KILKENNY FIRE and RESCUE SERVICE

DRIVER AND PUMP OPERATORS COURSE

AT

KILKENNY CITY FIRE SERVICE HEADQUARTERS

3rd – 7th September 2007

FIRE and RESCUE SERVICE
KILKENNY
PREVENTING PROTECTING RESPONDING

MONDAY

09.00 – 09.15	**Introduction to Course**	**C.F.O.**
09.15 – 09.45	**Health & Safety**	**S.A.C.F.O.**
09.45 – 10.45	**Introduction to Appliances – Controls, warning lights, gauges, safety alarm etc.**	
10.45 – 11.00	**Tea Break**	
11.00 – 12.00	**Driver Familiarisation**	
12.00 – 13.00	**Driving Instruction**	
13.00 – 14.00	**Lunch**	
14.00 – 15.00	**Introduction to pumps and primers**	**14.00 – 15.00) - P.J. Butler**
15.00 – 17.00	**Open driving**	**15.00 – 16.00)** **16.00 – 17.00)**

TUESDAY

09.00 – 10.00	**Positioning Appliances – Ladder & Hose Reel Drill**	
10.00 – 12.00	**Pumping from open source**	
12.00 – 13.00	**Driving Instruction**	
13.00 – 14.00	**Lunch**	
14.00 – 17.00	**Driving Instruction**	**14.00 – 15.00) - P.J. Butler** **15.00 – 16.00)** **16.00 – 17.00)**

WEDNESDAY

09.00 – 10.45	**Introduction to G.P. 1600 and Ziegler Pump, priming demo and practice priming**	
10.45 – 12.00	**Practice priming with portables and main appliance**	
12.00 – 13.00	**Driving Instruction**	**P.J. Butler**
13.00 – 14.00	**Lunch**	
14.00 – 17.00	**Driving Instruction**	**14.00 – 15.00) – P.J. Butler** **15.00 – 16.00)** **16.00 – 17.00)**

THURSDAY

09.00 – 13.00	**Driving Instruction**	**09.00 - 10.00) - P.J. Butler** **10.00 - 11.00)** **11.00 – 12.00)** **12.00 – 13.00)**
13.00 – 14.00	**Lunch**	
14.00 – 15.30	**Engine Failure main appliance**	
15.30 – 17.00	**Relay Pumping**	

FRIDAY

09.00 – 13.00	**Open Driving / Pump Operation**	**09.00 – 10.00) – P.J. Butler** **10.00 – 11.00)**
13.00 – 14.00	**Lunch**	
14.00 – 16.00	**R.T.A. Drill**	
16.00 – 16.30	**Cleaning and checking of equipment**	
16.30 – 17.00	**End of Course Discussion**	

KILKENNY
FIRE and RESCUE SERVICE

SECTION 1 - THE SYSTEM OF VEHICLE CONTROL

DEFINITION:
The system of vehicle control is a way of APPROACHING and NEGOTIATING hazards that is METHODICAL, safe and leaves nothing to CHANCE.

THE SYSTEM IS DIVIDED INTO FIVE PHASES:

1. **INFORMATION**
2. **POSITION**
3. **SPEED**
4. **GEAR**
5. **ACCELERATION**

THE FIVE PHASES OF THE SYSTEM ARE:

1. **INFORMATION** **T** AKE information
   U SE information
   G IVE information

2. **POSITION** Position yourself so that you can pass the hazard/s safely and smoothly

3. **SPEED** Adjust your speed as necessary. Use the accelerator, brake or (when necessary to avoid skidding) gears to give you the speed which will enable you to complete the manoeuvre. Make good use of acceleration sense.

4. **GEAR** Once you have the right speed for the circumstances, engage the correct gear for that speed. If you have to brake to get the right speed, you can make the gear change before the end of the braking (overlapping). But always avoid late braking and snatched gear changes.

5. **ACCELERATION** Take account of your speed, other road users, and the road and traffic conditions ahead, decide whether it is appropriate to accelerate away from the hazard. Choose an appropriate point to accelerate safely and smoothly.

SECTION 2 - WHAT MAKES A GOOD DRIVER

THIS SECTION COVERS

- **Statistics**
- **Pointers to Better Driving**

STATISTICS

When was the last time you had an accident, or maybe a near miss, and whose fault was it?

