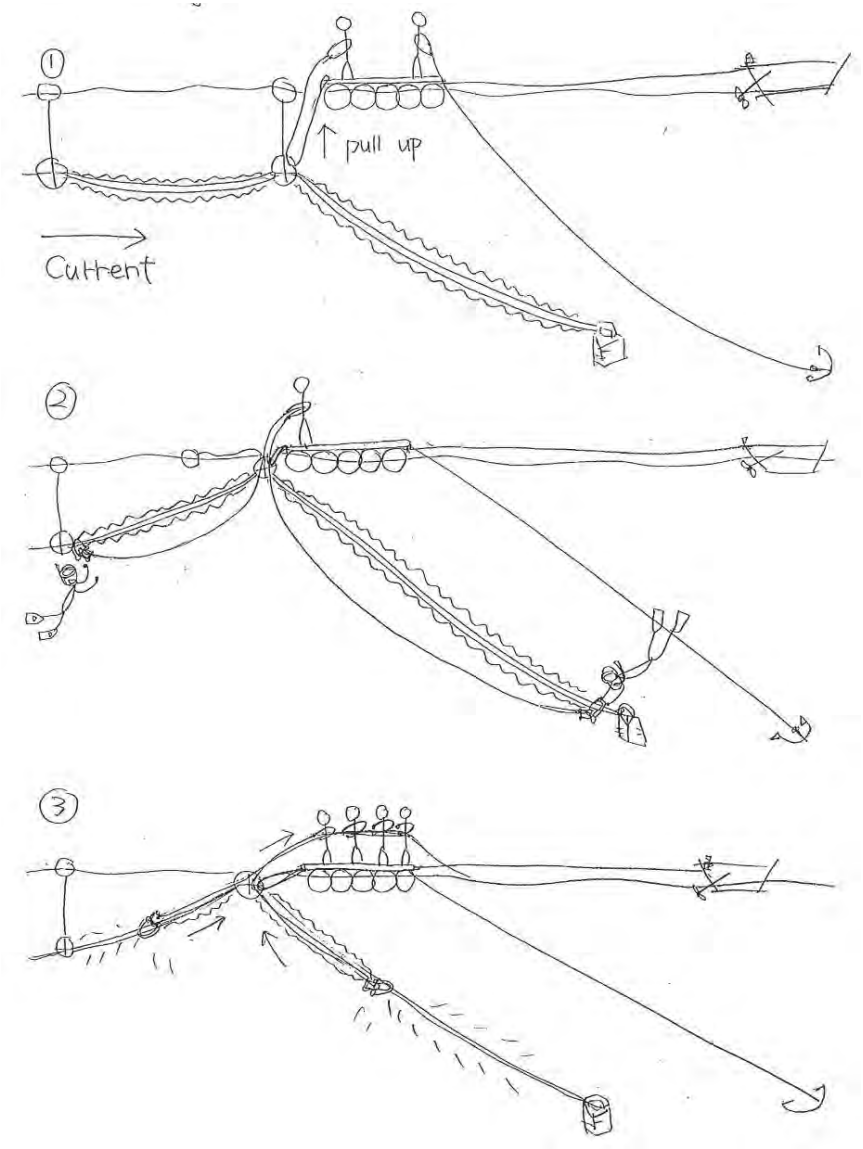


Figure 1. Procedure for cleaning ropes of submersible cages system. See the text for the procedure.

B. Tightening ropes

The ropes get elongated as they used because of the material (polyethylene) elasticity and loosening of braid. The grid mooring system of JICA cages have superior fixing capacity of cage system as the flexible rope structure distribute the stress over the cage system and more ropes are used for holding the whole system compared to the single mooring system. But those advantages function only when the system are maintained appropriately.

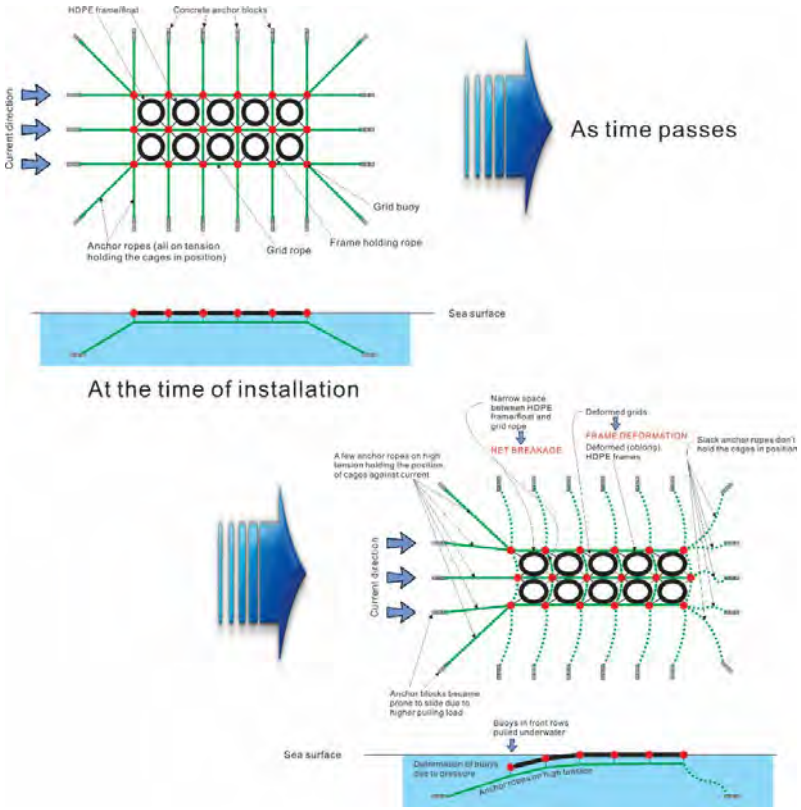


Figure 2. Problems expected by non-maintenance of grid mooring system

An anchor rope functions as intended only when the tension is exerted on the rope. When it is slack and floating, it does not contribute to hold the cage system. When the extent of slackness of the ropes exceeds the critical level, there are several problems to start occurring (Figure 2), which includes: 1) cutting of net by abrasion of net to grid frame rope, 2) deformation of HDPE ring, 3) deformation of buoy, and 4) sliding of entire cage system.

Tightening of anchor rope for the submersible cage system can be done with a rope. Project recommend to do this as illustrated in Figure 3.

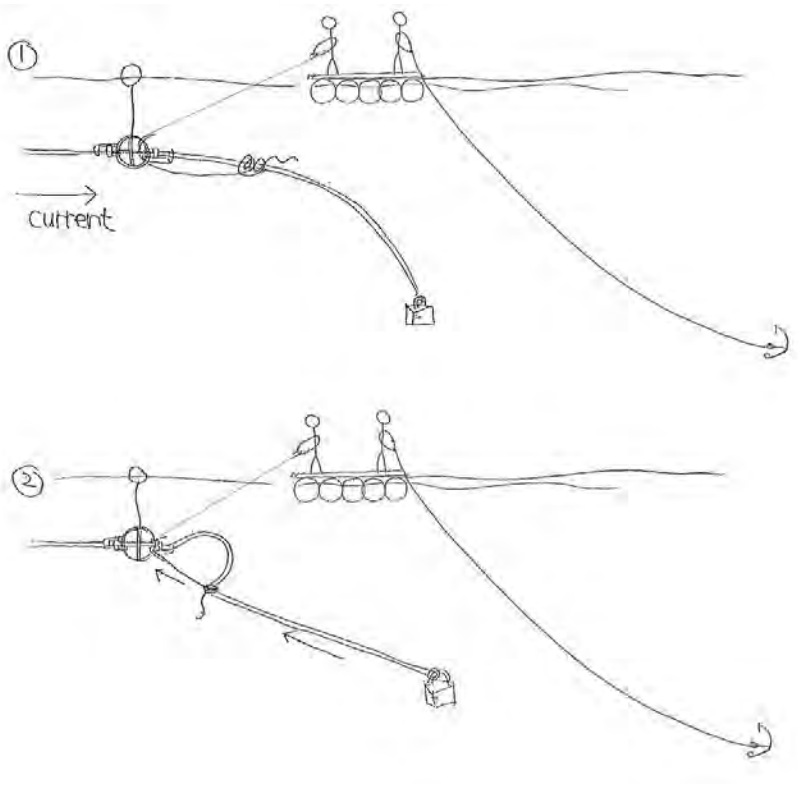


Figure 3. Tightening of an anchor rope. See the text for the explanation.

Procedure for tightening anchor ropes:

1. Set a raft near the metal corner ring and pass a pulling rope of about 10 to 15 mm diameter through the corner ring.
2. Tie the end of pulling rope to the anchor rope at the position about 5 to 10 m from the corner ring. Tying should be done in the way it does not slip along the anchor rope. The location of tying positon on the anchor rope depends on the slackness of the rope. The more slack the anchor rope, the distant the position from the corner ring. This operation needs to be done by a diver.
3. Pull the pulling rope so that the anchor rope is pulled at the tied point. This will make the upper portion of the anchor rope above the tied position with the pulling rope free-floating in the water. The anchor rope at the upper end where it is tied to the corner ring is not pulled.
4. While the persons on the raft hold the pulling rope and keep the upper portion of anchor rope above the tied points free floating, the diver underwater unties the anchor rope at the corner ring, tightens the anchor rope, and ties it again after taking out the slackness. This tying operation can be done easily because the upper portion of anchor rope is held with no tension. Practically, what the diver does is to stretch the free floating portion of the anchor rope and re-tie the rope to the corner ring.

   The anchor rope should be tied in the way that it is easy to untie for frequent tightening operation. A tying method recommended is shown in Figure 4.
5. After the anchor rope is securely re-tied by the diver, the persons on the raft can release the pulling rope. The diver untie the pulling rope at the end where it is tied to the anchor rope.

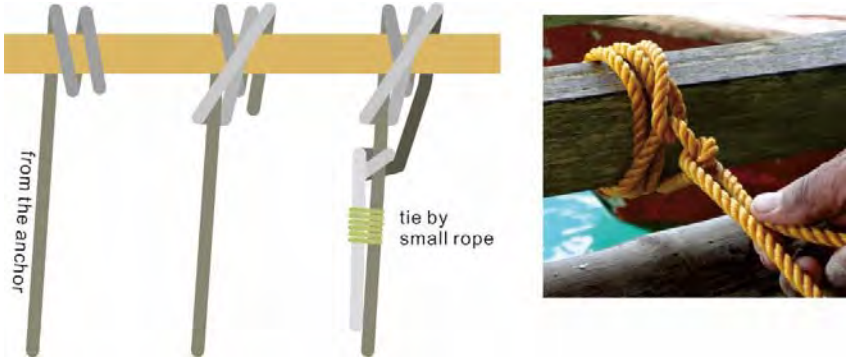


Figure 4. Tightening of an anchor rope recommended for frequent tightening operation.

The tightening of anchor ropes needs to be done regularly, as often as possible. Whenever an operator finds the rope slack, tightening should be applied. When the operation is not carried out for a long time, the ropes becomes very slack so that the tightening operation may result in a deformation of grid mooring system. The following sequence of tightening is recommended to follow in such a case. As a rule of thumb, it is recommend to limit the length of anchor rope shortened at a time to less than 2 meters. By keeping this rule and tightening the anchor ropes little by little at a time, occurrence of deformed grid mooring system is avoided. This procedure is recommended also for such times as preparation before the typhoon season when the entire cage system is carefully examined.

<u>Sequence of tightening operation by anchor rope locations (Figure 5)</u>

1. Pull the anchor ropes located on the downstream side of the grid mooring. Tie only the two corner ropes (those ropes attached diagonally to the cage system) at this time. The pulling operations need to be completed during the time when the tide is on the same direction so the operation is recommended to start before the peak

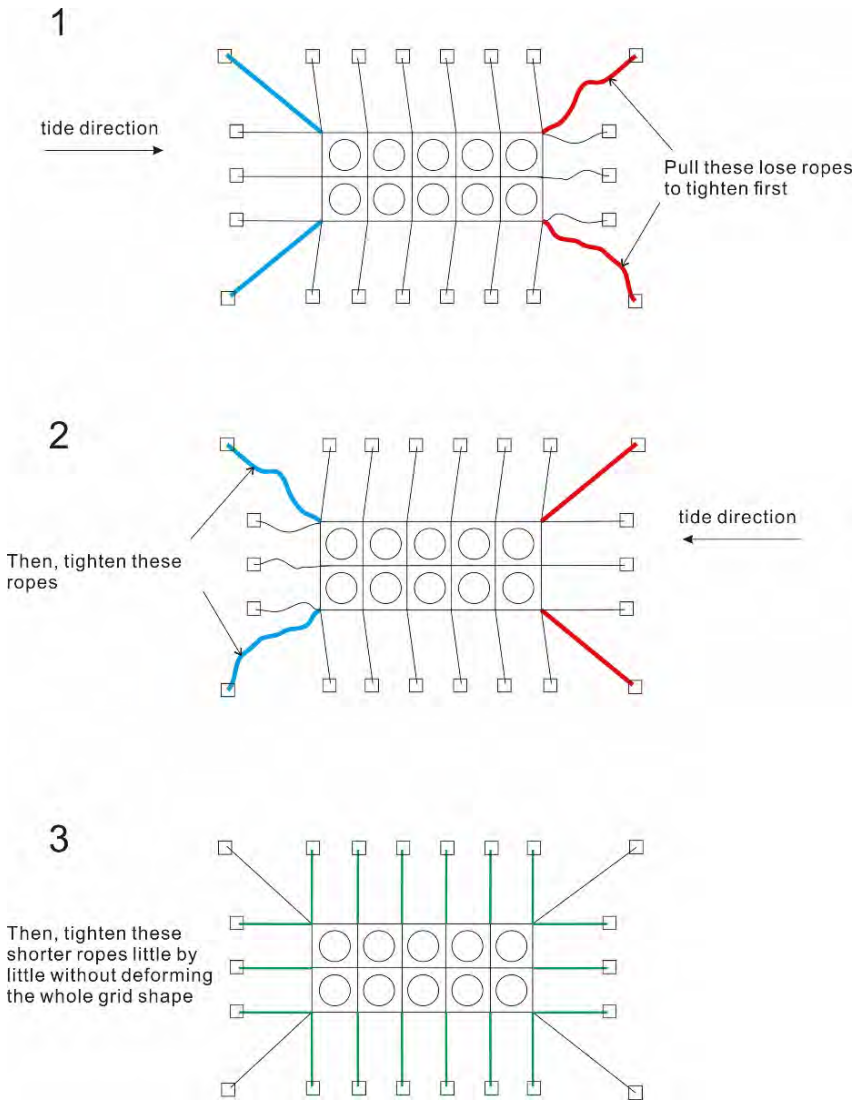


Figure 5. Sequence of tightening operation by anchor rope locations when a large amount of slackness needs to be removed.

current time. As mentioned above, limit the length of tightening at a time less than 2 meters. If the slackness exceeds the level that allows the operators to shorten the anchor rope more than 2 m, pull only 2 m per one tightening operation and let the remaining slackness be removed by pulling on the other side.

2. Wait for the change of current direction. When the current has changed and the ropes on the opposite side get loose, then start tightening those ropes. Tighten again only the corner ropes.

3. After four corner ropes are properly tightened, pull the other ropes which are attached to the direction of the current or attached perpendicular to it.

Appendix-3: Deficiency in Supply of Milk Fish Fry/Fingerlings after Typhoon Yolanda

Shortage of Milkfish Fingerling Supply after Super Typhoon Yolanda

The fingerlings of milkfish are produced through a two-step system composed of hatcheries and nurseries (Figure 1). The artificial fingerling production of milkfish starts by spawning at a hatchery where the fish are reared for about one month and sold as milkfish "fry". The milkfish fry from hatcheries is less than 1 g in weight and too fragile to be stocked in fish cages directly, but they can be transported in a large quantity by packing in plastic bags with oxygen for a long distance. They are shipped from hatcheries to intermediate growers called "nursery" located outside of the regions or even to overseas. Actually, most nurseries in Region 8 are importing fry from the largest hatchery in the country located in General Santos, Mindanao, before the time of Typhoon Yolanda. The shortage of fry from the hatchery was not the main cause of the shortage in the Eastern Visayas region after the Typhoon Yolanda.

The fry from hatcheries are reared for 3 to 4 months in nurseries to grow to 4 to 5 inches in length for sale to the grow-out farmers. Called "fingerlings", the fish at this size are stocked in cages, ponds, or pens for growing into market size (300 to 500 g). The rearing of fry was carried out in earthen ponds located near coasts as the fish requires brackish water in its

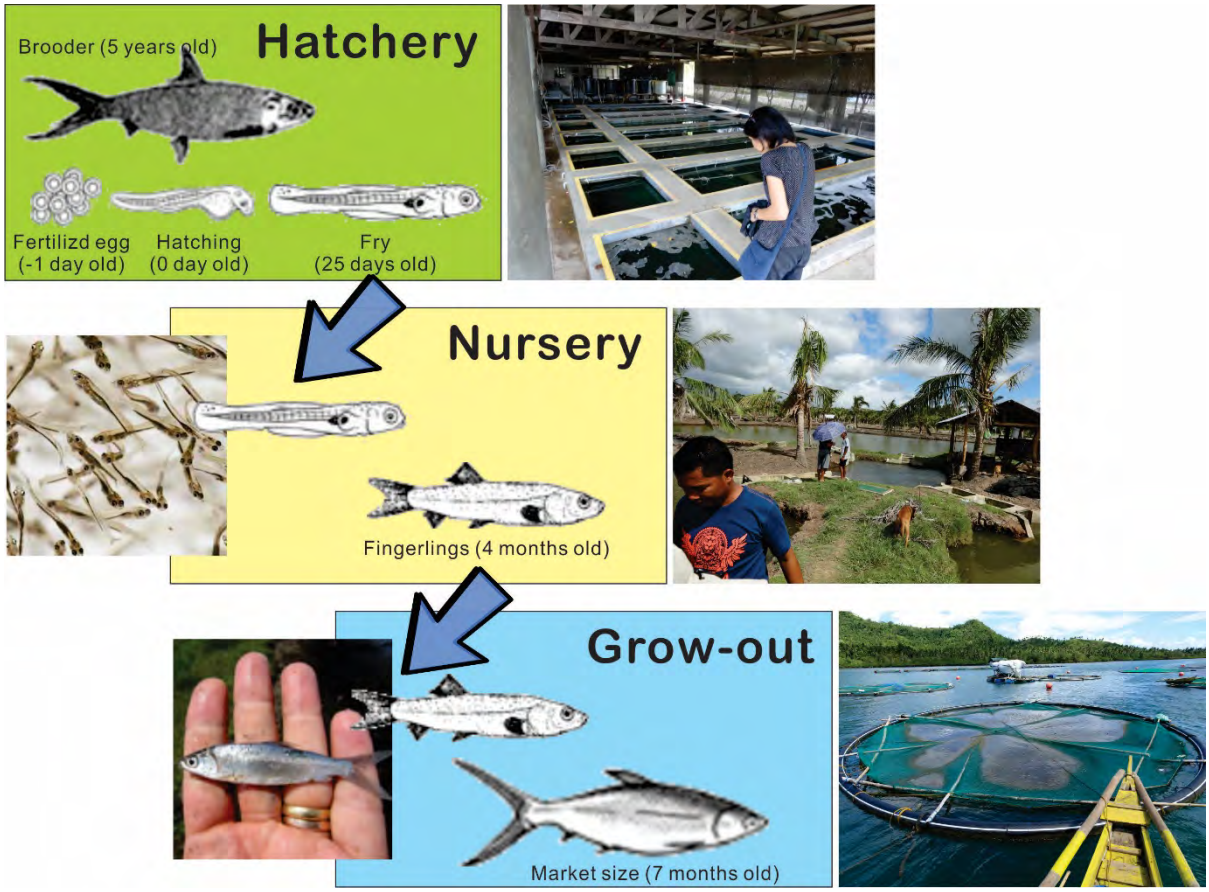


Figure 1. Milkfish fingerling production system

early life stage. These earthen facilities on coastal areas were damaged by Typhoon Yolanda and resulted in severe shortage in fingerling supply to the grow-out farmers. The fingerlings are too large to ship outside of the region and are not done because of economic reasons.

Appendix-4: Contents of the Action Plan prepared in the Milk Fish VCA Workshop

Attachment-4

Contents of the Action Plan prepared in the Milk Fish VCA Workshop

I. INPUT SUPPLIER

STRATEGY	ACTIVITIES	RESPONSIBLE PERSON	TIMELINE
Objective 1. ***To develop local hatcheries operator for fingerling production***			
A. Identify quality area suited for hatchery	➢ Conduct consultation meetings with LGU and other stakeholders *Possible sites for hatcheries* *-Amandayehan, Basey* *-Tanauan, Leyte* *-Tacloban North (existing proposal in Embassy of Japan)*	➢ LGU hatchery operators , BFAR, etc./Stakeholders (fingerlings and feed producers), DTI	➢ June 2015-July 2016
B. Identify agencies to support the development of hatchery	➢ Visit/linkage to support agencies *Support agencies* *-BFAR 8, LGU, DOST 8, DOLE 8, BuB as source of fund, DTI 8*		
C. Establishment of Hatchery	➢ Identification and provision of area for the establishment of hatchery	➢ LGU	➢ September 2015
	➢ Formulation of Proposal for the establishment of hatchery	➢ BFAR 8 *Focal Persons* *-Lea Tumabiene* *-Nelia Gabon* *-Engr. Rolando Ay-ay* *Note: If JICA can provide fund for the establishment of hatchery*	➢ September 2015
	➢ Consultation between BFAR and interested Hatchery Operators if they can operate it	➢ BFAR and interested hatchery operators	
Comments and Suggestions: 1. Mr. Yu proposes village level or backyard hatchery to produce the fry, assisted by BFAR and the LGU **2.** Seacage has renewed license in Basey to operate hatchery in Basey			
D. *Accreditation of Input Supplier*	➢ Review and Revise guidelines	➢ BFAR	➢ December 2015
Objective 2: ***Establish village level feed mill to supply the hatchery and grower operators***			
A. Establishment of Feed Mill	➢ Identification of availability of raw materials in the area (corn, cassava, protein-fish meal, soy beans and by products of processing plants) *Note: Involvement of DA in the production of raw materials for the village level feed mill*	➢ LGU-MAO	➢ July (for Basey) ➢ August (for Tanauan)

	➢ Inquire VSU- if there are existing studies on village level feed mills	➢ BFAR, DOST, VSU	➢ September 2015
	➢ Determine the feed requirement if this will suffice the establishment of a village level feed mill	➢ BFAR & LGU	
	➢ Feed formulation study & study on the efficiency of feed mills	➢ DOST	➢ For validation and discussion
	➢ Possibility of adopting village type Feed Mill Model in Bukidnon worth 10M and 5.5M	➢ BRC	
Comment and Suggestion: **1.** Determine the viability because it might come out more expensive if we formulate own feeds rather than buying commercial feeds			
Objective 3: ***To have skills of manpower requirement to provide technical expertise on fingerling production***			
A. Manpower Pool Development from Hatchery to Nursery	➢ Organize Manpower within the area (Mariculture/Fishery)	➢ Mariculture graduates/fisheries; TESDA; BFAR	
	➢ Technical training on farming and feed formulation/mixing (soya, cassava & corn) for feed requirement	➢ BFAR *Panabo (request* BFAR *Panabo to conduct the training)*	
Comments and Suggestions: 1. BFAR is willing to conduct training to develop capabilities of workers			

II. MILKFISH GROWERS

STRATEGY	ACTIVITIES	RESPONSIBLE PERSON	TIMELINE
Objective: To lessen the cost of farm inputs in Milkfish production			
A. Manpower Pool Development	➢ Conduct of management/entrepreneurial trainings for all members	➢ DTI	➢ Within this year 2015
B. Marketing and Pricing	➢ Conduct daily Price Monitoring/Bulletin	➢ LGU, Locators	➢ July Onwards
	➢ Scheduling of harvest so that prices will not go down or prevent glut in the market • Linkages between growers and traders	➢ LGU, Locators	
C. Documentation and Traceability	➢ Strict implementation of document requirement Transport of product • Auxiliary Invoice • Local Transport Permit Aqua Farm Registration accreditation Licensing	 ➢ LGU ➢ BFAR ➢ BFAR ➢ LGU	
Comments and Suggestions/ Issues and Concerns: 1. Low Dissolved Oxygen in the area for fish pen-Tanauan, compressor are prohibited if they are in the pumpboat and used in fishing operations. Use compressors are aerators instead. 2. Conflict between LGU and cage operators			

3. Local Bangus producers suffer losses due to presence of Bangus coming from Davao which have lower price
4. July 3 activity will be at Tacloban City Fish Port as dry run for 2 weeks
5. Mr. Yu offers his post at the Tacloban Fish Port to the VC participants at 3% of gross sales

MARKET SITUATION OF BANGUS IN TACLOBAN

**market price of Bangus from Davao ranges from P93.00-97.00 and sold at Tacloban market at P100.00 (+)*

**if production of Bangus in the region is low, Davao's selling price for Bangus is P3,000.00/tub*

III. PROSESSORS

STRATEGY	ACTIVITIES	RESPONSIBLE PERSON	TIMELINE
Objective: ***To produce quality processes Milkfish compliant to regulatory and market requirement***			
A. Consistency of the Product Preparation (Standardization)	➢ Calcium analysis and Halal test	➢ DOST	
B. Compliance to Regulatory and Licensing	➢ Compliance to Business Registration and Permit Requirements • Business Permits • DTI Permit • Fire Permit • Sanitary Permit • Tax *Note: Business permit application is ongoing for SCWFA Enterprise, Sta. Cruz.* *-For Basey, permit is still on process*	➢ LGU ➢ DTI ➢ BFP ➢ LGU ➢ BIR	➢ August 2015 *Note: By August, all permits should be completed*
C. Upgrading of facilities	➢ Preparation of project proposal and engineering design for fund sourcing	➢ DOST Food Safety Team (Ms. Mayen), OPA-Leyte (Ms. Sievert)	➢ June-July 2015
	➢ Site inspection, bidding and construction	➢ LGU	➢ Dec. 2016-Tanauan ➢ August 2015-Tolosa ➢ Dec. 2016-Basey
	➢ Construction of GMP compliant processing facility for Basey and Tanauan.	➢ Embassy of Japan (funder)	➢ June 2015
	➢ Upgrading the Tolosa Plant-compliance to the GMP requirements.	➢ Embassy of Japan (funder)	➢ June 2015
	➢ Orientation on GMP/SSOP and HACCP	➢ BFAR and DOST	➢ Within this year
	➢ Compliance to FDA requirements for LTO	➢ BFAR	➢ August 2015-Tolosa ➢ Within this year-Basey ➢ Within this year-Tanauan
D. Compliance to Packaging Requirements, labeling and barcoding	➢ Review existing studies on the shelf life of the Softboned Bangus (How to's)	➢ DOST	➢ August 2015
	➢ Improvement of packaging and labeling design of the	➢ DTI assisted	➢ Within this year (on-going)

	Softboned Bangus		
E. Improve Access to Financing	➢ Preparation of project proposal for operation funding requirements for DOLE	➢ Mr. Masuda, Ms. Imelda Sievert, DOLE	➢ June 2015
F. Enhance Access to Market	➢ Prepare directory for target buyers/target market ➢ Obtain and comply requirements of target buyers	➢ Group of Processors as listed ➢ Group of processors as listed	➢ June to August 2015
	➢ Federation for Basey, Tanauan, and Tolosa Groups-JICA will form them into a federation to have an even distribution of Softboned Bangus in the region.	➢ JICA assisted	➢ 1st week of July 2015?
	➢ Market Promotion • Jingle (Tanauan) • Product Testing	➢ Locators, LGU, DTI ➢ DTI	
Comments and Suggestions: 1. Available funds for the processing plant from JICA but we need funds from the LGU to buy the land where the facility will be constructed- Tanauan 2. Processing plant is not compliant with Food Safety and Regulatory Requirements. **3.** Sizes of Softboned Bangus sold in the market should be standardized-Mr. Yu			
IV. TRADERS			
STRATEGY	**ACTIVITIES**	**RESPONSIBLE PERSON**	**TIMELINE**
A. Good Packaging and Labeling	➢ Pasalubong Center • Make sure it's approved by DTI	➢ Bahandi ➢ DTI	
B. Present Promo Collateral does not speak "well" for the product	➢ Participate in Trade Fair • Before going international, product launching should be organized for the Softboned Bangus as new product, inviting everyone in the region • Tap a Media to advertise in the newspaper	➢ For North West Leyte Chamber (Baybay, Palompon, and Ormoc)	➢ Before the year end, if the product is ready
	➢ Business launching and Trading Center • This will be put in Ormoc, because it is accessible to local markets going to islands • Trading center will connect all the buyers (i.e. restaurants) and it's advisable that producers are present to have someone knowledgeable about the product to market for business matching		
	➢ Marketing with use of Social media (i.e. Facebook) there are a lot of products being marketed using facebook. Given the communication in region 8 is upgraded. Because this also an avenue to market outside the Philippines or international		
(AS IS-No further discussion because there was no representative from the traders)			
Issue on a trader: (Warblitz)			

1. Not fulfilling the promise to buy the products from Basey. Ordered 20kls Softboned Bangus.

V. ENABLERS

STRATEGY	ACTIVITIES	RESPONSIBLE PERSON	TIMELINE
Objectives:			
A. Human Resource Development	➢ Organizational, entrepreneurial trainings • Coaching (continuous coaching for the business) Resource: Training venue on site	➢ Ms. Badette Corsiga (DTI (RO8)	➢ July –August 2015 ➢ Continuous
B. IEC	➢ Develop information networking using ICT (Market information database, ordinances, regulatory requirements)	➢ Respective LGU (Citizen's Charter)	➢ December 2015
C. Market Research	➢ Conduct market research on Processed Bangus	➢ Ms. Badette Corsiga (DTI RO8)	➢ December 2015
D. Access to Finance	➢ A proposal to support the Bangus Industry in the municipalities	➢ Responsible LGU	➢ Enroll on 2016 to be implemented on 2017
E. Policy Creation and Enforcement	➢ Request GPBP on the guidelines for the procurement (because of the difficulty on government procurement)	➢ Atty. De Escoto	➢ December 2015

Appendix-5: Updated Competence Based Curriculum for Shield Metal Arc Welding (SMAW) NCII (TESDA Training Material)

COMPETENCY-BASED CURRICULUM

Sector:

METALS AND ENGINEERING

Qualification:

Skills Upgrading Program for

Shielded Metal Arc Welding (SMAW) NC II

TECHNICAL EDUCATION AND SKILLS DEVELOPMENT AUTHORITY
REGIONAL TRAINING CENTER
Tacloban

Japan International Cooperation Agency

TABLE OF CONTENTS

COURSE DESIGN

COURSE TITLE : **SHIELDED METAL ARC WELDER (SMAW)**

NOMINAL DURATION : **268+120 hours=388hrs (34+**15 **days) =49 days**

QUALIFICATION LEVEL : **NC II**

COURSE DESCRIPTION :

This course is designed to enhance the knowledge, desirable attitudes and skills to perform shielded metal arc welding work to the standard expected in the workplace.

The course covers, competencies such as; utilize specialized communications, develop team and individual needs, apply problem solving techniques in the workplace, perform workplace safety and housekeeping, interpret blueprint, set up work area equipment and accessories, prepare weld joints, deposit weld beads, prepare materials and tools, weld carbon steel pipes and plates in all position for fillet and groove welds and **fabricate and install steel trusses, steel window casement and other related iron works.**

ENTRY REQUIREMENTS :

Candidate /trainee must posses any of the following qualifications:

- 18 years old and above;
- Good moral character;
- Can communicate both orally and in written form.

COURSE STRUCTURE:

BASIC COMPETENCIES

(18 hours)

UNIT OF COMPETENCY	MODULE TITLE	LEARNING OUTCOMES	NOMINAL DURATION
1. Participate in workplace communication	1.1 Participating in workplace communication	1.1.1 Obtain and convey workplace information 1.1.2 Complete relevant work related documents. 1.1.3 Participate in workplace meeting and discussions	4 hours
2. Work in a team environment	2.1 Working in a team environment	2.1.1 Describe and identify team role and responsibility in a team 2.1.2 Describe work as a team	4 hours
3. Practice career professionalism	3.1 Practicing career professionalism	3.1.1 Integrate personal objectives with organizational goals 3.1.2 Set and meet work priorities 3.1.3 Maintain professional growth and development.	6 hours
4. Practice occupational health and safety	4.1 Practicing occupational health and safety	4.1.1 Identity hazards and risks 4.1.2 Evaluate hazards and risks 4.1.3 Control hazards and risks 4.1.4 Maintain occupational health and safety awareness	4 hours

COMMON COMPETENCIES

(56 hours) +14

UNIT OF COMPETENCY	MODULE TITLE	LEARNING OUTCOMES	NOMINAL DURATION
1. Apply safety practices	1.1 Applying safety practices	1.1.1 Identify hazardous area 1.1.2 Use personal protective clothing and devices 1.1.3 Perform safe handling of tools, equipment and materials 1.1.4 Perform first aid 1.1.5 Use Fire extinguisher **1.1.6 Perform safe structural works at an elevated workplace**	8+ 2 hours
2. Interpret drawing and sketches	2.1 Interpreting drawing and sketches	2.1.1 Identify standard alphabet of lines 2.1.2 Identify orthographic/ isometric views 2.1.3 Interpret standard drawing symbols, dimensional tolerances and notations **2.1.4 Interpret and analyze specific project plan**	8+ 4 Hours
3. Perform industry calculation	3.1 Performing industry calculation	3.1.1 Perform four fundamental operations. 3.1.2 Perform conversion of units 3.1.3 Perform calculations on algebraic expressions 3.1.4 Compute percentage and ratio **3.1.5 Estimate materials for specific project plan**	8+4 hours
4. Contribute to quality system	4.1 Contributing to quality system	4.1.1 Inspect work done. 4.1.2 Apply quality standards to work 4.1.3 Protect company property and customer interests	4 hours
5. Use hand tools	5.1 Using hand tools	5.1.1 Select hand tools 5.1.2 Use hand tools 5.1.3 Maintain hand tools	4 hours
6. Prepare weld materials	6.1 Preparing weld materials	6.1.1 Set up cutting equipment 6.1.2 Cut and prepare edge of materials 6.1.3 Clean surfaces and edges 6.1.4 Prepare welding consumables 6.1.5 Prepare welding safety	8 hours

UNIT OF COMPETENCY	MODULE TITLE	LEARNING OUTCOMES	NOMINAL DURATION
		and protective equipment	
7. set-up welding equipment	7.1 Setting-up welding equipment	7.1.1 Set up welding machine 7.1.2 Set up welding accessories 7.1.3 Set up welding positioners, jigs and fixtures	4 hours
8. Fit-up materials	8.1 Fitting up materials	**8.1.1 Layout Materials** 8.1.2 Perform tack welding 8.1.3 Check gap and alignment **8.1.4 Install support/stiffeners**	4+4 hours
9. Repair weld	9.1 Repairing weld	9.1.1 Mark/locate weld defects 9.1.2 Prepare tools and equipment 9.1.3 Remove defects 9.1.4 Perform re-welding	8 hours

CORE COMPETENCIES
(194 hours) + 106

UNIT OF COMPETENCY	MODULE TITLE	LEARNING OUTCOMES	NOMINAL DURATION
1. Weld carbon steel plates and pipes using SMAW	1.1 Performing groove welding on carbon steel plate	1.1.1 Weld carbon steel plates in flat position (1G) 1.1.2 Weld carbon steel plates in horizontal position (2G) 1.1.3 Weld carbon steel plates in vertical position (3G) 1.1.4 Weld carbon steel plates in overhead position (4G) 1.1.5 Weld carbon steel plates in flat position (1F) 1.1.6 Weld carbon steel plates in horizontal position (2F) 1.1.7 Weld carbon steel plates in vertical position (3F) 1.1.8 Weld carbon steel plates in overhead position (4F)	114 hours
	1.3 Performing groove welding on carbon steel pipe	1.2.1 Weld carbon steel pipe in flat position (2G) 1.2.2 Weld carbon steel pipe in horizontal position (5G) 1.2.3 Weld carbon steel pipe in vertical position (6G)	80 hours
	1.2 Performing welding and steel Fabrication	***1.2.1 Prepare materials, tools and equipment*** ***1.2.2 Perform Lay outing*** ***1.2.3 Fabricate parts*** ***1.2.4 Install specific project***	***+106 hrs.***

ASSESSMENT METHODS:

- Written examination
- Demonstration of practical skills
- Direct observation
- Interview

COURSE DELIVERY:

- Modular
- Demonstration
- Lecture
- Discussion
- Dual training
- Self-paced learning

RESOURCES:

Equipment
- DC welding machine complete with accessories
- Welding booth
- Welding table or jig
- Stabilizing oven
- Portable Welding Machine
- Cut off saw
- Oxy- acetylene welding and cutting
- Bar cutter

Training materials
- Reference books
- Manuals
- Catalogs
- Brochures
- Modules/LEs
- CDs/Video tapes
- Arc welding manuals
- Welding standards
- Welding procedures specifications (WPS)
- Project Plan

Tools/accessories/supplies
- Set of box wrench
- Chipping hammer
- Steel brush
- Dark glass
- Clear glass
- Weld gauge
- Penlight
- Dye penetrant (DPT)
- Electrodes
- Cutting / grinding disk
- Carbon steel plates / pipes
- Portable oven
- Portable grinder
- L square
- Plumb bob
- Hose level
- Spirit Level
- Hacksaw
- Angle bars
- Flat bars

Personal protective equipment
- safety shoes
- safety goggles
- apron
- gloves
- leggings
- Safety harness
- Welding mask

TRAINER'S QUALIFICATIONS:

- Must be a holder of Welding (SMAW) NC II.
- Must have undergone training on Training Methodology I (TM I).
- Must be computer literate.
- Must be physically and mentally fit.
- *Must have at least 2 years job/ industry experience.
- Must be a civil service eligible or appropriate professional license issued by the Professional Regulatory Commission (for government position).

* Optional: only when required by hiring institution

AS PER TESDA RESOLUTION NO. 2004-03

MODULES OF INSTRUCTION

BASIC COMPETENCIES

SHIELDED METAL ARC WELDING (SMAW) NC II

UNIT OF COMPETENCY : **PARTICIPATE IN WORKPLACE COMMUNICATION**

UNIT CODE : **500311105**

MODULE TITLE : **PARTICIPATING IN WORKPLACE COMMUNICATION**

MODULE DESCRIPTOR : This module covers the knowledge, skills and attitudes required to obtain, interpret and convey information in response to workplace requirements.

SUGGESTED DURATION : 4 hours

PREREQUISITE : Receive and Respond to workplace Communication. (NC I)

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module the students/ trainees will be able to:

LO1. Obtain and convey workplace information

LO2. Complete relevant work related documents.

LO3. Participate in workplace meeting and discussion.

LO1. OBTAIN AND CONVEY WORKPLACE INFORMATION

ASSESSMENT CRITERIA:

1. Specific relevant information is accessed from appropriate sources.
2. Effective questioning, active listening and speaking skills are used to gather and convey information.
3. Appropriate medium is used to transfer information and ideas.
4. Appropriate non-verbal communication is used.
5. Appropriate lines of communication with superiors and colleagues are identified and followed.
6. Defined workplace procedures for the location and storage of information are used.
7. Personal interaction is carried out clearly and concisely.

CONTENTS:

- Parts of speech
- Sentence construction
- Effective communication

CONDITIONS:

The students/ trainees must be provided with the following:

- Writing materials (pen & paper)
- References (books)
- Manuals

METHODOLOGIES:

- Group discussion
- Interaction
- Lecture
- Reportorial

ASSESSMENT METHODS:

- Written test
- Practical/performance test
- Interview

L02. COMPLETE RELEVANT WORK RELATED DOCUMENTS

ASSESSMENT CRTERIA:

1. Ranges of forms relating to conditions of employment are completed accurately and legibly.
2. Workplace data is recorded on standard workplace forms and documents.
3. Basic mathematical processes are used for routine calculations.
4. Errors in recording information on forms/ documents are identified and rectified.
5. Reporting requirements to superior are completed according to enterprise guidelines.

