FIRE SERVICE EXAMINATION BOARD

STUDY NOTE

EXAMINATION	SUB-OFFICERS EXAMINATION
PAPER	OPERATIONS
SUBJECT	SCIENCE AND FIREFIGHTING
ITEM	WATER RELAYING
STUDY NOTE No.	2105

INTRODUCTION TO THE STUDY NOTE

This study note has been prepared as the basis of study in connection with the qualifying examinations for promotion.

Candidates will be expected to demonstrate knowledge of the information contained in the study note and understand how it should be applied:

The 'References' made at the end of the Study Note are included for information only and candidates will not be expected to study these as part of the bibliography.

WATER RELAYING

1. Introduction

When water has to be conveyed to the fireground from distant sources, one of the principle methods used is to relay the water over the distance using pumps and hose.

This study note identifies a number of the key issues involved.

2. Water Relaying

A water relay comprises a number of pumps spaced at intervals along a route between a water source and the point where the water is required.

There are two types of water relay:

(a) Closed circuit, in which the water is pumped through hose direct from one pump to the next; and

(b) Open circuit, in which it is pumped through hose via portable dams placed between the pumps.

The principal advantage of the open system, ie the ability to maintain a flow for a period at the fire even if the base pump becomes inoperative, is offset by the greater amount of equipment and effort required.

Because of this, the open circuit method is now seldom used.

In a closed circuit relay, the first, or base, pump takes its water from the source and pumps through hose lines either directly, or via a series of booster pumps, to the pump situated at the fireground.

The function of these booster pumps is to compensate for the pressure lost due to friction in the hose. The distance between the pumps is regulated by the amount of friction loss and the contours of the route.

3. Emergency Supply

When operating a closed circuit water relay there is the possibility of loss of supply if any of the relay or booster pumps fail. To act as emergency supply in this event, portable dam(s) should be readily available on the fireground.

4. Aim of a Water Relay

The aim of organising a water relay is to deliver the required quantity of water to the fireground with the minimum of equipment.

Without careful pre-planning it is likely that a greater number of appliances will be used than is strictly necessary, or that the quantity of water delivered will not be sufficient to meet firefighting needs.

5. Flowrate

The flowrate available from a water relay depends on two factors:

(a) The performance of the pumps used;

(b) The ability of the hose to convey the water.

A pump's performance can be determined from a knowledge of the maximum flowrate available at a quoted pressure eg 7 bar or 10 bar.

The ability of the hose to convey water is limited by friction loss and is therefore highly dependent on its diameter.

6. Planning

The planning of an effective water relay depends on matching the pumps' ability to deliver water with the ability of the hose to convey it.

There is no point in having large capacity pumps attempting to deliver water through long lengths of small diameter hose.

For a given flowrate the maximum spacing between appliances will be determined by the distance over which the pressure in the hose falls to slightly above atmospheric so that it becomes necessary to boost the pressure with another pump.

7. Twinned Hose

If, for a given flowrate a line of hose is twinned, the flowrate in each line will be halved and consequently the friction loss, which depends on the square of the flowrate, will be reduced to a quarter of its former value. Thus, with twinned lines of hose, the distance between pumps may be four times as great as it is with a single line to deliver the same quantity of water.

8. Pump Capacity

If pumps of different capacities are used, the maximum output of the relay will be dictated by the output of the pump with the lowest capacity.

If the pumps are not equally spaced and supplied with water on level ground, the maximum output of the relay will be dictated by the flowrate in the longest stage.

9. Relaying over Undulating Ground

It frequently happens that the ground over which a relay is laid is not level, and if the gradients concerned are sufficiently great some adjustment of the distances between pumps becomes necessary.

Where the ground between pumps is uphill, some of the pump pressure will be used up in raising the water to the higher level with the result that less pressure will be available to overcome frictional resistance in the hose.

It may be possible to increase the pump pressure in order to compensate for this, provided that the pump is not already working at full throttle, but otherwise the intended flowrate can only be maintained by reducing the distance between the pumps.

Conversely, where the ground between pumps lies downhill, the static head offsets the frictional resistance in the hose, so the pumps can be spaced further apart.

10. Position of the Base Pump

The output from the base pump, which has to supply the water, will control the flow through the relay. If this pump is not working efficiently, the whole of the relay will be impaired.

When working from open water, suction conditions will govern the input of the base pump; the full rated output can be expected if the vertical suction lift is not more than 3 metres and no more than three lengths of suction hose are used.

To achieve the best results the base pump should therefore be situated as near as practicable to the water source, with the minimum suction lift.

11. Spacing between First Two Pumps

Because a base pump working from open water has to use a part of its energy in lifting the water from the source to the pump inlet, there will be something of a reduction in the pressure available to pump the water through the hose on the delivery side to the first booster pump.