Following that incident, did you evaluate what happened? If not, then you probably learnt nothing from the experience and maybe you are still committing the same errors today.

Statistics show that 90% of all accidents are caused by driver error.

One third of all accidents are rear end shunts caused by driving too close to the vehicle in front;

One quarter of all accidents are caused by one vehicle driving across the path of another vehicle's priority; and

One sixth of all accidents involve a loss of directional control.

If only we would learn from our experiences by taking a look at what happened and making an honest evaluation, we could then incorporate the result into our driving standard, thereby eliminating the possibility of it happening again.

POINTERS TO BETTER DRIVING

Here are a few suggestions of how we can make a start to becoming a better driver.
You need to:

- Have a good level of attention
- Have accurate observations
- Match the vehicle speed and direction to the situation;
- Be aware of the risks inherent in particular road and traffic situations.
- Act to keep identified risks to a minimum.
- Be aware of your own limitations and those of the vehicle and the roads.
- Have skilful use of the vehicle controls.
- Assess your attitude to other road users.
- Assess your attitude to speed.
- Assess your attitude to risk taking.

A skilful driver will also be able to develop:

- A rapid and accurate perception of the relevant information.
- A rapid choice of an appropriate response.
- An accurate execution of the chosen response.

REMEMBER:

Practice makes perfect, but over-confidence is dangerous, particularly following a period of training, as drivers often overestimate their driving abilities.

SECTION 3 - OBSERVATION

THIS SECTION COVERS:

- **Scanning the Environment**
- **Hazard Awareness**
- **Driving Plans**

Observation means using sight, hearing and even smell to gain as much information about conditions as possible.

Good observation provides the extra time needed to react to any situation.

SCANNING THE ENVIRONMENT

Drivers who can scan a large area and prioritise the dangers they have seen have a lower accident rate than those who look at the same scene but cannot see any possible dangers.

You can improve your observations by:

- Moving your eyes and head in all directions
- Development your sensitivity to the variety of possible hazards in different driving situations
- Looking for hazards of any shape and size and from all directions.

Improving observations depends on learning experience and a commitment to developing this awareness.

Looking But Not Seeing

Drivers only see what they expect to see when they need to take action, and this usually results in driving actions being rushed due to inadequate planning. When you look ahead you must look for and expect to see objects within the range of your vision. Remember the words of former World Motor Racing Champion Jackie Stewart "Seeing is not something that happens, seeing is something you do".

Zones of Visibility

Looking ahead has already been mentioned but there are occasions where vision is restricted. However there are aids to help the driver when approaching these zones.
For example:

- When approaching a bend look for open spaces and breaks in hedgerows, fences and walls, it could show a hazard round the bend.
- The curvature of lamp posts or trees can indicate the severity of a bend.
- Using shop windows as a mirror to see round a bend.
- At night the angle of other vehicle's headlights or taillights can show the curvature of the road ahead.

HAZARD AWARENESS

Keep your Distance

The closer the driver is behind the vehicle in front, particularly if it is a heavy goods vehicle the less you can see. By dropping back two or three vehicle lengths, not only will the view be increased, the overall stopping distance will be improved.

Developing Your Hazard Awareness

In general when you hear your name mentioned you prick up your ears.

This alertness, along with the other senses can be used to your advantage in your every day driving. As you drive along the road looking ahead, your peripheral vision should react to any form of movement that may indicate a hazard.

Use the information gained from your observations to:

- Anticipate hazards
- Prioritise the hazards
- Decide what to do by formulating a driving plan.

Anticipation

Anticipation improves with driving experience and the amount of effort you put into developing it.

To this end observation links are of value, these include:

- Passengers standing up on a bus
- An ice cream van parked at the roadside
- Vehicles in a lay by
- Vehicle movement on or around a petrol station.

Put Hazards in Order

The intensity of danger associated with hazards varies with:

- The hazard itself
- How close it is to you
- Road layout
- Whether the hazard is stationary or moving
- How fast you are approaching it

DRIVING PLANS

The appropriate course of action must take into account:

- What can be seen
- What cannot be seen
- What might reasonably be expected to happen
- Which hazard represents the biggest danger?
- What to do if things turn out differently (contingency plans).

