

Oil & Gas Safety Engineering & Management



Why HSE is so important in Oil & Gas?

- This industry involves high risk activities including but not limited to exploration, production and processing of highly flammable & explosive materials
- Massive manpower, heavy-complicated-expensive machinery and extensive support system
- High investment and long payback period
- Strategic and vital industry
- Remote and Harsh Environment
- Accident consequences could be catastrophic in terms of number of casualties, environment pollution, lost of investment and reputation damage

Piper Alpha Platform, UK North Sea



- Operated by Occidental Petroleum (Caledonia) Ltd. Produces 10% north sea oil
- Explosion in 6th July 1988, killing 167 men, only 61 survivors. Total insured loss was about USD 3.4 billion
- Still hold the work record as the worst offshore oil disaster in terms of lost of lives

BP Macondo – Deep water Horizon, US GoM



- Well blowout on 20 April 2010 in Macondo Prospect operate by BP resulting explosion in Deep water Horizon semi submersible rig (transocean operated), 11 people lost and never found
- Oil keep flowing from subsea well for 87 days until capped at 15 July 2010, estimated 4.9 million barrels total discharge to Gulf of Mexico
- In July 2015, BP agreed to pay USD 18.7 billion penalty, the largest in US history
- Still hold the world record as the largest accidental marine oil spill

Understanding Hazard and Risk

- Hazard is any source having potential to damage harm, or adverse health effects on something or someone under certain condition at work
- Hazard can cause harm or adverse effects (to individual as health effects or property losses)
- Example

Source	Hazard	Harm Caused
Object	Knife (sharp edge)	Cut
Material	Benzene	Leukemia
Energy source	Electricity	Electrocution
Condition	Wet floor	Slip, fall
Process	Welding	Metal fume fever

Risk

- Risk is the chance of probability that a person will be harmed or experience an adverse health effect if exposed to a hazard.
- It may also apply situations with property or equipment loss
- Risk is the combination of likelihood and severity of a specified hazardous event occurring. In mathematical term, risk can be calculated as:

$$\text{Risk} = \text{Likelihood} \times \text{Severity}$$

Risk

- Likelihood is an event likely to occurs within specific period or in specified circumstances
- Severity is the outcome from an event such as injury or health of people, or damage to property, or environment pollution, or any combination of those

Hazard Identification and Risk Assessment

- It is a process to identify hazards, analyze or evaluate the risk associated with that hazard, and determine appropriate ways to eliminate or control the hazard
- In practical terms, it is a thorough look at your workplace to identify those things, situations, processes, etc. that may cause harm, particularly to people
- After identification is made, you evaluate how likely and severe the risk is, and then decide what measures should be in place to effectively prevent or control the harm from happening
- All risk will be tabulated and scored to determine the overall risk

Sample of Consequence Table

Severity	People	Asset Damage	Environment (Oil spill)	Media
Catastrophic	Multiple fatalities	> USD 50,000	> 500 barrels	International news
Fatal	Single fatality	< USD 50,000	< 500 barrels	National news
Major	Lost Time Incident	< USD 10,000	< 100 barrels	Local news
Moderate	Restricted Work Day	< USD 5,000	< 5 barrels	Local rumor
Minor	First Aid	< USD 1,000	< 1 barrels	Internal rumor