CONTENTS:

- Basic mathematics
- Technical writing
- Types of forms

CONDITIONS:

The students/trainees must be provided with the following:

- Paper
- Pencils/ball pen
- Reference books
- Manuals

METHODOLOGIES:

- Group discussion
- Interaction
- Lecture

ASSESSMENT METHODS:

- Written test
- Practical/performance test
- Interview

LO3. PARTICIPATE IN WORKPLACE MEETINGS AND DISCUSSIONS

ASSESSMENT CRITERIA:

1. Team meetings are attended on time.
2. Own opinions are clearly expressed and those of others are listened to without interruption.
3. Meeting inputs are consistent with the meeting purpose and established protocols.
4. Workplace interaction are conducted in a courteous manner appropriate to cultural background and authority in the enterprise procedures.
5. Questions about simple routine workplace procedures and matters concerning conditions of employment are asked and responded.
6. Meeting outcomes are interpreted and implemented.

CONTENTS:

- Sentence construction
- Technical writing
- Recording information

CONDITIONS:

The students/trainees must be provided with the following:

- Paper
- Pencils/ball pen
- References (books)
- Manuals

METHODOLOGIES:

- Group discussions
- Interaction
- Lecture

ASSESSMENT METHODS:

- Written test
- Practical/performance test
- Interview

UNIT OF COMPETENCY : **WORK IN A TEAM ENVIRONMENT**

UNIT CODE : **500311106**

MODULE TITLE : **WORKING IN A TEAM ENVIRONMENT**

MODULE DESCRIPTOR : This module covers the knowledge, skills, and attitudes required to relate in a work based environment.

SUGGESTED DURATION : 4 hours

QUALIFICATION LEVEL : NC II

PREREQUISITE : TEAMWORK (NC I)

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module, the students/ trainees will be able to:

LO1. Describe and identify team role and responsibility in a team.

LO2. Describe work as a team.

LO1. DESCRIBE AND IDENTIFY TEAM ROLE AND RESPONSIBILITY IN A TEAM

ASSESSMENT CRITERIA:

1. Role and objective of the team is identified.
2. Team parameters, relationships and responsibilities are identified.
3. Individual role and responsibilities within team environment are identified.
4. Roles and responsibilities of other team members are identified and recognized.
5. Reporting relationships within team and external to team are identified.

CONTENTS:

- Team role.
- Relationship and responsibilities
- Role and responsibilities with team environment.
- Relationship within a team.

CONDITIONS:

The students/ trainees must be provided with the following:

- Standard operating procedure (SOP) of workplace
- Job procedures
- Client/supplier instructions
- Quality standards
- Organizational or external personnel

METHODOLOGIES:

- Group discussion/interaction
- Case studies
- Simulation

ASSESSMENT METHODS:

- Written test
- Observation
- Simulation
- Role playing

LO2. DESCRIBE WORK AS A TEAM MEMBER

ASSESSMENT CRITERIA:

1. Appropriate forms of communication and interactions are undertaken.
2. Appropriate contributions to complement team activities and objectives were made.
3. Reporting using standard operating procedures followed.
4. Development of team work plans based from role team were contributed.

CONTENTS:

- Communication process
- Team structure/team roles
- Group planning and decision making

CONDITIONS:

The students/trainees must be provided with the following:

- SOP of workplace
- Job procedures
- Organization or external personnel

METHODOLOGIES:

- Group discussion/interaction
- Case studies
- Simulation

ASSESSMENT METHODS:

- Observation of work activities
- Observation through simulation or role play
- Case studies and scenarios.

UNIT OF COMPETENCY : **PRACTICE CAREER PROFESSIONALISM**

UNIT CODE : **500311107**

MODULE TITLE : **PRACTICING CAREER PROFESSIONALISM**

MODULE DESCRIPTOR : This module covers the knowledge, skills and attitudes in promoting career growth and advancement, specifically to integrate personal objectives with organizational goals set and meet work priorities and maintain professional growth and development.

NOMINAL DURATION : 6 hours

CERTIFICATE LEVEL : NC II

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module, the trainee/student must be able to:

LO1. Integrate personal objectives with organizational goals

LO2. Set and meet work priorities

LO3. Maintain professional growth and development

LO1. INTEGRATE PERSONAL OBJECTIVES WITH ORGANIZATIONAL GOALS

ASSESSMENT CRITERIA:

1. Personal growth and work plans towards improving the qualifications set for professionalism are evident.
2. Intra and interpersonal relationship in the course of managing oneself based on performance evaluation is maintained.
3. Commitment to the organization and its goal is demonstrated in the performance of duties.
4. Practice of appropriate personal hygiene is observed.
5. Job targets within key result areas are attained.

CONTENTS:

- Personal development-social aspects: intra and interpersonal development
- Organizational goals
- Personal hygiene and practices
- Code of ethics

CONDITIONS:

The students/ trainees must be provided with the following:

- Workplace
- Code of ethics
- Organizational goals
- Hand outs and Personal development-social aspects
- CD's, VHS tapes, transparencies

METHODOLOGIES:

- Interactive -lecture
- Simulation
- Demonstration
- Self paced instruction

ASSESSMENT METHODS:

- Role play
- Interview
- Written examination

LO2. SET AND MEET WORK PRIORITIES

ASSESSMENT CRITERIA:

1. Competing demands to achieve personal, team and organizational goals and objectives are prioritized.
2. Resources are utilized efficiently and effectively to manage work priorities and commitments.
3. Practices and economic use and maintenance of equipment and facilities are followed as per established procedures.
4. Job targets within key result areas are attained.

CONTENTS:

- Organizational Key Result Areas (KRA)
- Work values and ethical standards
- Company policies on the use and maintenance of equipment

CONDITIONS:

The students/ trainees must be provided with the following

- Hand outs on
  - Organizational KRA
  - Work values and ethics
  - Company policies and standards
  - Sample job targets
- Learning guides
- CD's, VHS tapes, transparencies

METHODOLOGIES:

- Interactive lecture
- Group discussion
- Structured activity
- Demonstration

ASSESSMENT METHODS:

- Role play
- Interview
- Written examination

LO3. MAINTAIN PROFESSIONAL GROWTH AND DEVELOPMENT

ASSESSMENT CRITERIA:

1. Training and career opportunities relevant to the job requirements are identified and availed.
2. Licenses and/or certifications according to the requirements of the qualifications are acquired and maintained
3. Fundamental rights at work including gender sensitivity are manifested/ observed
4. Training and career opportunities based on the requirements of industry are completed and updated.

CONTENTS:

- Qualification standards
- Gender and development (GAD) sensitivity
- Professionalism in the workplace
- List of professional licenses

CONDITIONS:

The students/trainees must be provided with the following

- Quality standards
- GAD handouts
- CD's, VHS tapes on professionalism in the workplace
- Professional licenses samples

METHODOLOGIES:

- Interactive lecture
- Film viewing
- Role play/simulation
- Group discussion

ASSESSMENT METHODS:

- Demonstration
- Interview
- Written examination
- Portfolio assessment

UNIT OF COMPETENCY	:	**PRACTICE OCCUPATIONAL HEALTH AND SAFETY PROCEDURES**
UNIT CODE	:	**5003111058**
MODULE TITLE	:	**PRACTICING OCCUPATIONAL HEALTH AND SAFETY PROCEDURES**
MODULE DESCRIPTOR	:	This module covers the knowledge, skills and attitudes required to comply with the regulatory and organizational requirements for occupational health and safety such as identifying, evaluating and maintaining occupational health and safety (OHS) awareness.
NOMINAL DURATION	:	4 hours
CERTIFICATE LEVEL	:	NC II

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module, the trainee/student must be able to:

LO1. Identity hazards and risks

LO2. Evaluate hazards and risks

LO3. Control hazards and risks

LO4. Maintain occupational health and safety awareness

LO1. IDENTIFY HAZARDS AND RISKS

ASSESSMENT CRITERIA:

1. Workplace hazards and risks are identified and clearly explained.
2. Hazards/risks and its corresponding indicators are identified in with the company procedures.
3. Contingency measures are recognized and established in accordance with organizational procedures.

CONTENTS:

- Hazards and risks identification and control
- Organizational safety and health protocol
- Threshold limit value (TLV)
- OHS indicators

CONDITIONS:

The students/ trainees must be provided with the following:

- Workplace
- Personal protective equipment (PPE)
- Learning guides
- Hand-outs
  - Organizational safety and health protocol
  - OHS indicators
  - Threshold limit value
  - Hazards/risk identification and control
- CD's, VHS tapes, transparencies

METHODOLOGIES:

- Interactive -lecture
- Simulation
- Symposium
- Group dynamics

ASSESSMENT METHODS:

- Situation analysis
- Interview
- Practical examination
- Written examination

LO2. EVALUATE HAZARDS AND RISKS

ASSESSMENT CRITERIA:

1. Terms of maximum tolerable limits are identified based on threshold limit values (TLV)
2. Effects of hazards are determined.
3. OHS issues and concerns are identified in accordance with workplace requirements and relevant workplace OHS legislation.

CONTENTS:

- TLV table
- Philippine OHS standards
- Effects of hazards in the workplace
- Ergonomics
- ECC Regulations

CONDITIONS:

The students/trainees must be provided with the following

- Hand outs on
  - Philippine OHS standards
  - Effects of hazards in the workplace
  - Ergonomics
  - ECC regulations
- TLV table
- CD's, VHS tapes, transparencies

METHODOLOGIES:

- Interactive lecture
- Situation analysis
- Symposium
- Film viewing
- Group dynamics

ASSESSMENT METHODS:

- Interview
- Written examination
- Simulation

LO3. CONTROL HAZARDS AND RISKS

ASSESSMENT CRITERIA:

1. OHS procedures for controlling hazards and risk are strictly followed.
2. Procedures in dealing with workplace accidents, fire and emergencies are followed in accordance with the organization's OHS policies.
3. Personal protective equipment (PPE) is correctly used in accordance with organization's OHS procedures and practices.
4. Procedures in providing appropriate assistance in the event of workplace emergencies are identified in line with the established organizational protocol.

CONTENTS:

- Safety regulations
  - Clean air act
  - Electrical and fire safety code
  - Waste management
  - Disaster preparedness and management
- Contingency measures and procedures

CONDITIONS:

The students/trainees must be provided with the following:

- Hand outs on
  - Safety Regulations
  - Clean air act
  - Electrical and fire safety code
  - Waste management
  - Disaster preparedness and management
  - Contingency measures and procedures
- OHS personal records
- PPE
- CD's, VHS tapes, transparencies

METHODOLOGIES:

- Interactive lecture
- Symposium
- Film viewing
- Group dynamics
- Self-paced instruction

ASSESSMENT METHODS:

- Written examination
- Interview
- Case/situation analysis
- Simulation

LO4. MAINTAIN OCCUPATIONAL HEALTH AND SAFETY AWARENESS

ASSESSMENT CRITERIA:

1. Procedures in emergency related drill are strictly followed in line with the established organization guidelines and procedures.
2. OHS personal records are filled up in accordance with workplace requirements.
3. PPEs are maintained in line with organization guidelines and procedures.

CONTENTS:

- Operational health and safety procedure, practices and regulations
- Emergency-related drills and training

CONDITIONS:

The students/trainees must be provided with the following

- Workplace
- PPE
- OHS personal records
- CD's, VHS tapes, transparencies
- Health record

METHODOLOGIES:

- Interactive lecture
- Simulation
- Symposium
- Film viewing
- Group dynamics

ASSESSMENT METHODS:

- Demonstration
- Interview
- Written examination
- Portfolio assessment

MODULES OF INSTRUCTION

COMMON COMPETENCIES

SHIELDED METAL ARC WELDING (SMAW) NC II

UNIT OF COMPETENCY : **APPLY SAFETY PRACTICES**

UNIT CODE : **MEE721201**

MODULE TITLE : **APPLYING SAFETY PRACTICES**

MODULE DESCRIPTION : This module covers safety practices applied in the workplace.

SUGGESTED DURATION : 4 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Identify hazardous area

LO2. Use personal protective clothing and devices

LO3. Perform safe handling of tools, equipment and materials

LO4. Perform first aid

LO5. Use Fire extinguisher

LO6**. Perform Safe structural works at an elevated workplace**

LO1. IDENTIFY HAZARDOUS AREA

ASSESSMENT CRITERIA:

1. Hazards are identified correctly in accordance with OHS procedures.
2. Safety signs and symbols are identified and adhered to in accordance with workplace safety procedure.

CONTENTS:

- Hazard to be avoided in welding
- Welding safety signs and symbols
- Occupational safety standards and enterprise safety policies.

CONDITION:

The students/ trainee should be provided with:

- Safety sign and symbols
- Instructional materials
  - Reference book
  - Learning modules/manuals
  - Safety standards manual
  - Enterprise safety policies/guidelines

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview

LO2. USE PERSONAL PROTECTIVE CLOTHING AND DEVICES

ASSESSMENT CRITERIA:

1. Personal protective clothing/equipment (PPE) identified as per job requirements
2. Proper wearing of PPE are properly observed in accordance with workplace safety policies.
3. PPE conformed with the approved occupational safety standards.

CONTENTS:

- Personal protective equipment (PPE) for different welding operations
- Proper uses of different types of personal protective equipment (PPE)
- Occupational safety standards and enterprise safety policies.

CONDITION:

The students/ trainee should be provided with:

- Personal protective equipment (PPE)
  - Hard hat
  - Safety shoes
  - Gloves
  - Goggles
  - Welder apron

- Instructional materials for:
  - Reference book
  - Learning modules/manuals
  - Safety standards
  - Enterprise safety policies/guidelines

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview

LO3. PERFORM SAFE HANDLING OF TOOLS, EQUIPMENT AND MATERIALS

ASSESSMENT CRITERIA:

1. Pre-use checking and inspection of tools and equipment are conducted in accordance with industry/ company policies.
2. Safe handling of tools, equipment and materials are properly observed in accordance with OHS requirements and industry/ company policies.
3. Safety label and tag of tools and equipment are strictly followed in accordance with industry/ company policies.

CONTENTS:

- Pre-use inspection and checking procedure
- Safe handling of tools, equipment and materials
- Equipment and power tools orientation and familiarization
- Workplace Occupational Health and Safety procedures

CONDITION:

The students/ trainee should be provided with:

- Equipment/accessories
  - Hard hat
  - Safety shoes
  - Gloves
  - Goggles
  - Welder apron

- Instructional materials:
  - Reference book
  - Learning modules/manuals
  - Safety standards
  - Enterprise safety policies/guidelines

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview

LO4. PERFORM FIRST AID

ASSESSMENT CRITERIA:

1. First aid treatment of injuries are carried out according to recommended procedures
2. Emergency hotline and proper authority are accessed and contacted in accordance with workplace procedure.

CONTENTS:

- Different types of injuries
- First aid treatment procedure
- Emergency hotline number and offices
- Proper handling of injured individual

CONDITION:

The students/ trainee should be provided with:

- Equipment
  - First aid kit (different types)
  - Oxygen
  - Stretcher
  - Medicine

- Learning materials
  - Video tape, CD's, transparencies

- Directory hotline number and offices

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO5. USE FIRE EXTINGUISHER

ASSESSMENT CRITERIA:

1. Fire fighting equipment identified according to types/source of fires.
2. Use of fire fighting equipment demonstrated in accordance with manufacturer's instructions.
3. Used fire fighting equipment and accessories are recorded/reported for replacement/refill in accordance with enterprise approved safety regulations.

CONTENTS:

- Types of fire fighting equipment
- Types of fire extinguishers
- Fire hoses
- Fire hydrants
- Sources/causes of fires
- Proper use of fire fighting equipment

CONDITION:

The students/ trainee should be provided with:

- Equipment
  - Fire extinguishers (different types)
  - Fire hydrants
  - Video players/monitors

- Learning materials
  - Types of fires/sources
  - Types of fire fighting equipment and its operations
  - Manuals on fire protection regulations
  - Video tape, CD's, transparencies
  - Report cards/checklist

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO6. PERFORM SAFE STRUCTURAL WORK IN AN ELEVATED WORKPLACE

ASSESSMENT CRITERIA:

1. **Procedures in emergency related drill are strictly followed in line with the established organization guidelines and procedures.**
2. **OHS personal records are filled up in accordance with workplace requirements.**
3. **PPEs are maintained in line with organization guidelines and procedures.**
4 **.Proper procedures in installing scaffolding are observed**

CONTENTS:

- **Operational health and safety procedure, practices and regulations**
- **Emergency-related drills and training on an elevated workplace**
- **Procedures in wearing body harness**
- **Safe installation of scaffoldings**

CONDITIONS:

The students/trainees must be provided with the following

- **Workplace with an elevated condition**
- **PPE**
- **OHS personal records**
- **CD's, VHS tapes, transparencies**
- **Health record**

METHODOLOGIES:

- **Interactive lecture**
- **Simulation**
- **Film viewing**
- **Group dynamics**

ASSESSMENT METHODS:

- **Demonstration**
- **Interview**
- **Observation on real work**
- **Written examination**
- **Portfolio assessment**

UNIT OF COMPETENCY : **INTERPRET DRAWINGS AND SKETCHES**

UNIT CODE : **MEE721202**

MODULE TITLE : **INTERPRETING DRAWING AND SKETCHES**

MODULE DESCRIPTION : This module covers knowledge, skills and attitudes required to interpret drawing and sketches in accordance with work plan specifications.

SUGGESTED DURATION : 8+**2** hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Identify standard alphabet of lines

LO2. Identify orthographic/ isometric views

LO3. Interpret standard drawing symbols, dimensional tolerances and notations

LO4. Interpret and analyze specific project Plan

LO1. IDENTIFY STANDARD ALPHABET OF LINES

ASSESSMENT CRITERIA:

1. Alphabet of lines identified according to ISO.
2. Alphabet of lines are clearly explained according to their use.

CONTENTS:

- Alphabet of lines and applications
- Drawing specifications
- Dimensions
- Scaling

CONDITION:

The students/ trainee should be provided with:

- Equipment/accessories
  - OHP/transparencies
  - computer
  - Video/multi-media materials

- Training materials
  - reference book,
  - learning modules
  - blueprint (sample)
  - writing instrument
  - drawing instrument

METHODOLOGIES:

- Lecture/demonstrations
- Self-paced instruction
- Presentation

ASSESSMENT METHODS:

- Written
- Direct observation
- Interview/oral

LO2. IDENTIFY ORTHOGRAPHIC/ ISOMETRIC VIEWS

ASSESSMENT CRITERIA:

1. Orthographic and isometric views are clearly explained
2. Orthographic and isometric drawing are identified based on plan

CONTENTS:

- Types of welding joints and symbols
- Welding positions, codes and plan specifications
- Contour symbols
- Drawing technique
  - o Perspective
  - o Exploded view
  - o Hidden view technique
- Projections
  - o First angle projections
  - o Third angle projections

CONDITION:

The students/ trainee should be provided with:

- Equipment/accessories
  - OHP/transparencies
  - Computer
  - Video/multi-media materials

- Training materials
  - Reference book,
  - Learning modules
  - Blueprint (sample)
  - Writing instrument
  - Drawing instrument

METHODOLOGIES:

- Lecture/demonstrations
- Self-paced instruction
- Presentation

ASSESSMENT METHODS:

- Written
- Direct observation
- Interview/oral

LO3. INTERPRET STANDARD DRAWING SYMBOLS, DIMENSIONAL TOLERANCES AND NOTATIONS

ASSESSMENT CRITERIA:

1. Drawing symbols are interpreted according to drawing standards
2. Dimensional tolerances, notations are interpreted according to specifications

CONTENTS:

- Types of welding joints and symbols
- Welding positions, codes and plan specifications
- Contour symbols
- Welding process (abbreviation)

CONDITION:

The students/ trainee should be provided with:

- Equipment/accessories
  - OHP/transparencies
  - Computer
  - Video/multi-media materials

- Training materials
  - Reference book,
  - Learning modules
  - Blueprint (sample)
  - Writing instrument
  - Drawing instrument

METHODOLOGIES:

- Lecture/demonstrations
- Self-paced instruction
- Presentation

ASSESSMENT METHODS:

- Written
- Direct observation
- Interview/oral

LO4. INTERPRET AND ANALYZE SPECIFIC PROJECT PLAN

ASSESSMENT CRITERIA:

1. Drawing symbols are interpreted according to drawing standards
2. Dimensional tolerances, notations are interpreted according to specifications
3. Specific design of joint are interpreted according to plan
4. **Critical task and techniques was analyzed according to plan.**

CONTENTS:

- Types of welding joints and symbols
- Welding positions, codes and plan specifications
- Welding process
- **Different types of working drawing**
- **Dimensions in metric and English**
- **Conversion of units**

CONDITION:

The students/ trainee should be provided with:

- Equipment/accessories
  - Personal Computer
  - Video/multi-media materials

- Training materials
  - Reference book,
  - Learning modules
  - Blueprint (sample)
  - Writing instrument
  - Drawing instrument

METHODOLOGIES:

- Lecture/demonstrations
- Self-paced instruction
- Presentation

ASSESSMENT METHODS:

- Written
- Direct observation
- Interview/oral
- Demonstration

UNIT OF COMPETENCY : **PERFORM INDUSTRY CALCULATION**

UNIT CODE : **MEE721203**

MODULE TITLE : **PERFORMING INDUSTRY CALCULATION**

MODULE DESCRIPTION : This module covers knowledge, skill and attitude required to compute/calculate quantity /size/cost of materials/parts, and convert systems of measurements using formulas and other methods. This also includes measuring instruments and its applications.

SUGGESTED DURATION : 8 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Perform four fundamental operations.

LO2. Perform conversion of units

LO3. Perform calculations on algebraic expressions

LO4. Compute percentage and ratio

LO 5. Estimate material

LO1. PERFORM FOUR FUNDAMENTAL OPERATION

ASSESSMENT CRITERIA:

1. Simple calculations involving whole numbers, mixed numbers, fraction and decimal are performed using four fundamental operations

CONTENTS:

- Mathematical operations
  - subtraction
  - addition
  - multiplication
  - division
- Industrial mathematics
- Computation formulas finding areas of:
  - plane
  - circles
  - triangles
  - other geometrical figures

CONDITION:

The students/ trainee should be provided with:

- Equipment/ accessories
  - Calculators

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO2. PERFORM CONVERSION UNIT

ASSESSMENT CRITERIA:

1. Units are converted to the required figure using the given formulae
2. English measurements are converted to metric measurements according to procedure.

CONTENTS:

- Units
  - Fractions
  - Mixed numbers
  - Decimal
- Conversion of English to metric (vise versa)

CONDITION:

The students/ trainee should be provided with:

- Equipment/ accessories
  - Calculators

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO3. PERFORM CALCULATIONS ON ALGEBRAIC EXPRESSIONS

ASSESSMENT CRITERIA:

1. Simple calculations are performed on algebraic expressions using the four fundamental operations
2. Simple transposition of formulae are carried out to isolate the variable required, involving the four fundamental operations.
3. Appropriate formula applied and results obtained in accordance with job specifications.

CONTENTS:

- English and metric system of measurements
- Four fundamental operations
- Method of transposing formulae
- Equation formulation

CONDITION:

The students/ trainee should be provided with:

- Equipment/ accessories
  2. Calculators

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO4. COMPUTE PERCENTAGE AND RATIO

ASSESSMENT CRITERIA:

1. Percentages are computed using appropriate formula.
2. Ratio and proportion are computed using appropriate formula.

CONTENTS:

- Ratio and proportion
- Calculation
- Percentage and ratio

CONDITION:

The students/ trainee should be provided with:

- Equipment /accessories
  - Calculators

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO5. Estimate Material

ASSESSMENT CRITERIA:

1. **Length, areas, volumes, number of (sheets, bars) are computed according to plan**
2. **Proper approach of estimating materials are followed according to company standard**

CONTENTS:

- Ratio and proportion
- **Calculation on volumes ,areas and length through algebra ,geometry and trigonometry**
- Percentage and ratio
- **Procedures in estimating materials**

CONDITION:

The students/ trainee should be provided with:

- Equipment /accessories
  - Calculators

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self-pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

UNIT OF COMPETENCY : **CONTRIBUTE TO QUALITY SYSTEM**

UNIT CODE : **MEE721204**

MODULE TITLE : **CONTRIBUTING TO QUALITY SYSTEM**

MODULE DESCRIPTION : This modules covers knowledge, skill and attitude required to inspect work against specification and standards and apply quality standards to work.

SUGGESTED DURATION : 4 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Inspect work done.

LO2. Apply quality standards to work

LO3. Protect company property and customer interests

LO1. INSPECT WORK DONE

ASSESSMENT CRITERIA:

3. Appropriate inspections are conducted to ensure company quality systems and procedures are maintained/ followed.
2. Job specifications/work order and quality standards are identified.
3. Faults/defects are identified and rectified according to company procedures.

CONTENTS:

- Quality system and procedures
  - Work instructions
  - Safe work procedures
  - Product specifications
  - Equipment maintenance schedules
  - Technical procedures adopted or specifically prepared standards
  - Company/industry rules
- Faults and defects
- Communication/feedback methods-written and verbal

CONDITION:

The students/ trainee should be provided with:

- Inspection record manual
- Job specification
- Workplace/company procedure manual
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO2. APPLY QUALITY STANDARDS TO WORK

ASSESSMENT CRITERIA:

1. Inspections are conducted throughout the manufacturing processes to ensure quality standards are maintained.
2. Appropriate quality standards are applied throughout the production/fabrication process.
3. All activities are coordinated throughout the workplace to ensure efficient quality work outcomes.
4. Records of work quality are maintained according to the company requirements

CONTENTS:

- Quality standard/ISO
- Work inspection techniques/procedures
- Record maintenance
- Communication process

CONDITION:

The students/ trainee should be provided with:

- Inspection record manual
- Quality standard
- Job specification
- Workplace/company procedure manual
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO3. PROTECT COMPANY PROPERTY AND CUSTOMER INTERESTS

ASSESSMENT CRITERIA:

1. Possible damage to company property is avoided by adherence to company quality procedures.
2. Quality of work is reviewed to ensure customer requirements and company standards are met.

CONTENTS:

- Company systems, processes and work quality requirements
- Quality assurance principles
- Safety precautionary measures
- Handling materials, tools and equipment

CONDITION:

The students/ trainee should be provided with:

- Inspection record manual
- Quality standard
- Job specification
- Workplace/company procedure manual
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

UNIT OF COMPETENCY : **USE HAND TOOLS**

UNIT CODE : **MEE721205**

MODULE TITLE : **USING HAND TOOLS**

MODULE DESCRIPTION : This modules covers knowledge skills and attitude required to use hand tools

SUGGESTED DURATION : 4 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Select hand tools

LO2. Use hand tools

LO3. Maintain hand tools

LO1. SELECT HAND TOOLS

ASSESSMENT CRITERIA:

1. Hand tools selected are appropriate to the requirements of the task.
2. Unsafe or defective tools are identified and marked for repair according to procedure

CONTENTS:

- Types and uses of hand tools
- Hand tool defects

CONDITION:

The students/ trainee should be provided with:

- Hand tools
  - o Hacksaws
  - o Hammers (ball peen, chipping)
  - o Punches
  - o Screwdrivers
  - o Wrenches
  - o Scrapers
  - o Chisels
  - o Gouges
  - o Files
  - o Clamps

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO2. USE HAND TOOLS

ASSESSMENT CRITERIA:

1. Hand tools are used to produce the desired outcomes to job specifications.
2. Task performed in accordance with company or industry safety procedure

CONTENTS:

- Types and uses of hand tools
- Tasks:
  - Adjusting
  - Dismantling
  - Assembling
  - Finishing of item or components

CONDITION:

The students/ trainee should be provided with:

- Hand tools
  - Hacksaws
  - Hammers (ball peen, chipping)
  - Punches
  - Screwdrivers
  - Wrenches
  - Scrapers
  - Chisels
  - Gouges
  - Files
  - Clamps

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO3. MAINTAIN HAND TOOLS

ASSESSMENT CRITERIA:

1. Routine maintenance of hand tools is undertaken according to standard operating procedures, principles and techniques.
2. Hand tools are stored in designated location in accordance with manufacturer's instruction/standard operating procedure.

CONTENTS:

- Routine maintenance
  - o Lubricating
  - o Tightening
  - o Simple tool repair
  - o Hand sharpening
  - o Cleaning
- Proper storage of hand tools

CONDITION:

The students/ trainee should be provided with:

- Hand tools
  - o Hacksaws
  - o Hammers (ball peen, chipping)
  - o Punches
  - o Screwdrivers
  - o Wrenches
  - o Scrapers
  - o Chisels
  - o Gouges
  - o Files
  - o Clamps

- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Demonstration

UNIT OF COMPETENCY : **PREPARE WELD MATERIALS**

UNIT CODE : **MEE721206**

MODULE TITLE : **PREPARING WELD MATERIALS**

MODULE DESCRIPTION : This modules covers knowledge, skills and attitude required in preparing weld materials.

SUGGESTED DURATION : 8 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Set up cutting equipment

LO2. Cut and prepare edge of materials

LO3. Clean surfaces and edges

LO4. Prepare welding consumables

LO5. Prepare welding safety and protective equipment

LO1. SET UP CUTTING EQUIPMENT

ASSESSMENT CRITERIA:

1. Cutting equipment should be operational and should conform to acceptable OH&S standards
2. Cutting equipment fittings, connection and power source are checked in accordance with workplace procedure

CONTENTS:

- Parts and function of cutting equipment
- Procedures in setting–up of cutting equipment
- Procedure in checking cutting equipment functionality.

CONDITION:

The students/ trainee should be provided with:

- Hand tools
- Cutting equipment and accessories
- Gases (oxygen, acetylene, LPG)
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO2. CUT AND PREPARE EDGE OF MATERIALS

ASSESSMENT CRITERIA:

1. Materials are cut to specified dimension/specifications.
2. Task are performed in accordance with company/industry requirement and safety procedure

CONTENTS:

- Cutting operation procedure
- Cutting material with different process
  - Oxy-acetylene gas cutting equipment (manual and automatic)
  - Plasma cutting equipment
  - Shearing machine
  - Disc cutter
  - Cutting electrode

CONDITION:

The students/ trainee should be provided with:

- Hand tools
- Cutting equipment and accessories
- Gases (oxygen, acetylene, LPG)
- Air compressor
- Shearing machine
- Disc cutter
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Demonstration

LO3. PREPARE WELDING CONSUMABLES

ASSESSMENT CRITERIA:

1. Consumables, materials, specified and quantity determined in accordance with job requirements.
2. Correct materials selected in accordance with job requirements.

CONTENTS:

- Consumable materials specifications
- Equipment and tools for preparing plates and pipes edges
- Safe working practices in preparing consumables

CONDITION:

The students/ trainee should be provided with:

- Hand tools
- Cutting equipment and accessories
- Gases (oxygen, acetylene, LPG)
- Air compressor
- Shearing machine
- Disc cutter
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Demonstration

LO4. CLEAN SURFACES AND EDGES

ASSESSMENT CRITERIA:

1. Surfaces are cleaned to required specifications.
2. Task performed in accordance with company or industry requirements and safety procedure

CONTENTS:

- Procedures and techniques of preparing plates and pipe edges for welding
- Equipment and tools for preparing plates and pipes edges
- Safe working practices

CONDITION:

The students/ trainee should be provided with:

- Hand tools
- Cutting equipment and accessories
- Mild steel
- Carbon steel
- Alloy steel
- Cutting gases
- Gouging electrodes
- Grinding/cutting discs
- Run on/run off, backing plates/ring
- Shearing machine
- Disc cutter
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Demonstration

LO5. PREPARE WELDING SAFETY AND PROTECTIVE EQUIPMENT

ASSESSMENT CRITERIA:

1. PPE should conform to acceptable OH&S requirement and standards.
2. Welding safety and protective equipment are checked in accordance with safety procedure

CONTENTS:

- Procedures and techniques in checking protective equipment
- Safe working practices and handling of protective equipment

CONDITION:

The students/ trainee should be provided with:

- Personal protective equipment
- Supplies/materials
  - Pencil/paper
  - Reference books
  - Learning materials/module
  - OHP/transparencies
  - Video/multi-media materials

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Demonstration

UNIT OF COMPETENCY : **SET-UP WELDING EQUIPMENT**

UNIT CODE : **MEE721207**

MODULE TITLE : **SETTING-UP WELDING EQUIPMENT**

MODULE DESCRIPTION : This modules covers knowledge, skills and attitude required in setting up welding equipment.

SUGGESTED DURATION : 4 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Set up welding machine

LO2. Set up welding accessories

LO3. Set up welding positioners, jigs and fixtures

LO1. SET UP WELDING MACHINE

ASSESSMENT CRITERIA:

1. Primary cable attached to welding machine primary cable terminal
2. Primary cable attached to power source.
3. Welding machine checked for functionality.
4. Polarity switch, if any, set to DC reverse.
5. Cable terminals checked for tightness.

CONTENTS:

- Parts and function of welding machine (SMAW)
- Procedures in setting –up of welding machines
- Procedure in checking welding machine functionality.

CONDITION:

The students/ trainee should be provided with:

- Equipment and accessories
  - AC/DC Welding machine
  - Welding cables
  - Ground clamp
  - Primary cable
  - Power source connectors and outlets
- Tools
  - Set of screw driver
  - Set of wrenches
- Supplies/materials
  - Electrical tape
  - Rubber tape
- Instructional materials
  - Reference book /modules/ learning guides/ video CDs
  - Equipment manual

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO2. SET UP WELDING ACCESSORIES

ASSESSMENT CRITERIA:

1. Electrode cable connected to positive of welding machine.
2. Ground cable connected to negative terminal of welding machine.
3. Ground clamp attached to workpiece/material.
4. Welding cable checked for crack, burns and cuts.
5. Primary cable attached to welding machine primary cable terminal

CONTENTS:

- Parts and function of welding machine accessories and consumables
- Procedures in setting-up of welding accessories
- Procedure in checking welding machine functionality.

CONDITION:

The students/ trainee should be provided with:

- Equipment and accessories
  - AC/DC Welding machine
  - Welding cables
  - Ground clamp
  - Primary cable
  - Power source connectors and outlets

- Tools
  - Set of screw driver
  - Set of wrenches

- Supplies/Materials
  - electrical tape
  - Rubber tape

- Instructional materials
  - Reference book /modules/ learning guides/ video CDs,
  - Equipment manual

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO3. SET UP WELDING POSITIONER, JIGS AND FIXTURES

ASSESSMENT CRITERIA:

1. Braces, stiffeners, rails and other jigs are provided and in conformity with job requirements.
2. Work items/materials are protected from strong winds, drafts and rainfall

CONTENTS:

- Types of welding positioner, jigs and fixture
- Different kind of jigs and fixture
- Uses and function of welding positioner, jigs and fixture

CONDITION:

The students/ trainee should be provided with:

- Welding positioner
- Jigs and fixture
- Tools
- Supplies/materials
- Instructional materials
  - Reference book /modules/ learning guides/ video CDs,
  - Equipment manual

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

UNIT OF COMPETENCY : **FIT UP WELD MATERIALS**

UNIT CODE : **MEE721208**

MODULE TITLE : **FITTING UP WELD MATERIALS**

MODULE DESCRIPTION : This modules covers knowledge, skills and attitude required in fitting up weld materials.

SUGGESTED DURATION : 4 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1.Perform Lay outing

LO2 Check gap and alignment

LO3. Install support/stiffener

LO4 Perform tack welding

LO1. PERFORM LAY OUTING

ASSESSMENT CRITERIA:

1. **Lay outing was performed according to plan and specification**
2. **Lay outing tools selected according to work requirements**
3. **Lay outing procedures was observed according to work requirements**

CONTENTS:

- **Types of lay outing tools**
- **Uses of lay outing tools**
- **Codes and specification**
- **Procedures in lay outing**

CONDITION:

The students/ trainee should be provided with:

- **Welding machine equipment and accessories**
- **Lay outing Tools**
- **Supplies/materials**
- **Personal protective equipment**
- **Drawing plan and specification**
- **Instructional materials**
  - **Reference book/ modules/ learning guides/ video CDs**
  - **Equipment manual**

METHODOLOGIES:

- **Lecture/demonstrations**
- **Self-pace learning**
- **Group discussion**

ASSESSMENT METHODS:

- **Written/oral**
- **Direct observation**
- **Interview**
- **Demonstration**

LO2. CHECK GAP AND ALIGNMENT

ASSESSMENT CRITERIA:

1. Root gap is prepared/checked in accordance with WPS requirements
2. Alignment of work piece are checked in accordance with welding standard
3. Included angle are checked in accordance with WPS

CONTENTS:

- Fit up tolerances
- Work piece alignment procedure
- Fit up

CONDITION:

The students/ trainee should be provided with:

- Measuring tools
- Work piece
- Personal protective equipment
- Drawing plan and specification
- Instructional materials
  - Reference book /modules/ learning guides/ video CDs,
  - Equipment manual

METHODOLOGIES:

- Lecture/demonstrations
- Self pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO3. Install support/stiffener

ASSESSMENT CRITERIA:

- **Support is installed according to work requirement**
- **Fit up tolerances was observed according to industry practice.**
- **Alignment procedures was observed according to industry practice**

CONTENTS:

- Fit up tolerances
- Work piece alignment procedure
- Fit up procedure

CONDITION:

The students/ trainee should be provided with:

- Measuring tools
- Work piece
- Personal protective equipment
- Drawing plan and specification
- **Stiffeners/support materials**
- **Welding equipment**
- **Welding consumables**
- Instructional materials
  - Reference book /modules/ learning guides/ video CDs,
  - Equipment manual

METHODOLOGIES:

- Lecture/demonstrations
- Self-pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

LO4 PERFORM TACK WELDING

ASSESSMENT CRITERIA:

1. Tack welding is performed in accordance with the welding procedure requirements
2. Joints are free from rust, paints, grease and other foreign materials prior to fit up or tacking.

CONTENTS:

- Kind of tacking
- Welding procedure standard requirement
- Codes and specification

CONDITION:

The students/ trainee should be provided with:

- Welding machine equipment and accessories
- Tools
- Supplies/materials
- Personal protective equipment
- Drawing plan and specification
- Instructional materials
  - Reference book/ modules/ learning guides/ video CDs
  - Equipment manual

METHODOLOGIES:

- Lecture/demonstrations
- Self-pace learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Interview
- Demonstration

UNIT OF COMPETENCY : **REPAIR WELD**

UNIT CODE : **MEE721209**

MODULE TITLE : **REPAIRING WELD**

MODULE DESCRIPTION : This modules covers knowledge, skills and attitude required in repairing weld.

SUGGESTED DURATION : 8 hours

SUMMARY OF LEARNING OUTCOMES:

At the completion of the module the trainees/students must be able to:

LO1. Mark/locate weld defects

LO2. Prepare tools and equipment

LO3. Remove defects

LO4. Perform re-welding

LO1. MARK/LOCATE WELD DEFECTS

ASSESSMENT CRITERIA:

1. Location of weld defects identified/determined in accordance with industry standard.
2. Weld defects marked for repair in accordance with industry standard.
3. Procedures in locating weld defects performed as per approved procedures.