By carrying out this procedure will ensure that the vehicle will at all times be:

- In the correct position
- Travelling at the right speed
- With the right gear engaged.

REMEMBER
TO
ANTICIPATE
PRIORITISE
PLAN

SECTION 4 - ACCELERATION SENSE

THIS SECTION COVERS:

- **Examples**
- **Effective Use**
- **Result**

Acceleration sense is the ability to vary vehicle speed in response to changing road and traffic conditions by accurate use of the accelerator.

In order to use acceleration sense effectively the driver must be in the most responsive gear relative to the speed of the vehicle.

EXAMPLES OF ITS USE:

- **When moving off**
- **Overtaking**
- **Complying with speed limits**
- **Following other vehicles**
- **Approaching bends**

EFFECTIVE USE DEPENDS ON:

- **Careful observations**
- **Full anticipation**
- **Sound judgement of speed and distance**
- **Driving experience**
- **Vehicle capabilities**

POOR ACCELERATION SENSE RESULTS IN:

- Accelerating away from stationary, then having to brake sharply to slow down.
- Accelerating up to a slower vehicle, then having to brake prior to overtaking.
- Falling short of an intended stopping point, then having to apply more acceleration to reach it.

REMEMBER

Acceleration sense may be used in every facet of driving.

SECTION 5 – STEERING

THIS SECTION COVERS:

- **Mechanisms**
- **Characteristics**
- **Techniques**

STEERING MECHANISMS

There are two types of steering mechanisms:

- Non-power assisted
- Power assisted

Non-power assisted steering is the basic mechanism and relies on the driver's strength to move the wheel.

Power assisted steering is a device which assists the driver to turn the wheel. This method has slight variations, depending on the manufacturer. One type is graduated. This means that the slower the vehicle goes, the lighter the steering becomes, and conversely the faster the vehicle goes, the heavier the steering becomes. This is so the driver can "feel" the tyres on the road.

STEERING CHARACTERISTICS

The two most common are:

- Understeer (the vehicle responds less to steering movements).
- Oversteer (the vehicle responds more to steering movements).

STEERING TECHNIQUES

The most common method of steering a vehicle is to cross the hands. However, this method is not entirely safe, because at some point one hand is totally off and away from the wheel.

In order to combat this unsafe driving habit, it is recommended that the "pull push" method is adopted for normal steering movements. There can be variations of this method when it comes to steering at slow speeds, i.e. when reversing or manoeuvring.

When adjusting the driver's seat in preparation to move off, the hands should be placed on the wheel at the "ten to two" position, thumbs placed on the inside rim, and a bend in the elbows should be clearly visible. This allows for maximum leverage when turning the wheel. It will also allow you full access to the majority of the switches.

The Pull Push Method

With this method of steering, neither hand passes the twelve o'clock or six o'clock position.

Making a Left Hand Turn

Starting with the hands in the "ten to two" position on the wheel:-

- As you pull the wheel down with the left hand to make the turn, let the right hand slide down the wheel.

Both hands should be opposite each other and heading for the six o'clock position.

If, during this action, sufficient steering movement has been produced to make the turn, then, still using the left hand, control the wheel back to the "ten to two" position.

If, however, more steering movements are required when both hands reach the "six o'clock" position, then:-

- Grip the wheel with the right hand and slacken the grip with the left;
- Push the wheel upwards with the right hand;
- Let the left hand slide up the wheel.

Both hands should be opposite each other and heading for the twelve o'clock position.
Continue these movements until sufficient lock has been applied.

To return the wheel to a straight line, start with the hand that was the last one to put the lock on, and reverse the above procedure.
By doing this, when the wheels are in a straight line, the hands are once again in the "ten to two" position.

When making a right hand turn, the opposite movements should be used.