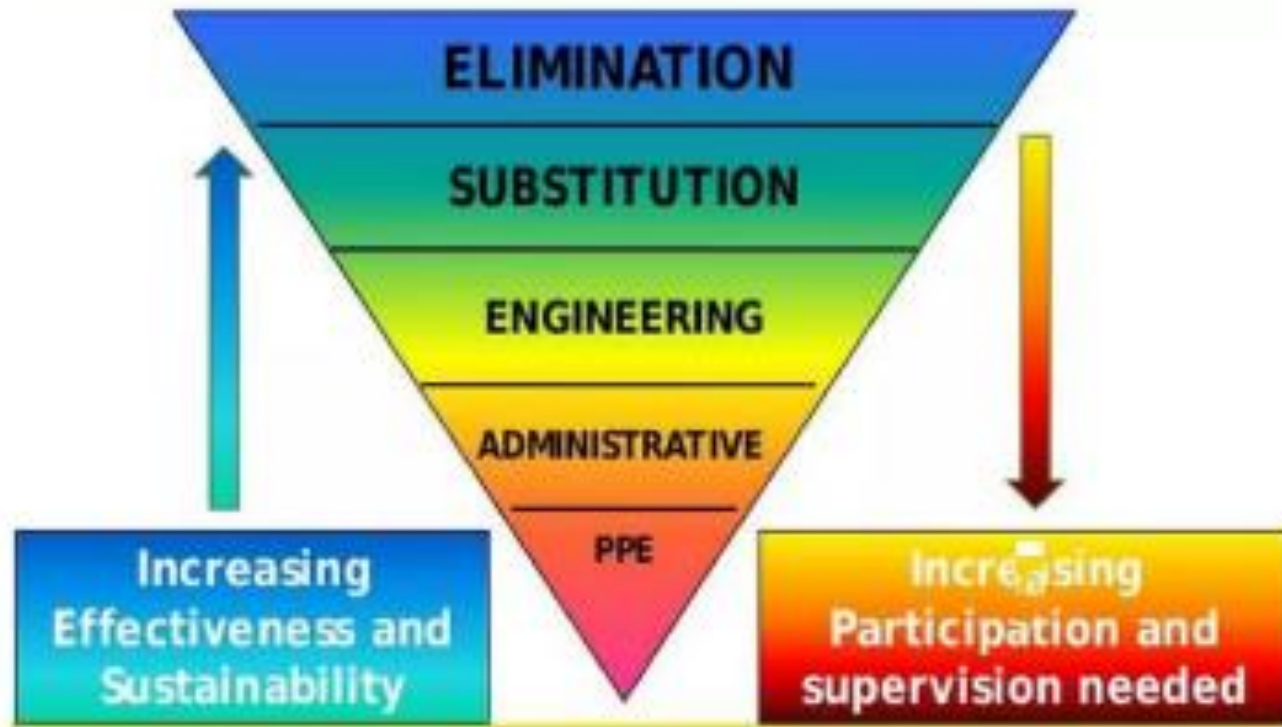
- Likelihood / probability of an accident happen can be known from international / company standard, if not available then professional judgment with supervisor approval is required.

Sample of Risk Assessment Table

			Potential Consequences				
			L6	L5	L4	L3	L2
			Minor injuries or discomfort. No medical treatment or measureable physical effects.	Injuries or illness requiring medical treatment. Temporary impairment.	Injuries or illness requiring hospital admission.	Injury or illness resulting in permanent impairment.	Fatality
			Not Significant	Minor	Moderate	Major	Severe
Likelihood	Expected to occur regularly under normal circumstances	Almost Certain	Medium	High	Very High	Very High	Very High
	Expected to occur at some time	Likely	Medium	High	High	Very High	Very High
	May occur at some time	Possible	Low	Medium	High	High	Very High
	Not likely to occur in normal circumstances	Unlikely	Low	Low	Medium	Medium	High
	Could happen, but probably never will	Rare	Low	Low	Low	Low	Medium

- Likelihood will be ranked, i.e. rare = 1, almost certain = 5
- Consequence also ranked , i.e. insignificant=1, catastrophic=5
- Risk will be ranked & categorized, i.e. risk<4=low, risk>15=extreme
- Higher risk means more precaution to be given to reduce the risk until acceptable level

Sample of Risk Assessment Table



- Each activity has different hazard, so the control method will also be different
- During HIRA session, control method for each hazard will be applied to reduce the hazard level until ALARP (As Low As Reasonable Practice)
- It is very important to understand the hazard and its control method
- Normally all control methods will be used during field work

Oil & Gas Hazards

- Pressure Hazards (High pressure oil / gas from reservoir, inside pipes & vessels, high pressure steam from boiler)
- Temperature hazards (High temperature at compressor discharge pipe, low temperature at liquid nitrogen tank)
- Motion hazards (rotating drill pipes, rotating motor shaft, swing object during lifting)
- Chemical hazards (corrosion inhibitor, lube oil)
- Electrical hazards (lightning, electric work)