CONTENTS:

- Types of welding defects
- Procedures in locating weld defects
- Proper uses of NDT equipment or tools

CONDITION:

The students/trainees must be provided with:

- Equipment and accessories
- Tools
  - Chipping hammer
  - Steel brush

- Supplies/materials
  - Carbon steel plates
  - Pipe ;alloy pipe

- Instructional materials
  - Reference book/ modules/ learning guides/ video CDs,
  - Welding charts,
  - Work plans
  - Drawing and specifications relevant to the task

METHODOLOGIES:

- Lecture/ demonstrations
- Self-paced learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Return demonstration

LO2. PREPARE TOOLS AND EQUIPMENT

ASSESSMENT CRITERIA:

1. Tools and equipment are prepared appropriate to the job requirements
2. Tools and equipment are properly checked to the job requirements

CONTENTS:

- Tools and equipment and their uses
- Procedures in checking tools and equipment

CONDITION:

The students/trainees must be provided with:

- Equipment and accessories
- Tools
  - Chipping hammer
  - Steel brush
  - Electric grinders

- Supplies/Materials
  - Carbon steel plates
  - Cutting/ grinding disk
  - Carbon steel plates
  - Pipe

- Instructional materials
  - Reference book/ modules/ learning guides/ video CDs,
  - Welding charts,
  - Work plans
  - Drawing and specifications relevant to the task

METHODOLOGIES:

- Lecture/ demonstrations
- Self-paced learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Return demonstration

LO3. REMOVE DEFECTS

ASSESSMENT CRITERIA:

1. Weld defects removed/excavated in accordance with welding procedures.
2. Removal of non-defective welds is minimized and cleaned.
3. Visual and dye-penetrant test are performed to verify the extent of removal of defects

CONTENTS:

- Dye penetrant testing principle and applications.
- Procedures of dye penetrant testing
- Weld defects removal and excavation

CONDITION:

The students/trainees must be provided with:

- Tools
  - Chipping hammers
  - Steel brush

- Supplies/materials
  - Developer
  - Penetrant
  - Cleaner
  - Cloth/ clean rag

- Instructional materials
  - Reference book/ modules/ learning guides/ video CDs
  - Welding charts
  - Work plans
  - Drawing and specifications relevant to the task

METHODOLOGIES:

- Lecture/ demonstrations
- Self-paced learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Return demonstration

LO4. PERFORM RE-WELDING

ASSESSMENT CRITERIA:

1. Re-welding performed in accordance with approved repair procedure.
2. No new weld defects or damages occurred during re-welding.
3. Weld visually checked after re-welding for acceptability

CONTENTS:

- Rectifying weld defects
- Re-welding procedures
- Visual inspection of weld

CONDITION:

The students/trainees must be provided with:

- Equipment and accessories
  - Welding machine with complete accessories

- Tools
  - Chipping hammers
  - Steel brush
  - Electric grinders

- Welding supplies/materials
  - Carbon steel plates
  - Cutting/ grinding disk
  - Welding consumables

METHODOLOGIES:

- Lecture/ demonstrations
- Self-paced learning
- Group discussion

ASSESSMENT METHODS:

- Written/oral
- Direct observation
- Return demonstration

MODULES OF INSTRUCTION

CORE COMPETENCIES

SHIELDED METAL ARC WELDING (SMAW) NC II

UNIT OF COMPETENCY : **WELD CARBON STEEL PLATES**

UNIT CODE : **MEE721306**

MODULE TITLE : **PERFORMING GROOVE WELDING ON CARBON STEEL PLATES**

MODULE DESCRIPTOR : This module covers the knowledge, skills and attitude in performing groove welding on carbon steel plates in different positions such as 1G, 2G, 3G, & 4G

NOMINAL DURATION : 120 hours

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module the trainee/student must be able to:

LO1. Weld carbon steel plates in flat position (1G)

LO2. Weld carbon steel plates in horizontal position (2G)

LO3. Weld carbon steel plates in vertical position (3G)

LO4. Weld carbon steel plates in overhead position (4G)

LO1. WELD CARBON STEEL PLATES IN FLAT POSITION (1G)

ASSESSMENT CRITERIA:

1. Root penetration not exceeding allowable tolerances specified by welding codes/ standards on
   - concavity
   - convexity
   - undercut
   - excess penetration
   - lack of fusion
   - burn-through
   - cracks
2. Weld capping/ final pass not exceeding allowable tolerances specified by welding codes/ standards on
   - height of reinforcement
   - underfill
   - porosities
   - undercut
   - cracks
   - cold laps
3. Uniformity of bead ripples must be in accordance with welding standards
4. Stringer or layered beads deposited in accordance with welding standards
5. Finish weldment visually acceptable in accordance with welding standards for:
   - spatters
   - arc strikes
   - slag
   - uniformity of beads

CONTENTS:

- Essentials of welding
- International welding codes and standards
- Acceptable weld profiles
- Weld defects, causes and remedies
- Welding Procedure Specifications (WPS)
- Welding techniques and procedures
- Safe welding practices

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Welding booth
   - Portable oven

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/demonstration
- Dualized
- Self-paced learning

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

LO2. WELD CARBON STEEL PLATES IN HORIZONTAL POSITION (2G)

ASSESSMENT CRITERIA:

1. Root penetration not exceeding allowable tolerances specified by welding codes/ standards on
   - concavity
   - convexity
   - undercut
   - excess penetration
   - lack of fusion
   - burn-through
   - cracks
2. Weld capping/ final pass not exceeding allowable tolerances specified by welding codes/ standards on
   - height of reinforcement
   - underfill
   - porosities
   - undercut
   - cracks
   - cold laps
3. Uniformity of bead ripples must be in accordance with welding standards
4. Stringer or layered beads deposited in accordance with welding standards
5. Finish weldment visually acceptable in accordance with welding standards for:
   - spatters
   - arc strikes
   - slag
   - uniformity of beads

CONTENTS:

- Essentials of welding
- International welding codes and standards
- Acceptable weld profiles
- Weld defects, causes and remedies
- Welding Procedure Specifications (WPS)
- Welding techniques and procedures
- Safe welding practices

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Welding booth
   - Portable oven

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/demonstration
- Dualized
- Self-paced learning

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

LO3. WELD CARBON STEEL PLATES IN VERTICAL POSITION (3G)

ASSESSMENT CRITERIA:

1. Root penetration not exceeding allowable tolerances specified by welding codes/ standards on
   - concavity
   - convexity
   - undercut
   - excess penetration
   - lack of fusion
   - burn-through
   - cracks
2. Weld capping/ final pass not exceeding allowable tolerances specified by welding codes/ standards on
   - height of reinforcement
   - underfill
   - porosities
   - undercut
   - cracks
   - cold laps
3. Uniformity of bead ripples must be in accordance with welding standards
4. Stringer or layered beads deposited in accordance with welding standards
5. Finish weldment visually acceptable in accordance with welding standards for:
   - spatters
   - arc strikes
   - slag
   - uniformity of beads

CONTENTS:

- Essentials of welding
- International welding codes and standards
- Acceptable weld profiles
- Weld defects, causes and remedies
- Welding Procedure Specifications (WPS)
- Welding techniques and procedures
- Safe welding practices

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Welding booth
   - Portable oven

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/demonstration
- Dualized

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

LO4. WELD CARBON STEEL PLATES IN OVERHEAD POSITION (4G)

ASSESSMENT CRITERIA:

1. Root penetration not exceeding allowable tolerances specified by welding codes/ standards on
   - concavity
   - convexity
   - undercut
   - excess penetration
   - lack of fusion
   - burn-through
   - cracks
2. Weld capping/ final pass not exceeding allowable tolerances specified by welding codes/ standards on
   - height of reinforcement
   - underfill
   - porosities
   - undercut
   - cracks
   - cold laps
3. Uniformity of bead ripples must be in accordance with welding standards
4. Stringer or layered beads deposited in accordance with welding standards
5. Finish weldment visually acceptable in accordance with welding standards for:
   - spatters
   - arc strikes
   - slag
   - uniformity of beads

CONTENTS:

- Essentials of welding
- International welding codes and standards
- Acceptable weld profiles
- Weld defects, causes and remedies
- Welding Procedure Specifications (WPS)
- Welding techniques and procedures
- Safe welding practices

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Welding booth
   - Portable oven

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/demonstration
- Dualized

ASSESSMENT METHODS:

- Written/oral
- Interview

Direct observation

UNIT OF COMPETENCY : **WELD CARBON STEEL PIPE**

UNIT CODE : **MEE721306**

MODULE TITLE : **PERFORMING GROOVE WELDING ON CARBON STEEL PIPES**

MODULE DESCRIPTOR : This module covers groove welding on carbon steel pipe in different positions such as 2G, 5G & 6G.

NOMINAL DURATION : 80 hours

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module the trainee/student must be able to:

LO1. Weld carbon steel pipes in horizontal position (2G)

LO2. Weld carbon steel pipes in Fixed pipe horizontal position (5G)

LO3. Weld carbon steel pipes in fixed pipe, inclined at 45° position (6G)

LO1. WELD CARBON STEEL PIPE IN HORIZONTAL POSITION (2G)

ASSESSMENT CRITERIA:

1. Root penetration not exceeding allowable tolerances specified by welding codes/ standards on
   - concavity
   - convexity
   - undercut
   - excess penetration
   - lack of fusion
   - burn-through
   - cracks
2. Weld capping/ final pass not exceeding allowable tolerances specified by welding codes/ standards on
   - height of reinforcement
   - underfill
   - porosities
   - undercut
   - cracks
   - cold laps
   - uniformity of bead ripples must be in accordance with welding standards
   - stringer or layered beads deposited in accordance with welding standards
3. Finish weldment visually acceptable in accordance with welding standards for:
   - spatters
   - arc strikes
   - slag
   - uniformity of beads

CONTENTS:

- Essentials of welding
- International welding codes and standards
- Acceptable weld profiles
- Weld defects, causes and remedies
- Welding Procedure Specifications (WPS)
- Welding techniques and procedures
- Safe welding practices

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Welding booth
   - Portable oven

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/demonstration
- Dualized

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

LO2. WELD CARBON STEEL PIPE IN FIXED PIPE HORIZONTAL POSITION (5G)

ASSESSMENT CRITERIA:

1. Root penetration not exceeding allowable tolerances specified by welding codes/ standards on
   - concavity
   - convexity
   - undercut
   - excess penetration
   - lack of fusion
   - burn-through
   - cracks
2. Weld capping/ final pass not exceeding allowable tolerances specified by welding codes/ standards on
   - height of reinforcement
   - underfill
   - porosities
   - undercut
   - cracks
   - cold laps
3. Uniformity of bead ripples must be in accordance with welding standards
4. Stringer or layered beads deposited in accordance with welding standards
5. Finish weldment visually acceptable in accordance with welding standards for:
   - spatters
   - arc strikes
   - slag
   - uniformity of beads

CONTENTS:

- Essentials of welding
- International welding codes and standards
- Acceptable weld profiles
- Weld defects, causes and remedies
- Welding Procedure Specifications (WPS)
- Welding techniques and procedures
- Safe welding practices

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Welding booth
   - Portable oven

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/demonstration
- Dualized

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

LO3. WELD CARBON STEEL PIPE IN FIXED, PIPE INCLINED AT 45° POSITION (6G)

ASSESSMENT CRITERIA:

1. Root penetration not exceeding allowable tolerances specified by welding codes/
   - standards on
   - concavity
   - convexity
   - undercut
   - excess penetration
   - lack of fusion
   - burn-through
   - cracks
2. Weld capping/ final pass not exceeding allowable tolerances specified by welding codes/ standards on
   - height of reinforcement
   - underfill
   - porosities
   - undercut
   - cracks
   - cold laps
3. Uniformity of bead ripples must be in accordance with welding standards
4. Stringer or layered beads deposited in accordance with welding standards
5. Finish weldment visually acceptable in accordance with welding standards for:
   - spatters
   - arc strikes
   - slag
   - uniformity of beads

CONTENTS:

- Essentials of welding
- International welding codes and standards
- Acceptable weld profiles
- Weld defects, causes and remedies
- Welding Procedure Specifications (WPS)
- Welding techniques and procedures
- Safe welding practices

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Welding booth
   - Portable oven

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
4. Personal protective equipment
   - safety shoes
   - apron
   - leggings
   - safety goggles
   - gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/demonstration
- Dualized

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

UNIT OF COMPETENCY : PERFORM WELDING AND STEEL FABRICATION

UNIT CODE :

MODULE TITLE : PERFORMING WELDING AND STEEL FABRICATION

MODULE DESCRIPTOR : This module covers welding, fabrication and installation of all iron works related to e.g. steel trusses, steel railings, steel window casement, etc.

NOMINAL DURATION : 106 hours

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module the trainee/student must be able to:

1.2.1 Prepare materials, tools and equipment

1.2.2 Perform Lay outing

1.2.3 Fabricate parts

1.2.4 Install specific project

LO1 PREPARE MATERIALS, TOOLS AND EQUIPMENT

ASSESSMENT CRITERIA:

1. **Exact quantity of materials, tools and equipment was prepared according to requirement.**
2. **Correct specification of materials ,tools and equipment followed according to plan**

CONTENTS:

- **Different types of materials in iron works**
- **Specifications of materials, tool and equipment**
- **Metal edge preparation**

CONDITIONS:

The student/trainee must be provided with the following:

1. **Equipment**
   - **Welding machine (AC or AC/DC)**
   - **Welding table or jig**
   - **Portable grinder**
   - **Portable oven**
   - **Oxy-acetylene welding cutting**

2. **Tools/Accessories**
   - **Welding mask**
   - **Steel brush**
   - **Clear glass**
   - **Chipping hammer**
   - **Dark glass**
3. **Supplies/ Materials**
   - **Electrodes**
   - **Carbon steel plates**
   - **Cutting grinding disk**
   - **Necessary bars**
4. **Personal protective equipment**
   - **Safety shoes**
   - **Apron**
   - **Leggings**
   - **Safety goggles**
   - **Gloves**
5. **Training Materials**
   - **Arc welding manuals**
   - **Welding procedures specifications (WPS)**
   - **Welding standards**

METHODOLOGIES:

- **Lecture/discussion**
- **demonstration**
- **OJT**

ASSESSMENT METHODS:

- **Written/oral**
- **Interview**
- **Direct observation**

LO2. PERFORM LAY OUTING

ASSESSMENT CRITERIA:

1. **Lay outing was performed according to plan and specification**
2. **Lay outing tools selected according to work requirements**
3. **Lay outing procedures was observed according to work requirements**
4. **Safety was observed according to industry standard**

CONTENTS:

- **Types of lay outing tools**
- **Uses of lay outing tools**
- **Codes and specification**
- **Procedures in lay outing**

CONDITION:

The students/ trainee should be provided with:

- **Welding machine equipment and accessories**
- **Lay outing Tools**
- **Supplies/materials**
- **Personal protective equipment**
- **Drawing plan and specification**
- **Instructional materials**
  - **Reference book/ modules/ learning guides/ video CDs**
  - **Equipment manual**

METHODOLOGIES:

- **Lecture/demonstrations**
- **Self-pace learning**
- **Group discussion**

ASSESSMENT METHODS:

- **Written/oral**
- **Direct observation**
- **Interview**
- **Demonstration**

LO3. FABRICATE STEEL TRUSSES

ASSESSMENT CRITERIA:

1. **Materials/parts is identified according to requirements.**
2. **Locations/position is observed according to plan**
3. **Proper shaping, design of parts is observed**
4. **Quality finished is observed according to company requirements**

CONTENTS:

- **Different types of iron works materials**
- **Bench working**
- **Shaping/designing**
- **Techniques in fabricating parts**

CONDITION:

The students/ trainee should be provided with:

- **Welding machine equipment and accessories**
- **Oxy-acetylene welding and cutting equipment**
- **Ball peen Hammer aggregate size**
- **Measuring tools**
- **Jig**
- **Working Bench**
- **C-clamp**
- **Bench vise**
- **Pattern**
- **Hacksaw**
- **Vise grip**
- **Different shapes of dolleys**
- **Personal protective equipment**
-
- **Instructional materials**
  - **Reference book/ modules/ learning guides/ video CDs**
  - **Equipment manual**

  -Project Plan

METHODOLOGIES:

- **Lecture/discussion**
- **demonstrations**
- **Self-pace learning**
- **Group discussion**

ASSESSMENT METHODS:

- **Written/oral**
- **Direct observation**
- **Interview**
- **Demonstration**

LO4. INSTALL SPECIFIC PROJECT

ASSESSMENT CRITERIA:

1. Installation procedure is analyzed according to work requirements
2. Safe working condition during installation is observed
3. Installation procedure is followed according to work requirement
4. Proper equipment for installation is properly utilized

CONTENTS:

- **Safety procedure in installation**
- **Installation procedure of any iron works**
- **Types of lifting equipment and operation**
- **Different fastening techniques**
- **Safe welding practices**

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
- **Welding machine (AC or AC/DC)**
- **Portable grinder**
- **Lifting equipment**
- **Scaffolding**

2. Tools/Accessories
- **Welding mask**
- **Steel brush**
- **Clear glass**
- **Chipping hammer**
- **Dark glass**

3. Supplies/ Materials
- **Electrodes**
- **Necessary materials for installing such project**
- **Cutting grinding disk**

4. Personal protective equipment
- **Safety shoes**
- **Apron**
- **Leggings**
- **Safety goggles**
- **Gloves**
- **body harness**

5. Training Materials
- **Arc welding manuals**
- **Welding procedures specifications (WPS)**
- **Welding standards**

METHODOLOGIES:

- **Lecture/discussion**
- **demonstration**
- **Dualized**

- **Self-paced learning**

ASSESSMENT METHODS:

- **Written/oral**
- **Interview**
- **Direct observation**

What is Competency-Based Curriculum (CBC)

- A competency-based curriculum is a framework or guide for the subsequent detailed development of competencies, associated methodologies, training and assessment resources.
- The CBC specifies the outcomes which are consistent with the requirements of the workplace as agreed through the industry or community consultations.
- CBC can be developed immediately when competency standards exist.
- When competency standards do not exist, curriculum developers need to clearly define the learning outcomes to be attained. The standard of performance required must be appropriate to industry and occupational needs through the industry/enterprise or specified client group consultations.

These materials are available in both printed and electronic copies.

For more information please contact:
Technical Education and Skills Development Authority (TESDA)
Telephone Nos.: 893-8281, 817-4076 to 82 loc. 611 to 630, 631 and 635 or visit our website: www.tesda.gov.ph or the TESDA Regional or Provincial Office nearest you.

Appendix-6: TESDA Training Module for Shield Metal Arc Welding (SMAW) (TESDA Training Material)

COMPETENCY BASED LEARNING MATERIAL

Sector : **METALS AND ENGINEERING**

Qualification Title: **SHIELDED METAL ARC WELDING NC II**

Unit of Competency: **Perform Welding and Steel Fabrication using SMAW**

Module Title: **Performing Welding and Steel Fabrication using SMAW**

Technical Education & Skills Development Authority

REGIONAL TRAINING CENTER IN COOPERATION WITH **JICA**

Tacloban City

HOW TO USE THIS COMPETENCY BASED LEARNING MODULE

Welcome to the Module: Performing Welding and Steel Fabrication. This Module contains training materials and activities for you complete.

The unit of competency Perform welding and Steel Fabrication contains the knowledge Skills and Attitude required for SMAW. It is one of the Core Module for **National Certificate Level II (NC II).**

You are required to go through a series of learning activities in order to complete each learning outcome of the module. In each learning outcome there are information sheets resource sheets and Reference materials for further reading to help you better understand the required activities. Following these activities on your own and answers self-check at the end of each learning outcome. Get the answer key from your instructor and check your work honestly. If you have questions please don't hesitate to ask your facilitator for assistance.

Recognition of Prior Learning (RPL)

You may already have some or most of the knowledge and skill covered in this module because you have been working for someone already complete training in this area.

If you can demonstrate to your trainer that you are complete in a particular skill or skills talk to him/her about having them formally recognized so won't have to do the same training again. If you have qualification or certificates of competency from previous trainings, show them to your trainer if the skills you acquired are still relevant to this module they may become part of the evidence you can present for RPL

At the end of this learning is a learning diary to record important dates, jobs undertakes and other workplace events that will assist you in providing further details to your trainer or assessors. A record of achievement also provided for your trainer to complete once you completed the module.

The learning materials was prepared to you help achieve the required competency, in **Applying Safety Practices.** This will be source of information for you to acquire the knowledge and skills in this particular trade independently and your own pace with minimum supervision or help from your instructor.

In doing the activity to complete the requirements of this module, please be guided the following:

- Talk to your trainer and agree on how you will both organize the training under this module. Read through the module carefully. It is divided into section which cover all the skills and knowledge you need to successfully complete.

- Work through all information and complete the activities in each section. Read the information sheets and complete self-cheeks provided in this module.

- Most probably your trainer will tell you about the important things you need to consider when you are completing the activities and it is important that you listen and take notes.

- You will be given plenty of opportunities to ask question the practice on job. Make sure you practice your skills during regular work shifts. This way you will approve both your speed and memory and also your confidence.
- Talk to more experienced work mates and ask for their guidance.
- Use self-cheek question at the end of each section or test your own progress
- When you are ready, ask your trainer to watch your perform the activities outlined in this module.
- As you work through the activities, ask for written feedback on your progress. Your trainer keeps feedback/pre-assessment report for this reason. When you have completed this learning material and feel confident that you have had sufficient knowledge and skills, your trainer will arrange the appointment with a registered assessor to assess you. The result of the assessment will be recorded in your Competency Achievement Record.

(SMAW NCII)
COMPETENCY-BASED LEARNING MATERIALS

List of Competencies

No.	Unit of Competency	Module Title	Code
1.	Perform groove welding on carbon steel plate using SMAW	Performing welding on carbon steel plate using SMAW	
2.	Perform groove welding on carbon steel pipe using SMAW	Performing groove welding on carbon steel pipe using SMAW	
3.	***Perform Welding and Steel fabrication using SMAW***	***Performing Welding and Steel fabrication using SMAW***	

MODULE CONTENT

UNIT OF COMPETENCY : **PERFORM WELDING AND STEEL FABRICATION**

UNIT CODE :

MODULE TITLE : **PERFORMING WELDING AND STEEL FABRICATION**

MODULE DESCRIPTOR: This module covers welding, fabrication and installation of all iron works related to steel trusses, steel railings, and steel window casement, etc.

NOMINAL DURATION : 106 hours

SUMMARY OF LEARNING OUTCOMES:

Upon completion of this module the trainee/student must be able to:

1.2.1 Prepare materials, tools and equipment

1.2.2 Perform Lay outing

1.2.3 Fabricate steel trusses

1.2.7 Install specific project

LO1 PREPARE MATERIALS, TOOLS AND EQUIPMENT

ASSESSMENT CRITERIA:

1. Exact quantity of materials, tools and equipment was prepared according to requirement.
2. Correct specification of materials ,tools and equipment followed according to plan
3. Materials was prepared according to requirements

CONTENTS:

1. Different types of materials in iron works
2. Specifications of materials, tool and equipment
3. Preparing materials

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Portable oven
   - Oxy-acetylene welding cutting
   - Plasma Cutter

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
   - Necessary bars
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/discussion
- demonstration
- OJT

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

Learning Experiences

Learning Outcome 1

Prepare materials, tools and equipment

Learning Activities	Special Instructions
Please read the **preliminary pages** so that you will understand the scope of the module and how to go page by page on the module	If you have question please do not hesitate to call the attention of your trainer
Every **Learning Outcome** has its own info sheets to read, after reading you can practice answering **self-check** and apply it using the **task sheet or a job sheet.**	

INFORMATION SHEET 3.1-1

Different Roof Framing Materials and its Specifications

Learning Objectives:

After reading this INFORMATION SHEET, YOU MUST be able to:

- Familiarize different materials to be used for roof framing.

ROOF FRAMING refers to the assembly of roof members fitted or joined together to provide support for the roof covering. Also, commonly called "**TRUSS S**

Types of Roof Framing Materials:

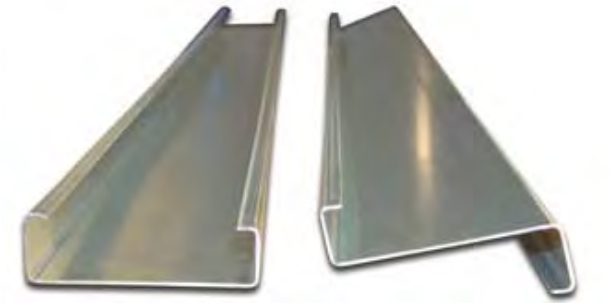
1. **ANGLE BARS** – (ASTM A36) The material commonly used in fabricating trusses comes in different sizes and thickness.

SIZE (mm)	THICKNESS (mm)
25 x 25 x 6000	2 - 6mm
50 x 50 x 6000	
65 x 65 x 6000	

**These are the commonly used sizes, while 2 is the mostly used thickness of Angle Bars*

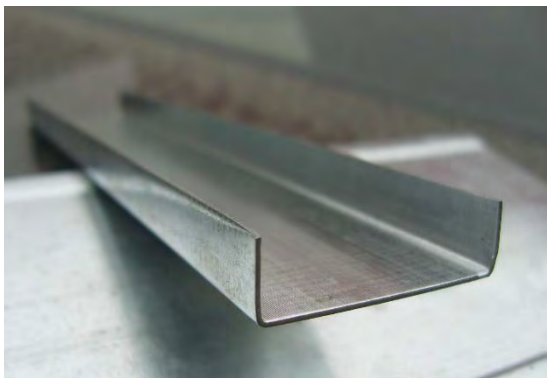
2. **Z or C – PURLINS** (ASTM A446) – A roof framing member that span parallel to the building eave and support the roof decking or sheeting. The purlins are in turn supported by rafters or walls.

SIZE (mm)	THICKNESS (mm)
50 x 100 x 6000	0.80, 1.20, 2.00
50 x 75 x 6000	
50 x 150 x 6000	



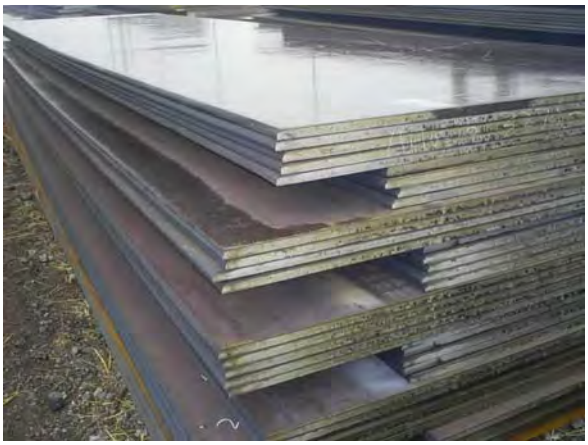
3. **C – CHANNEL** (ASTM A6) – An alternative to C – purlins for its superior strength and durability.

SIZE (mm)	THICKNESS (mm)
50 x 100 x 6000	1.20, 2.00
50 x 150 x 6000	



4. **FLAT BAR** - Used mostly as additional bracing and fabricating facia frame. Flat bars' commercially available and commonly used sizes are 1" (25mm), 1 ½" (40mm) and 2" (50mm) in 0.50 – 4mm thickness.

5. **STEEL PLATE** – The material mainly used for making gusset plates with a standard dimension of 1.20m x 4.80m. Commonly used thickness are 1.6, 2, 6, 8 and 10mm.



6. **PLAIN BARS & TURNBUCKLE** – Plain steel bars are used as sag rods and bracings. When plain bars are used for cross bracings, a turnbuckle, normally at 10mm or 12mm diameter, is attached at the other end of the bar.

PLAIN BAR

TURNBUCKLE

WELDING ELECTRODE – commonly known as "WELDING ROD" are metal wires with baked on chemical coatings. The rod is used to sustain the welding arc and to provide the filler metal required for the joint to be welded.

Basic Stick Welding Electrode Selection

- The prefix "E" designates an arc welding electrode. The first two digits of a 4-digit number and the first three digits of 5-digit number indicate minimum tensile strength. For example, E6010 is a 60,000 psi tensile strength electrode while E10018 designates a 100,000 psi tensile strength electrode.

E	**60**	**1**	**10**
Electrode	Tensile Strength	Position	Type of Coating and Current

- The next to last digit indicates position. The "1" designates an all position electrode, "2" is for flat and horizontal positions only; while "4" indicates an electrode that can be used for flat, horizontal, vertical down and overhead. The last 2 digits taken together indicate the type of coating and the correct polarity or current to use. See chart below:

Digit	**Type of Coating**	**Welding Current**
0	High cellulose sodium	DC+
1	High cellulose potassium	AC, DC+ or DC-
2	High titania sodium	AC, DC-
3	High titania potassium	AC, DC+
4	Iron powder, titania	AC, DC+ or DC-
5	Low hydrogen sodium	DC+
6	Low hydrogen potassium	AC, DC+
7	High iron oxide, iron powder	AC, DC+ or DC-
8	Low hydrogen potassium, iron powder	AC, DC+ or DC-

As a welder, there are certain electrodes that you will most likely see and use time and time again as you go about your daily operations. A DC machine produces a smoother arc. DC rated electrodes will only run on a DC welding machine. Electrodes which are rated for AC welding are more forgiving and can also be used with a DC machine.

Here are some of the most common electrodes and how they are typically used:

- **6010 and 6011** – deep penetration works well in all positions and is excellent on dirtier metals. DC only and designed for putting the root bead on the inside of a piece of pipe, this is the most penetrating arc of all.
- **6013** – mild penetration, works well in all positions and needs a cleaner joint.
- **7018** – mild penetration works well in all positions and works best on clean metals.

- **7024 –** mild penetration works well in the flat positions and needs a clean joint.

Electrode Sizes and Amperage Used		
ELECTRODE DIAMETER (Thickness)	AMPERAGE	PLATE
1.6 mm (1/16")	**20 – 40**	**UP TO 4.8mm (3/16")**
2.4 mm (3/32")	**40 – 125**	**UP TO 6.35mm (1/4")**
3.2 mm (1/8")	**75 – 185**	**OVER 3.2mm (1/8")**
4.0 mm (5/32")	**105 - 250**	**OVER 6.35mm (1/4")**
4. 8 mm (3/16")	**140 – 305**	**OVER 9.5mm (3/8")**
6.35 mm (1/4")	**210 – 430**	**OVER 9.5mm (3/8")**
7.93 mm (5/16")	**275 - 450**	**OVER 12.70mm (1/2")**

WELDING EQUIPMENT

WELDING MACHINE – the primary apparatus required for welding and fabrication of welded articles from semi-finished stock. A set of welding equipment for operations that require some degree of participation by a welder is called a "welding position or station".

Most commonly used types of welding machine:

1. DC INVERTER

Unlike traditional arc welders, moder
inverter arc welders are very small, li
and portable. Even the cheap ones
available from as little as £100 functi
well, though the more expensive ones
(up to £500) will be much more robus
and will normally last much longer.

Pros:
Very efficient - they can run up to ab
140 amps on a 13 amp 240V supply,
and tend to have have good duty cycl
(you can weld for longer on higher se

Small, lightweight and very portable.
Generally less than 10kg in weight.

DC output results in easy arc starting

Most inverters have features such as hot starting to improve the ease of starting, and a soft finish to reduce the crater at the end of a weld.

All but the cheapest have 70V or 80V OCV (open circuit voltage)

Most can be used for scratch start TIG. More expensive ones tend to have HF (high frequency) start functions for TIG welding.

Pricier ones have features such as "arc force" which adjusts the voltage on the fly to cope with dirty plate.

Cons:
Inverter machines are complex electronically, and repairs can be very expensive. The cheaper ones are sensitive to knocks and spikes in input voltage. The more expensive ones have more protection - some are designed to withstand being dropped from 0.5m.

Verdict:
DC inverters are the sensible buy for anyone new to arc welding. Even the cheapest ones tend to weld very nicely, the downside of the cheap ones being that cheap components that don't last very well.

2. DC TRANSFORMER

Transformer based arc welders are normally very heavy, and are aimed at TIG welding in a workshop rather than portability.

Pros:
These are excellent quality welders - for ease of use they are only bettered by decent inverter welders.

Duty cycles tend to be higher than modern inverter welders, so these machines are still used by fabrication companies when they need to do long runs of weld at very high amps.

Can last for much longer than inverter based machines, and are easier and cheaper to repair if they do go wrong. Many are still in regular use after 30 years.

The TIG welding capabilities.

Cons:
Not Portable: A Syncrowave 300 weighs 330kg and is the size of a house.

The machines with huge power requirements - the Syncrowave manual recommends a 110 amp 240V supply.
The buzz from the enormous transformers and 2 foot diameter fans create a lot of noise.
Parts available for the older ones is becoming sketchy.

Verdict:
Buy one secondhand if you want something that will last and have the space to keep it.

Different Tools and Uses In Steel Fabrication

Types of Tools:
1. Layout/ Measuring Tools
2. Personal Protective Equipment (PPE)
3. Cutting Tools

LAYOUT/ MEASURING TOOLS and its USES:

1. STEEL TAPE – also called TAPELINE, is a flexible rule of thin steel that retracts into a protective case. It is used for measuring irregular and regular shapes.

3. **L – SQUARE** – or a CARPENTER'S SQUARE, is an instrument used by draftsmen primarily used to measure and draw right angles. Its name comes from the general shape of the instrument.

4. **CHALK LINE or CHALK BOX** is a tool for marking long, straight lines on relatively flat surfaces, much farther than is practical by hand or with a straightedge.

5. CHALK STONE

PERSONAL PROTECTIVE EQUIPMENT (PPE)

1. **FULL – BODY JUMPSUIT/COVERALL** – The main personal protective equipment (PPE) intended to protect welders from metal splatter and high heat by the use of fire resistant and thermally insulating materials.

2. **GLOVES** – worn by the welder to protect the hands from flying sparks, heat or even flame-ups.

3. **SAFETY GOGGLES** – an eyewear that usually enclose or protect the area surrounding the eye for protection during welding or cutting. They provide protection against debris, the heat from welding, and, with the proper filters, the optical radiation resulting from the welding.

4. **WELDING HELMET** – a headgear used when performing certain types of welding to protect the eyes, face and neck from flash burn, ultraviolet light, sparks, infrared light, and heat.

5. **SAFETY SHOES** – is a durable boot or shoe that has a protective reinforcement in the toe which protects the foot from falling objects or compression, usually combined with a mid – sole plate to protect against punctures from below

6. **HARDHAT** - a type of helmet predominantly used in workplace environments such as industrial or construction sites to protect the head from injury due to falling objects, impact
with other objects, debris, rain, and electric shock

7. **MARKING CHALK** – a piece of chalk or chalklike substance used for marking.

SELF CHECK 3.1-1

1. A personal protective equipment use to protect hands during welding.
    a. Masonry gloves
    b. Laundry gloves
    c. Welding gloves
    d. None of the above
2. A measuring tool used to measure linear measurements
    a. Pull-push rule
    b. Vernier caliper
    c. Ruler
    d. Micrometer
3. A power source during welding job.
    a. Oxy-acetylene welding and cutting
    b. AC or DC welding machine
    c. Plasma Cutter
    d. Electrode Oven
4. A PPE use to protect face during grinding
    a. Welding helmet
    b. Welding goggles
    c. Face shield clear
    d. Eye glass

Information Sheet 3.1-2

Material preparation

Procedures in Cutting Metals

Learning Objectives:

After reading this INFORMATION SHEET, you should be able to:

1. Familiarize the different procedures in cutting metals.
2. Prepare Metal edges

Types of Cutting tools:

1. Circular Saw
2. Plasma Cutter
3. Oxy-acetylene cutter

Cutting – the process of preparing and cutting the steel with a specific dimension based on a given shop drawing.

CUTTING USING A CIRCULAR SAW (CUT – OFF)

1. Prepare the metal to be cut.
2. If there are presence of dirt and rust, use a steel or cup brush to clean the metal.
3. Using the steel tape, measure the required length and mark it using a chalk. To ensure that cutting of metal is in right angle, use an L – square as aid for marking.
4. Place the metal on the table with the marked area in front of the blade. Lock the metal in place to avoid movement while cutting.
5. Turn on the circular saw to start the cutting. Press the blade slowly against the metal until it's completely cut off.

CUTTING USING A PLASMA CUTTER

1. Prepare the metal to be cut.
2. If there are presence of dirt and rust, use a cup brush to clean the metal.
3. Using the steel tape, measure the required length and mark it using a chalk. To ensure that cutting of metal is in right angle, use an L – square as aid for marking.
4. Place the steel plate on top of a table or platform.
5. Turn on the **plasma cutter** and adjust the amperage to **40**.
6. Turn on the **compressor**.
7. Place the nozzle tip directly on top of the marked line, **push** the ON button to start cutting.
8. Continue cutting along the marking until finished.

CUTTING USING OXY – ACETYLENE

1. Prepare the metal to be cut.
2. If there are presence of dirt and rust, use a cup brush to clean the metal.
3. Using the steel tape, measure the required length and mark it using a chalk. To ensure that cutting of metal is in right angle, use an L – square as aid for marking.
4. Place the steel plate on top of a table or platform.

   You may use a C – clamp to temporarily fix the plate to the table and prevent movement during cutting.

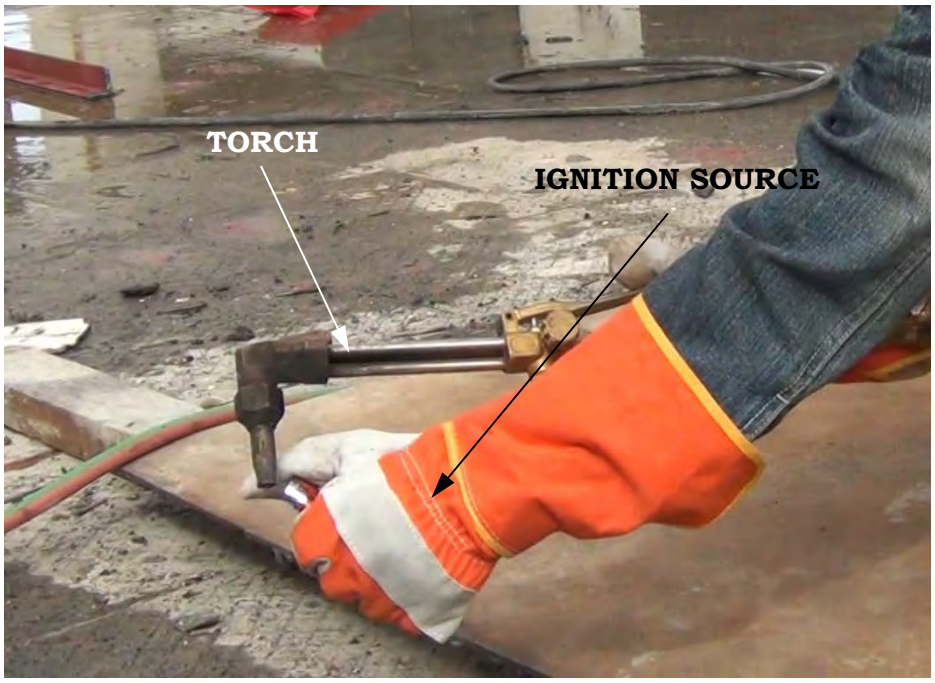
5. Set up the cutting torch. Hook up the gauges to the tanks. Make sure the acetylene regulator is turned off before turning on the gas valves. As safety practice, NEVER allow acetylene pressure to exceed 15 psi

6. Turn the oxygen regulator off or down and then adjust the oxygen pressure.

   Open the main oxygen tank all the way. Open the regulator valve slowly until pressure reads between 25 and 40 psi.

   Open the oxygen valve on the torch to allow the atmosphere to vent out of the hose. Open the forward valve slightly for 3 – 5 seconds until the hose is purged. Close the forward valve.

7. Light the torch. Open the acetylene valve again, allowing the oxygen remaining in the mixing chamber to purge for a few seconds, then shut the valve until you can barely hear gas escaping. Holding the striker in front of the torch tip, with the tip facing inside the striker (or toward the ignition source, for electronic strikers), squeeze the handle. A small yellow flame should appear at the tip when the sparks from the striker ignite the acetylene.



8. Adjust the acetylene valve until you have a yellow flame about 10” (25.40 cm) long. Make sure the flame begins at the torch tip.

9. Turn the forward oxygen valve slowly. The flame color will turn from yellow to light blue as sufficient oxygen is supplied to completely combust the acetylene.

Open the oxygen valve more to increase the flame size until the length of the inner flame is just over the thickness of the steel you are intending to cut.

10. Bring the tip of the inner flame to the surface of the steel you are going to cut.

    Push the cutting valve handle down slowly to release the oxygen jet, which ignites the molten steel. Begin moving the torch tip slowly along the line of your cut when the jet is cutting through the steel.

Metal Edge Preparation

BEVELING – a method of softening the edge as safety measure, wear resistance or to facilitate mating with another piece.

METAL EDGE PREPARATION (BEVELING):

1. Prepare the metal for beveling.
2. Using a C – clamp, fix the metal to the edge of a working table.
3. Position the grinder on the metal edge in an angled position.
4. Start grinding slowly until the edge is beveled.