REMEMBER:

KEY LEARNING POINTS TO PRACTISE:

- **Place both hands on the wheel in the "ten to two" position.**
- **Keep both hands on the wheel when cornering, braking firmly or driving through deep water.**
- **On slippery roads, steer delicately or skids may be induced.**
- **Hold the wheel lightly, but be ready to tighten the grip if necessary.**
- **Keep both hands on the wheel when driving along, except when you need to operate a control.**

KEY POINTS TO AVOID:

- **Do not place your elbows on the window frame or arm rests; this reduces control.**
- **At NO time whilst driving should both hands be off the wheel at the same time.**

SECTION 6 - POSITIONING

This Section covers:

- **Importance of positioning.**
- **Zones of Risk.**
- **Positioning.**
- **Stopping and parking positions.**

Importance of Positioning

Positioning is the key element to making safe progress. The ideal road position depends on many things, these include:

- Safety
- Observations
- Traffic conditions
- Road layout
- Cornering
- Manoeuvrability
- Assisting traffic flow
- Making your intentions clear.

The overriding factor is safety, and this should never be sacrificed for any other advantage.

REMEMBER:
Sacrifice speed and position for safety.

Zones of Risk

By carefully choosing your position you can do much to reduce the risk of having an accident.

Nearside Risks

These include:

- Cyclists: Wherever possible give cyclists as much room as you would when overtaking a car.
- Pedestrians: Observe pedestrian movements and if possible move away from them.
- Parked vehicles and their occupants. Give these hazards at least an open doors width.

Offside Risks

The greatest danger here is coming into conflict with approaching traffic. If possible move to your left, if not reduce speed.

Where both nearside and offside risks are apparent you need to adopt a mid-line position that is equal distance between both sets of hazards. This is, of course, providing there is

enough room for you to safely continue, but because of a reduction in space a reduction in speed must be given serious consideration.

You must always be able to stop if the unexpected happens, such as a child running out from between parked vehicles.

REMEMBER:

If you lose space then you must lose speed.

SECTION 7 – DRIVERS' DUTIES

1. Read and understand the Council's Safety Statement and carry out your work in accordance with its requirements.

2. Carry out duties of firefighters as directed by the Officer in Charge.

3.(a) Ensure that any defects in your vehicles are reported immediately to your Station Officer.

3.(b) Make regular inspections of your vehicle for obvious defects.

4. Complete all the items on checklist provided as per Brigade policy.

5. Ensure before reversing that there are no obstructions or people behind the vehicle. Request firefighter to act as banksman to direct you when reversing a vehicle.

6. Ensure that when reversing or driving towards an edge that a suitable wheel stop has been provided to prevent the vehicle going over the edge.

7. Report all accidents or damage, however minor, to your Station Officer.

8. Ensure that all items on your vehicle are well secured.

9. Drive safely and comply with Road Traffic Regulations where applicable to emergency vehicles.

10 (a) Ensure that all lockers and doors are secured prior to driving the vehicle.

10 (b) Ensure that all heating and charging lines and exhaust extraction systems to vehicles are disconnected prior to leaving the station.

10 (c) Ensure that all equipment is stowed securely in appliance after use.

10(d) On return to stations ensure that all heating and charging lines and exhaust extraction systems are connected.

11. Ensure that appliances are properly equipped and fuelled before leaving the station after use.

12. Ensure that vehicle log book is completed after use of appliance.

DRIVER & PUMP OPERATORS COURSE

QUESTIONS AND ANSWERS ON PUMP OPERATING

1. **Q**. What is a positive pump?

A.
A positive pump is one in which energy is imparted to the water or other fluid by displacement between a plunger or rotor and the casing of the pump, the moving parts making an air and watertight joint with the casing. It must deliver all the water it receives there being no way in which water can be slipped.

2. **Q.** Describe the action of an exhaust ejector priming device?

A.
This is where use is made of exhaust gases from the engine. By the operation of priming leaver a clapper valve diverts the exhaust gases from their normal passage to the silencer to another exhaust pipe. In this pipe a venture action is set up thereby causing the air in the suction hose and pump casing to be extracted and passed to atmosphere.

3. **Q.** Enumerate the types of priming devices suitable for use with centrifugal pumps.

A.
(1) Reciprocating (2)Exhaust ejector (3) Rotary
(3a) Water ring (3 b) Sliding vane (4) Water seal

4. **Q.** What tests are carried out with pumps and when?

A
(i) Output test – Quarterly.
(ii) Vacuum test – Quarterly
(iii) Water pressure test – When necessary.
(iv) Deep lift test - At two-yearly intervals and at any time considered necessary by Workshops.