Oil & Gas Hazards

- Gravity hazards (Slip, Fall, Falling object, Heavy lifting)
- Noise Hazards (High noise at compressor area)
- Hazardous atmosphere (gas release from vent, sulfide acid inside gas)
- Confined space hazards (work inside pressure vessel)
- Excavation hazards (laying buried onshore pipe)
- Sharp object hazard (work with grinding machine)

Oil & Gas Hazards

- Sharp object hazards (work with grinding machine)
- Water & Underwater hazards (scaffolding work above sea, subsea pipeline inspection)
- Radioactive hazards (welding inspection by X-ray)
- Manual Handling hazards (wrong position during manual lifting)

Controlling Oil & Gas Hazard - 1

Case Study 1: High Pressure Oil / Gas from the Reservoir

- Elimination: not possible since our goal is to extract oil & gas from the reservoir to the surface
- Substitution: Not possible
- Engineering: Install Blow Out Preventer (BOP) during drilling and Christmas Tree during production
- Administrative: Permit to Work during drilling operation and drilling SOP shall be strictly followed
- Personal Protective Equipment: Special PPE during drilling shall be worn, i.e. high impact hand gloves

Controlling Oil & Gas Hazard - 1



Blow Out

BOP



High Impact Gloves

Controlling Oil & Gas Hazard - 2

Case Study 2: High Temperature at Compressor Discharge Pipe

- Elimination: Not possible since during compression, kinetic energy absorbed will be converted into heat
- Substitution: Also Not possible
- Engineering: Install pipe insulation which can withstand the max. temperature of compressed gas but the outer part is still cool enough if touched by human
- Administrative: At least safety induction for personnel who will work at compressor area
- Personal Protective Equipment: At least standard PPE shall be worn

Controlling Oil & Gas Hazard - 2



Pipe Heating Insulation

Gas Turbine
Compressor



Controlling Oil & Gas hazard - 3

- In general, hazard elimination is almost impossible in many case, that's why oil & gas industry had been a long time considered as a high risk industry
- However, due to its high and strategic value of oil & gas experts had developed special engineering to ensure the safety of this industry
- Basically there are 2 types of safety engineering
 1. **Process Safety:** focus on preventing fires, explosions and accidental chemical release in process facilities
 2. **Occupational safety & health:** focus on the management of personal safety
- Since safety engineering only is not sufficient, specific procedures, guidelines, and permit to work must be applied for specific activities on the field
- PPE shall be considered as the last protection to human an certain job need special PPE in addition to standard PPE, i.e. welding job need special welding mast, not just safety glasses

Human factors in Hazard control

- From human perspective, controlling hazard must involve the knowledge and the health
- Special training is required for personnel working in dangerous location like oil and gas industry
- For people working or just visit to offshore facility, especially when travelling by helicopter, they must completed BOSIET (Basic Offshore Safety Induction and Emergency training) or T-BOSIET (Tropical BOSIET) for tropical region
- BODIET consists of
 - Safety Induction
 - Helicopter Underwater Escape Training
 - Sea Survival
 - Fire Fighting
 - First Aid
- Beside training, personnel shall pass medical check up and not under drug and/or alcohol influence



BOSIET



Incident Definition

Incident:

- An unplanned, undesired event that hinders completion of a task and may cause injury, illness, or property damage or some combination of all three in varying degrees from minor to catastrophic.
- Unplanned and undesired do not mean unable to prevent
- Unplanned and Undesired also do not mean unable to prepare for Crisis planning is how we prepare for serious incidents that occur that require response for mitigation.

Incident Definition

Accident:

- Definition is often similar to incident, but supports the mindset that it could not have been prevented.
- An accident is the opposite of the fundamental intentions of a safety program, which is to find hazards, fix hazards, and prevent incident.
- When we accept that accidents have no cause, we assume that they will happen again