SELF CHECK 3.1.2

_____1. An equipment use to cut metal using oxygen and a fuel.

_____2. An arc cutting equipment use to cut stainless metal.

_____3. A unit of pressure in English system use set working pressure in a gas cutting equipment

TASK SHEET 3.1-1

Title: Perform cutting using Oxy-acetylene cutting equipment

Performance Objective: Given the equipment, tools, you should be able to cut metal using oxy-acetylene cutting equipment following standard procedure.

Supplies/Materials :piece of metal

Equipment :Oxy-acetylene cutting equipment

Steps/Procedure:

1. Prepare the metal to be cut.
2. If there are presence of dirt and rust, use a cup brush to clean the metal.
3. Using the steel tape, measure the required length and mark it using a chalk. To ensure that cutting of metal is in right angle, use an L – square as aid for marking.
4. Place the steel plate on top of a table or platform.

   You may use a C – clamp to temporarily fix the plate to the table and prevent movement during cutting.

5. Set up the cutting torch. Hook up the gauges to the tanks. Make sure the acetylene regulator is turned off before turning on the gas valves. As safety practice, NEVER allow acetylene pressure to exceed 15 psi

6. Turn the oxygen regulator off or down and then adjust the oxygen pressure.

   Open the main oxygen tank all the way. Open the regulator valve slowly until pressure reads between 25 and 40 psi.

   Open the oxygen valve on the torch to allow the atmosphere to vent out of the hose. Open the forward valve slightly for 3 – 5 seconds until the hose is purged. Close the forward valve.

7. Light the torch. Open the acetylene valve again, allowing the oxygen remaining in the mixing chamber to purge for a few seconds, then shut the valve until you can barely hear gas escaping. Holding the striker in front of the torch tip, with the tip facing inside the striker (or toward the ignition source, for electronic strikers), squeeze the handle. A small yellow flame should appear at the tip when the sparks from the striker ignite the acetylene.

8. Adjust the acetylene valve until you have a yellow flame about 10" (25.40 cm) long. Make sure the flame begins at the torch tip.

9. Turn the forward oxygen valve slowly. The flame color will turn from yellow to light blue as sufficient oxygen is supplied to completely combust the acetylene.

   Open the oxygen valve more to increase the flame size until the length of the
   inner flame is just over the thickness of the steel you are intending to cut.

10. Bring the tip of the inner flame to the surface of the steel you are going to cut.

    Push the cutting valve handle down slowly to release the oxygen jet, which ignites the molten steel. Begin moving the torch tip slowly along the line of your cut when the jet is cutting through the steel.

Assessment Method:

Performance Criteria Checklist 3.1-1

CRITERIA **Did you….**	**YES**	**NO**
1. Observed safety in using the equipment?		
2. Operate the equipment according to manufacturer's manual?		
3. Observed proper cutting procedure?		

LO`2 PERFORM LAY OUTING

ASSESSMENT CRITERIA:

1. Exact measurements was observed according to plan.
2. Lay outing procedures was observed according to industry standard

CONTENTS:

1. Lay outing techniques
2. Procedures in lay outing steel trusses

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Portable oven
   - Oxy-acetylene welding cutting
   - Plasma Cutter

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
   - L-square
   - Plumb bob
   - Marker
   - Pull push rule
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
   - Necessary bars
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/discussion
- demonstration
- OJT

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

Information Sheet 3.2-1
Lay Outing Techniques

Learning Objectives:

After reading this INFORMATION SHEET, YOU MUST be able to:

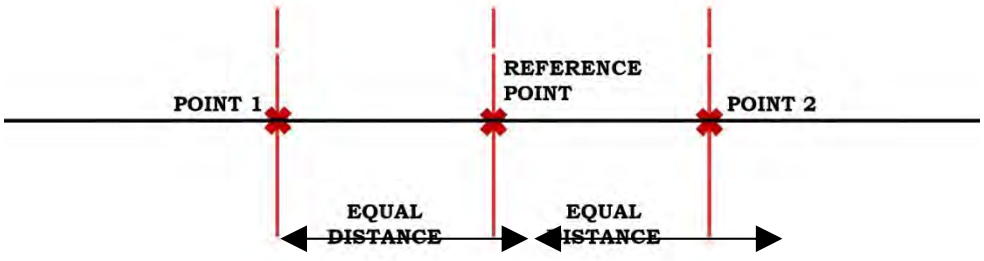
1. Familiarize various lay outing techniques.

One of the basic fundamentals of lay outing is making sure perpendicular/ intersecting lines are in 90 degrees/ right angle. The following techniques will be discussed on how to obtain an accuracy in lay outing perpendicular/ intersecting lines.

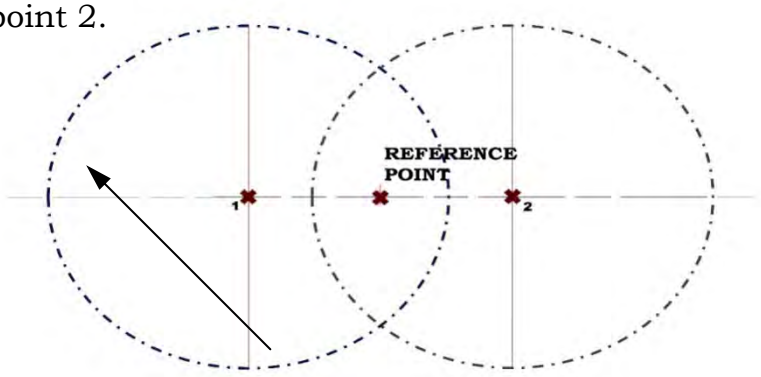
HOW TO LAY OUT 90° USING AN IMPROVISED COMPASS USING A STRING AND PIECE OF WOOD WITH NAIL AT BOTH ENDS

1. DRAW a straight line on a plane surface and MARK a point on the line.

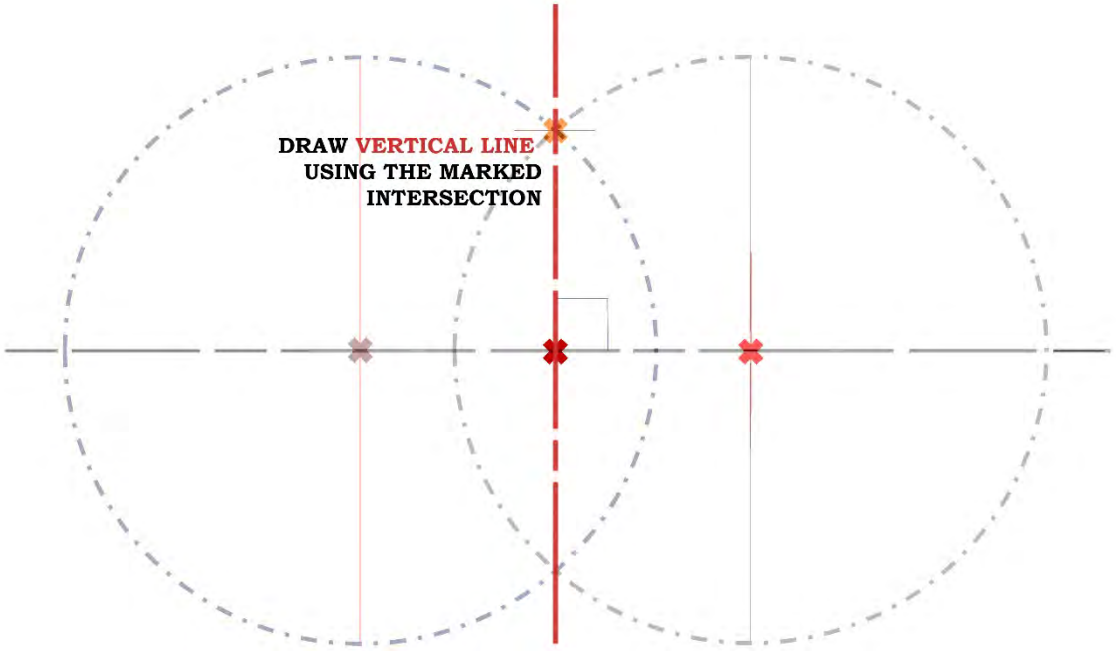
On that same line MARK additional two (2) points equidistant from the center point.



2. Using the improvised compass, draw circles using points 1 & 2 as center point. Diameter of the circle should be more than the distance between reference point and 1. Use this same diameter in drawing circle at point 2.



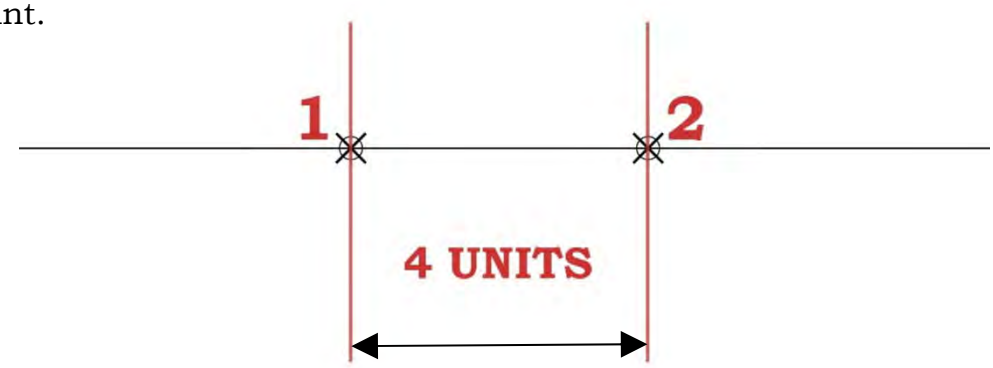
3. DRAW a line from the MARKED intersection point to the FIRST point. The ANGLE between the HORIZONTAL and VERTICAL lines will be 90 degree.



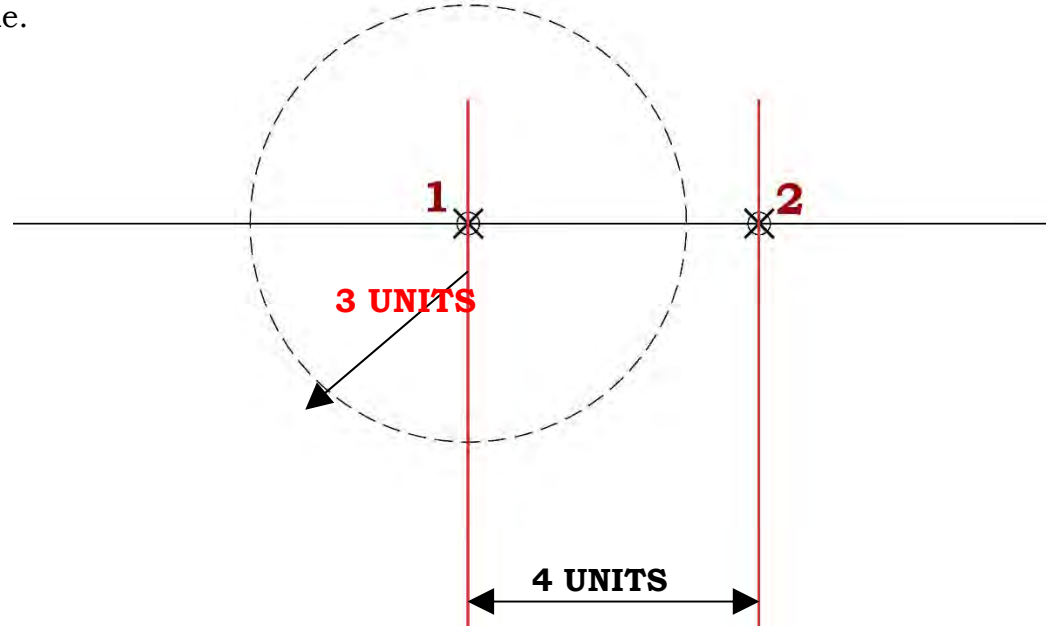
HOW TO LAY OUT 90° USING A COMPASS AND STRAIGHT EDGE

1. DRAW a straight line and MARK a point on the line.

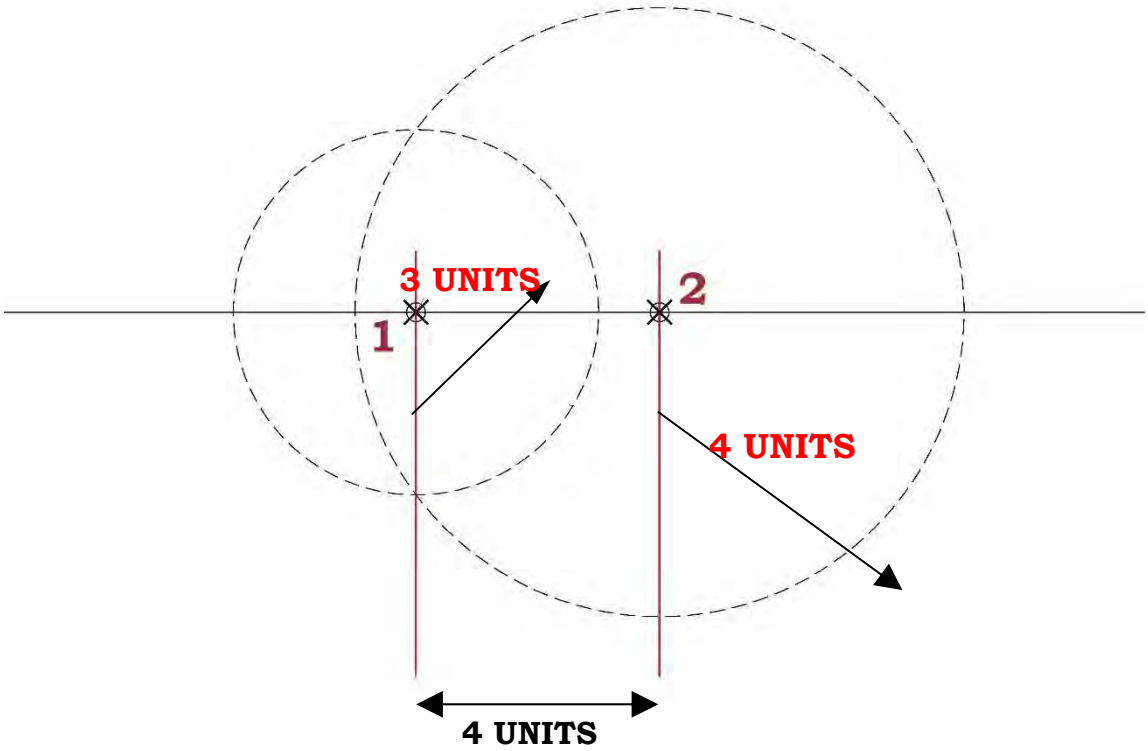
2. MARK a SECOND point on the line FOUR (4) UNITS from the FIRST point.



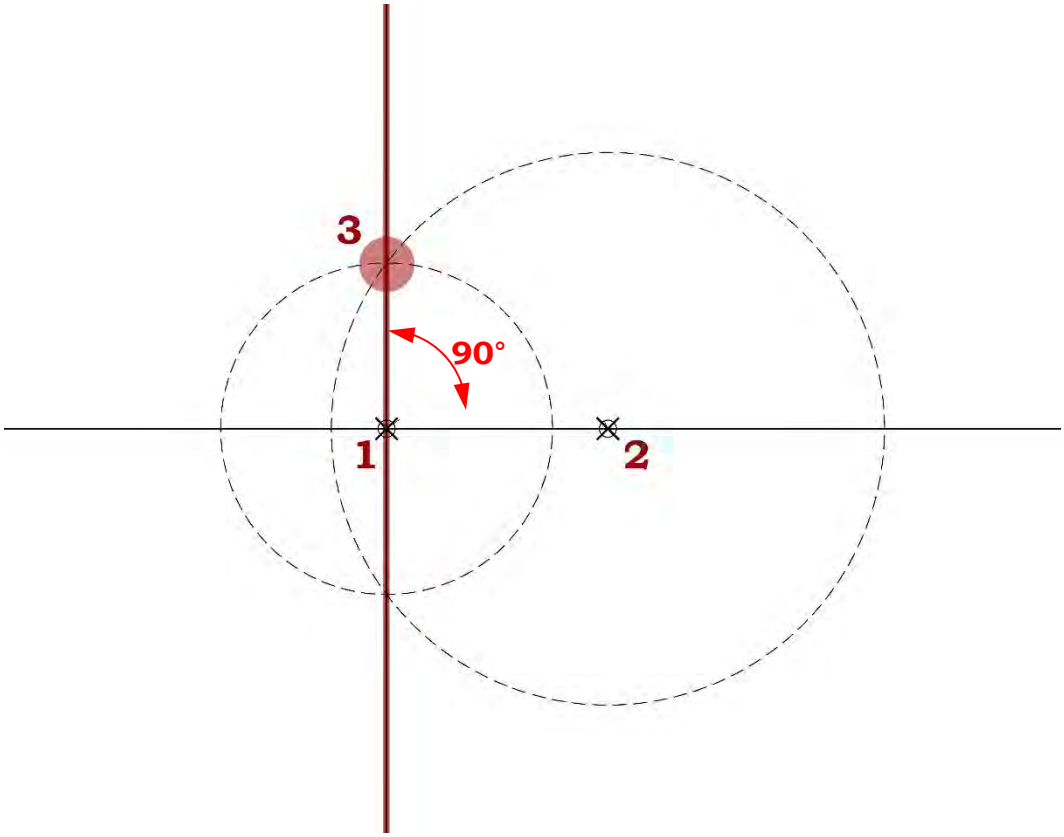
3. DRAW a circle with a RADIUS OF 3 UNITS from FIRST point. DRAW another circle, this time with a RADIUS OF 5 UNITS from the SECOND point. This will make an intersecting point with the previous circle.



4. DRAW another circle, this time with a RADIUS OF 5 UNITS from the SECOND point. This will make an intersecting point with the previous circle.



5. MARK the INTERSECTING POINT of the TWO (2) circles. DRAW a line from the THIRD (3) POINT to the FIRST (1) POINT. The ANGLE between the FIRST and SECOND line is 90 degree.


3
90°
1
2

SELF CHECK 3.2-2

1. Illustrate how to make a 90 degrees angle using compass
2. Give at least 5 lay outing tools

TASK SHEET 3.2-1
Title:LAY OUT 90° USING AN IMPROVISED COMPASS USING A STRING AND PIECE OF WOOD WITH NAIL AT BOTH ENDS
Performance Objective: Given lay outing tools, you should be able to lay out 90 degrees using an improvised compass using a string following standard procedure.
Supplies/Materials :Compass, chalk line, piece of wood ,nail and lay outing tools
Equipment :
Steps/Procedure: 1. DRAW a straight line on a plane surface and MARK a point on the line. 2. On that same line MARK additional two (2) points equidistant from the center point. 3. Using the improvised compass, draw circles using points 1 & 2 as center point. Diameter of the circle should be more than the distance between reference point and 1. Use this same diameter in drawing circle at point 2. 4. DRAW a line from the MARKED intersection point to the FIRST point. The ANGLE between the HORIZONTAL and VERTICAL lines will be 90 degree.
Assessment Method:

Performance Criteria Checklist 3.2-2

CRITERIA **Did you....**	YES	NO
1. Arrive to a 90 degrees angle against horizontal		
2. Follow the steps in making 90 degrees angle		
3. Use the lay outing tool properly		

Information Sheet 3.2-2
Procedures in Lay Outing Steel Truss

Learning Objectives:

After reading this INFORMATION SHEET, YOU MUST be able to:

1. Familiarize procedure in lay outing a truss.

LAY OUT – the process of interpreting construction plans and marking the location of proposed structure.

Although we use steel truss in this discussion refers, this procedure is also applicable to wood trusses lay outs.

PROCEDURES IN LAY OUTING STEEL TRUSS

1. Study the shop drawing. Take note of all the dimensions on plan. Make sure of the accuracy of the dimensions by checking it with actual measurements of the structure's roof beams.

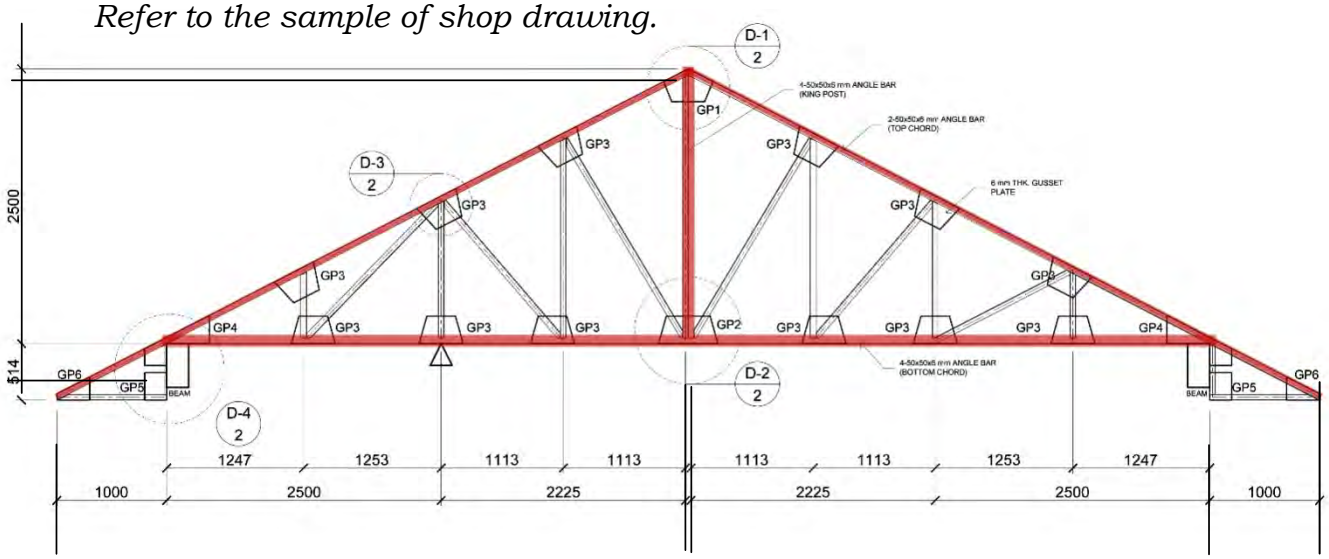
2. In a flat surface, start the layout by creating lines of the 3 main components of truss – bottom chord, king post (main vertical bar), and top chords, respectively.

3. Using a chalk line and steel tape, mark the lines for bottom chord, king post and top chords.

   Apply the lay outing techniques discussed previously to ensure that vertical members are in right angle (90°).

4. Continue the same procedure with other web members.

Refer to the sample of shop drawing.



LAY OUTING of BOTTOM CHORD

LAY OUTING of VERTICAL POST (90° degree layout technique)

LAY OUTING of VERTICAL POST (90° degree layout technique)

LAY OUTING of VERTICAL POST (90° degree layout technique)

LAY OUTING of TOP CHORD

SELF CHECK 3.2-2

Enumerate the steps in lay outing steel trusses

TASK SHEET 3.2-3

Title: Interpret working drawing of a steel trusses and make an actual lay out

Performance Objective: Given all the necessary materials, plan and lay outing tools, you should be able to perform actual lay outing following the plan.

Supplies/Materials : angle bars ,lay outing tools ,electrode, grinding stone

Equipment :Welding equipment, Oxy-acetylene cutting equipment, grinder

Steps/Procedure:

1. Study the shop drawing. Take note of all the dimensions on plan. Make sure of the accuracy of the dimensions by checking it with actual measurements of the structure's roof beams.

2. In a flat surface, start the layout by creating lines of the 3 main components of truss – bottom chord, king post (main vertical bar), and top chords, respectively.

3. Using a chalk line and steel tape, mark the lines for bottom chord, king post and top chords.

   Apply the lay outing techniques discussed previously to ensure that vertical members are in right angle (90°).

4. Continue the same procedure with other web members.

Assessment Method:

Performance Criteria Checklist _____

CRITERIA **Did you....**	**YES**	**NO**
Follow the procedure in lay outing?		
Observed correct measurement as to the plan?		

LO3 FABRICATE STEEL TRUSSES

ASSESSMENT CRITERIA:

1. Selection of truss design is in accordance to plan
2. Fabrication procedures was followed according to company requirements.

CONTENTS:

1. Different steel trusses design
2. Parts of steel trusses
3. Common Steel Trusses
4. Essentials in welding
5. Fabrication procedure of steel trusses

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Portable oven
   - Oxy-acetylene welding cutting
   - Plasma Cutter

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
   - Necessary bars
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/discussion
- demonstration
- OJT

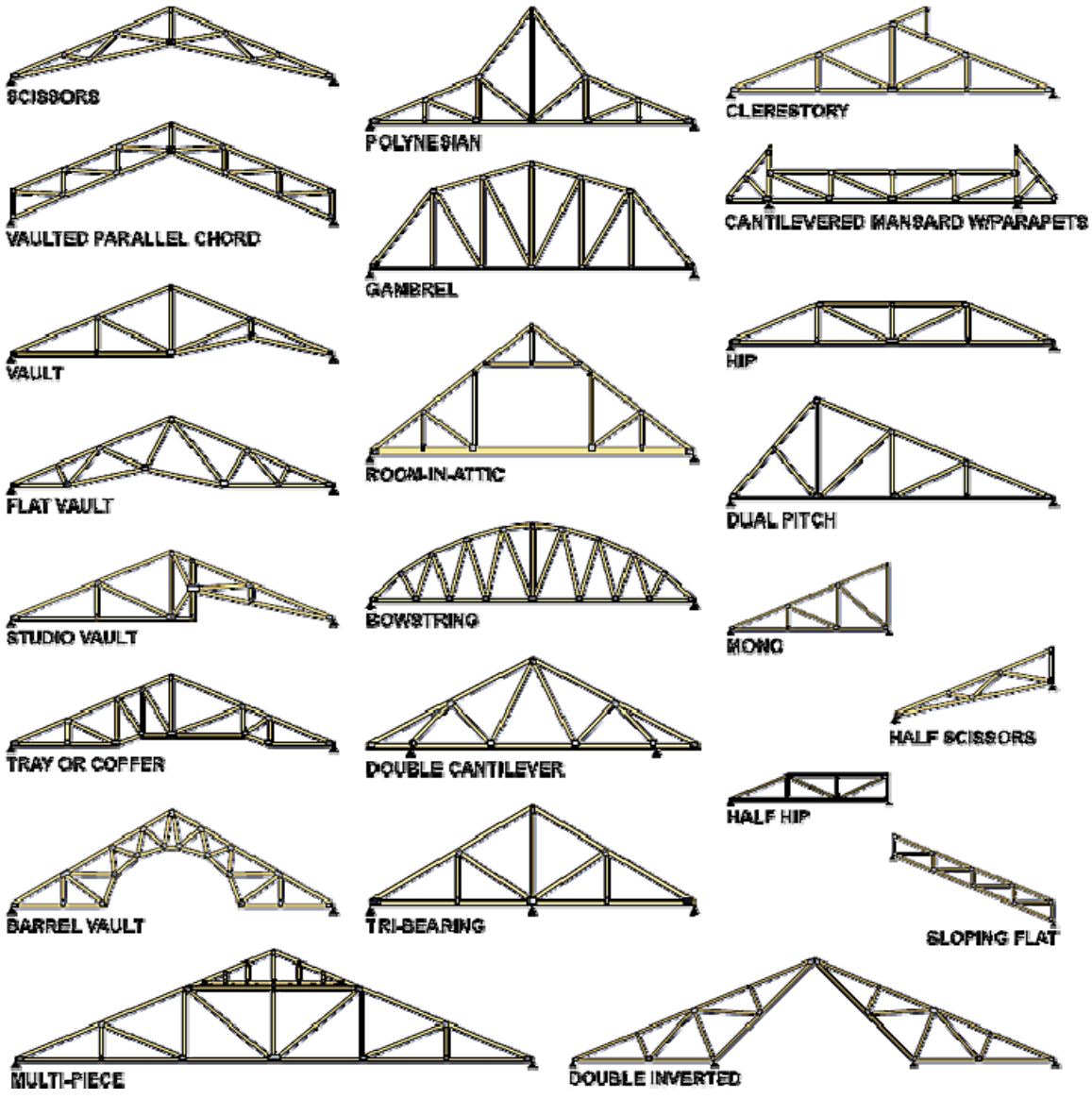
ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

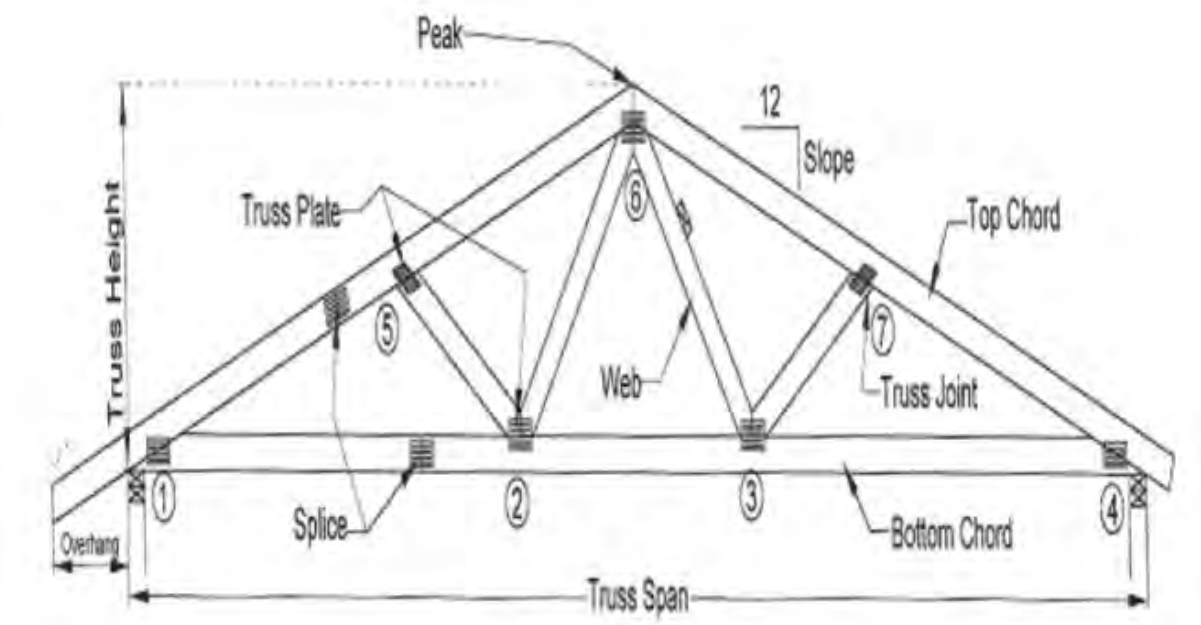
INFORMATION SHEET 3.3-1

Learning Objective: After reading the information sheet, trainees will be able to identify
different design of steel trusses and steps in fabricating steel trusses

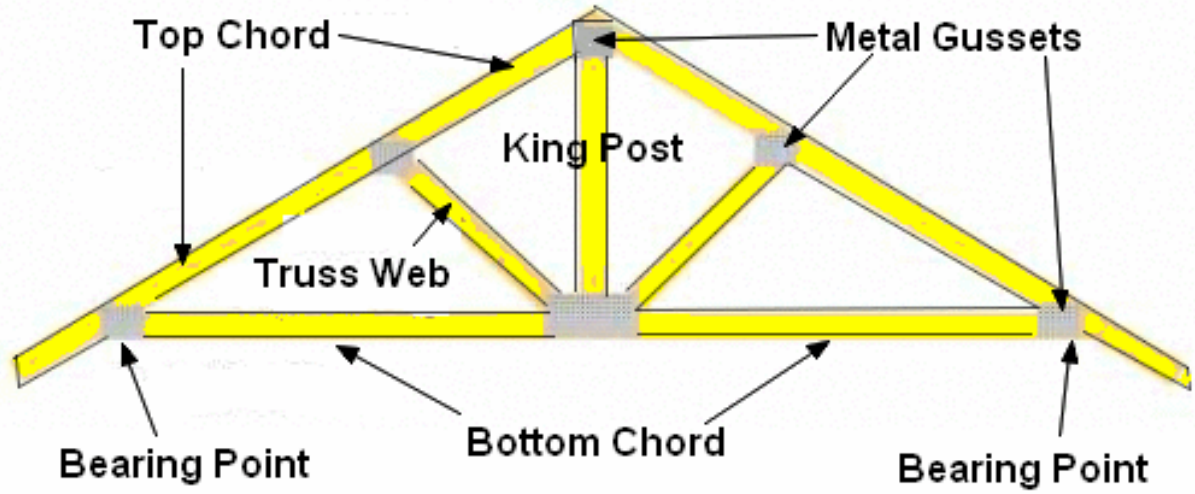
DIFFERENT STEEL TRUSSES DESIGN



PARTS OF STEEL TRUSSES



Common Roof Truss



SELF-CHECK 3.3-1

1. Enumerate parts of common truss.
2. Explain a groove weld and a fillet weld
3. Draw 3 types of trusses according to construction

INFORMATION SHEET 3.3-2

Welding Fundamentals

Learning Objectives:

After reading this INFORMATION SHEET, YOU MUST be able to:

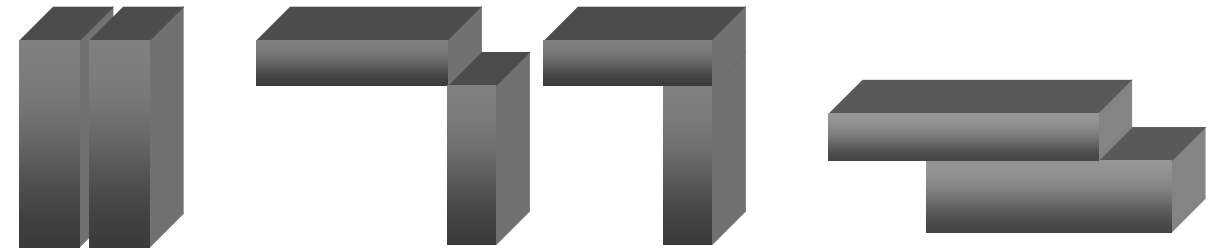
1. Familiarize the basic fundamentals of welding.

WELDING is a materials joining process in which two or more parts are coalesced at their contacting surfaces by a suitable application of heat and/or pressure. It involves localised coalescence of metals or non-metals produced either by heating the materials to the welding temperature, with or without the application of pressure, or by the application of pressure alone.

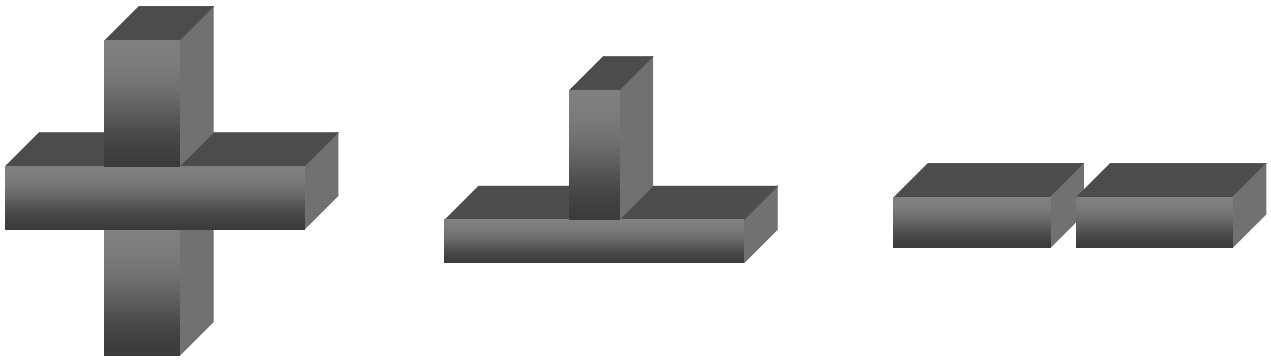
(Welding) JOINTS The junction of members or the edges of members that are to be joined or have been joined.

ARC WELDING refers to a group of welding processes in which heating of the metals is accomplished by an electric arc.

TYPES OF WELDING JOINTS



EDGE **OPEN & CLOSED CORNER**
LAP



CRUCIFORM **TEE** **BUTT**

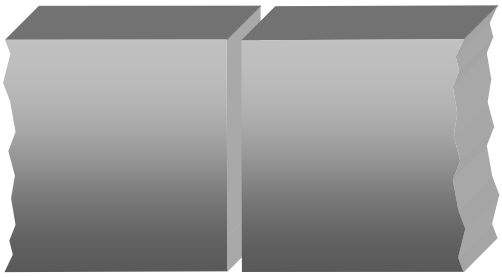
EDGE The parts in an edge joint are parallel with at least one of their edges in common, and the joint is made at the common edge(s)

OPEN/ CLOSED CORNER The parts in a corner joint form a right angle and are joined at the corner of the angle.
CRUCIFORM is a specific joint in which four spaces are created by the welding of three plates of metal at right angles
LAP This joint consists of two overlapping parts.

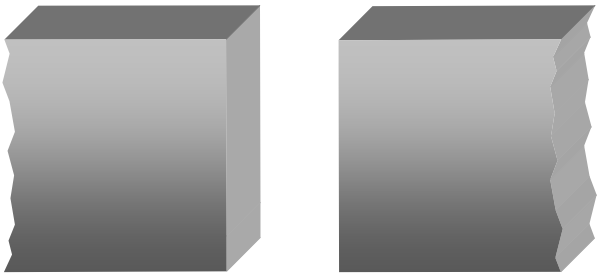
TEE In a tee joint, one part is perpendicular to the other in the approximate shape of the letter "T"

BUTT In this joint type, the parts lie in the same plane and are joined at their edges.

BUTT PREPARATIONS



SQUARE EDGE CLOSED BUTT



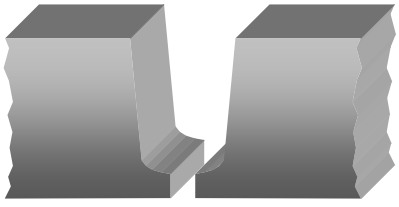
SQUARE EDGE OPEN BUTT

SINGLE SIDED BUTT PREPARATIONS
Single sided preparations are normally made on thinner materials, or when access from both sides is restricted.

SINGLE BEVEL

SINGLE VEE

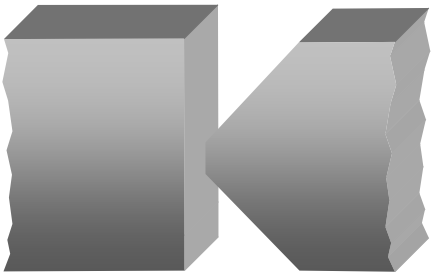
SINGLE "J"



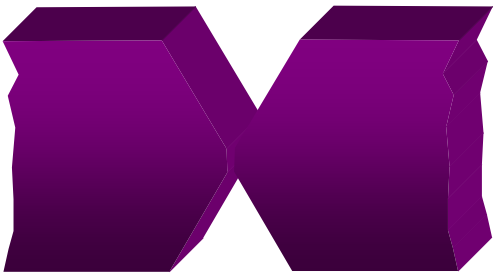
SINGLE "U

DOUBLE SIDED BUTT PREPARATIONS

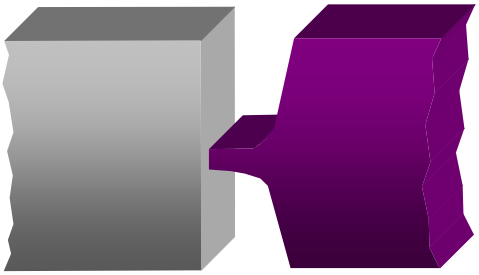
Double sided preparations are normally made on thicker materials, or when access from both sides is unrestricted.