5. **Q.** What is a Compound gauge and on what side of the pump is it fitted?

A.
A Compound gauge is usually of the Bourdon Tube or Diaphragm type. It registers the depth of lift on the negative side (generally marked in red) and incoming pressure on the positive side (marked in black). The gauge is fitted on the inlet side of the pump.

6. **Q.** What is a pump primer?

A.
A device which will exhaust the air in the suction hose and pump casing and allow atmospheric pressure to force water up to the pump entry.

7. **Q.** Give the formula for finding flow from a branch.

A.
$\frac{2}{3}d^2 \times \sqrt{P}$

8. **Q.** A pressure of 3 bars is required at the branch. What factors should be taken into consideration to achieve this pressure?

A.
Frictional loss in hose (approximately 0.2 bars per 25 m.) plus 0.1 bar for ever metre rise and minus 0.1 bar for every metre below the pump.

9. **Q.** What is the average priming speed for pumps?

A.
1,000 revolutions per minute, unless pre-set by manufacturer.

10. **Q**. You are pumping from open water at a pressure of 4 bars and have a vacuum reading of 0.4 bar, there is a sudden increase in vacuum reading with a loss of pressure. What is the cause?

A.
Suction strainer becoming blocked (weeds, straw, sacking, etc.)

11. **Q.** Describe the Vacuum test given to a pump.

A.
All lengths of suction should be inspected to see that couplings are in good condition and that washers are in place, collars and threads should be lightly oiled or greased if necessary. All lengths of suction should then be connected up to the suction inlet of the pump with blank cap in position at the end of the last length but leaving blank caps off all deliveries. The primer should be run at priming speed for not more than 45 seconds, priming should cease after obtaining 0.8 bar or more vacuum and the compound gauge needle should then be watched if the needle falls back to 0.3 bar in less than one minute an excessive air leak is present. All joints should again be tightened and another endeavour made. If this still fails, then the Water Pressure

test should be carried out to determine the leak. The Vacuum test should be done after the packing gland has been saturated.

12. **Q.** When are Deep Lift tests carried out, state the depth of lift for various capacity pumps.

A.
Pumps with a capacity greater than 900 1/min-7 bar 6-8 m.
Pumps with a capacity between 450-900 1/min. – 5-6 m.
Pumps with a capacity below 450 1/min – 3-4 m.

13. **Q.** When are branches and nozzles tested and what does one look for?

A.
Nozzles should be inspected frequently to ensure that the inside section is truly circular and that no scratches or indentations are present. All nozzles should be tested under pressure ever six months (during a pumping test for instance). Diffuser, hand-controlled and adjustable jet branches should also be tested under pressure every six months and operated to check that they are working satisfactorily.

14. **Q.** When working from open water to what depth should the top of the metal strainer be submerged and why?

A.
To a depth equal to at least three times the diameter of the suction if it is nearer to the surface it will tend to rise and the formation of a vortex will cause aeration which will result in a poor supply, crackling and inefficient jets and eventual loss of water.

15. **Q.** What is meant by Indirect Closed Circuit cooling system?

A.
Indirect Closed Circuit cooling is when the water is passed from the high pressure side of the pump through piping to a heat exchanger situated at the base of the radiator and returned through piping to the low pressure side of the pump, this system is normally operated automatically.

16. **Q.** Describe the output test for a 4000 1/m in pump.

A.
All pumps should be subjected to a pumping test quarterly from open water using one length of hose per delivery. With a lift as near as possible to but not exceeding 3 m. four hose lines with 25 mm nozzles, 5 bar pressure, for 15 minutes.

17. **Q.** What is meant by a "Balanced Flow"?

A.
This applies to Relay Pumping and is obtained by efficient pump operation in conjunction with efficient gauge reading, for it is only by this means that a balanced flow throughout the relay can be maintained. The operator of an intermediate pump should ensure that the reading on the Compound Gauge is at zero, this will mean that the pump is balanced, and is delivering all the water being received.

18. **Q.** When pumping, the pressure gauge shows a sudden drop in reading. What can cause this?

A.
This could be caused by a burst length of delivery hose or by a hand-controlled branch or adjustable nozzle being opened up.

19. **Q.** Describe the Water Pressure test.