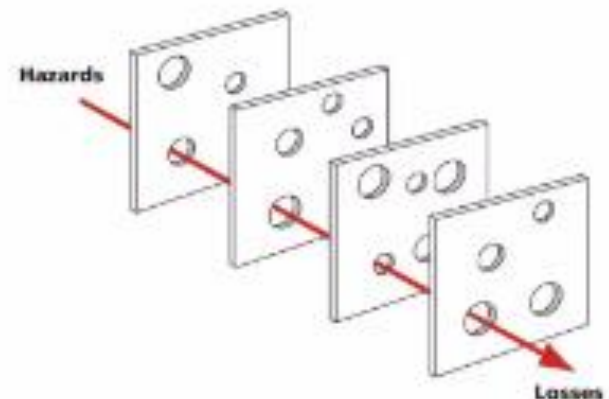
Incident Definition

Near Miss:

- A subset of incident that could have resulted in injury, illness or property damage, if given a different set of circumstances, but did not.
- Near misses are also known as 'Close Calls'.
- Perhaps the better term to consider is 'Near Hit'

Swiss Cheese Models

- It is model to show that a risk of threat becoming reality (incident) is mitigated by the differing layer and the types of defenses which are layered behind each other
- In other world, incident is caused by multiple (not just one) failure of protection system
- After an accident, a team of investigator will conduct a root cause analysis to find the cause and propose the improvement to prevent the similar thing happen again.



Occupational Injury (OI)

- A pain (cut, fracture, sprain, etc.) resulting from a work related activity (activities in work environment which are or ought to be subject to management controls)



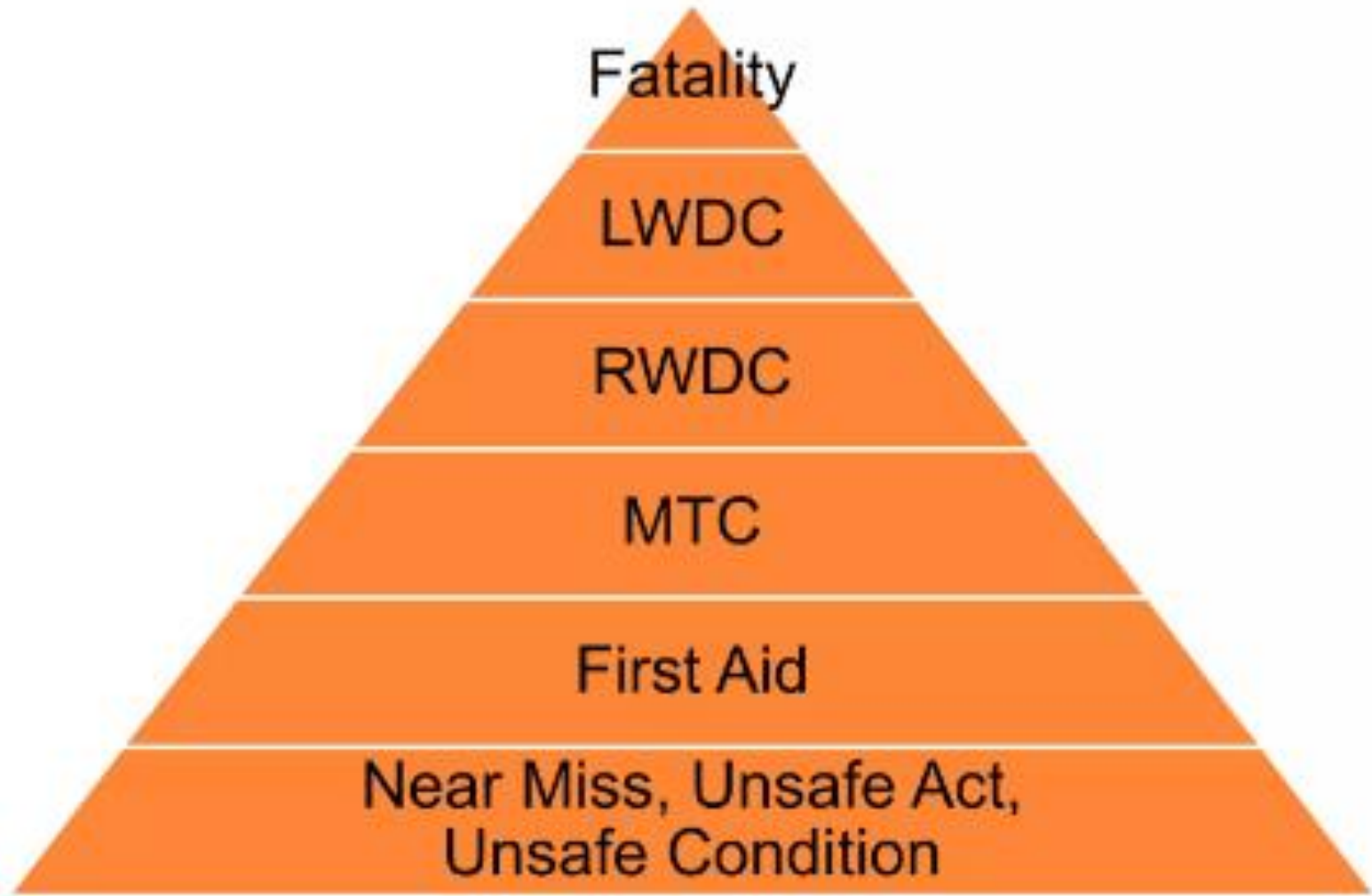
Occupational Injury (OI)