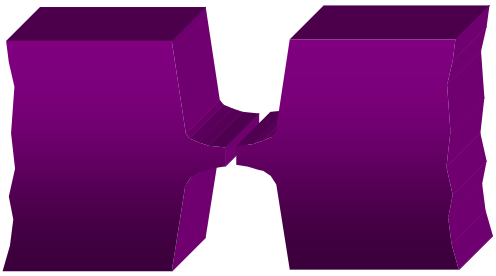
DOUBLE BEVEL



DOUBLE VEE

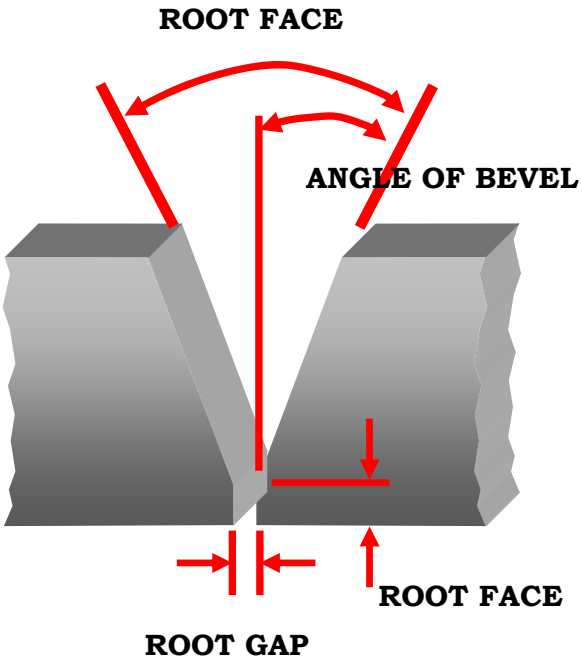


DOUBLE - J

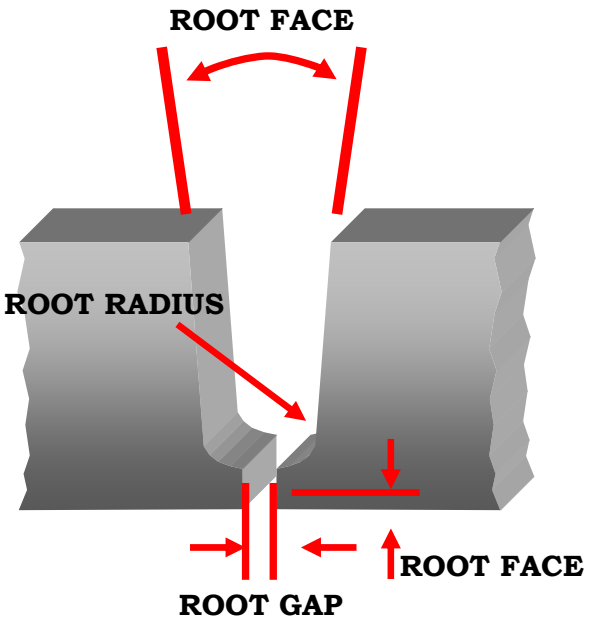


DOUBLE - U

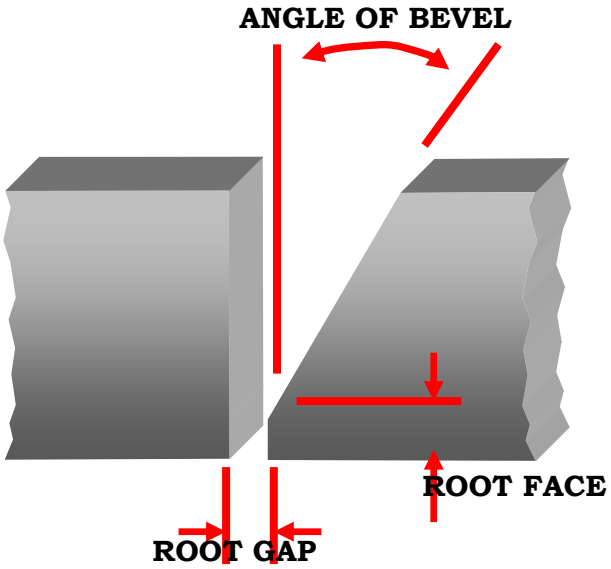
JOINT PREPARATION TERMINOLOGY



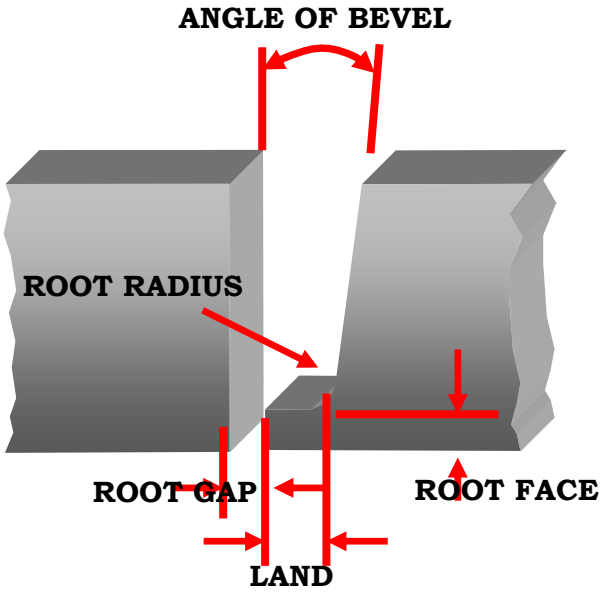
SINGLE – V BUTT



SINGLE – U BUTT



SINGLE BEVEL BUTT

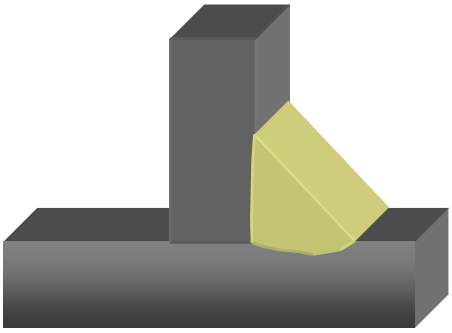


SINGLE BEVEL BUTT

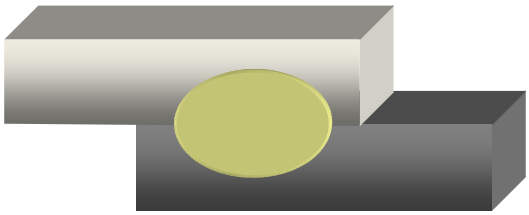
WELD TERMINOLOGY

BUTT WELDING is a welding technique used to connect parts which are nearly parallel and don't overlap.

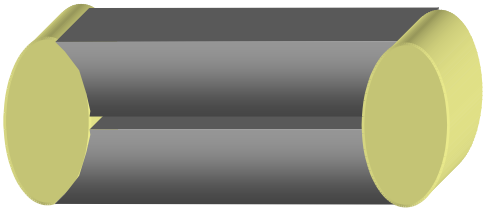
FILLET WELDING refers to the process of joining two pieces of metal together whether they be perpendicular or at an angle.



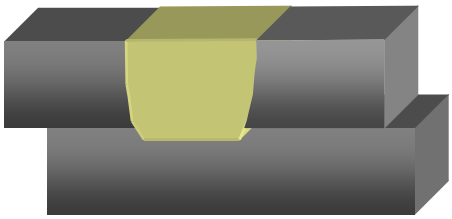
SPOT WELD or TACK welding is a method of joining metals by a number of separate points.



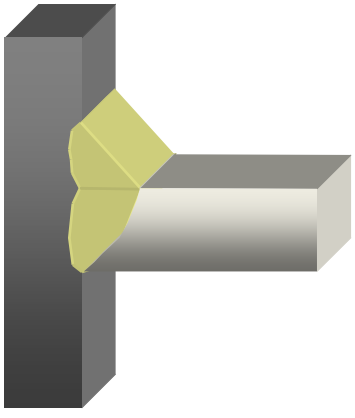
EDGE WELD is a groove type of weld, are placed side by side and welded on the same edge.



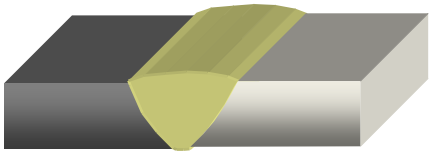
PLUG WELD is used to fasten two pieces of metal together by drilling a hole into the top piece and then laid over the bottom one.



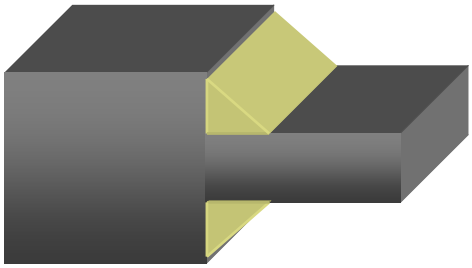
COMPOUND WELD is a single-sided T-butt weld with superimposed fillet weld



WELDED BUTT JOINTS



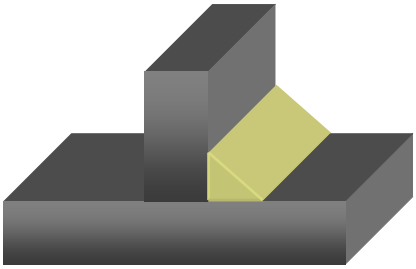
BUTT welded butt joint



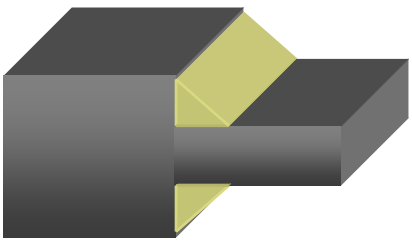
FILLET welded butt joint

COMPOUND welded butt joint

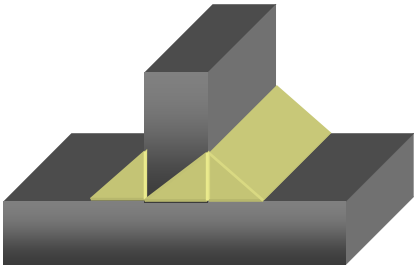
WELDED TEE JOINTS



FILLET welded tee joint



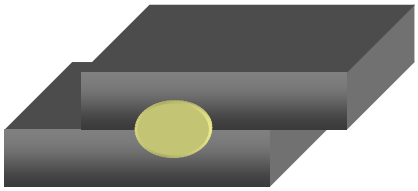
BUTT welded tee joint



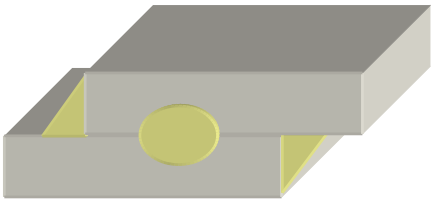
COMPOUND welded tee joint

WELDED LAP JOINTS

FILLET welded lap joints

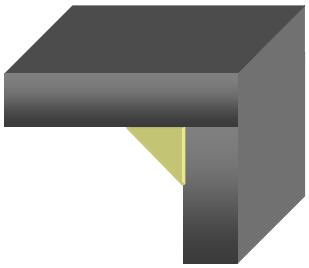


SPOT welded lap joint

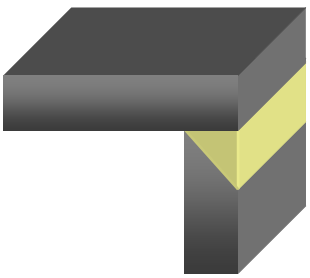


COMPOUND welded lap joint

WELDED CLOSED CORNER JOINTS



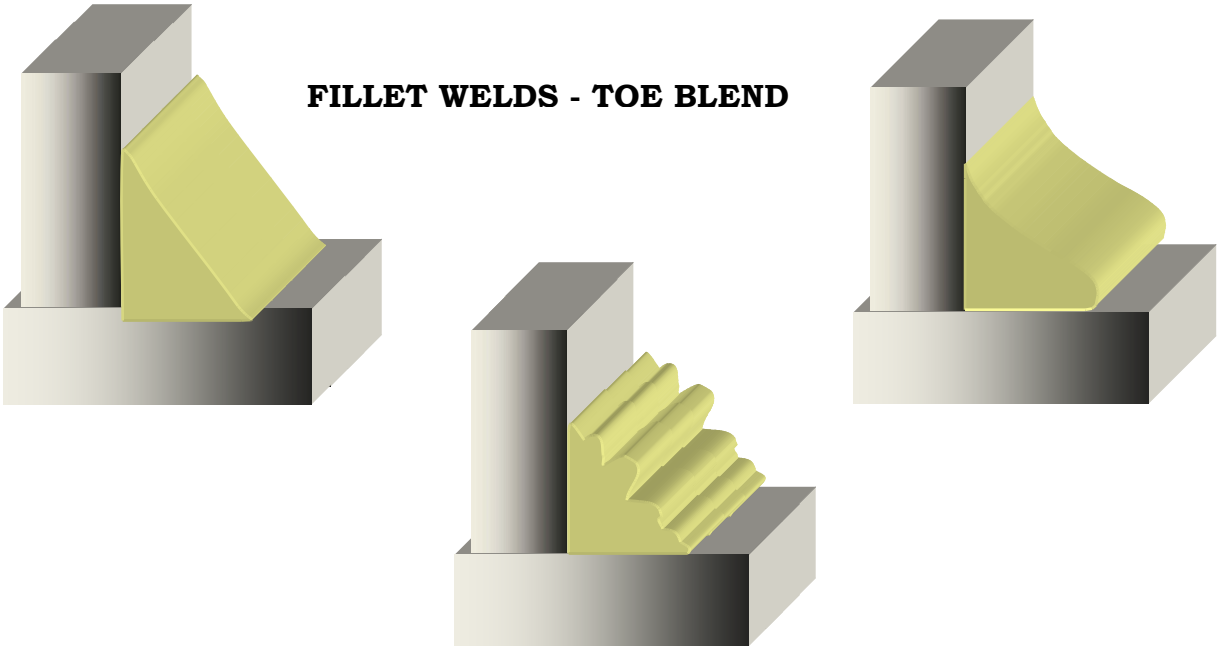
FILLET welded closed corner joints



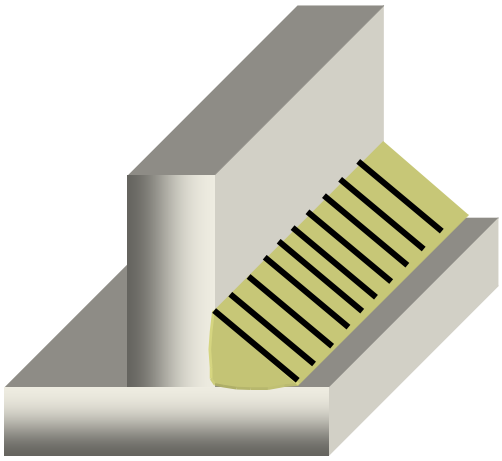
BUTT welded closed corner joints

COMPOUND welded closed corner joints

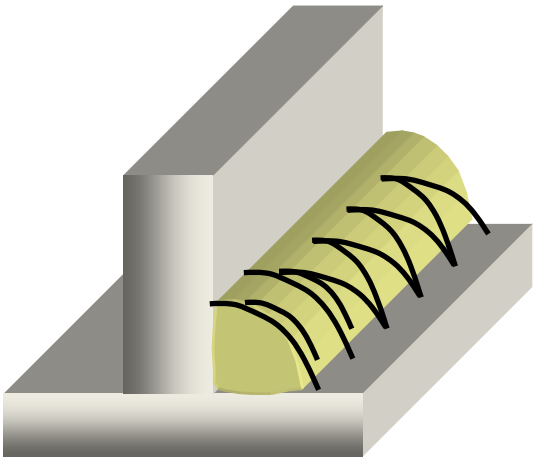
FEATURES TO CONSIDER



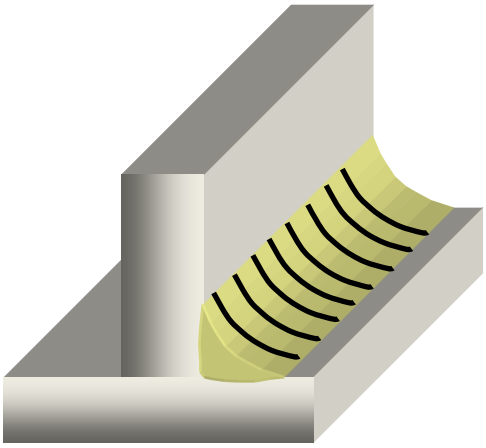
FILLET WELD SHAPES



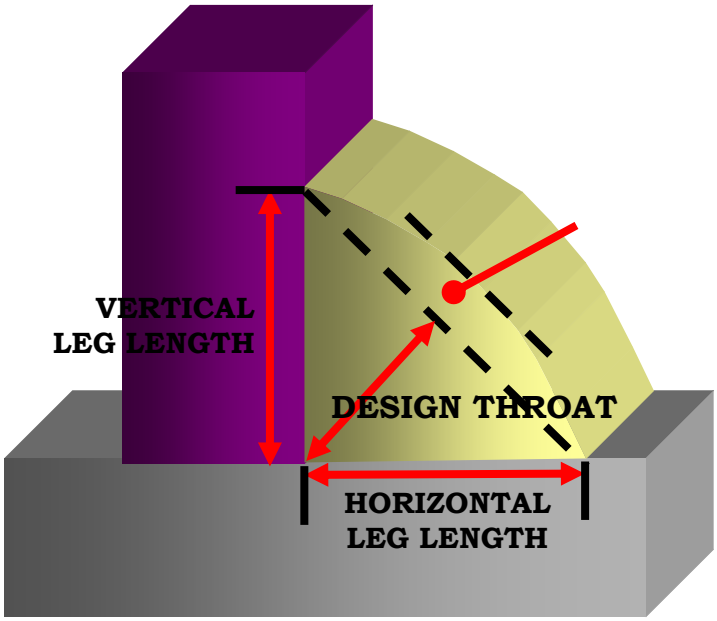
MITER FILLET



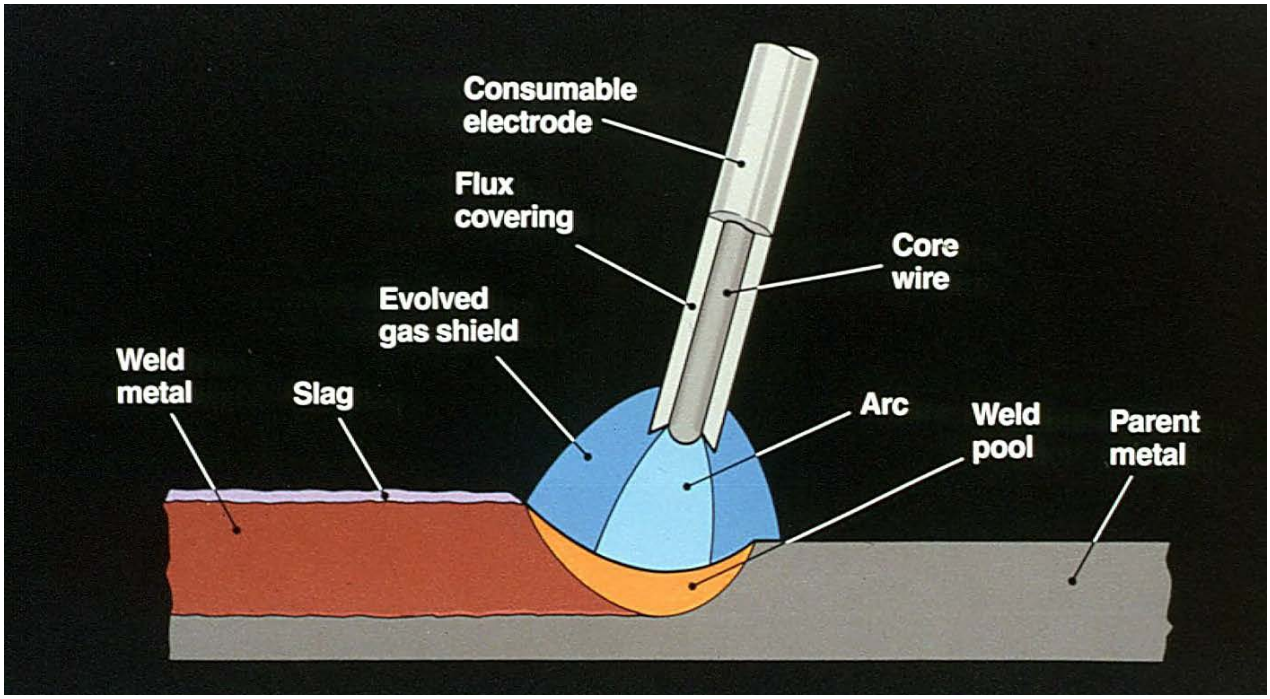
CONVEX FILLET



CONCAVE FILLET


VERTICAL
LEG LENGTH
DESIGN THROAT
HORIZONTAL
LEG LENGTH

PRINCIPLE OF OPERATION



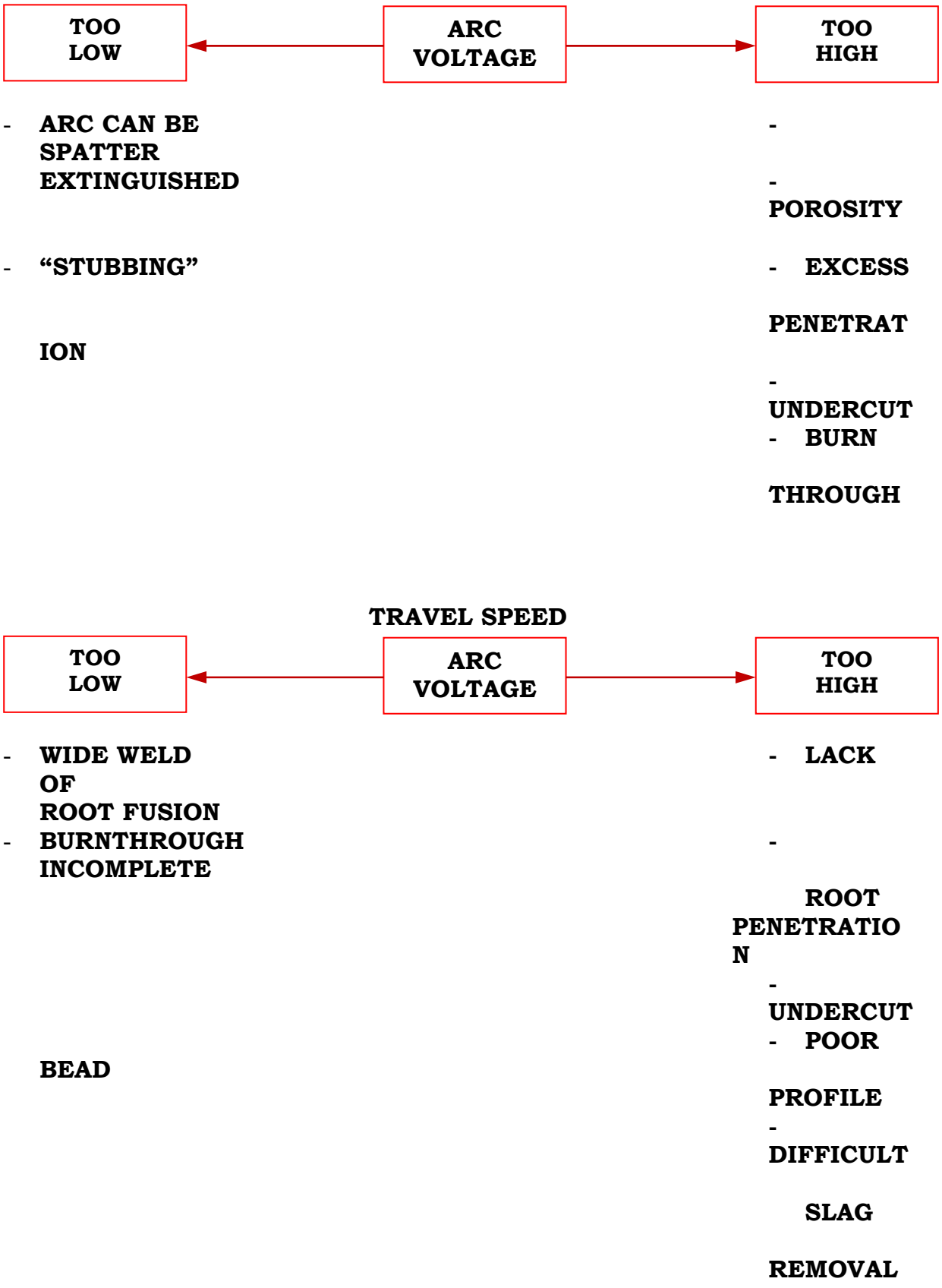
WELDER CONTROLS:

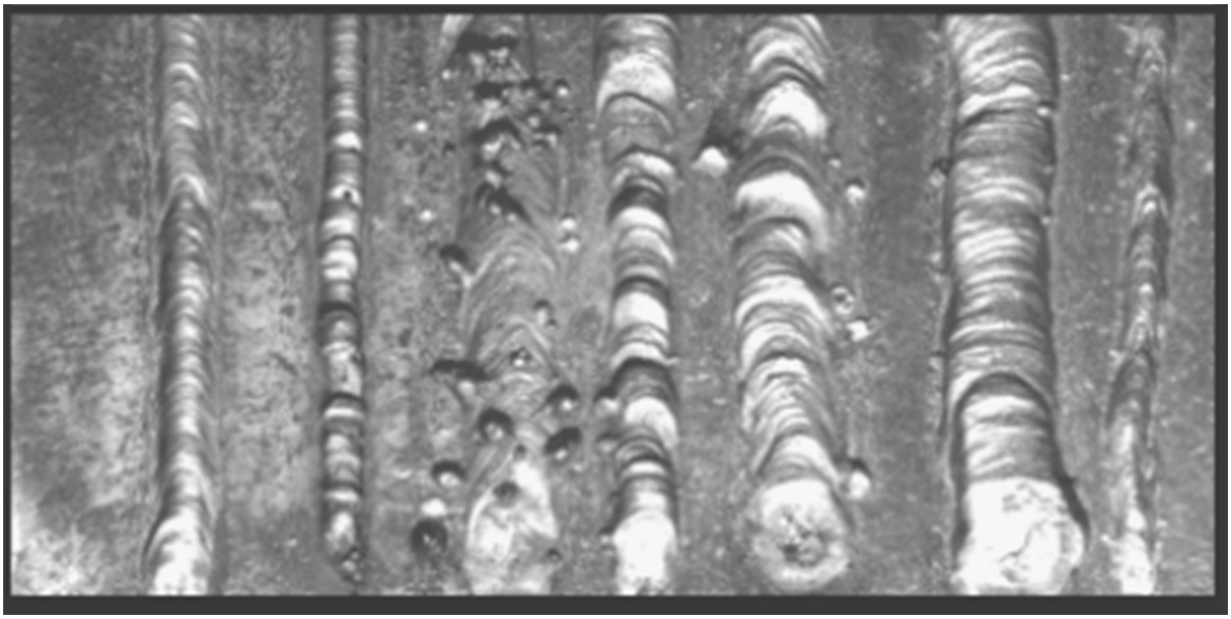
- Arc length
- Angle of electrode
- Speed of travel
- Amperage settings

WELDING PARAMETERS

WELDING CURRENT

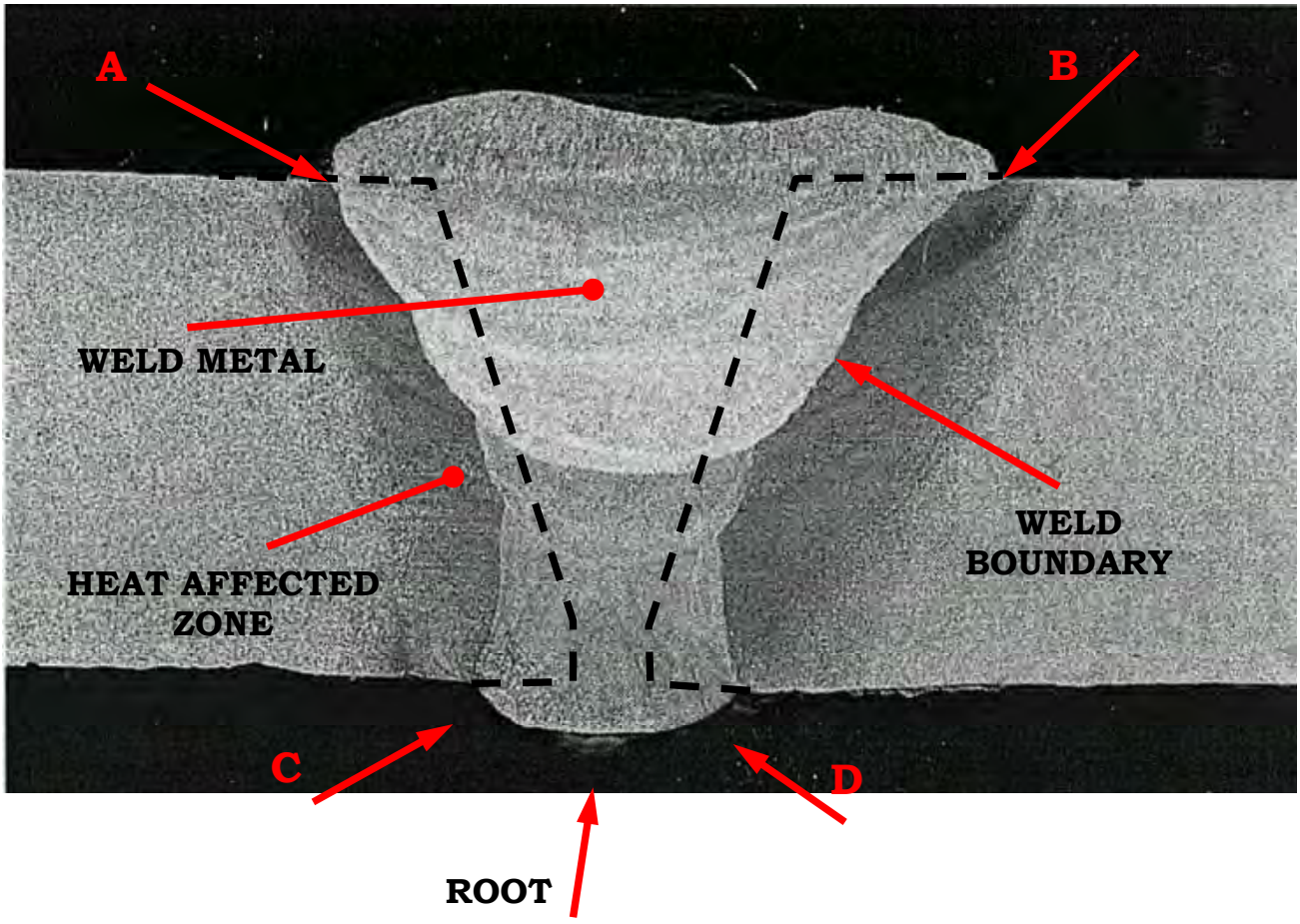
TOO LOW	**WELDING CURRENT**	**TOO HIGH**
- **POOR STARTING SPATTER**		-
- **SLAG INCLUSIONS**		- **EXCESS PENETRATION**
- **WELD BEAD CONTOUR UNDERCUT**	**OF**	- **TOO HIGH**
- **LACK BURN PENETRATION**		**FUSION/ THROUGH**


TOO LOW
ARC VOLTAGE
TOO HIGH
- ARC CAN BE SPATTER EXTINGUISHED
- "STUBBING"
ION
-
- POROSITY
- EXCESS PENETRATION
- UNDERCUT
- BURN THROUGH
TRAVEL SPEED
TOO LOW
ARC VOLTAGE
TOO HIGH
- WIDE WELD OF ROOT FUSION
- BURNTHROUGH INCOMPLETE
BEAD
- LACK
-
ROOT PENETRATION
- UNDERCUT
- POOR PROFILE
- DIFFICULT SLAG REMOVAL

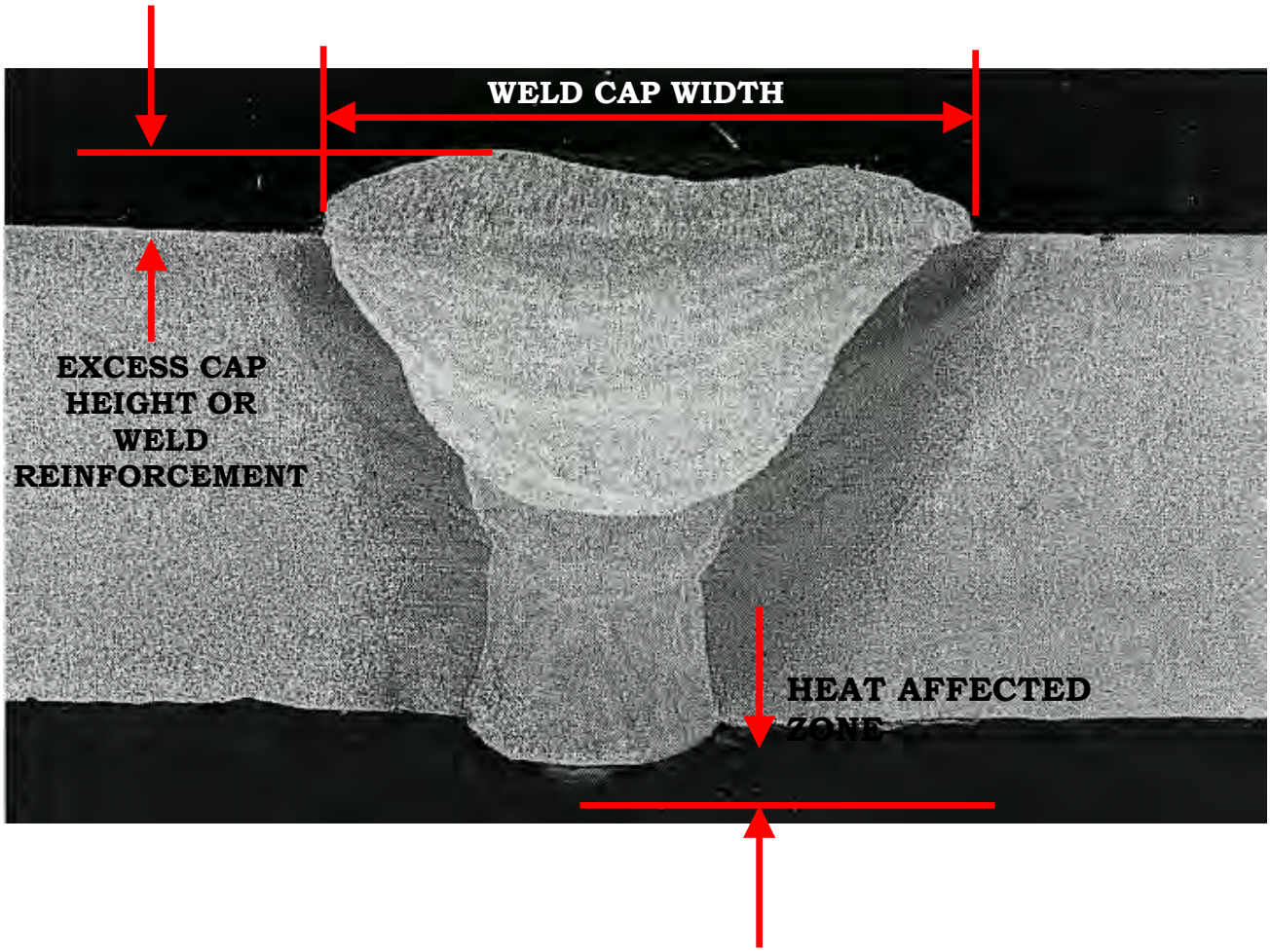


MMA quality (left to right) - CURRENT, ARC LENGTH AND TRAVEL SPEED NORMAL; CURRENT TOO LOW; CURRENT TOO HIGH; ARC LENGTH TOO SHORT; ARC LENGTH TOO LONG; TRAVEL SPEED TOO SLOW; TRAVEL SPEED TOO HIGH

WELD ZONE TERMINOLOGY



A, B, C & D = Weld Toes


WELD CAP WIDTH
EXCESS CAP HEIGHT OR WELD REINFORCEMENT
HEAT AFFECTED ZONE

Information Sheet _____
Welding Defects

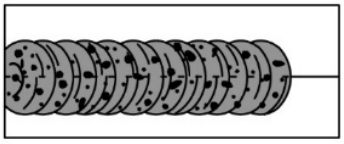
Learning Objectives:

After reading this INFORMATION SHEET, YOU MUST be able to:

1. Familiarize the different types of welding defects.

WELDING DEFECTS

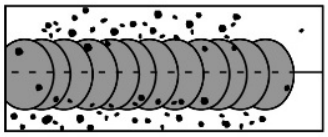
1. POROSITY



Porosity – small cavities or holes resulting from gas pockets in weld metal.

Possible Causes	Corrective Actions
Arc length too long.	Reduce arc length.
Workpiece dirty.	Remove all grease, oil, moisture, rust, paint, coatings, slag, and dirt from work surface before welding.
Damp electrode.	Use dry electrode.

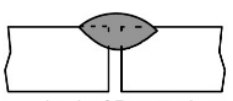
2. EXCESSIVE SPLATTER



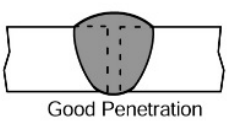
Excessive Spatter – scattering of molten metal particles that cool to solid form near weld bead.

Possible Causes	Corrective Actions
Amperage too high for electrode.	Decrease amperage or select larger electrode.
Arc length too long or voltage too high.	Reduce arc length or voltage.

3. INCOMPLETE FUSION



Lack of Penetration



Good Penetration

Lack Of Penetration – shallow fusion between weld metal and base metal.

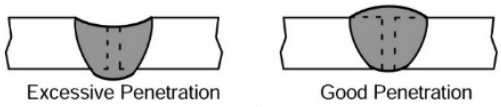
Possible Causes	Corrective Actions
Improper joint preparation.	Material too thick. Joint preparation and design must provide access to bottom of groove.
Improper weld technique.	Keep arc on leading edge of weld puddle. Reduce travel speed.
Insufficient heat input.	Increase amperage. Select larger electrode and increase amperage.

4. LACK OF PENETRATION

Incomplete Fusion – failure of weld metal to fuse completely with base metal or a preceeding weld bead.

Possible Causes	Corrective Actions
Insufficient heat input.	Increase amperage. Select larger electrode and increase amperage.
Improper welding technique.	Place stringer bead in proper location(s) at joint during welding. Adjust work angle or widen groove to access bottom during welding. Momentarily hold arc on groove side walls when using weaving technique. Keep arc on leading edge of weld puddle.
Workpiece dirty.	Remove all grease, oil, moisture, rust, paint, coatings, slag, and dirt from work surface before welding.

5. EXCESSIVE PENETRATION

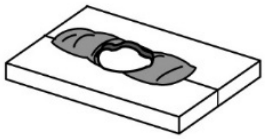


Excessive Penetration – weld metal melting through base metal and hanging underneath weld.

Excessive Penetration Good Penetration

Possible Causes	Corrective Actions
Excessive heat input.	Select lower amperage. Use smaller electrode.
Improper weld technique.	Adjust travel speed.

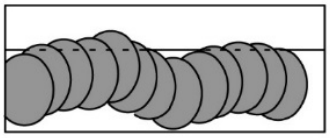
6. BURN THROUGH



Burn-Through – weld metal melting completely through base metal resulting in holes where no metal remains.

Possible Causes	Corrective Actions
Excessive heat input.	Select lower amperage. Use smaller electrode. Increase and/or maintain steady travel speed.

7. WAVINESS OF BEAD



Waviness Of Bead – weld metal that is not parallel and does not cover joint formed by base metal.

Possible Causes	Corrective Actions
Unsteady hand.	Use two hands. Practice technique.