A.
The suction is connected by a suitable adaptor to a hydrant, the static pressure of which does not exceed 3 bar. One delivery should be opened to allow air to escape and the hydrant should then be turned on slowly. The delivery is shut down as soon as water commences to flow from it and the full pressure of the hydrant allowed to develop. If the hydrant pressure is in excess of 3 bars one delivery should be left open and the hydrant should then be opened sufficiently to allow the test pressure to build up to the required amount which should not exceed 3 bars. Any leak present will be indicated by the water flowing from it, and steps should be taken to rectify this. When carrying out this test, the hydrant must not be turned on until the pump delivery valve is open, and the pump delivery valve must be closed slowly.

20. **Q.** You have a loss of vacuum whilst at work, what is the cause?

A.
This is not a common fault, but if it does occur it should be investigated on the same lines as for "No vacuum reading". It is usually due to the strainer having become partially or wholly uncovered, due to the supply having fallen too low, or the strainer having risen (e.g. when working in a shallow stream or dam).

21. **Q.** Why must delivery valves be kept closed when priming with an Exhaust Ejector primer?

A.
With this type of primer the efficiency depends on the speed at which the gases leave the discharge nozzle. Priming is for this reason carried out at high engine revolutions with a fully opened throttle. Once water reached the pump it would

pass through the delivery and along the hose with considerable force with possible danger to an unsuspecting branch man.

22. **Q.** What is the function of a branch and nozzle?

A.
The function of a branch and nozzle at the end of a line of hose is to convert the pressure energy to velocity energy.

23. **Q.** Describe the action of a Centrifugal Pump.

A.
A Centrifugal pump has no valves, pistons or plungers and does not work by displacement. It makes use instead, of centrifugal force and consists essentially of a number of radial vanes embodied in circular side plates known as an impeller which receives the water at its centre and discharges it at its periphery. This impeller which is rigidly mounted inside a casing on a central shaft driven by external power, is rotated at the speed required to produce the necessary pressure, thus inducing a flow through the pump. The water from the suction inlet is picked up by the impeller vanes which pass it through to. The water at this point is discharged at such a high velocity that the greater part of its energy is in the form of "Kinetic or Velocity" energy, but it now enters the casing where the velocity is greatly reduced and most of its energy is converted to the form required "Pressure" energy.

24. **Q.** When working from a hydrant what advantage would be gained by twinning the lines of soft suction?

A.
The velocity would be halved and frictional loss quartered.

25. **Q.** What are the factors affecting the practical lift of a pump?

A.
(a) Raising the water from its existing level to the intake of the pump.
(b) Overcoming frictional resistance to the water both on entering and on passing through the strainers and suction hose.
(c) Overcoming resistance due to change of direction as the water enters the pump impeller (this is known as "entry loss").
(d) Creating flow. A certain proportion of the available atmospheric pressure is used in creating flow in the water, this varies according to the velocity in the suction hose, but in all cases represents a relatively small proportion of available pressure.

26. **Q**. What are the factors to be taken into consideration when setting up a water relay?

A.
(a) The quantity of water required.
(b) The number, type and capacity of appliances and quantity of equipment available.
(c) The distance from the source of supply.

27. **Q.** What are the factors governing frictional loss?

A.
(a) It varies directly with the length of the pipe.
(b) For the same velocity, it decreases directly with the increase in diameter.
(c) It increases approximately as the square of the velocity or rate of flow.
(d) It increases with the roughness of the interior of the pipe.
(e) It is, for all practical purposes, independent of pressure.

28. **Q.** What is the cause of a crackling jet?

A.
A crackling jet is caused by air being taken into the pump together with the water, air is drawn into the pump at atmospheric pressure, and is then compressed to the same pressure as the water. The air expands again with slight explosive force to its original pressure as it is discharged from the nozzle. It is generally caused by the strainers not being sufficiently submerged when pumping from open water, or by a slight leak in the suction side of the pump.

29. **Q**. What is a pump?

A.
A machine driven by some external power, for transmitting energy to fluids.

30. **Q.** One certain type of fire pump has come to be regarded in this country as the best for the fire service, what is this?

A.
The centrifugal pump.

31. **Q.** Pumps can be classified into five basic types, name these.