Classifications:

- **Fatality**
 - OI which results loss of life, either immediately or after being hospitalized
- **LWDC (Lost Work Day Case)**
 - OI which results in person being completely unfit to work on any day after the incidents
- **LTI (Lost Time Injuries)**
 - Cases involving LWDC and fatality
- **RWDC (Restricted Work Day Case)**
 - OI which results in a person being unfit for full performance of the regular job on any day after the incident
- **MTC (Medical Treatment Case)**
 - OI which is more severe than first aid but less than RWDC
- **FAC (First Aid Case)**
 - OI which can be cured by simple first aid treatment

Note: Classification may differ for different company

Occupational Injury Triangle



Permit to Work (PTW)

- Formal management system used to control high risk activities. These enables an assessment of risk to be made and to specify control measures which will be put in place in order to minimize the risk
- It is legal document which will be used as a reference in case of accident happen
- Permit to Work must be evaluated by Safety Authority and Operating Authority and approved by Installation Manager / Site Manager
- Two types of main permit
 - COLD (No ignition source)
 - HOT (involve ignition source)

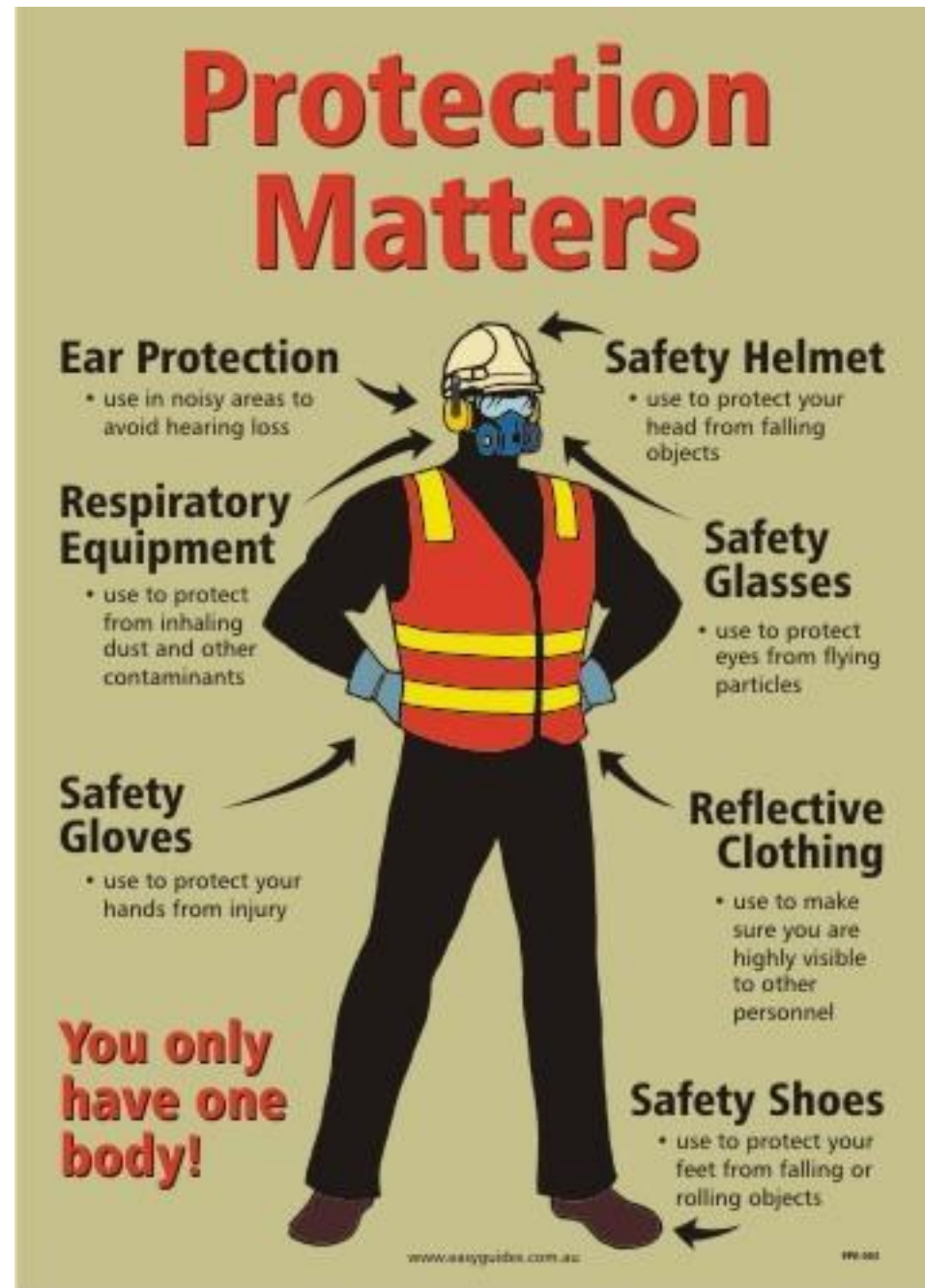
Permit to Work (Sample)