Welding Procedures

Learning Objectives:

After reading this INFORMATION SHEET, YOU MUST be able to:

1. Familiarize the 2 basic welding procedures.

WELDING PROCEDURES

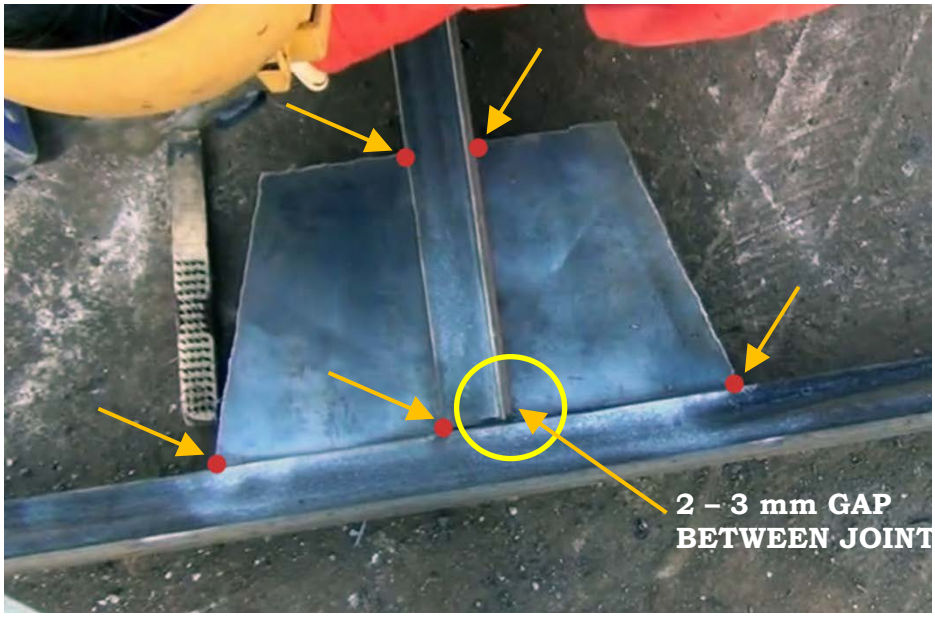
TACK WELDING - refers to a temporary weld used to create the initial joint between two pieces of metal being welded together.

IMPORTANCE OF TACK WELDING:

- Ease of removal in order to correct improper alignment with components you're welding together
- Stabilizes the overall alignment of components you're welding together
- Reduces movement and distortion during the welding process
- Offers temporary joint strength if an object needs to be moved or repositioned during the welding process

TACK WELDING

1. Using a C – Clamp, stabilize the portion of truss for tack welding.
2. Observe a 2 – 3mm gap between members. The gap is to ensure welding penetration between members.
3. If the steel is dirty, use a cap brush to clean the surface.
4. As a safety practice, a welder shall wear a protective suit, safety shoes, glove and google prior to welding activity.
5. Attach an electrode to the holder. Use E6013 for this procedure.
6. Switch ON the welding machine and set the amperage to 110.
7. Start the tack welding procedure, weld only at the edges/ end of the connections.

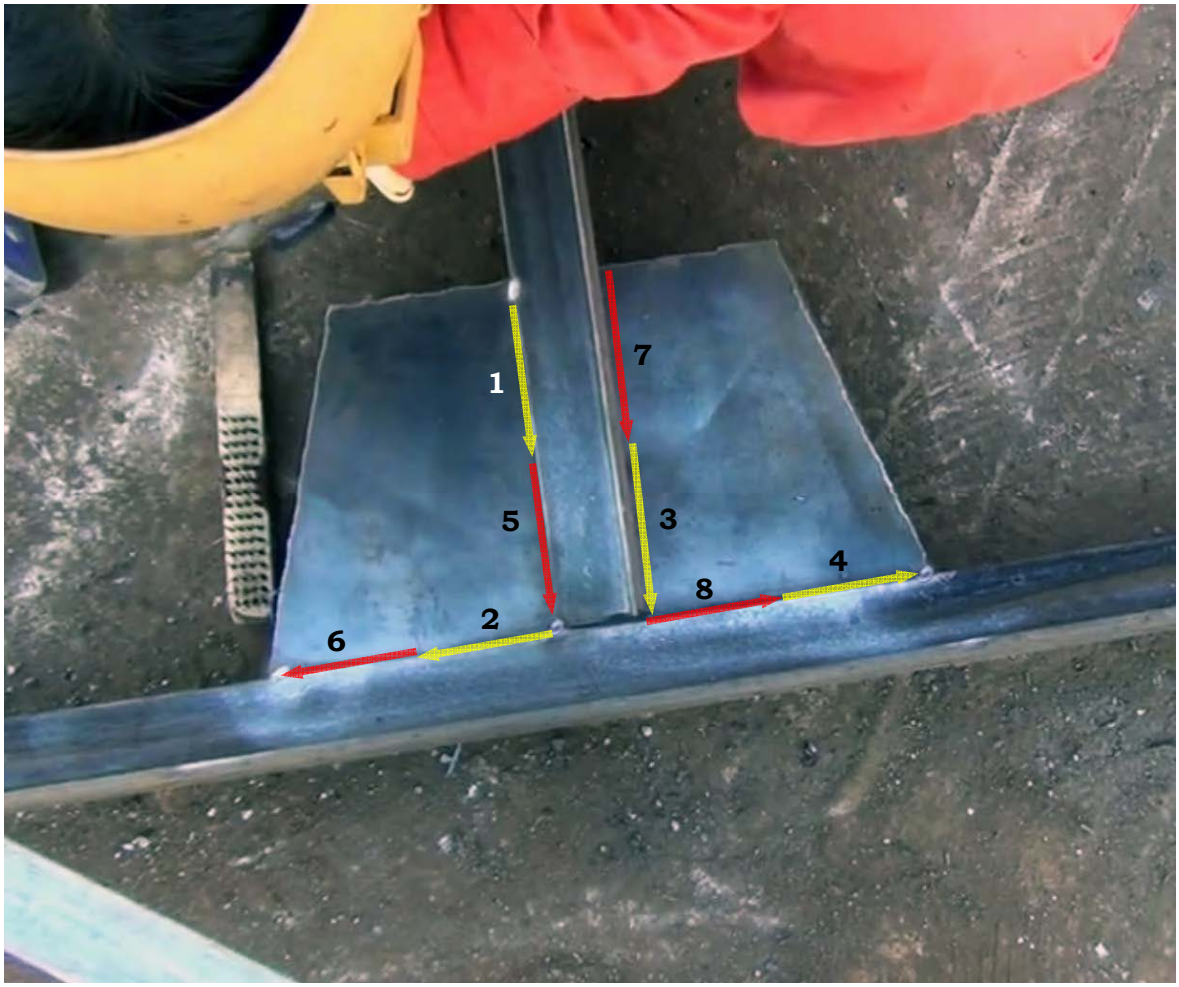


FULL WELDING - refers to a permanent weld used in joining two pieces of metal.

FULL WELDING
After tack/spot welding the joints, a welder usually checks the assembly for misalignment or distortion before welding the joints permanently.

PROCEDURE:

1. Using a cup brush, clean the surface of the metal for some excess slags/ flux or dirt.
2. Attach an electrode to the holder. Use E7018 for this procedure.
3. Switch ON the welding machine and set the amperage to 140.
4. Start full welding procedure. It is advisable to weld the metal by "batch". This is to avoid distortion or warping of steel caused by excessive heat during welding. Use the image below as reference for the sequence in full welding procedure.



5. After the metal cools down, paint the surface with metal primer.

FABRICATION AND ERECTION OF STRUCTURAL STEELWORK

1.0 INTRODUCTION

The steel-framed building derives most of its competitive advantage from the virtues of prefabricated components, which can be assembled speedily at site. Unlike concreting, which is usually a wet process conducted at site, steel is produced and subsequently fabricated within a controlled environment. This ensures high quality, manufacture offsite with improved precision and enhanced speed of construction at site.

The efficiency of fabrication and erection in structural steelwork dictates the success of any project involving steel-intensive construction. Current practices of fabrication and erection of steel structures in India are generally antiquated and inefficient. Perhaps, this inadequate infrastructure for fabrication is unable to support a large growth of steel construction. In India, the fabrication and erection of structural steelwork has been out of the purview of the structural designer. Nevertheless, in the future emerging situation, the entire steel chain, i.e. the producer, client, designer, fabricator and contractor should be able to interact with each other and improve their efficiency and productivity for the success of the project involving structural steelwork. Hence it becomes imperative that structural designers also must acquaint themselves with all the aspects of the structural steel work including the "fabrication and erection," and that is the subject matter of the present chapter to briefly introduce good fabrication and erection practices.

2.0 FABRICATION PROCEDURE

Structural steel fabrication can be carried out in shop or at the construction site. Fabrication of steelwork carried out in shops is precise and of assured quality, whereas field fabrication is comparatively of inferior in quality. In India construction site fabrication is most common even in large projects due to inexpensive field labour, high cost of transportation, difficulty in the transportation of large members, higher excise duty on products from shop. Beneficial taxation for site work is a major financial incentive for site fabrication. The methods followed in site fabrication are similar but the level of sophistication of equipment at site and environmental control would be usually less. The skill of personnel at site also tends to be inferior and hence the quality of finished product tends to be relatively inferior. However, shop fabrication is efficient in terms of cost, time and quality.

Structural steel passes through various operations during the course of its fabrication. Generally, the sequence of activities in fabricating shops is as shown in Table1. The sequence and importance of shop operations will vary depending on the type of fabrication required. All these activities are explained briefly in the subsequent parts of the section.

Table 1: Sequence of activities in fabricating shops

S.No.	Sequence of Operation
1.	Surface cleaning
2.	Cutting and machining
3.	Punching and drilling
4.	Straightening, bending and rolling
5.	Fitting and reaming
6.	Fastening (bolting, riveting and welding)
7.	Finishing
8.	Quality control
9.	Surface treatment
10.	Transportation

2.1 Surface cleaning

Structural sections from the rolling mills may require surface cleaning to remove mill scale prior to fabrication and painting.

Hand preparation, such as wire brushing, does not normally conform to the requirements of modern paint or surface protection system. However in some applications manual cleaning is used and depending on the quality of the cleaned surface they are categorised into Grade St-2 and Grade St-3.

Blast cleaning is the accepted way of carrying out surface preparation in a well-run fabrication shop. Abrasive particles are projected on to the surface of the steel at high speed by either compressed air or centrifugal impeller to remove rust and roughen the surface before applying the coating. By using shot or slag grits, both of which have an angular profile, surface oxides are removed and a rougher surface is obtained to provide an adequate key for metal spraying or special paint. Depending upon the increase in the quality of the cleaned surface, the blast cleaning is categorised into Grade – Sa2, Grade – Sa2½ and Grade Sa- 3.

Flame cleaning is another method of surface cleaning. In this method the surface is cleaned using an oxy-acetylene torch which works on the principle of differential thermal expansion between steel and mill scale. In another method called ‘ the steel piece is immersed in a suitable acid and the scale and rust are removed.

2.2 Cutting and Machining

Following surface preparation, cutting to length is always the first process to be carried out, and this is done by any of the following methods.

2.2.1 Shearing and cropping

Sections can be cut to length or width by cropping or shearing using hydraulic shears. Heavy sections or long plates can be shaped and cut to length by specialist plate shears. For smaller plates and sections, machines featuring a range of shearing knives, which can accept the differing section shapes, are available.

2.2.2 Flame Cutting or Burning

In this method, the steel is heated locally by a pressurised mixture of oxygen and a combustible gas such as propane, which passes through a ring of small holes in a cutting nozzle. The heat is focussed on to a very narrow band and the steel melts at 1500^0 C when a jet of high-pressure oxygen is released through a separate hole in the centre of the nozzle to blast away the molten metal in globules. The desired cuts are obtained quickly by this process. However due to a rapid thermal cycle of heating and cooling, residual stresses and distortion are induced and hence structural sections that are fabricated using flame cutting are treated specially in the design of structural steelwork.

2.2.3 Arc Plasma Cutting

In this method, the cutting energy is produced electrically by heating a gas in an electric arc produced between a tungsten electrode and the workpiece. This ionises the gas, enabling it to conduct an electric current. The high-velocity plasma jet melts the metal of the work piece. The cut produced by plasma jet is very clean and its quality can be improved by using a water injection arc plasma torch. Plasma cutting can be used on thicknesses upto about *150 mm* but the process is very slow.

2.2.4 Cold Sawing

When a section cannot be cut to length by cropping or shearing, then it is normally sawn. All saws for structural applications are mechanical and feature some degree of computer control. There are three forms of mechanical saw - circular, band and hack. The circular saw has a blade rotating in a vertical plane, which can cut either downwards or upwards, though the former is more common. Band saws have less capacity. Sections greater than

600 mm X 600 mm cannot be sawn using band saws. The saw blade is a continuous metal edged, with cutting teeth, which is driven by an electric motor. Hack saws are mechanically driven reciprocating saws. They have normal format blades carried in a heavy duty hack saw frame. They have more productivity than band saws.

2.3 Punching and Drilling

Most fabrication shops have a range of machines, which can form holes for connections in structural steelwork. The traditional drilling machine is the radial drill, a manually operated machine, which drills individual holes in structural steelwork. But this method has become too slow for primary line production. Therefore, larger fabricators have installed NC (Numerically Controlled) tooling, which registers and drills in response to keyed in data. These can drill many holes in flanges and webs of rolled steel sections simultaneously. It is also possible to punch holes, and this is particularly useful where square holes are specified such as anchor plates for foundation bolts. While this method is faster compared to drilling, punching creates distortion and material strain hardening around the holes, which increase with material thickness. Its use is currently restricted to smaller thickness plates. In order to reduce the effect of strain hardening and the consequent reduction in ductility of material around punched holes, smaller size (*2 mm* to *4 mm* lesser than final size) holes are punched and subsequently reamed to the desired size.

2.4 Straightening, Bending and Rolling

Rolled steel may get distorted after rolling due to cooling process. Further during transportation and handling operations, materials may bend or may even undergo distortion. This may also occur during punching operation. Therefore before attempting further fabrication the material should be straightened. In current practice, either rolls or gag presses are used to straighten structural shapes.

Gag press is generally used for straightening beams, channels, angles, and heavy bars. This machine has a horizontal plunger or ram that applies pressure at points along the bend to bring it into alignment. Long plates, which are cambered out of alignment longitudinally, are frequently straightened by rollers. They are passed through a series of rollers that bend them back and forth with progressively diminishing deformation.

Misalignments in structural shapes are sometimes corrected by spot or pattern heating. When heat is applied to a small area of steel, the larger unheated portion of the surrounding material prevents expansion. Upon cooling, the subsequent shrinkage produces a shortening of the member, thus pulling it back into alignment. This method is commonly employed to remove buckles in girder webs between stiffeners and to straighten members.

It is frequently used to produce camber in rolled beams. A press brake is used to form angular bends in wide sheets and plates to produce cold formed steel members.

2.5 Fitting and Reaming

Before final assembly, the component parts of a member are fitted-up temporarily with rivets, bolts or small amount of welds. The fitting-up operation includes attachment of previously omitted splice plates and other fittings and the correction of minor defects found by the inspector.

In riveted or bolted work, especially when done manually, some holes in the connecting material may not always be in perfect alignment and small amount of reaming may be required to permit insertion of fasteners. In this operation, the holes are punched, *4 to 6 mm* smaller than final size, then after the pieces are assembled, the holes are reamed by electric or pneumatic reamers to the correct diameter, to produce well matched holes.

2.6 Fastening Methods

The strength of the entire structure depends upon the proper use of fastening methods. There are three methods of fastening namely bolting, riveting and welding. A few decades back, it was a common practice to assemble components in the workshop using bolts or rivets. Nowadays welding is the most common method of shop fabrication of steel structures. In addition to being simple to fabricate, welded connection considerably reduce the size of the joint and the additional fixtures and plates. However, there is still a demand for structural members to be bolted arising from a requirement to avoid welding because of the service conditions of the member under consideration. These may be low temperature performance criteria, the need to avoid welding stresses and distortion or the requirement for the component to be taken apart during service e.g. bolts in crane rails or bolted crane rails.

2.7 Finishing

Structural members whose ends must transmit loads by bearing against one another are usually finished to a smooth even surface. Finishing is performed by sawing, milling or other suitable means. Several types of sawing machines are available, which produce very satisfactory finished cuts. One type of milling machine employs a movable head fitted with one or more high-speed carbide tipped rotary cutters. The head moves over a bed, which securely holds the work piece in proper alignment during finishing operation.

Bridge specifications require that sheared edges of plates over a certain thickness be edge planed. This is done to remove jagged flame cut edges and the residual stresses at the edges. In this operation, the plate is clamped to the bed of milling machine or a planer. The cutting head moves along the edge of the plate, planing it to a neat and smooth finish.

The term finish or mill is used on detail drawings to describe any operation that requires steel to be finished to a smooth even surface by milling, planing, sawing or other machines.

2.8 Surface Treatment

Structural steelwork is protected against corrosion by applying metal or paint coating in the shop or at site.

2.8.1 Metal Coatings

The corrosion protection afforded by metallic coating largely depends upon the surface preparation, the choice of coating and its thickness. It is not greatly influenced by the method of application. Commonly used methods of applying metal coating to steel surfaces are hot-dip galvanising, metal spraying, and electroplating. Electroplating is generally used for fittings and other small items.

Galvanising is the most common method of applying a metal coating to structural steelwork. In this method, the cleaned and fluxed steel is dipped in molten zinc at a temperature of about 450^0C. The steel reacts with molten zinc to form a series of zinc or iron alloys on its surface. As the steel workpiece is removed, a layer of relatively pure zinc is deposited on top of the alloy layers. For most applications galvanised steel does not require painting.

An alternative method of applying metallic coating to structural steelwork is by metal spraying of either zinc or aluminium. The metal, in powder or wire form, is fed through a special spray gun containing a heat source, which can be either an oxy-gas flame or an electric arc. Molten globules of the metal are blown by a compressive jet on to the previously blast cleaned steel surface. No alloying occurs and the coating, which is produced, consists of porous overlapping platelets of metal. The pores are subsequently sealed, either by applying a thin organic coating which soaks into the surface, or by allowing the metal coating to weather, when corrosion products block the pores.

2.8.2 Paint Coatings

Painting is the principal method of protecting structural steelwork from corrosion. Paints are usually applied one coat on top of another, each coat having a specific function or use.

The primer is applied directly on to the cleaned steel surface. Its purpose is to wet the surface and to provide good adhesion for subsequently applied coats. Primers for steel surfaces are also usually required to provide corrosion inhibition. They are usually classified according to the main corrosion-inhibitive pigments used in their formulation, e.g. zinc phosphate, zinc chromate, red lead, and metallic-zinc. Each of these inhibitive pigments can be incorporated into a range of binder resins e.g. zinc phosphate alkyd primers, zinc phosphate epoxy primers, zinc phosphate chlorinated-rubber primers.

The intermediate coats (or undercoats) are applied to build the total film thickness of the system. This may involve application of several coats. The finishing coats provide the first-line defence against the environment and also determine the final appearance in terms of gloss, colour etc. They also provide UV protection in exposed condition. Intermediate coats and finishing coats are usually classified according to their binders, e.g. vinyl finishes, urethane finishes.

The various superimposed coats within a painting system have, of course, to be compatible with one another. They may be all of the same generic type or may be different, e.g. chlor-rubber base intermediate coats that form a film by solvent evaporation and no oxidative process, may be applied on to an epoxy primer that forms a film by an oxidative process which involves absorption of oxygen from the atmosphere. However, as a first precaution, all paints within a system should normally be obtained from the same manufacturer. The reader may refer to *IS:487(1985)* to know more about the surface treatment using paints.

Detailed treatment of corrosion protection systems will be found in the Chapter on 'Corrosion, fire protection and fatigue considerations of steel

2.9 Welded connections

Welding is used extensively for joining metals together and there is no doubt that it has been a most significant factor in the phenomenal growth of many industries. The different terminology used in welds are explained in *IS:812(1957).*

A welded joint is made by fusing (melting) the steel plates or sections along the line of joint. The metal melted from each member of the joint unites in a pool of molten metal, which bridges the interface. As the pool cools, molten

metal at the fusion boundary solidifies, forming a solid bond with the parent metal. When solidification completes, there is a continuity of metal through the joint.

There are five welding process regularly employed namely:

(i) Shielded Metal Arc Welding (SMAW)
(ii) Submerged-Arc Welding (SAW)
(iii) Manual Metal-Arc welding (MMA)
(iv) Metal-Active Gas welding (MAG)
(v) Stud welding

All these methods of welding has been described with illustrations, in the chapter on 'Welds - Static and Fatigue Strength - I'. Nevertheless, for the sake of completeness, these methods are briefly enumerated below.

2.9.1 Methods of welding

(1) Shielded Metal Arc Welding (SMAW)

This is basically a semi-automated or fully automated welding procedure. The type of welding electrode used would decide the weld properties. Since this welding is carried out under controlled condition, the weld quality is normally good.

(2) Submerged-Arc welding (SAW)

This is fully mechanised process in which the welding head is moved along the joint by a gantry, boom or tractor. The electrode is a bare wire, which is advanced by a motor. Here again, since the welding is carried out in controlled conditions, better quality welds are obtained.

(3) Manual Metal-Arc welding (MMA)

This is the most widely used arc welding process and appears to be advantageous for labour intensive Indian construction practices. As it is manually operated it requires considerable skill to produce good quality welds. Hence in the case of MMA, stringent quality control and quality assurance procedures are needed. In India, the Welding Research Institute, BHEL, Trichy, Tamil Nadu, conducts periodical courses for welders and weld inspection personnel. Welders who are employed in actual fabrication are, infact, graded according to their training and skills acquired.

(4) Metal-Active Gas welding (MAG)

This process is sometimes referred to as Metal-Inert Gas (MIG) welding. It is also manually operated. A gas that does not react with molten steel shields the arc and the weld pool. This protection ensures that a sound weld is produced free from contamination-induced cracks and porosity. Nevertheless, this procedure also depends on the skills of the welder.

(5) Stud welding

This is an arc welding process and is extensively used for fixing stud shear connectors to beam in the composite construction. The equipment consists of gun hand tool (Fig.1(a) and 1(b)), D.C. power source, auxiliary contractor and controller. The stud is mounted into the chuck of the hand tool and conical tip of the stud is held in contact with the work piece by the pressure of a spring on the chuck. As soon as the current is switched on, the stud is moved away automatically to establish an arc. When a weld pool has been formed and the end of the stud is melted the latter is automatically forced into the steel plate and the current is switched off. The molten metal, which is expelled from the interface, is formed into a fillet by a ceramic collar or ferrule, which is placed around the stud at the beginning of the operation. The ferrule also provides sufficient protection against atmospheric contamination (Figs. 1(a) and 1(b)).

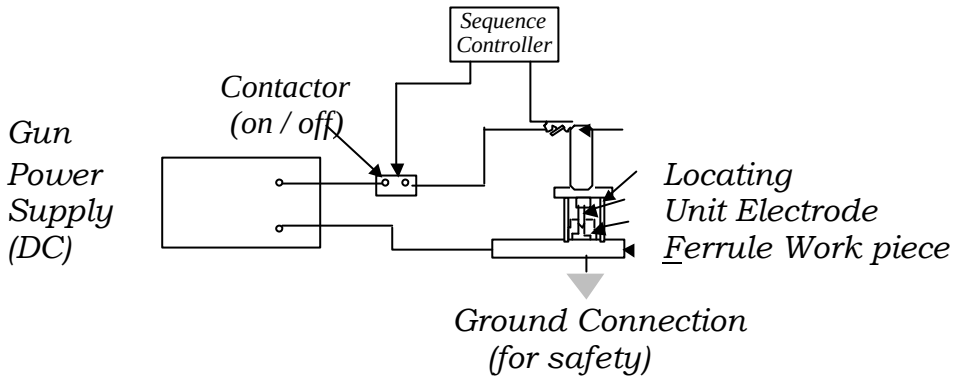
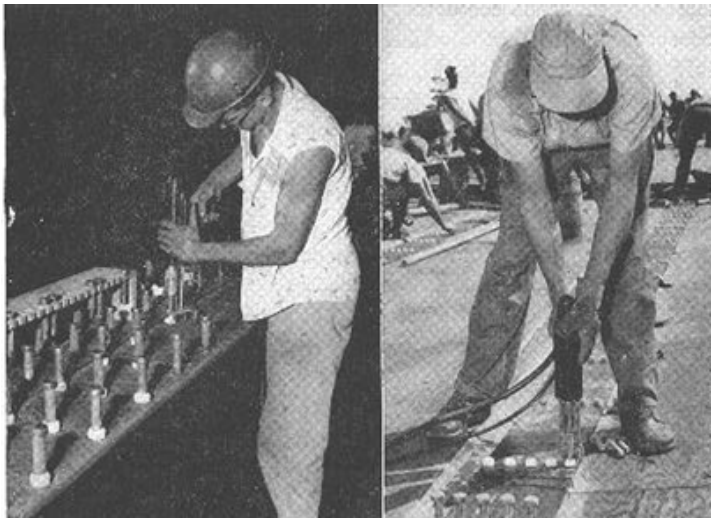


Fig 1(a): Stud Welding (Schematic Diagram)

This process offers an accurate and fast method for attaching shear connectors, etc with the minimum distortion. While it requires some skill to set up the weld parameters (voltage, current, arc time and force), the operation of equipment is relatively straight forward.



(a) Shop welding (b) Site welding

Fig.1 (b) Stud Welding on composite beam

3.0 RESIDUAL WELDING STRESSES AND DISTORTION

3.1 Residual welding stresses

When a weld such as a butt weld is completed and begins to cool the hot weld and parent metal contracts longitudinally. The surrounding cold parent metal resists this contraction so that the weld is subjected to a tensile stress. This is balanced by the compressive stresses induced in the cold regions of the parent plate. These self-equilibrating forces introduce residual stresses both in the longitudinal and transverse direction. These stresses can even reach yield stress. Hence, the fabricator should adopt good fabrication practices that reduce the detrimental effect of residual stresses.

3.2 Residual distortions due to welding

3.2.1 Butt welds

Fig. 2 shows a typical angular rotation of the plates due to a single V butt weld. This occurs because the major part of the weld is to one side of the neutral axis of the plate. This induces greater contractile stresses on that side. A double V or double U butt weld preparation reduces this distortion.

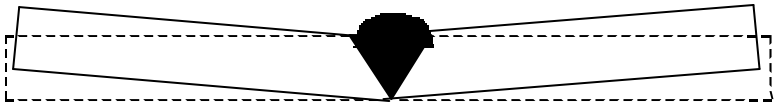


Fig 2: Angular distortion of butt weld

The welding sequence for double preparation has an important influence on the resultant distortion. If a few weld runs are first made on one side, and the plate turned over and then the same number of runs are made on the second side (i.e., sequential welding), a 'balanced' weld will be produced with little distortion. This will not, of course, be possible in situations where rotation of the plate is impracticable such as a plate, which is part of a large fabrication.

One aspect of butt-welding that should be noted is where back gouging is necessary to produce a full penetration weld. This can lead to distortion because the back gouging will produce bigger weld on the second side about the neutral axis of the plate. Such distortion can be reduced using an unsymmetrical weld section. Single V butt welds may produce cusping as shown in Fig.3 if the overall plate is restrained. This can be reduced by using a double V butt weld.

Fig 3: Cusping due to transverse butt weld

3.2.2 Fillet welds

In single and double fillets, shrinkage across the throat area can lead to distortion as shown in Fig.4. The distortion caused by a double fillet weld is important in box or plate

girder webs where stiffeners are attached to only one side of the web. The use of a thicker plate can reduce the fillet weld angular distortion due to increased stiffness.

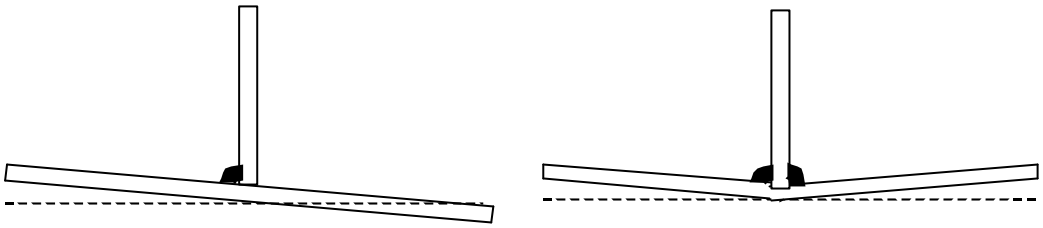
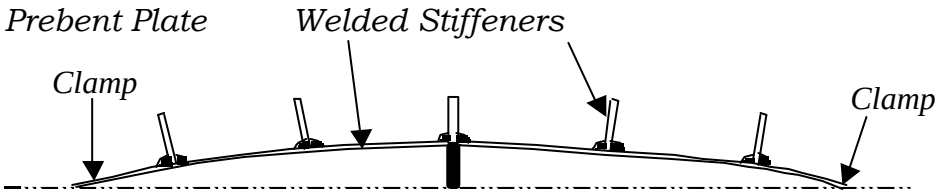


Fig 4: Angular distortion of fillet welds

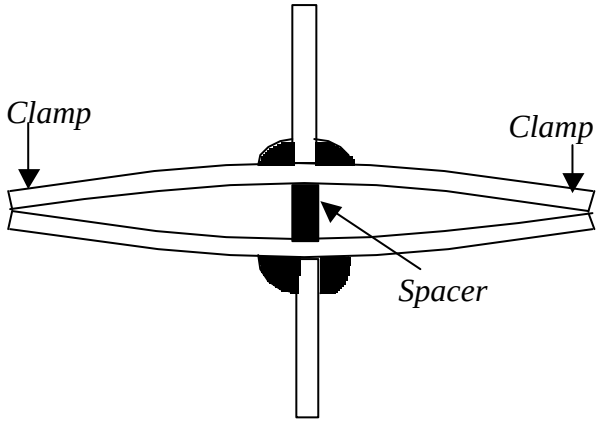
3.3 Control of distortion

Some distortion from welding is due to transverse and longitudinal contraction of weldments. Adopting suitable methods that can resist contraction can control the distortion. Weld distortion of a flat plate with a series of stiffeners on one side can be countered by elastically prebending the plates. In a similar manner two T sections can be welded, prebent back to back, to prevent final curvature in the web plate. Presetting the flange

plate at an angle initially as shown in Fig.5 and Fig.6 may reduce the angular rotation due to a single fillet.



(a) Prebent Plate Spacer



(b) Prebent T's

Fig 5: Prebending

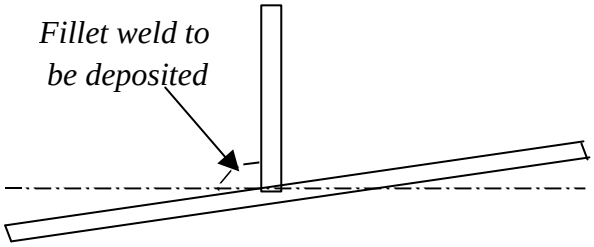


Fig 6: Preset for fillet weld

Sometimes both presetting and prebending may be required, e.g. in plate girder fabrication where the web to flange welds are made automatically. When the welds are made manually, it is customary to put the stiffeners into the girder before the web/flange welds are made; in this way the square profile of the web to flange is maintained. Where automatic welding is employed the stiffeners cannot be put first since they would impede the progress of the automatic machine; in this presetting of the flange plates may be required. Welding should preferably be started at the centre of the fabrication and all succeeding welds from the centre outwards. This allows contraction to occur in the free condition. If the welding sequence is not chosen correctly, locked up stresses at either end of a welded portion can lead to uncorrectable distortions.

Restraint procedure to reduce the effect of weld distortion should be carefully planned otherwise it can lead to solidification cracking.

3.4 Methods of correcting distortion

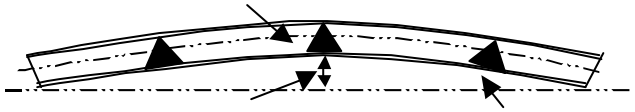
In general, there are two methods available to correct distortion namely:

(a) applying force and (b) heating

Light sections can be corrected by applying force such as by hydraulic presses and local jacking or wedging. While heavier structures will require heating to apply stresses to reduce or eliminate the distortion. The effect of heating is similar to that of welding in which distortion results from the induced stresses. An area of steelwork will expand when heated but this expansion will be constrained by the surrounding cold unheated area, causing a plastic upset. On cooling, the area contracts and the element then becomes shorter, this principle can be used to correct or induce any curvature. The heat must be evenly applied right through the material, if not, unwanted curvature may occur in the plan of the section. Fig.*7* shows some of the methods to induce and correct distortion. Fig.*7(c)* shows how it can be applied to a H section in which a camber is required. Rectangular heating across the bottom flange will shorten it compared with the top flange and hence induce camber. Since the shortening of the flange in the heated areas may tend to buckle the web adjacent to the flange, the heat is also applied to the web in a triangular manner such that the most affected part of the web contracts with the flange. In a similar manner a cambered plate may be straightened by applying triangular heating with the bases of the triangles parallel to the plate edges to be shortened. When the plate cools the heated edge will shorten and so reduce the camber. For panels in box girder webs, spot heating as shown in Fig.*7(d)* may be employed to reduce the concavity produced by the welding around the panel perimeter. Each spot contracts on cooling and induces a local plate shrinkage within the panel boundary and so reduces the dish. If the heat applied and the web panel thickness are such that there is a large temperature difference between the surfaces of the plate at each spot heat, then the resultant contraction on the hotter surface will produce a greater correction of the dish.

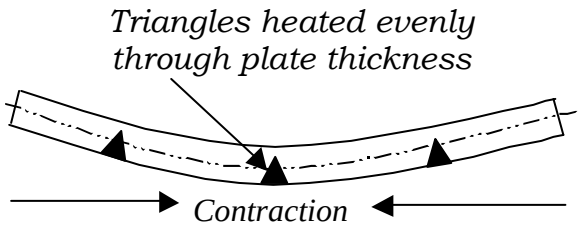
Triangular heat

across the web

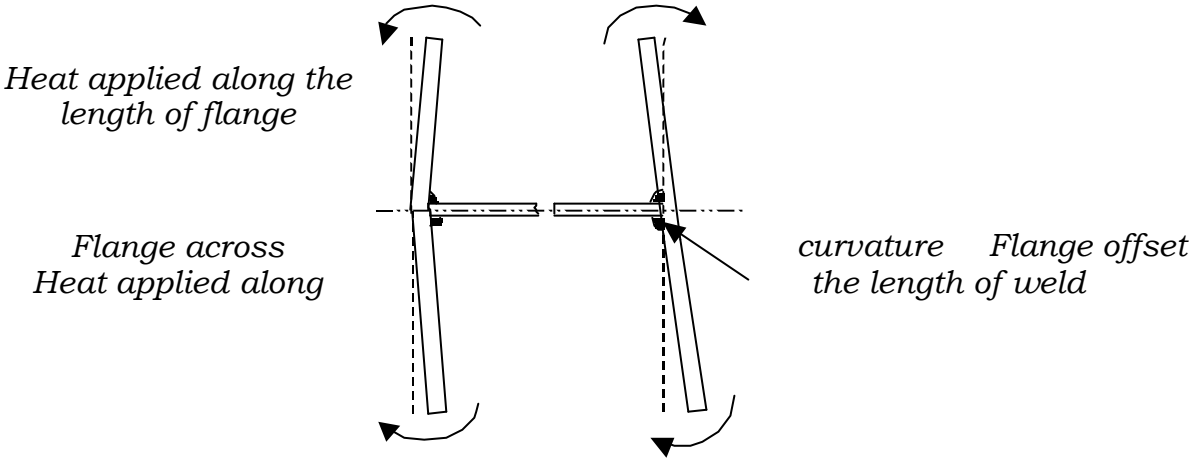


Camber induced Rectangular heat input by heating across flange

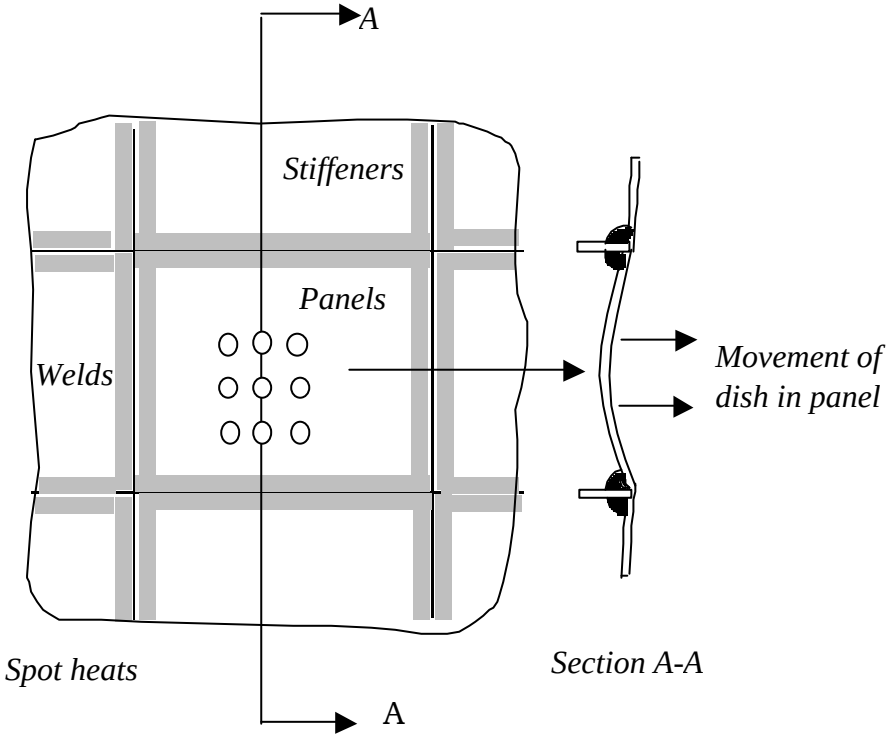
7(a) Camber of beam by heating



7(b) Cambered Plate



7(c) Distorted flanges



7(d) Spot Heating of dished Panel

Fig 7. Methods of correction of distortion

3.5 Defects in welds

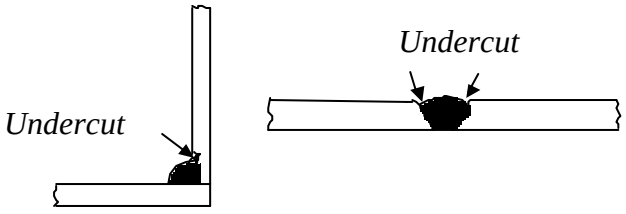
Faulty welding procedure can lead to defects in the welds, thereby reducing the strength of the weld.

Fig.*8* shows some of the common defects in welds. Some of these are:

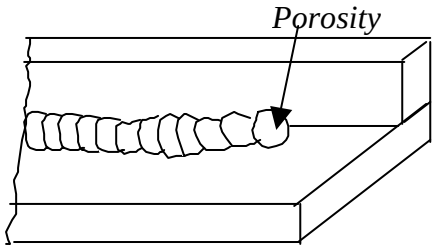
(i) Undercut
(ii) Porosity
(iii) Incomplete Penetration
(iv) Lack of side wall fusion
(v) Slag inclusions
(vi) cracks

All these weld defects are discussed in the chapter on 'Weld – Static and Fatigue strength – I'. It should be emphasised that a 'theoretical 100% error free' weld is not achievable in practice. While good quality welds are the priority of welders and weld inspectors, minor defects do normally creep in. Hence these defects are assessed during a weld inspection.

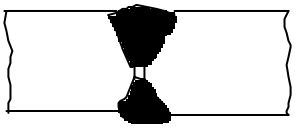
If the defects are within acceptable limits, they are accepted. If not, alternative measures of rectification may have to be carried out. Table *2* shows nature of some of the defects and their acceptability limits.



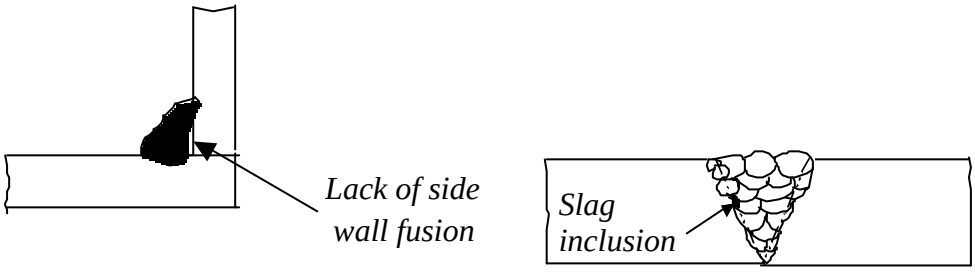
(a) *Undercut*



(b) *Porosity*



(c) Lack of Penetration



(d) Lack of side wall *(e) Slag inclusion fusion*

Fig. 8: Defects in welds

Table 2: Nature of defects and their acceptability limits.