A.
(1) Force pumps.
(2) Lift pumps.
(3) Bucket and plunger pumps.
(4) Rotary and semi-rotary pumps.
(5) Centrifugal pumps.

32. **Q.** Before any pump can either lift or transmit water or other fluid, a means must be provided for inducing the water to enter the pump. Name three methods:

A.
(a) By atmospheric pressure.
(b) By gravitation.
(c) By water under pressure from a hydrant or other source.

33. **Q.** What is the simplest type of pump known?

A.
The force pump consisting of a solid plunger which moves up and down in a cylinder fitted with inlet and outlet valves. Water or air is drawn in on the upward stroke and discharged on the downward.

34. **Q.** What is the function of the impeller in a centrifugal pump?

A.
To impart high velocity to the water.

35. **Q.** What is the natural law know as centrifugal force?

A.
The tendency of a revolving body to fly out from the centre of rotation.

36. **Q.** What is the function of the volute or diffuser in a centrifugal pump?

A.
To transform the velocity of the water imparted by the impeller into pressure energy.

37. **Q.** What is an impeller?

A.
The impeller is a circular metal casting mounted on and keyed rigidly to, a central shaft, by which it is revolved in either a volute or a diffuser.

38. **Q.** What governs the pressure and quantity of water given by a centrifugal pump?

A.
(a) The speed.
(b) The diameter and the size of the passages of the impeller.

39. **Q.** What is a volute?

A.
The volute is a casting which forms the pump casing so shaped that the water that is thrown off the perimeter of the impeller passes through a passage of gradually increasing capacity until it reaches the delivery outlet.

40. **Q.** What is a two-stage pump?

A.
Two single-stage pumps coupled together.

41. **Q.** In a multi-stage pump how is the pressure in each stage calculated?

A.
The final delivery pressure is divided by the number of stages.

42. **Q.** What are the five main advantages of a centrifugal pump?

A.
(1) Simple in construction and operation.
(2) Easily balanced, requires little attention and its efficiency is less easily reduced by careless operation.
(3) Occupies little space, light in weight, initial costs are small as compared to other types of pumps.
(4) Continuous flow requires no air vessels.
(5) Sudden shut down calls for no pressure relief valves.

43. **Q.** What is a "Supplementary" primer?

A.
The term "Supplementary" primer is used to indicate a device which is not incorporated in the main pump itself, but is an independent piece of equipment which can be brought in and out of action as required.

44. **Q.** What is the definition of a "power take-off?

A.
A device for converting the power from a road engine gearbox to a secondary use.

45. **Q.** What are the advantages of an indirect cooling system?

A.
(a) The engine cooling water is maintained at a constant temperature without the violent fluctuations which are present with a direct system.
(b) The pump can be used with safety from salt or dirty water.
(c) As the same water is retained in the header tank it is possible to sue anti-freeze compound in winter, thus enabling the pump to get to work immediately without the necessity for first filling the tank with water.

46. **Q.** Why is a reciprocating pump self priming?

A.
Since the pump is of the positive displacement type it is generally self priming and all that is necessary to get to work is to lower the suction into the water and commence pumping, the same plungers first exhausting the air and them pumping water.

47. **Q.** What is the function of the hose-reel equipment?

A.
To provide an immediate supply of water for extinguishing small fires and for attacking larger fires until full size hose can be got to work.

48. **Q.** What is cavitation?

A.
A condition in a pump when it is attempting to deliver more water than it is receiving.

49. **Q**. Why should care be taken to avoid any sharp vertical bends when laying out hard suction between the pump and the water?

A.
If these bring any part of the suction above the level of the suction inlet, they lead to air pockets which may result in a bad supply.

50. **Q.** Why is hard suction secured by line before being lowered into the water?

A.
To take the greater part of the weight off the inlet coupling and also to enable the hose to be drawn up to clean the strainer, or at the conclusion of pumping.

51. **Q**. Before a centrifugal pump can be got to work from open water it must be primed. Assuming that the pump controls are operated how is this achieved?

A.
Sufficient air must be exhausted from the pump casing causing a partial vacuum to be created in the suction hose to allow atmospheric pressure on the surface of the open water to force it up and thus fill the suction pump casing.

52. **Q.** When the priming level is operated explain what happens to the gauges.