Permit to Work										THIS PERMIT NEEDS TO BE DISPLAYED AT ALL TIMES			
Location:						Date Issued:		Permit Number:					
Plant Identification:						Start Time:		Finish Time:					
Type of Permit: Tick ✓		General	Electrical	Roof Void & Heights	Hot Work	Confined Spaces	Other Specify	Asbestos special permit required					
Name of Contractor/Company:			Work to be carried out, and approx time req:			Precautions:		Protective Equipment:					
Risk Assessment Method Statement & Liability Insurance provided by contractors						Scaffolding checked and signed off		Yes No N/A					
						Ladders checked (to be tied/footed)		Yes No N/A					
						Floor area clean/dry		Goggles					
						Harness to be worn		Gloves					
						Area safe (cordoned off)		Safety Footwear					
						Correct fire protection within 3m		Hearing Protection					
						Fire guard required		Hard Hat					
						Area clear of combustible materials		Dust Mask					
						Sewers, drains, sealed within 5m		Safety Harness					
								High Vis. Jacket/Vest					
Safety Precautions (To be completed by the person responsible for carrying out the work)					Yes	No	N/A						
1. Have you been given a copy of the Site Safety Rules?													
2. Has a risk assessment been carried out?													
3. Are the workforce qualified to carry out the task?													
4. Is appropriate PPE available? (Tick box for Protective Equipment)													
5. Isolated electrical supply? Work in accordance with current Electricity at Work regs.													
6. Voltage detection instrument required?													
7. Isolator locked off / tagged? Work in accordance with I.E.E. Wiring regs. (BS7671).													
8. Is work being carried out at height?													
9. Are ladders or Scaffolding required - Maintained in safe cond. - ready to use?													
10. Is a license required and in place for scaffolding?													
11. Are personnel aware of means of escape and method of raising alarm?													
12. Risk of falling objects?													
13. Details of fragile roof explained?													
14. Are at least two fire extinguishers available?													
15. Are personnel trained in use of fire extinguishers?													
16. Have flammable liquids / materials been removed from area?													
17. Have Gas cylinders been properly secured?													
18. Is safe access and egress confirmed?													
19. Are personnel trained and supplied with Breathing Apparatus?													
20. Lifeline and rope held on outside of confined space?													
Services to be isolated: Eng. Name & Sign					Yes	No	N/A	Specify					
Fire Alarm / Zone													
Electrics													
Water													
Gas / "Specify"													
Hazardous Chemicals													
Advise relevant departments of any intended isolation & signage posted.													
COSHH and Lone Working					Yes	No	N/A						
Has COSHH data been supplied with substances?													
Have COSHH precautions been identified & implemented?													
Is work being carried out by a Lone Worker?													
If Yes is monitoring required?													
Daily Inspections													
Initials													
Date													
Time Checked													
Fire watch (To be completed by member of staff or Contractor responsible for this work before returning this permit.)													
Recommended Duration:													
Name:								Signature:					
Position:								Date:					
Site Contact					CONTRACTOR TO ENSURE THE SECURITY OF THE WORK AREA AND/OR BUILDING AT ALL TIMES								
Issuing Authority:					Hand back:								
I authorise the work to be carried out and have notified the relevant personnel.					I certify that all work is completed and left in a safe condition. This permit is now cancelled.								
Name: _____ Signature: _____					Name: _____ Signature: _____ Date: _____								
Performing Authority:					Hand back:								
I have read and understand the conditions of this permit.					I certify that all the work is complete, all guards and safety devices reinstated and the area clear.								
Name: _____ Signature: _____					Name: _____ Signature: _____ Date: _____								