Nature of Defect	Acceptance Norms	Disposition
1. Crack, Lack of Fusion	Not accepted	Confirm by Magnetic Particle Inspection, repair and retest.
2. Crater	Not accepted	Fill by weld deposit.
3. Undercut	Upto *0.8 mm* accepted	Fill and grind smooth.
4. Porosity for butt or fillet welds	One pore of dia. < *2.4 mm* every *100 mm* length is permitted. However pores of dia. > *2.4 mm* not accepted	To be repaired.

4.0 QUALITY CONTROL IN FABRICATION

Quality assurance during fabrication assumes utmost importance in ensuring that the completed structure behaves in the manner envisaged during design stage. Any deviation from these design considerations as reflected in detail drawings may introduce additional stresses to the structure and affect its strength and durability. This section discusses the relevant aspects in fabrication and erection, which need to be considered to achieve the desired quality.

4.1 Fabrication

A fabricator's work starts from the point of procurement of raw materials including fasteners and ends with the dispatch of the fabricated items to site for erection.

In order to ensure that the fabrication can be carried out in accordance with the drawings, it is necessary that inspection and checking is carried out in accordance with an agreed Quality Assurance Plan (QAP). The plan should elaborate on checks and inspections of the raw materials and also of the components as they are fabricated, joined etc.

During the last two decades, fabrication activities have increased steadily in yards adjacent to work. In the absence of controlled environment (as in an organised workshop), the quality of workmanship of such fabrication is likely to suffer. It has, therefore, become all the more important to motivate the fabricators to appreciate the usefulness of Quality Assurance Plans and introduce the system in all their works and at site as well.

4.1.1 Imperfections in Fabrication

Structural steelwork cannot be fabricated to exact dimensions and some degree of imperfection is bound to occur during fabrication process. The limits of various imperfections are spelt out in the specifications. In the design, these are accounted by adopting a factor of safety for material. However, in some components an increase of imperfection beyond these limits may lead to reduction in the strength and durability of the structure e.g., imperfections on the straightness of the individual flanges of a rolled beam or a fabricated girder results in the reduction of strength of the girder due to lateral torsional buckling which may cause an overall bow in the girder. This, in turn, may generate twisting moments at the supports.

As a rule all columns and struts should be checked for straightness on completion of fabrication. Also, all rolled and fabricated girders should be checked over a distance in the longitudinal direction equal to the depth of the section in the region and points of concentrated load.

4.1.2 Making holes

Excessive cold working of structural steel can cause reduction in ductility, embrittlement and cracking. Punching holes is a cold-working operation and can, therefore, cause brittle fracture. This becomes critical for the durability of structures subjected to fluctuation of stresses such as railway bridges and crane girders. Under cyclic loading fatigue cracks can initiate from such punched holes. In such cases, holes for bolts may be formed either by drilling or by punching undersize holes followed by reaming to

desired size. Drilling is preferable to punching, because it reduces the chances of brittle fracture. Studies show that punching may produce short cracks extending radially from the hole, thereby enhancing the possibility of initiating brittle fracture at the hole when the member is loaded. Even in statically loaded structures the maximum thickness of plates in which holes can be punched is restricted.

4.1.3 Shop assembly and camber check

For important structures particularly for bridges, it is necessary to have the fabricated units temporarily assembled at the place of fabrication before these are dispatched to site for erection. During this operation, the overall dimensions of the structure including alignment, squareness, camber etc. should be confirmed. Inadequate or erroneous camber, in fact, introduces huge secondary stresses in the members instead of eliminating these as originally desired. Shop assembly also ensures that the open holes drilled in various units are within tolerable limits.

4.1.4 Welded joints

As presented in the previous sections, welded joints are very important as far as the quality control of the joints is concerned. It is well known that joints are the last straw of strength in structural steelwork. Any poor quality weld would detrimentally affect the joint and in turn affect the performance of the whole structure itself. Hence welded joints need thorough inspection during and after the fabrication. Different methods of NonDestructive Testing (NDT) and evaluation of welds are available. The NDT procedures are elaborated in the chapter on 'Welds Static and Fatigue Strength – I'. Depending upon the severity of service loading, the QAP may call for the level of NDT to be used. Guidance could be obtained from *IS:822(1970)* for the inspection of the welded joints.

5.0 ERECTION

5.1 General

Erection of steel structures is the process by which the fabricated structural members are assembled together to form the skeletal structure. The erection is normally carried out by the erection contractor. Generally the steps that are involved in the erection of steel structures are shown in Table 3. The erection process requires considerable planning in terms of material delivery, material handling, member assembly and member connection. Proper planning of material delivery would minimise storage requirement and additional handling from the site storage, particularly heavy items. Erection of structural steel work could be made safe and accurate if temporary support, falsework, staging etc. are erected. Before erection the fabricated materials should be verified at site with respect to mark numbers,

key plan and shipping list. The structural components received for erection should be stacked in such a way that erection sequence is not affected due to improper storing. Care also should be taken so that steel structural components should not come in contact with earth or accumulated water. Stacking of the structures should be done in such a way that, erection marks and mark numbers on the components are visible easily and handling do not become difficult. From the earlier discussion it should emphasised that safe transportation of fabricated items to the site, their proper storage and subsequent handling are the pivotal processes for the success of fabrication of structural steel work.

Table 3: Sequence of Activities during Erection

S. No.	Sequence of Operation
1.	Receiving material from the shop and temporarily stacking them, if necessary.
2.	Lifting and placing the member and temporarily holding in place.
3.	Temporarily bracing the system to ensure stability during erection.
4.	Aligning and permanently connecting the members by bolting or welding.
5.	Connecting cladding to the steel structural skeleton. Application of a final coat of painting.

Guidance for handling and storage for material shall be obtained from *IS: 7969(1975*). The fabrication at shop or site should be so planned that units to be handled weigh nearly the same. The erection drawing should reach the site of construction well in advance to plan the erection sequence and material handling. Erection should be carried out with the help of maximum possible mechanisation. Normally anyone or more of the material handling systems, such as tower crane; crane mounted on rails, crawling crane, pneumatic tire mounted crane, and derrick crane may be used for handling the material. Details of the above said erection equipments can be found in any standard textbooks on construction equipment.

A variety of methods can be employed for the erection of a structure. Normally, the selection of the method is influenced by the type of the structure, site conditions, equipment, quality of skilled labour, etc. available to the erector.

However, regardless of the method adopted the main aim during erection is the safety and preservation of the stability of the structure at all times. Most structures which collapse do so during erection and these failures are very often due to a lack of understanding on someone's part of what another has assumed about the erection procedure. Hence, it is emphasised that as far

as strength and stability of the components during erection are concerned, they must satisfy the provision of *IS: 800(1984)*. For the guidance on general fabrication and erection of structural steel work, Chapter 11 of IS:800 (1984) must be followed. As far as safety is concerned guidance could be obtained from Indian safety code for structural steelwork *IS:7205(1974)*. Before the commencement of the erection, all the erection equipment tools, shackles, ropes etc. should be tested for their load carrying capacity. Such tests if needed may be repeated at intermediate stages also.

5.2 Bracings

During the entire erection period, the steelwork should be securely bolted or otherwise fastened and braced to take care of the stresses from erection equipment or the loads carried during erection. In addition to this, adequate provisions to resist lateral forces and wind loads during erection should also be made according to local conditions.

Normally bracings are built into all types of structures to give them a capability to withstand horizontal forces produced by wind, temperature and the movements of crane and other plant in and on the building. Bracings can be permanent or temporary.

Temporary bracings required at some stages of the work must have properly designed connections and should be specifically referred to in the erection method statement.

The decision on sequence of erection such as which member should be erected first for providing initial stability to the structure or whether temporary bracings should be used for this purpose should be taken at an early stage of planning of the erection process. Fig.*9* illustrates this point. As permanent bracings have been provided in AB, bay erection should logically start from AB bay to give stability and ensure proper alignment of the erected structure. In case, for some reason erection has to start from DE bay, it would be necessary to provide temporary bracings in this bay. The bracing system should be retained till the permanent bracings are fixed in the AB bay. Any mis-alignment at initial stage will impair the performance, of the structure when completed. Early or unauthorised removal of temporary bracings is a common cause of collapse in a partially completed frame.

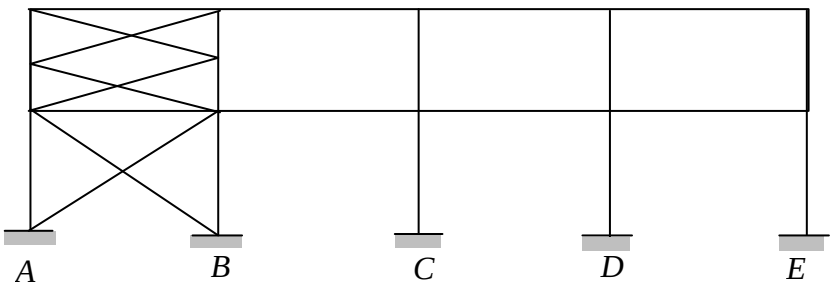


Fig 9. Bracing System

Having considered the need for installing temporary bracings and the need to postpone fixing permanent bracings, consideration should be given to the overall economy of retaining the temporary bracings and perhaps leaving out the permanent bracings. It is a costly and potentially dangerous business to go back into a structure solely in order to take out temporary members, or to insert components that had to be left out temporarily.

5.3 Maintaining tolerances

The best way of erecting a structure within the acceptable tolerance limits is to make sure that accuracy is achieved from the very beginning of the job.

Table 4: Maximum permissible tolerance in erected steel structures

S.No	Description	Tolerance in(mm)
1.	**Columns:**	
(i)	Out of plumbness of column axis from true vertical axis Heights upto *30 m*	± / *1000* or ±*25* whichever is less
(ii)	Heights over *30 m*	± / *1200* or ±*35* whichever is less
2.	**Trusses:** Lateral shift in location of truss from its true vertical position	±*10*
3.	**Crane girders and ribs:** Shift in plane of alignment with respect to true axis of crane rail.	±*5*
4.	**Chimney and towers:** Out of plumbness (vertically from true vertical axis)	*1/1000* of the height of the chimney or tower

Thus quality control must start from the setting out of the foundations and the holding down bolts. This operation is often done at a stage when site conditions are disorderly and most untidy and the environment appears to be incongruous to accuracy. However, inaccuracies in marking the centrelines and the levels of foundations allowed at this stage are likely to cause misfit in the connections and misalignment of the structure leading to secondary stresses in the members. In such areas corrective measure must be taken by way of locally modifying some of the components so as to

eliminate the mismatch. Table 4 shows some typical tolerances that are accepted in structural steel work.

5.4 Joints

Most steel structures are fabricated by either bolting or welding in the shop and bolting or welding in the field. Durability of a structure largely depends on the quality of the joints made at site.

In bolted connections, care should be taken to ensure that all parts intended to be bolted together should be in contact over the whole surface and the surfaces should be thoroughly cleaned and painted with specified primer paint and the two matching plates or sections secured together while the paint is still wet by service bolts. After erection, the joint should be made by filling not less than *50%* of the holes with bolts. The service bolts are to be tightened. The holes that need enlargement to admit bolts or rivets should be reamed only after carefully examining the extent of the inaccuracy and the effect on the soundness of the structure. Such holes must not be formed by gas cutting process. The contact surfaces in HSFG connection if painted will develop lesser friction and this should have been accounted for in design. The fundamentals of HSFG connections are elaborated in the chapter on Bolted connections.

For connections to be done by welding, the components should be securely held in position to ensure alignment, camber etc., before welding is commenced.

In the case of field assembly using bolts the number of washers for the permanent bolts should not be more than two (and not less than one) for the nuts and one for the bolt head. It is desirable to use wooden rams and mallet to force the members in position so as to protect steelwork from injury and shock. It should also be ensured that the bolts project through the nut by atleast one thread. In the case of field assembly by welding almost all the precautions needed for shop welding may be followed. In the case of High Strength Friction Grip (HSFG) bolts the material surfaces should be absolutely free from grease, lubricant, dust, rust etc. and shall be thoroughly cleaned before assembling. The nuts should be pretensioned by a torque–wrench or by the turn of the nut method with the help of pneumatic wrench/lever. After tightening the bolt heads, nuts and edges of the mating, surfaces should be sealed with a coat of paint to obviate entry of moisture. In the case of connections such as base plate they must be aligned and levelled using wedges/ shims and subsequently filled by grouting.

6.0 SUMMARY

In this chapter the importance of fabrication and erection in structural steelwork is underlined. The various tasks involved in fabrication are discussed. The joints, which are important components in structural

steelwork are explained, with a special emphasis on welded joints. Some aspects of erection of steel structures are also presented. Thus an overall view of the fabrication and erection of structural steelwork is covered in this chapter.

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1. Pratt.J.L., " Introduction to the Welding of Structural Steelwork", 3rd revised edition, The Steel Construction Institute, 1989.

2. Owens G.W and Knowles P., 'Steel Designers manual', 5th Edition, The Steel Construction Institute, ELBS Blackwell Scientific Publishers, London 1994.

3. Ghoshal.A., " Quality Assurance and Training for Fabrication and Erection of Durable Steel Structures", Journal of the Indian National Group of the International Association for Bridge and Structural Engineering, vol.30, n1, Feb. 2000.

4. *IS:812-1957* Glossary of terms relating to welding and cutting of metals.

5. *IS:822-1970* Code of procedure for inspection of welds.

6. *IS:7205-1974* Safety code for erection of structural steelwork.

7. *IS: 7969-1975* Safety code for handling and storage of building materials.

8. *IS:*487-1985 Brush, Paint and Varnish (I) oval ferrule bound (ii) round ferrule bound (Third revision).

9. *IS 800- (1984)* Code of practice for general construction in steel, Chapter 11.

SELF CHECK 3.3-2

1. What is a groove weld and a fillet weld?
2. When a fillet weld applied?
3. What are the type welding joints?

TASK SHEET _____
Title: Fabricate steel trusses
Performance Objective: Given the necessary tools ,equipment and materials, ,you should be able to fabricate steel trusses following standard procedure
Supplies/Materials :Necessary bars, welding consumables ,gases
Equipment : Welding Machines ,Cutting Equipment ,Grinder
Steps/Procedure: 1. Surface cleaning 2. Cutting and machining 3. Punching and drilling 4. Straightening ,bending and rolling 5. Fitting and reaming 6. Fastening 7. Finishing 8. Quality control 9. Surface Treatment
Assessment Method:

Performance Criteria Checklist _____

CRITERIA **Did you….**	**YES**	**NO**
Fabricate steel truss according to requirements?		
Follow procedure in fabricating trusses?		
Observed safety in doing the task?		

OPERATION SHEET _____
Title: Operate Welding Machine
Performance Objective: Given the necessary tools ,equipment and materials, ,you should be able to operate the equipment following manufacturers manual
Supplies/Materials :Necessary bars, welding consumables ,gases
Equipment : Welding Machines
Steps/Procedure: 1. Check condition of the machine 2. Turn on machine 3. Set required parameters for welding 4. Connect ground clamp 5. Prepare for welding
Assessment Method:

Performance Criteria Checklist _____

CRITERIA **Did you….**	**YES**	**NO**
Fabricate steel truss according to requirements?		
Follow procedure in fabricating trusses?		
Observed safety in doing the task?		

LO4 INSTALL TRUSSES

ASSESSMENT CRITERIA:

1. Proper installation was observed according to industry standard
2. Safety was observed according to company requirements

CONTENTS:

1. Handling procedures
2. Lifting procedures
3. Installation procedures

CONDITIONS:

The student/trainee must be provided with the following:

1. Equipment
   - Welding machine (AC or AC/DC)
   - Welding table or jig
   - Portable grinder
   - Portable oven
   - Oxy-acetylene welding cutting
   - Plasma Cutter
   - Crane
   - Scaffolding

2. Tools/Accessories
   - Welding mask
   - Steel brush
   - Clear glass
   - Chipping hammer
   - Dark glass
3. Supplies/ Materials
   - Electrodes
   - Carbon steel plates
   - Cutting grinding disk
   - Necessary bars
   - Rope
4. Personal protective equipment
   - Safety shoes
   - Apron
   - Leggings
   - Safety goggles
   - Gloves
5. Training Materials
   - Arc welding manuals
   - Welding procedures specifications (WPS)
   - Welding standards

METHODOLOGIES:

- Lecture/discussion
- demonstration
- OJT

ASSESSMENT METHODS:

- Written/oral
- Interview
- Direct observation

INFORMATION SHEET 3.4-1

INSTALLING STEEL TRUSSES

Learning Objective: After reading the information sheet, trainees will be able to:

- Handle trusses during installation
- Provide bracing
- Consider installation variables
- Steps in installing trusses
- Hoisting

Handling

Most cold-formed steel trusses are delivered to job sites ready to be installed, but they still must be handled with care. The contractor is responsible for properly receiving, unloading and storing them.

According to the contractor:

• Carefully remove banding or metal attachment pieces to avoid damaging trusses and prevent personal injury.

• Avoid lateral truss bending.

• Trusses may be unloaded directly on the ground at the time of delivery or stored temporarily in contact with the ground after delivery.

• If trusses are to be stored horizontally for more than one week, place blocking of sufficient height beneath the stack of trusses at 8 feet to 10 feet on-centre.

• Store trusses on a slight slope to allow for draining.

• For trusses stored for more than one week, cover bundles to protect from the environment.

Bracing and restraints

To ensure correct and safe installation of cold formed steel trusses, temporary and permanent bracing is required. During construction, before all of the components of the truss system are in place, bracing acts to hold members upright, straight and in place. "The most typical bracing material being specified and utilized in today's marketplace is 1 1/2 inches by 20-gauge hat channel," says David Dunbar, PE, national sales manager, ITW TrusSteel, Orlando, Fla. "Bracing material being packaged with trusses themselves is becoming the industry norm."

A stabilizer can provide the lateral installation restraint for cold-formed steel trusses. "The stabilizer snaps on the top chord and bottom chord members, providing the required bracing of truss chords and also provides for the proper spacing," says Mike Pellock, executive vice president at Aegis Metal Framing, Chesterfield, Mo. "Stabilizers are delivered with the truss package."
Installation variables

An initial metal truss roof installation step is deciding which end or location of the building to start with. "This point is critical as subsequent trusses will be attached via lateral and diagonal bracing members to the first truss," says Dunbar. "If the

roof is a hip style, the #1 hip girder would be the starting point. If the roof is a straight A-frame, the gable end truss is usually selected as the starting point."

Interior bearing walls and beams will assist in keeping the trusses supported as temporary bracing is installed to keep trusses in-plane. Scaffolding is commonly utilized in the interior of a building on long- span trusses in place of interior bearing walls during installation.

Noonan feels different truss types don't influence installation as much as truss span length does. "The longer the span, the more equipment plays a greater role in the installation. If the truss is oversized, it may have to be built and shipped in two pieces requiring more installation time."

Dunbar agrees larger spans and steeper pitched roofs require considerably longer installation times, but also that longer and taller truss spans directly correlate to more web members being required. "Longer web members generally equates to more required web bracing," he says."Generic cee stud trusses and proprietary steel truss systems account for the majority of trusses manufactured today."

The International Building Code recognizes that the erection of trusses over 60 feet is inherently dangerous and poses significant risk to installers. Therefore, "The IBC (IBC 2009, Section2303.4.1.3) requires the involvement of a registered design professional to do the design for the temporary installation restraint and bracing and the permanent individual truss member restraint and bracing, Sias says.

Anchoring System

Anchor bolts are L – shaped bolts embedded into concrete and used to anchor construction supports like columns, steel beams, and plates. These are usually installed the same time with the concrete pouring of roof beams.

INSTALLING BASEPLATE TO THE ROOF BEAM

Before installing the baseplate, check first the horizontal level of the roof beam, using a leveling hose or a laser. To ensure that all plates are installed correctly, a leveling concrete/mortar is applied.

1. Based on the shop drawing, cut the required size of baseplate to be used for anchoring the truss. You can cut the plate by using a plasma cutter or an oxy – acetylene cutter.

2. fter cutting the required size of the baseplate, place it directly on top of the anchor bolts installed on the roof beam. Mark on the baseplate the locations of the anchor bolts.
3. Using an electric drill, drive a hole on the baseplate where the anchor bolts are to be bolted.

4. Install the baseplate; make sure the hole is aligned with the anchor bolts. Fix the plate with bolt and nut.

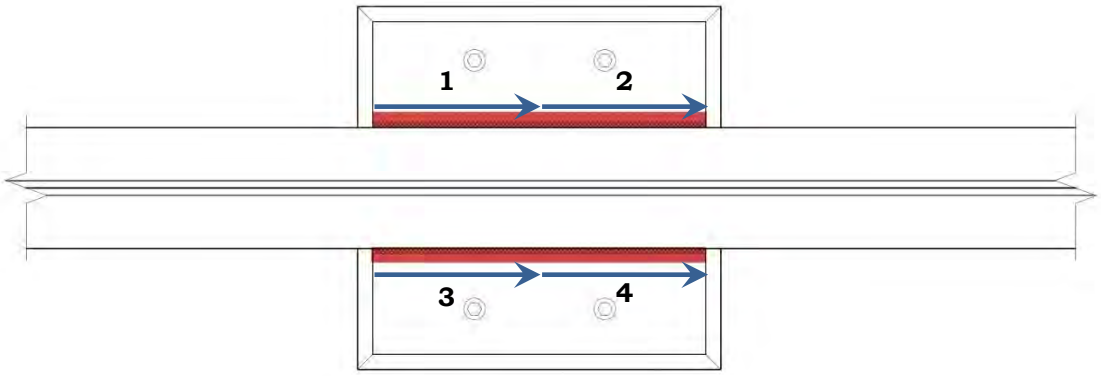
FIXING TRUSS TO BASEPLATE

After anchoring the baseplate to the roof beam, we are now ready to fix the truss to the baseplate.

1. Place the truss directly on top of the baseplate. Using a plumb bob or a level bar, check the vertical level of the truss. Make sure it is in right angle, or directly perpendicular to the baseplate.
2. To avoid misalignment and movement of the truss while it is being fixed, install a brace temporarily to hold the whole truss assembly.
3. Tack weld the bottom chord of truss at the edges of the baseplate. Use E6013 electrode at 100 amp.

4. Conduct a re – check of the elevation and alignment of the truss with respect to the structure. You're now ready to fix the truss permanently to the baseplate.
5. Attach an electrode to the holder. Use E7018 for full welding procedure.
6. Switch on the welding machine and set the amperage to 140.

7. Start the full welding procedure. Refer to the image below as guide:



Successful roof trusses installation steps are:

- Stage trusses.
- Lift first individual truss in place. Long trusses will require a spreader bar.
- Secure truss to bearing support with specified hardware.
- A screw gun can install hardware at the bearing support and bracing material.
- For first truss, the truss is restrained with bracing to the ground or building interior.
- Lift second truss in place.
- Secure second truss to bearing support with specified hardware.
- Secure second truss to first truss with installation bracing like a stabilizer or other material on the top chord, bottom chord and web plane per provided documents. Diagonal bracing is critical.
- Repeat for the following trusses.

Hoisting and connecting

Cranes and scissor lifts are two of the most commonly used pieces of machinery on a job site to hoist cold-formed steel roof trusses to the support and be braced. "Cranes may lift one truss at a time or a pre-packaged bundle of trusses lifted to the installation point at one time," says Dunbar. "Screws are the mechanical connection of choice at any given job site to connect bracing material to the trusses, clips to make truss-to-truss connections and clips to attach the truss to the bearing member."

To ease CFS installation, Sias says Simpson Strong-Tie Quik Drive Auto Feed Screw Driving Systems have features like quick-loading screw strips and a patented auto-advance mechanism. All lifting equipment should comply with OSHA regulations. When using a crane, SBCA advises:

- Do not overload the crane.

• Do not rely on banding or metal pieces used to attach trusses in a bundle to hoist and move bundles on the job site.

• Lift points for hoisting truss bundles are permitted anywhere along the top chords.

• Two lift points may be used for bundles with trusses up to 45 feet.

• Use at least three lift points for bundles with trusses greater than 45 feet.

LIFTING PROCEDURES

1. Familiarize the types of lifting procedures for trusses.

For best results, fabrication of trusses is best done on the ground and NOT in an elevated area like on top of the roof beam. This is done so that any correction or distortion can be easily corrected during welding activities. Another factor is the safety of the welders, that accidents such as falling from high ground can be avoided. Hence, after all trusses are fabricated, it is lifted to the roof beam with an aid of mechanical or lifting apparatus.

In this topic, we will discuss 2 of the most common equipment in lifting trusses to a higher ground.

1. **CHAIN BLOCK/HOIST** is designed for heavy duty lifting and materials handling operations. Chain block raises and lowers loads by pulling on the hand chain. It is usually designed with a thick steel hook at the top of a thick steel square. Wrapped around the square several times are a steel rope which serves as the pulley chain for lifting the load.

Sample 1

Sample 2

Sample 3

BOOM and PULLEY

SAMPLE INSTALLATION PROCEDURES OF STEEL TRUSSES

SELF CHECK 3.4-1

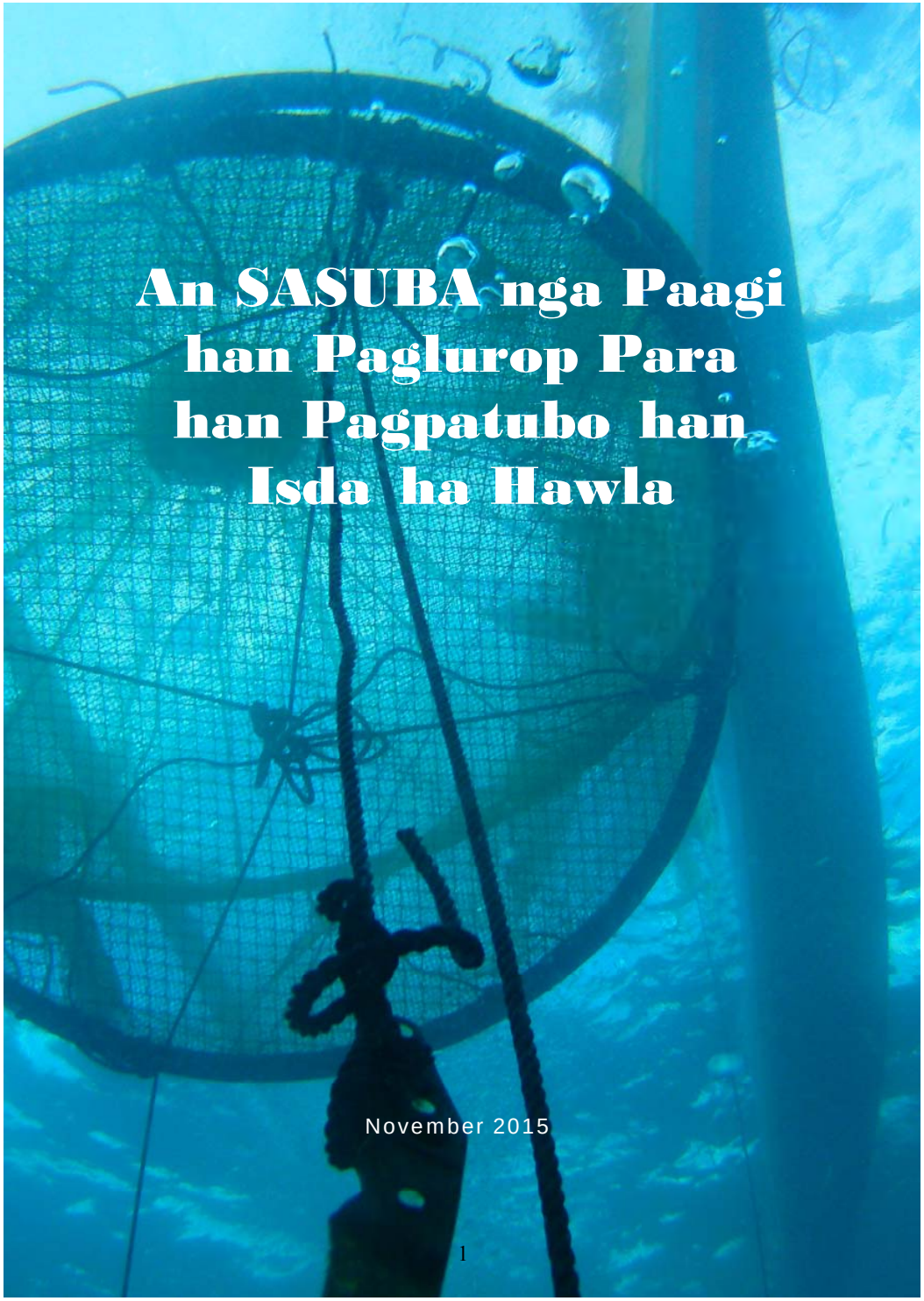
1. What are the steps in installing steel trusses?
2. What are the safety consideration in the installation?
3. Explain its step in installing steel truss

TASK SHEET 3.4-1
Title: Install Steel Trusses
Performance Objective: Given the fabricated steel truss, lifting equipment, welding machine and other materials, ,you should be able to install steel truss following the industry standard
Supplies/Materials :electrodes, rope,
Equipment :Lifting equipment, welding machine ,cutting equipment
Steps/Procedure: Stage trusses. • Lift first individual truss in place. Long trusses will require a spreader bar. • Secure truss to bearing support with specified hardware. • A screw gun an install hardware at the bearing support and bracing material. • For first truss, the truss is restrained with bracing to the ground or building interior. • Lift second truss in place. • Secure second truss to bearing support with specified hardware. • Secure second truss to first truss with installation bracing like a stabilizer or other material on the top chord, bottom chord and web plane per provided documents. Diagonal bracing is critical. • Repeat for the following trusses.
Assessment Method:

Performance Criteria Checklist _____

CRITERIA **Did you....**	**YES**	**NO**
1. Follow the correct procedures in installing steel trusses?		
2. Observed safety in the installation?		
3. Observed a high strength anchoring procedure?		

Appendix-7: SASUBA Operation Handbook



An SASUBA nga Paagi han Paglurop Para han Pagpatubo han Isda ha Hawla

November 2015

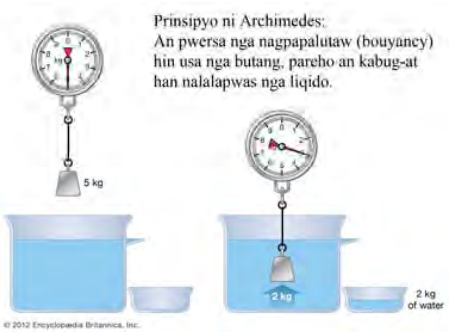
A2-7-1

An Sulod

Introduksyon ha SASUBA nga paagi han paglurop

A. Batakan nga Physics kabahin ha Paglurop.

1. ***Bouyancy*** o Kamalutaw ha Tubig.



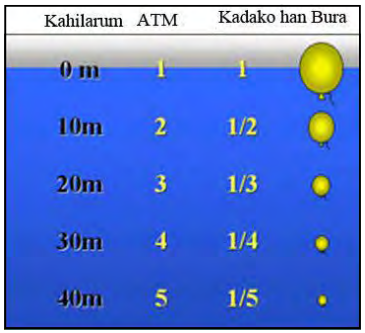
An bisan ano nga butang – bug-os man o parte la nga igtunlob ha bisan ano nga likido – in igduduso tipalutaw hin pwersa nga kapareho han kabug-aton han likido nga ginsaliwnan hito nga butang. Amo ine an gintatawag nga *Prinsipyo Archimedes*.

An kahoy nga may dako nga ***volume*** (o kadakuon) kumparar han iya timbang nalutaw ha tubig tungod han iya dako nga **buoyancy**, samtang an ***metal*** (sugad han puthaw o tingga) nga gutiay an *volume* kumparar han iya timbang malunod ha tubig tungod kay gutiay la an iya ***buoyancy***.

2. ***Pressure*** ha Tubig.

Kunsugad, malutaw ha tubig an lawas han tawo kay mas magarugaan ine kun ikumpara han pareho nga *volume* han tubig. Ngan tungod han ***buoyancy***, kinahanglan ka magsul-ot hin pabug-at kun karuyag mo makalurop dayon hin hilarum. Labot pa han pabug-at, kinahanglan liwat hin usa nga paraglurop nga magsul-ot hin kapay agud hiya makalurop hin maupay ngan dire dirudiretso nga malunod

An usa nga paraglurop naabat hin ***pressure*** (presyon) o pwersa tikang ha tubig labot pa han pwersa han hangin (***atmospheric pressure***).



i. ***Atmospheric Pressure***. Dire inaabat han tawo ine nga pwersa kun hiya natukdaw ha tuna, pero hi kita ngatanan nakarawat hin pwersa tungod han kabug-aton han hangin o an ginsisering nga ***gravity***. Ha bawbaw la han dagat, mayda 1 ka-kilo nga bug-at an kabug-osan nga hangin ha kada 1 ka-kubiko sentimetro (1 cm^2 at sea level). Amo ine an gintatawag

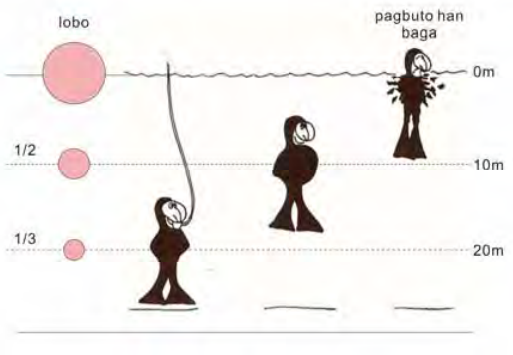
nga ***atmospheric pressure*** o **atm**. An atm in usa nga suklanan hine nga pwersa o ***pressure.***

ii. An tubig mas mabug-at ha hangin sanglit kun maglurop ka ilarum ha tubig, maabat ka hin mas makusog nga presyon kumpara kun aada ka ha bawbaw han dagat. Ha kahilarumon nga 10 metros, 1 Kg an timbang han 1 kwadrado –sentimetro han tubig, ngan amo ini an kanan hangin bug-at tipabawbaw han kalangitan. Kunsugad, ha kahilarumon nga 10 metros, an usa nga paraglurop naabat hin pwersa nga maabot 1 **atm** nga hangin ngan 1 **atm** nga tubig o ha kabug-osan nga 2 **atm**. Ha kahilarumon nga 20 metros, maabat hiya hin 3 **atm** o 1 **atm** han hangin ngan 2 **atm** tikang ha tubig. Kun amo ine, an **pressure** dida ha tubig na-umento hin 1 atm ha kada 10 metros nga kahilarumon han paglurop.

3. An Mahangin nga Butang (*Gaseous Body*) ngan an *Pressure.*

i. Pagbag-o han *Volume* han usa nga *Gaseous Body*.

An *volume* han gas nagtitikamenos samtang nag-uumento an *pressure*. Pananglitan, kun iglunod ha tubig an usa nga bola, magmemenos hin katunga (1/2) an ka-dakuoon han bola ha ka-hilarumon nga 10 metros, magmemenos hin ika-tulo nga parte (1/3) an bola ha 20 metros nga kahi-larumon. Pero, an mao ta nga bola, kun igbalik pa-igbaw, mabalik ngahaw



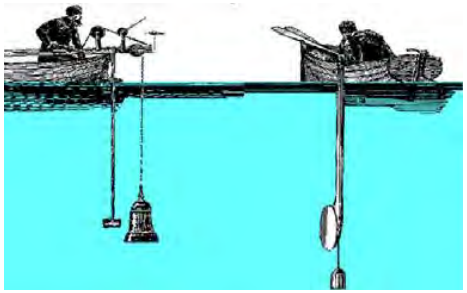
Kun pahanginan mo an bola didto ha ilarum han tubig ngan imo ine ig-isa tipa-igbaw, madako an *volume* hine ngan possible pumutok antes pa man ine umabot ha bawbaw han tubig. Sugad liwat an mahitatabo han imo baga, maputok, kun diri mo sundon an tama nga paagi han pagpa-igbaw tikang ha hiruhilarum nga parte han tubig.

ii. An Pagkonsumo hin Hangin ngan an Kahilarum han Paglurop.

An lawas han tawo mayda solido nga mga bukog ngan tubigan ug ma-humok nga mga unod. Diri ini maputok sugad han hanginon nga parte han aton lawas (an baga) bisan pa kun lumurop pa hin mas hilarum.

An mga bura han hangin nga tikang hin tubo (*airline tube*) nagtikadagko samtang nagtikahilarum an paglurop. Sanglit, an paraglurop nakonsumo hin mas damo nga hangin kun mas hilarum an iya lurop. Doble an kadamoon han hangin nga nakokonsumo ha 10m nga kahilarum kumpara kun ada ka ha igbaw han tubig. Triple an konsumo kun naabot na hin 20m an kahilarum han paglurop.

4. An Dalagan han tunog ha Tubig

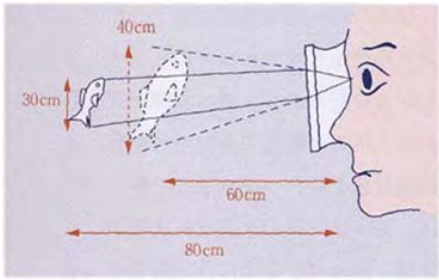


Ika-upat kapilo an kalaksihon ha pagdalagan/pag-abot han tunog ha tubig kumpara han kalaksihon hini ha kahanginan. Naabot hin 340 metros kada segundo (m/sec) an dalagan han tunog ha kahangi-nan (*sonic speed*), samtang 1,400 m/sec naman ha tubig.

Ha igbaw han tuna, inaabat han tawo an direksyon han tunog giu-tan han gintikangan ngada han takna nga kanya ini nababatian. Kundi, ha ilarum han tubig, diri inaabat an direksyon o tinitikangan han tunog tungod na han kalaksihon han dalagan han tunog. Kun nababati hin paraglurop an tunog han *screw* han baloto/motor, mahibabaroan niya nga may-ada baloto/ motor pero diri niya matutudlok kun hain ini.

5. An Suna ha Tubig

i. Pag-abat ha distansya ha ilarum ha tubig



Nakakakita kita hin butang tungod nga an retina han aton mga mata nakaka-abat han suna nga egin-iitsa hito nga butang. An kalaksihon ha pagdalagan han suna ha kahanginan amo in 1.33 ka-pilo nga mas ma-laksi kumpara ha tubig. Kun sugad,

ii. Pagbag-o han Kolor

Dirudilain an kolor han suna. Ginhuhuphop han tubig an mga kolor kun ini nasusunaan sanglit nawawara an kolor ha mas hilarum nga parte han tubig. An pula an siyahan nga nawawara, masunod an dulaw, ngan an asul. Nawa-wara an kolor nga pula ha kahiladmon nga 5m. Ha 40m, an asul na la an

nahibibilin, asya nga daw asul na la aton nakikit-an ilarum han tubig. Tungod hini nga epekto, an pula o rosas (pink) nga swimsuit ma-itom na pagkit-on ilarum ha tubig. An asul ug dulaw nga sul-ot diri ura-ura naaapektuhan an kolor ha ilarum ha tubig. Kun gumamit ka hin pansuna ilarum ha tubig, an kolor pareho ngahaw han nakikit-an ha igbaw han tubig.