A.
It will be found that the compound gauge is the first to react, the needle climbing slowly on the vacuum side as the lift is achieved. When a constant vacuum is achieved, the pressure gauge should then show a positive pressure.

53. **Q.** When a centrifugal pump is primed what pressure should be maintained to prevent loss of water, and provide adequate pressure in the supplementary cooling system?

A.
About 1 bar.

54. **Q.** At what moment should a priming lever be disengaged when lifting from open water.

A.
When a positive pressure is registered on the pressure gauge.

55. **Q.** Under what conditions should a packing gland be adjusted?

A.
This adjustment should always be made when the shaft is rotating and the pump is delivering water.

56. **Q.** What pressure is normally sufficient to give a good jet?

A.
2.5 bars at the branch is normally sufficient to give a good jet.

57. **Q.** On receiving the message "Reduce pressure" and in the absence of any stated pressure required, what reduction in pressure should the pump operator make?

A.
The pressure should be reduced by 0.5 bar.

58. **Q.** What is a rough approximation of pressure loss in 70 mm R/L Hose?

A.
About 0.2 bar per 25 m. length.

59. **Q.** When working with a pump from a hydrant, failure of water may occur; give the possible causes?

A.
(1) Failure of the supply itself i.e. fractured main or burst soft or hard suction between hydrant and pump.
(2) Choked internal strainer.
(3) Choked strainer in the standpipe head.
(4) Over-running the water supply when working with soft suction, causing the hose to flatten cutting off the supply.

60. **Q.** Is it possible to prime a pump with the delivery valve open?
Give reason for your answer.

A.
Yes – if the pump is in good condition. The delivery non-return valve will hold the vacuum until a positive pressure is obtained.

61. **Q.** The pump fails to prime and a high vacuum reading is registered. What are the possible faults:

A.
(1) Basket strainer, metal strainer, or internal strainer blocked.
(2) Collapse of internal wall of the suction hose.

62. **Q.** What does a decreased vacuum reading on the compound gauge denote when working from open water?

A.
(1) Level of water has risen.
(2) Less water being taken at the branch, e.g. when using hand-controlled branch.

63. **Q.** What is the relationship between "Pressure" and "Head"?

A.

For every metre/head, in a column of water, a pressure of 0.1 bar is exerted at the base of column.

64. **Q.** What height would a column of water have to be to exert one bar at its base?

A.
10 m.

65. **Q**. What is the formula for finding pressure from head?

A.
Pressure = 0981 x H or approx. $P = \frac{H}{10}$

66. **Q.** What is the formula for finding head from pressure?

A.
Head = 10.19 x p. H = 10 P.

67. **Q.** How is pressure and head expressed?

A.
(a) Pressure in terms of bars.
(b) Head in metre of water.

68. **Q**. The figures 10.19 and 0.0981 are frequently used in hydraulics. To what to they refer?

A.
10.10 is the height in metres to which a column of water can be raised by one bar pressure. 0.0981 is the pressure in bars exerted by a column of water one metre high.

69. **Q.** The maximum theoretical lift of a column of water is limited to a height of approximately 10 m. Why is this?

A.
A column of water 10 m. high is equivalent in weight to 1 bar acting on the exposed surface of the water at sea level.

70. **Q.** What is the maximum practical lift obtained with a pump and how is this measured?

A.
8 m. Under ideal conditions, 8.5 m. This lift is measured vertically from the surface of the water to the centre line of the impeller inlet or eye of the pump.

71. **Q.** What is "Pump entry loss"?

A.
The loss due to the shock of the water entering the impeller and having to change direction.

72. **Q.** Is any advantage gained in having an extra length of suction below the level of static water?

A.
No. As the water has to pass through the extra length, additional friction resistance will be caused.

73. **Q.** Describe how an increase in the temperature of water could affect the suction lift?

A.
Above a certain temperature (16°C) the reduction of atmospheric pressure in the suction hose allows the water to vaporise and decreases the practical lift.

74. **Q.** Why is it necessary to shut hydrants and hand-controlled branches slowly?

A.
In order to avoid water hammer which might burst hose or damage water mains and pumps.

75. **Q.** What are the two main types of gauges used for pressure and compound gauges?

A.
The Bourdon Tube and Diaphragm.