Permit to Work Flow Chart



Personal Protective Equipment (PPE)



TYPES OF PPES

❑ Respiratory Protective Equipment

e.g. SCBA, Air Respirators etc.



❑ Non- Respiratory Protective Equipment

e.g. Hard Hat, Gloves, Goggles, Safety Shoes etc.



NON-RESPIRATORY PROTECTIVE EQUIPMENTS

COMMON PPE

- ☐ Head Protection
- ☐ Eye & Face Protection
- ☐ Hand Protection
- ☐ Foot Protection



TYPES OF EYE & FACE PROTECTION

- ☐ Safety Glasses
- ☐ Safety Goggles
- ☐ Face Shields
- ☐ Welding Goggles
- ☐ Laser Safety Glass



TYPES OF GLOVES

- ☐ Leather Gloves
- ☐ Cotton Gloves
- ☐ Chemical Protection Gloves
- ☐ Insulated Rubber Gloves
- ☐ Welding Gloves



RESPIRATORY PROTECTIVE EQUIPMENT

- Respiratory protective equipment are **Life Saving Equipment**



TYPES OF PROTECTIVE DEVICES

- ☐ Air Purifying Devices (APD)
- ☐ Air Supplying Devices (ASD)
- ☐ Combination of air purifying and air supplying devices



AIR PURIFYING DEVICES

- Air purifying device cleans the contaminated atmosphere

Various types of air purifying device

- * Mechanical Filter Cartridge
- * Chemical Cartridge
- * Gas Mask
- * Powered Air Purifying Devices



AIR PURIFYING DEVICES



**Exposure to
silica dust in
construction
work**



AIR SUPPLYING DEVICES

- Air supplying devices provide respirable atmosphere to the wearer, independent of the ambient air

Types of Air Supplying Devices

- ❑ Self Contained Breathing Apparatus (SCBA)
- ❑ Compressed Air Breathing Apparatus (CABA)
- ❑ Emergency Escaping Breathing Apparatus (EEBA)
- ❑ Air Line Respirator (ALR)



BREATHING APPARATUS ANATOMY





Safety Helmet

High-visibility/reflective shirt/vest/coveralls. Fire retardant clothing if exposure to hydrocarbons.

Leg covered to ankles



SAFETY CAMPAIGN

12 Lifesaving Rules



Work with a valid
Work Permit when required



Do not walk under
a suspended load



Verify isolation before work
begins and use the specified
life protecting equipment



Wear your seat belt



Obtain authorisation before
entering a confined space



Protect yourself against a
fall when working at height



Conduct gas tests
when required



While driving, do not use
your phone and do not
exceed speed limits



No alcohol or drugs while
working or driving



Obtain authorisation before
overriding or disabling
safety critical equipment



Do not smoke outside
designated smoking areas



Follow prescribed Journey
Management Plan



**There is No Important Job that
you have No time to do it safely**