Kahirayo nga makikit-an an kolor ha limpyo nga tubig

Kolor	Wavelength (nm)	Kahilarum (metros)
Red	780 - 622	5
Orange	622 - 597	10
Yellow	597 - 577	20
Green	577 - 492	30
Blue	492 - 455	60

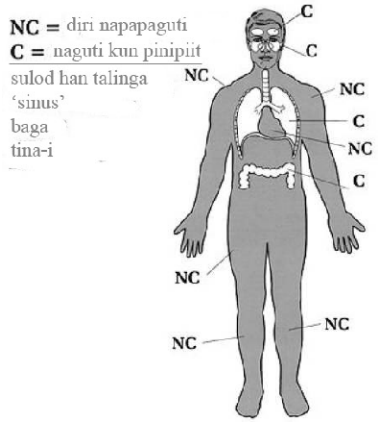
Source: Webster, M., *Art and Technique of Underwater Photography* (1998)

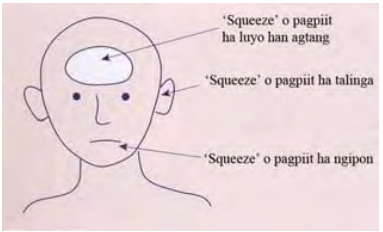
B. *Physiology* ha Paglurop ngan mga diperensya ha paglurop

1.Simple nga *physiology* ha paglurop

i. An *istruktura* han lawas han tawo ngan an paglurop

An lawas han tawo kaudgan tubigan an mga unod/parte han lawas sugad han mga kusog (*muscle*) ngan sulod ha ginhawa (*internal organs*) ngan gutiay la nga porsyento an bug-os/matig-a nga bukog. Kun an tawo mas hilarum an paglurop, an presyon han tubig naghahatag pwersa ha lawas. May kakayahan an lawas pagbalanse han presyon sakob han lawas dida han presyon ha gawas han lawas. Sanglit, diri nababag-o an porma han lawas kun aadto ini ilarum han tubig. An lawas han tawo may-ada mga buho (*cavities*) nga parte sugad han baga (*lungs*), tiyan, tinae, ngan *nasal cavity*. Ini nga mga buho nga parte sakob han lawas konektado ha gawas han lawas pinaagi hin mga aragianan o kanal (*ducts*), sanglit, nababalanse an presyon sakob ngan gawas han lawas. Kundi, kun ini nga mga aragianan/kanal nasasarad-an tungod hin pira nga rason, napupunod ini han panggawas nga presyon. Asya ini an sinisiring nga ***squeeze*** nga naghahatag hin suol ngan iba pa nga seryoso nga problema panlawas. Ha iba-iba nga klase hin ***squeeze***, pinakakomon an naka-apektar han talinga (butnga nga parte han kanal ha talinga), nasal cavity, ngan mga ngipon.





ii. Paglurop ngan Pagginhawa (*respiration*)

Nahinggok kita hin hangin ha 1 atm ngan may-ada ini 20% *oxygen* ngan 80% *nitrogen*. Ilarum ha tubig, nahinggot kita hin hangin ha presyon subay han kahilarumon. Pananglitan, ha 30m nga kahilarum, nahinggot kita hin hangin ha 4 atm o upat ka-pilo nga *volume* han hangin. An guti nga hugaw nga aada han hangin makaka-apektar han paraglurop depende han

Agud malikayan an sugad nga problema, kinahanglan malimpyo an hangin nga ginagamit. Kinahanglan waray ini sun-od nga gas tikang ha makina. An hangin nga igko-kompres kinahanglan liwat masaraan agud malimpyohan han gudtiay nga mga hugaw

Iba an inaabat han paraglurop nga naggiginhawa hin gin-kompres nga hangin ilarum ha tubig kumpara han pagginhawa ha katunaan. Kinahanglan paniguruhon han paraglurop an pagginhawa tungod nga nalilimitaran han *regulator* an abid han hangin.

2. Mga sakit durot han paglurop ngan pamaagi paglikay hini

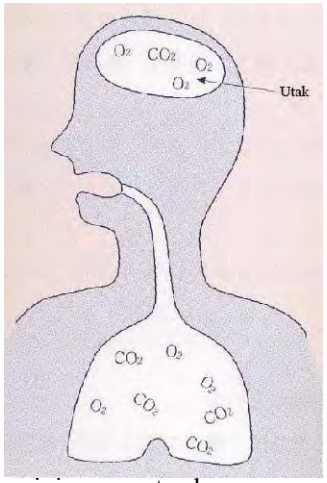
i. *Diving blackout* (Kawad-i hin balatian o kadismayo ha paglurop)

An maiha nga pagpugong pagginhawa maresulta hin kakulang *oxygen* ngan pagdamo/pagtirok hin *carbon dioxide* ha lawas. An hitaas nga kantidad hin *carbon dioxide* nagduduso han utak (ha sentro han pagginhawa) pagpadangat hin mensahe nga kinahanglan na hini guminhawa. Ha aton lawas, an utak an pinakahitaas nga nakonsumo hin *oxygen*. Sanglit, kun aton gan an aton pagginhawa hin maiha, an aton utak an siyahan nga napaparalisa ngan nawawad-an kita hin balatian o nadidismayo. Asya ini an sinisiring nga *diving blackout*.

Agud malikyan an kadismayo samtang nalurop, diri angay nga pugongan hin maiha an pagginhawa. An paraglurop kinahanglan pumaigbaw na kun umabat hiya hin kuri pagginhawa.

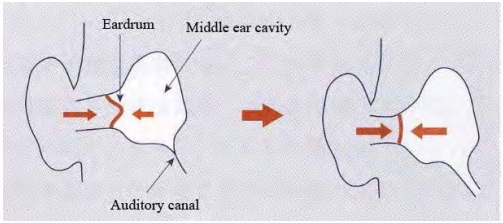
Nagin praktis na nga antes maglurop nga waray suplay nga hangin, naginhawa anay hin higlarum. Ini nga agsub nga pagginhawa in sinisiring nga *hyperventilation*. Pinaagi hini, epektibo nga nahigagawas an *carbon dioxide* agud mas maiha an paglurop. Kundi, delikado liwat ini nga praktis nga pwede mahingadto han kadismayo.

Kun gutiay an *carbon dioxide* pwede diri makapadangat hin mensahe an utak nga delikado na mawarayan hin *oxygen* an lawas. An hamubo nga lebel han *carbon dioxide* durot han *hyperventilation* nakapatagya han utak nga may-ada pa sadang nga kadamoon han *oxygen* ngan ini naghahatag hin hataas nga tsansa han pagkadismayo.



Agsub nahitatabo an kadismayo durante han paglangoy tipa-igbaw kun an presyon han *oxygen* ha dugo nagmemenos segun han kahiladmon. Posible liwat madismayo an paraglurop bisan kun naka-abot na ini ha bawbaw han tubig.

ii. Squeeze ha mga talinga (pagputok han manipis nga putos han *eardrum*)



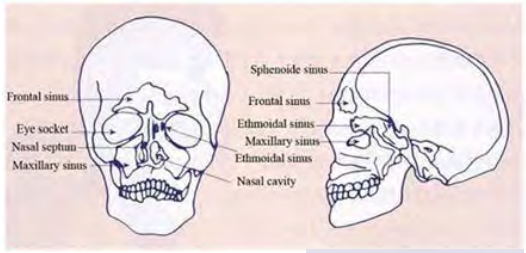
Samtang natikahilarum an paglurop, nag-uumento an presyon han tubig ngan ini pwersado nga nagduduon han sakob han talinga han paraglurop. Naabat hin suol an paraglurop. An suol inaabat pagabot ha 2-3m nga kahiladmon. Kun padayon nga mapahilarum pa paglurop, pwede pumutok an manipis nga putos ha sakob han talinga. Agud malikyan nga mahinabo ini, himuon an teknik nga *ear unplug*. Usa ini nga simple nga paghuyop ha irong samtang sarado ini ngan han hiwa.

An *ear unplug* mag-aabre han kanal ha talinga (*Eustachian tube*) nga kanunay sarado ngan an hangin ha sakob han hiwa (*buccal capsule*) masulod ngadto ha kabutngaan nga parte han kanal ha talinga agud mabalanse an presyon ha magkaluyo nga *eardrum*, ngan mawawara na an pagsuol.

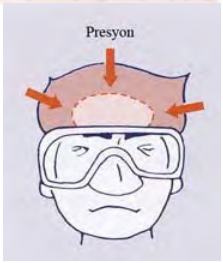
An epekto han *ear unplug* magka-iba ha kada tawo. Epektibo nga nahihimno ini han pira nga tawo pinaagi ha pagkiwa han sulang ngan pagtulon laway. Kinahanglan himuon oan *ear unplug* ha kada 1-3m nga paglurop.

Kun diri maupay an kondisyon pagginhawa han paraglurop, diri nira epektibo mahihimo an *ear unplug*. Kun sugad, diri na sira angay maglurop. An paglurop samtang maluya/diri maupay an panlawas ngan diri nakakahimo han *ear unplug* pwede magresulta ha pagputok han *eardrum* ngan iba pa nga disgrasya o kahibang han talinga. Makuri makahimo han *ear unplug* kun an maglulurop amo in hubog o naka-inom o kun di man piraw.

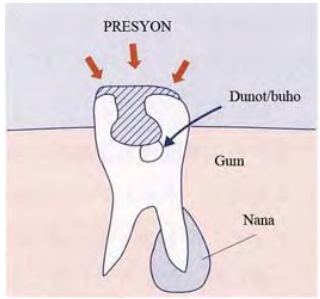
iii. *Squeeze* ha *nasal sinus*



May-ada pipira nga buho nga parte han aton ulo nga sinisiring nga *nasal sinus*. Sumpay ngan abierto ini nga *nasal sinus* ngadto han aragi-an han hangin ha aton irong. Kanunay nga abierto ini nga aragian agud nababalanse an presyon giutan han *nasal sinus* ngan han gawas samtang nalurop. Pero kun an panlawas nga kondisyon han paraglurop diri maupay sugad panaglitan kun may-ada sip-on, ini nga aragian han hangin pwede masarad-an tungod nga nahubag an *nasal sinus*. Sanglit, mag-iiba (o diri balanse) an mga presyon giutan ha sakob nga gawas han *nasal sinus*. Kun maglurop ha sugad nga kondisyon nga sarado ini nga aragian, magsusuol an *nasal sinus* thungod han hataas nga presyon tikang ha tubig. Aabaton ini ha 3-4m nga kahiladmon han paglurop. Waray epektibo nga paagi ha pagpamenos ha suol ha *nasal sinus* sanglit kinahanglan lumangoy na tipa-igbaw na paraglurop.



iv. *Squeeze* ha mga ngipon



Kun an usa ka tawo nagpa-upay na han buho nga ngipon, pwede nga may-ada nahimo nga buho ilarum han gin-upay nga ngipon.

Posible liwat nga magkamay-ada hin buho durot han naporma nga gas tungod han pagkadunot han nana ha puno han ngipon. Kadanay ini nga mga buho ha ngipon nakahatag problema ha paglurop tungod han *squeeze*.

Ini nga mga buho amo in sarado ngan diri naaapektuhan han presyon ha gawas. Kun an paraglurop may sugad nga buho ha ngipon, pwede hiya umabat hin duro nga sakit tungod han *squeeze* dida hiton nga buho.

v. *Squeeze* ha *mask* nga gamit paglurop

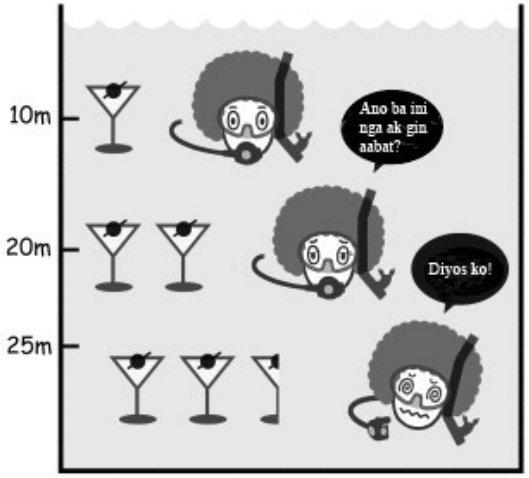
May-ada haluag nga espasyo sakob han *mask* paglurop. Samtang nalurop, an presyon han tubig naresulta hin *squeeze* ha *mask*. An paraglurop maabat hin duro nga presyon palibot han iya mga mata, ngan masuol ini ilabi pa kun waray la hihimoon. An diperensya ha presyon giutan han sakob ug gawas han *mask* pwede mabalanse pinaagi ha paghuyop hangin tikang ha irong. Ini nga paagi asya an sinisiring nga *mask blow*. Diri posible himoon an *mask blow* ha antepara nga tipo hin *mask* (*google*), ngan diri gihap ini eginrerekomendar nga gamiton ha higlarum nga paglurop.

vi. Suit squeeze

An mga paraglurop nga nagamit la hin ordinaryo nga panapton naka-eksperyensya hin magsuol nga mga marka ha ira panit katapos maglurop. Resulta ini han nahihimo nga mga pi-od ha panit durante han paglangoy tipa-igbaw. An mga pi-od nga may hangin nagkokompres kontra han panit, ngan an panit naiipit ngadto han mga pi-od ngan naresulta ini ha kasamad han panit.

vii. *Nitrogen narcosis* (ka-hilo tungod han pakahinggot hin Nitrohena)

An hangin may-ada 80% nga *volume* han *nitrogen gas* nga diri problema kun aada kita ha katunaan. Kundi, seryoso ini nga problema ha ilarum ha tubig. Ha mas hilarum nga parte, an *volume* han *gas* natikamenos sanglit an paraglurop nakonsumo hin mas damo nga *nitrogen gas* samtang natikahilarum an iya paglurop. Sugad-sugad hin nahuhubog an paraglurop ngan ini nga sintomas asya an ginsisiring nga *nitrogen narcosis*. Kun aada na ha kondisyon han *nitrogen narcosis* an paraglurop, nawawarayan na hiya hin pag-abat han direksyon ngan kahilarum ngan pwede nga padayon la hiya maglurop tipahilarum o buhian an *mouth piece* (nga nakakonekta ha *oxygen*), ngan magreresulta ini ha seryoso nga aksidente.



An epekto han *nitrogen narcosis* nasubay han kahiladmon han nalurop ngan nagigin seryoso nga problema kun naabot na ha 30m nga kahiladmon. Sanglit, kinahanglan likyan nga diri umabot ha sugad nga kahilarum an paglurop.

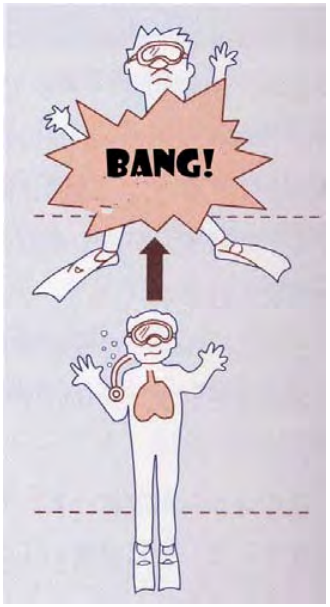
Kun umabat ka nga sugad-sugad ka han nahuhubog o kun nakikita mo an imo kaupod nga iba na an paggios, kinahanglan nga lumangoy na dayon kamo tipa-igbaw. Nawawara an sintomas han *nitrogen narcosis* kun nakakalangoy na ha mas hababaw nga parte.

viii. Paglikay han mga sakit ha baga

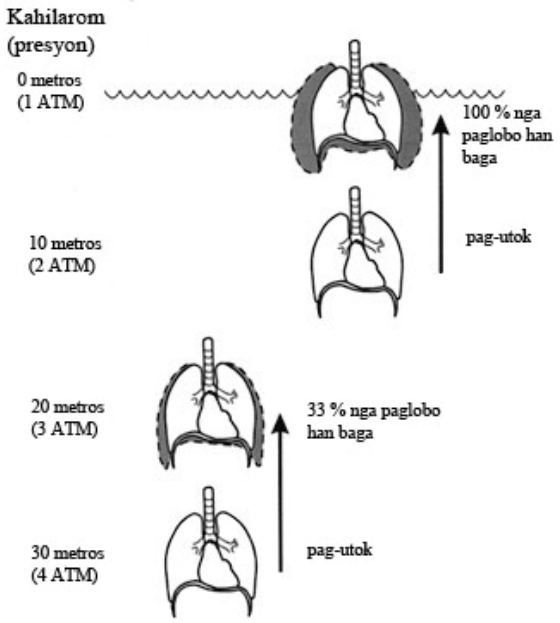
An mga paraglurop nahinggok hin *compressed* nga hangin ilarum ha tubig. Kun nalangoy na hira tipa-igbaw nga ginpupugngan an pagginhawa ha haligot nga takna, nadako an *volume* han hangin ha baga. Ha sugad nga higayon, pwede mahibang o pumutok an baga.

Agud malikyan an sugad nga disgrasya, kinahanglan padayon nga naggiginhawa an paraglurop ngan hinay-hinay nga maglangoy tipa-bawbaw agud

an presyon sakob han baga makabalanse han presyon ha gawas han lawas durante han pag-tipabawbaw.



An pag-umento han *volume* han *gas* nadepende ha kalaksihon ha pagbag-o han presyon, nga mas dako ha mas hababaw nga parte kumpara han ha halarum nga parte. Pananglitan, an *volume* han *gas* na-umento hin duha ka-pilo (2x) ha 10m nga pagtipabawbaw tikang ha 10m nga kahiladmon, kundi, na-umento ini hin 1.25x tikang ha kahiladmon nga 40m. Diri angay hunahunaon han mga paraglurop nga masayon la an hababaw nga paglurop kun an mga kadelikaduhan ha baga an pag-erestoryahan. Diri ini aplikable ha *skin diving* (diri nagamit han *compressed air*) tungod nga an hangin nga nahihinggot ha bawbaw han tubig amo in nabalik ngahaw ha mao ta nga presyon.

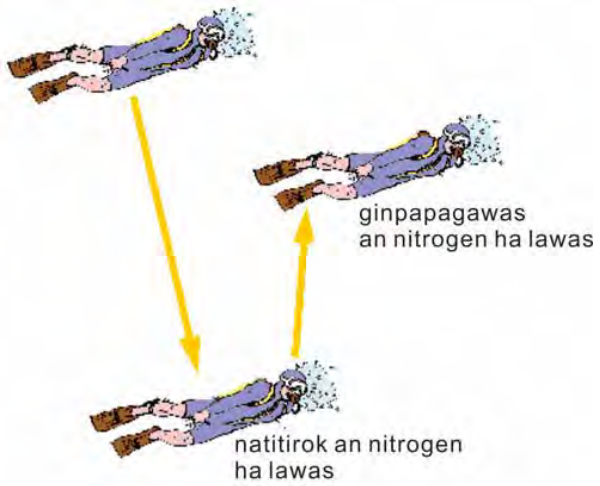


ix. Sakit durot han dekompresyon

Ha katunaan, naabot hin usa (1) ka-litro nga *nitrogen gas* an natutunaw ha dugo han tawo. An kadamoon han natutunaw nga *nitrogen gas* na-umento samtang na-umento liwat an presyon. May kadugangan nga 1 ka-litro nga natutunaw kun naabot na 10m an kahiladmon ha paglurop, ngan 2 ka-litro kun naabot na 20m an kahiladmon ha paglurop.

Kun nalangoy na tipabawbaw, namenos man liwat an presyon ngan an *nitrogen gas* natural nga egingagawas han lawas. Ha luyo nga bahin, kun madagmit hin duro an paglangoy tipabawbaw, waray sadang nga panahon agud igawas an *gas* ngan pwede magresulta ha pagporma hin mga bura ha sakob han mga *blood vessels* (aragian han dugo). Sugad-sugad ini han mga bura ha *softdrinks* ngan *beer* kun inaabrehan na an botelya. Dinhi hini nga mga irimnon, *carbon dioxide gas* an egintunaw pinaagi hin hitaas hin duro nga presyon. An tigda nga pagliwat han presyon durante ha pag-abre han botelya naresulta ha pagkaporma han mga bura han *carbon dioxide*.

An mga bura han *nitrogen gas* nga naporma sakob ha lawas han tawo naresulta hin pipira nga *physiological* nga mga problema, nga sinisiring nga *decompression disease*.



Nagtitikang pagkagawas an mga sintomas sini nga *decompression disease* sakob hin pira la ka-oras tikang ha paglurop. An pinakamenos nga sintomas amo in pangatol ngan paralisis naman an pinakagrabe nga kaso.

Agud malikyan ini nga *decompression disease*, kinahanglan hinay-hinay an paglangoy tipabawbaw agud mapugngan an pagporma han mga bura sakob ha lawas. An epekto han *decompression disease* nadepende ha kaihaon ngan kahilarumon han paglurop. May-ada balayan nga nagpapakita han tama nga oras ngan kahilarumon ha paglurop agud malikyan an *decompression disease*.

Kaya han lawas han tawo magdara hin maabot 2 ka-litro nga *nitrogen gas*. Karuyag sidngon sini nga haros wray kadelikaduhan ha *decompression disease* kun abot la ha 10m an paglurop, kun diin an katunaw han *nitrogen* amo in 2 ka-litro. Ginbanabana nga waray mahitatabo nga *decompression disease* kun abot la ha 1m an kahilarum ha paglurop bisan kun ha mas maiha nga panahon. An paglurop nga waray kadelikaduhan han *decompression disease* amo an sinisiring nga *non-decompression diving*.

x. Paglikay ha pagsakay ha eroplano katapos maglurop

Ha eroplano, namenos an presyon hin 1 atm. An mga bura nga natunaw durante han paglurop pwede maporma na liwat nga mga bura tungod ha pagmenos han presyon. Sanglit, eginrerekomendar nga kinahanglan likyan an pagsakay ha eroplano 12 ka-oras (mas maupay 24 oras) katapos maglurop. Kinahanglan an igo nga panahon nga umestar ha tuna an mga paraglurop agud maka-*adjust* an ira lawas antes sumakay ha eroplano.

C Pisikal nga kakayahan paglurop

An lawas han tawo may pisikal nga kakayahan nga para la han kinabuhi ha katunaan. Matuod, may-ada maglibsog nga mga tawo nga naayon ha paglurop. Bisanpaman, tungod nga nakakatagamtam an lawas hin dirudilain nga pisikal nga problema kun *compressed air* an ginagamit pagginhawa durot han hitaas nga presyon ha ilarum ha tubig, may-ada mga tawo nga diri gud kaangayan maglurop.

1. *Physiological* (medikal) nga kakayahan

i. Talinga-irong nga sistema (*Laryngological system*)

May mga tawo nga kinaiyahan na nga haligot/kurbada an kanal han talinga o han irong asya nga diri hira nakakahimo han *ear unplug* ug diri nakakagbalanse. Ini nga mga tawo may tendensiya nga magkamay-ada hin seryoso nga problema sugad han pagkabuong han manipis nga putos ha sakob han talinga o pag *squeeze* ha kanal han irong, ngan diri ini hira pwede maglurop.

ii. **Sistema ha Pagginhawa (*Respiratory System*)**

An mga tawo nga may-ada na sakit ha baga sugad han hika o pulmonya, maluya na an baga ug pwede magkamay-ada problema ha paglurop. Ginsasagdonan nga magpakonsulta anay ha doctor antes pagtikang ha paglurop.

iii. **Sistema ha Sirkulasyon han Dugo (*Circulatory System*)**

Adton may-ada mga sakit ha talinga, *anemia*, ngan alta-presyon diri pwede maglurop. Ilabi na an *cardiac angina* (sakit ha kusog han kasing-kasing) nga pwede magduso hin *stroke* durante ha paglurop ngan delikado ini kaupay.

iv. **Sistema nga may kalabutan han utak ngan nerbo (*Neural System*)**

May kadelikaduhan nga malumos an may epilepsi, dayabetes, nahiloan, ngan iba pa nga sakit nga pwede magresulta han kawad-i balatian (kadismayo).

2. Pisikal nga kondisyon

Adton waray pisikal nga mga problem paglurop pwede diri makaglurop tungod han ira kondisyon hiton nga adlaw o kun hira in masakit.

i. Sip-on

An sip-on nakakabara han kanal ha talinga ngan ha irong. Hini nga kondisyon, diri hira makakaghimo han *ear unplug*. Kun maglulurop nga may sip-on pwede makagdurot hin duro nga *squeeze* ha butnga nga parte han talingan ngan han *nasal cavity*.

ii. Pag-inom

An paglurop ilarum ha impluwensya han alcohol (irimnon) nakaka-apektar han normal nga sistema ha pagginhawa ngan han *neural* nga sistema. Pwede ka maapektuhan han *nitrogen narcosis* ngan *decompression disease*.

iii. Ka-piraw ngan ka-pagal

An kakulang katurog (ka-piraw) ngan ka-pagal negatibo nga maka-apektar ha paglurop. May tendensiya liwa ini nga magresulta ha *squeezes*.

3. Paglurop ngan an kababayen-an

i. An temperatura panlawas han babaye

An taba ha lawas han tawo may-ada *thermal insulation effect* (nakabulig pagnormalisa han temperature ilabi pa kun aada hin mahagkot nga lugar) . An babaye mas damo an taba ha lawas kumpara ha lalaki. Sanglit, an babaye

mas nakaka-ato han taghom (habubo nga temperature) ha kabug-osan. Usa ini nga bentaha ha paglurop.

Ha luyo nga bahin, an lawas han babaye mas guti an kusog (*muscle*) kumpara ha lalaki. An paso ha lawas natikang ha mga kusog sanglit mas guti an paso nga nahihimo han babaye kumpara ha lalaki. Dugang pa, an babaye nga diri paprehas an linya han lawas mas halapad an *surface area* kumpara ha lalaki sanglit mas madagmit nawawara an paso ha lawas han babaye kumpara ha lalaki. Amo ini an mga disbentaha ha paglurop han babaye.

Diri pa gud napapamatud-an nga mas hitaas an ilob ha taghom han babaye, ngan mas naagay hira maglurop kumpara ha lalaki.

ii. Paglurop ngan pagregla

Durante han temoprano nga parte han pagregla, naobserbahan nga naumento an pagkarga han tubig ngan pag-umento han timbang. Naieksperyensyahan liwat an suol ha ulo ngan kakulang kontrol ha emosyon. Maano pa man, napamatud-an na ha medikal nga ha kabug-osan diri seryoso nga problema ha paglurop an pagkamay-ada hin regal.

iii. Paglurop ngan pagburod

May-ada opinion medikal nga diri angay maglurop an usa nga burod ha msa hilarum pa han 18m ngan angay likyan an kondisyon nga habubo an temperature; kundi diri pa gud igo an mga datos medikal nga magsusuporta hini nga opinion. Ha pinakamenos, diri angay maglurop nga nagkikinahanglan hin maiha nga pagpugong ha pagginhawa nga maghahatag kadelikaduhan ha bata tungod han habubo nga suplay han *oxygen*.

D. Plano Paglurop

1. *Decompression diving* ngan *non-decompression diving*

Kun an paraglurop nalangoy tipabawbaw ha haligot nga oras katapos maglurop ha talaan nga oras ngan kahilarom, pwede hiya maapektuhan han *decompression disease*. Agud malikyan ini, kinahanglan hinay-hinay an kanya pagtipabawbaw diin napahuway ha kada takna (pananglitan, ha 6m ngan 3m nga kahiladmon) agud maigawas an *nitrogen gas* tikang ha lawas. An sugad nga paglangoy nga *stepwise ascending* asya an sinisiring nga *decompression diving*.

An tipo hin paglangoy nga dirudiretso an tipabawbaw nga waray pagpahuway ha kada takna asya an sinisiring nga *no decompression diving*. Hababaw la an ginluluropan ngan diri maiha an paglurop ha *no decompression*

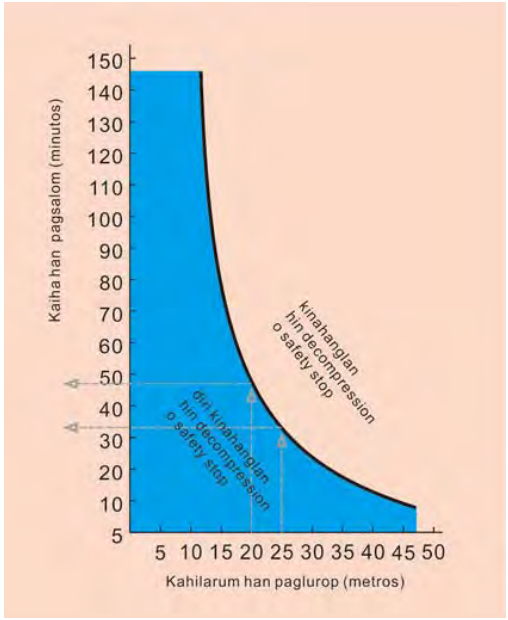
diving, agud waray kadelikaduhan (o risgo) han *decompression disease*.

Nagkikinahanglan hin espesyal nga mga gamit ha *decompression diving* sugad han ***depth meter*** **(nagsusukol han kahilarumon)** ngan BCD (buoyancy control device) [ekipahes nga nagkokontrol han pagkamalutaw] agud eksakto nga nasusunod an libre nga operasyon pagtipabawbaw. Posible nga himuon an ngatanan nga operasyon ha katubigan nga ginkikinahanglan para han *grouper farming* ha Victory Island ha QIP. Kinahanglan ha mga maglulurop nga maghimo hin plano ha paglurop sakob han oras (kaihaon) ngan kahiladmon subay ha ginpakita ha *graph* para han *no decompression diving*. An may asul nga kolor nga parte han *graph* nagpapakita han kumbinasyon han kahiladmon ngan oras ha paglurop ilarum han *no decompression diving*.

2. An paglurop nga *no decompression*

Kun ada la hamabaw an paglurop han tawo, pananglitan menos hin 1 ka metro, waray kakulba-an o *risk* hin pagkamay-ada *decompression sickness* bisan pa hiya maiha ha sugad nga kahalarom. Samtang nagtitika hilarom an pagsalom, nagtitika hitaas an *risk* nga magkamay-ada hin *decompression disease.* An kumbinasyon han kahalarom han pagsalom ngan an kaiha han paraglurop ha sugad nga kahalarom kun diin waray *risk* hand compression *sickness*, amo an gin tatawag nga *no decompression diving.*

An *graph* ha tuo nagpapakita han *boundary* han *no decompression* ngan an *decompression diving*. An naka-asul nga kolor nagpapakita kun pira ka minutos ha kadurudilain nga kahalarom an gin tatawag nga *no decompression diving*. An *X-axis* nagpapakita han kahalarum ha metros ngan an *Y-axis* nagpapakita hin han kaiha ha minutos ha sugad nga kahalarum. Pananglitan, ha pagsalom ngadto ha 20 metros, an pinakamaiha nga magpabilin an paraglurop ha sugad kahilarom nga diri hiya magkakamay-ada *decompression sickness*, amo in mga 48 minutos la.



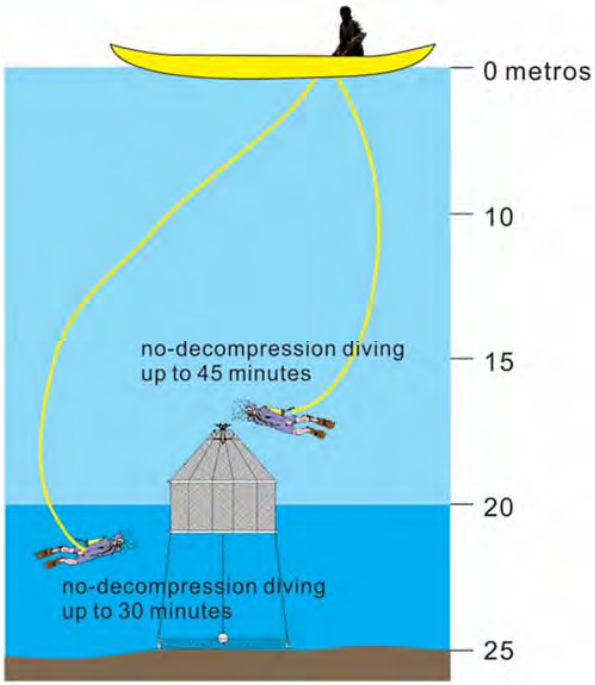
Puyde mabasa an *graph* pinaagi han: 1) pagsurat hin

linya pa-igbaw tikang han 20 metros ha *x-axis*, 2) kun umabot an linya ha kurba han *no decompression*, birik ngadi ha wala, 3) ngan pagsurat hin linya kutob ngadto han *Y-axis* kun diin mababasa an pinamaiha nga minutos nga puyde para han *no decompression diving*.

Pareho han ha kahilarom nga 25 m, kutob mga 33 minutos la didto an paraglurop para mahimo nga *no decompression diving* ini.

An gagamiton nga kahilarom ha *graph* amo an gin plaplanuhan nga pinakahilarom nga pagsalom han paraglurop hito nga pagsalom (bisan pa daw kadali la adto), diri an kahilarum kun diin didto ma-ukoy hin maiha an paraglurop o an *average* man han mga kahilarum nga kakadtuon.

Ha Victory Islad, ginbubutang han mga parapangisda an ira mga hawla han laup-lapu ha 20 metros kahilarum para magkamay-ada mapula nga kolor an isda *(Plectropomus leopardus*) ngan mapalit hin hitaas nga presyo kun igbaligya nga buhi. Ha palibot han Victory Island, an kahilarum han tubig nga binubutangan han mga hawla han lapu-lapu naabot hin 25 metros. An disenyo han JICA nga mga hawla natugot hin pagbutang han mga hawla ha magdurudilain nga kahilarom pinaagi han pag pahalaba o pagpahalipot han pisi nga nakahigot ngadto han lidong nga ankla. Gin rerekomendar nga igbutang an mga hawla ha kahilarum ubos hin 20 metros para an gagamiton nga kahilarom ha *graph* mga 25 metros kay an kaurog nga pagsalom amo an pagtubong ngan an inadlaw-adlaw nga panginano (*monitoring*) bubuhaton ha 20 m. Para hini nga kahilarum, 45 minutos an kaiha ha ilarom para *no decompression dive*. Ayaw gud paglapos hini nga kaiha.



Kun an trabahuon malapos hin 45 minutos para matapos, maupay nga magpabulig hin iba pa paraglurop. An kaiha ha ilarom han kada paraglurop diri malapos hin 45 minutos. An nagpapaandar han kompresor ha baluto magbabantay han oras ngan mahatag hin sinyales para pagpasabot ha mga nanlurop nga oras na nga pumabawbaw. An mga naglurop diri na malurop otro hito nga adlaw kay an epekto han pagsalom napabilin ha 6-12 oras.

Para han mga trabahuon nga nakinahanglan pagkadto ha salad nga 25 metros, pananglitan para mag-ayad han angkla o paghubad han mga pisi ha angkla para pagbutang han semilya, pag-ani o pagbalyo hin *net*, an kaiha ha ilarom kinahanglan di malapos hin 30 minutos.

Pirmi buhata an *no decompression diving* para mapamenos hin dako an pagkamay-ada hin decompression disease. Ha paglangoy pabalik ha bawbaw, himua nga batasan an pag-ukoy hin 3 ka minutos o mas maiha pa ha pag-abot ha 5 metros kahilarom san-o magpadayon pagtipa-igbaw.

3. Safety Stop

An *safety stop* amo an pag ukoy anay han pagtipa igbaw han paraglurop. Ini nga pag ukoy hin 3 o sobra pa ka minuto, agsob gin bubuhat ha 5 metros o 15 piyes tikang ha bawbaw san-o magpadayon paglangoy tipa igbaw. Para ini pagpagawas han natirok nga *nitrogen gas* ha lawas dida han paglurop. Himua ini nga batasan nga pag ukoy ha kada pag lurop. Ayaw gihap balik pag lurop ha sulod hin 6 ka oras tikang han imo una nga pagsalom. Kun mahimo, usa la ka beses pag lurop ha usa ka adlaw.

E. Ekipahes paglurop para ha SASUBA

Ig-eeksplikar an gamit han kada ekipahes han sistema nga SASUBA nga gin kokompone han 1) kompresor nga ginpapaandar hin usa nga makina o *engine*, 2) tangke han hangin, 3) hose han hangin, 4) regulator. Importante nga an paraglurop gumamit hin *mask* o silip panlurop, *fins* o kaway, ngan *weight belt* o pabug-at.

1. Kompresor

Ini nga compressor diri nagamit hin lana o aciete para maghatag hin hangin ha ilarom han tubig. An nahihiraan nga kompresor nakinahanglan hin aciete pagpadalunot han pag andar ngan may nagawas nga aciete ngadto han hose nga gingagawsan han hangin nga posible maka halo ha hangin nga nahihinggok han paraglurop. An pagpasulod han hangin hini nga waray aciete nga kompresor nagamit hin *filter* o pino nga sara para diri maupod an mga bug-os nga hugaw ha hangin. Mayda *pressure release valve* ini nga kompresor nga ginpapahungaw an sobra nga presyon kun menos an gamit nga hangin han paraglurop. Gin kakarga ini ha baluto ngan gin papadalagan ini hin de gasoline o disel na makina.

2. Tangke han hangin

An hangin tikang ha kompresor naagi anay ha usa nga tangke han hangin bag-o magamit han paraglurop. Ha sulod han tangke, gin papatugnaw ngan gin kukuha an tubig nga nasalakot ha hangin. An natirok nga hangin ha tangke namentinar han eksakto nga kadamo nga gingagawas nga hangin kun an kompresor naghuhugak-hugak ngan padayon nga nahatag hin reserba nga hangin ha naglurop ha sulod hin pira pa ka minutos bisan tigda na di na umandar an kompresor.

3. *Air hose* o hos para hangin

An hose an nagdadara han hangin tikang ha tangke ngadto han paraglurop. An kahaluag han lugar kun diin an paraglurop nagamit han SASUBA, malilimitaran han kahalaba han hos. Pananglitan, ha paggamit ha pagpatubo hin isda ha hawla, an kahilaba han *hose* diri malapos han kahalarom kun hain an hawla gin butang. Kinahanglan an hos may kadakmolon nga mailob han hitaas nga presyon han hangin tikang ha tangke ngan diri madali mapilo.

4. *Regulator*

An hangin gin hihinggok han paraglurop pinaagi han *regulator* nga nakataud ha katapusan han hos. Ha sulod han *regulator,* may *valve* o dila-dila nga naabre kun an paraglurop nahinggok hin hangin ngan nasara liwat kun naginhawa paggawas. Nahatag la ini hin hangin kun na hinggok an paraglurop. An kadamo han hangin nga kinahanglan la han paraglurop an ihahatag hini nga mekanismo amo nga gintatawag ini nga *demand regulator*. Mas masayon an pag ginhawa ha ilarom kun nagamit hin *mouthpiece* o an gin babanga han naglulurop.nga mayda *regulator*. Ha pagtikang han paglurop o ha kada beses nga an *mouthpiece* nagagawas ha baba, importante nga pagawson anay an tubig ha sulod han *mouthpiece* pinaagi han pagduon han *flexible diaphragm* ha may printi nga dapit. Katima paggamit, pahurumi hin kadali-ay ngan banlawi hin presko nga tubig. Ayaw igduon an *flexible diaphragm* samtang nagbabanlaw para diri sumulod an tubig ha hose ngan dumiretso ngadto han tangke.

5. *Mask*

An lamrag o *light* naiba kun ada ha tubig. Sanlit an at mata nga nakita pinaagi han kun natipa unan-o an lamrag nagi-os ha hangin, di gud nakakita hin klaro ha tubig, nakinahanglan han spasyo nga ada sulod han *mask* para makaklaro. An eksakto nga *mask* para paglurop amo an desinyo nga kun diin an irong ada ha sulod han mask pero puyde mapislit an irong para pag *equalize* o ear unplug ngan di mag kamay ada *mask squeeze*. Para diri maglubog an salamin han mask, gamita an im lura pagpahid ha sulod nga salamin han mask ngan banlawi hin kadali la ka usa kabeses.

6. *Fin (*kapay)

An kapay gamit para magpakurukusog pa han pwersa han imo tiil ha paglangoy.

7. Pabug-at o *weight belt*

Makapagdagmit an pabug-at ha im paglurop pero kinahanglan diri masyado mabug-at an imo gagamit nga pabug-at kay makukuri-an ka pag-gios ha ilarom ngan madali ka la kakapuyon.

8. *Diving garments* o bado para paglurop

Kun diri ka magamit hin *wet suit*, bisan T-shirt o sweatshirt makabulig para di mabag-id ha im panit an im mga igtataod ha lawas pareho han pabug-at.

9. *Glove, boots*

Mas protektado ka kun magamit hin *gloves* labi kun kinahanglan may kakapton ha ilarom han tubig. Likayi pagkapot hin ano man nga di nimo nakikilal-an. An *boots* ha paglurop makahatag hin proteksyon ha im tiil labi na kun damo an makakasamad ha lugar nga paglulurupon