In such circumstances it may be appropriate to reduce the distance between the base pump and the first booster pump to compensate for this loss of pressure.

12. Communications

For the efficient operation of a water relay, it is important to maintain good communications along the route, so that changes in conditions, orders to shut down, etc can be acted upon quickly.

The type of communications adopted will, of course, be dependent on conditions, availability of resources, and so on, and it is the responsibility of the water relay officer to devise an appropriate system.

If using radio sets, particularly at large incidents, water relay officers and operators should dedicate one channel solely for this use.

13. Charging with Water

Provided good communications have been established, it may be advantageous, especially if large diameter hose is being used, to partially charge the hose as the relay is being assembled. One delivery on each booster pump should be left open, in addition to the deliveries connected to the hose lines, to facilitate the removal of air from the system. As soon as water reaches the pump, this extra delivery should be closed.

The base pump should run at about half speed until the whole system has been charged.

When the officer in charge is satisfied that the relay is working satisfactorily, the speed of the base pump should be gradually increased until the full pressure is reached. During this period and subsequently, the booster pump operators should keep the relay in balance by gradually adjusting their throttles to a position where the compound gauge is reading just above zero. Booster pumps, having no suction conditions to contend with, should be running at a slightly slower speed than the base pump.

14. The Porter Relay

This incorporates a procedure to quickly establish a relay when the number of appliances initially available is limited and, as more appliances arrive, to gradually increase its capacity, but without at any time needing to interrupt the water supply. The arrangement was originally conceived for 2250 L/min pumps each of which carried 14 lengths of 70mm hose. However there is no reason why the principle could not be adapted to work with other equipment.

There are three stages to a porter relay:

(a) Stage 1

A supply to the base pump is established and a single line of hose is deployed between the booster pumps in the relay. One or two jets of water attack the fire;

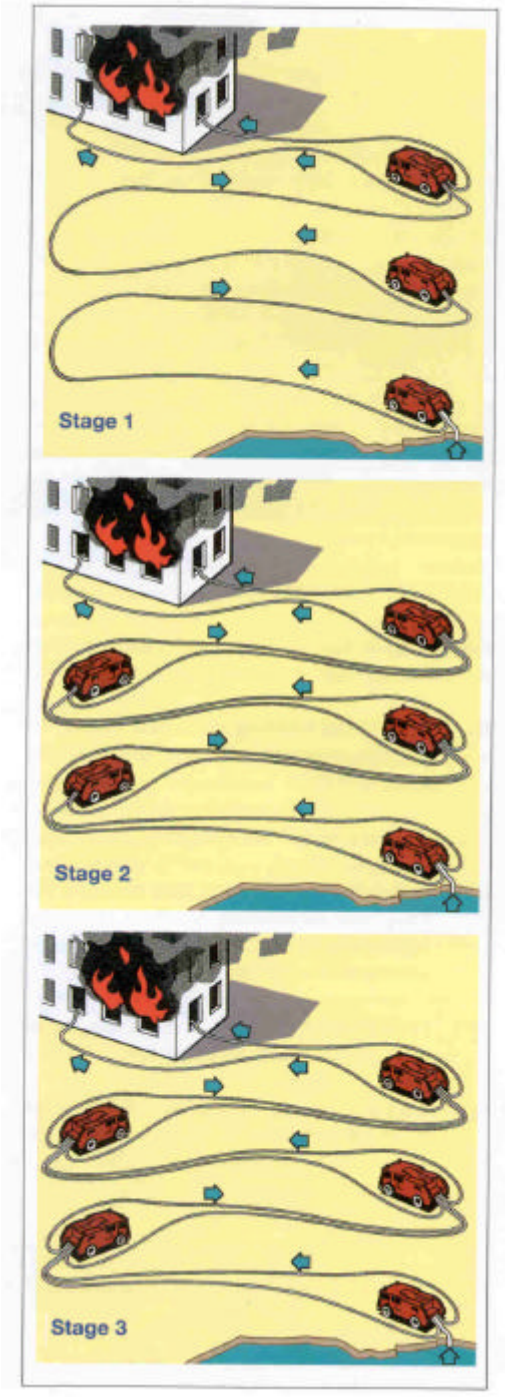
(b) Stage 2

Intermediate appliances are positioned in the relay when they arrive and second line of hose deployed without disturbing first line;

(c) Stage 3

Hose is twinned between all appliances.

Figure 1.below shows an example of the three stages of a typical Porter Relay.



15. Mechanical Breakdowns

Should a booster pump suffer a mechanical defect, provided the lines have been twinned there is usually no need to shut down the relay completely because when a replacement pump arrives the lines may be connected to it one at a time.

The relay will continue to function, although of course there will be a drop in the output and the throttles of the other booster pumps will have to be adjusted in the light of the changed conditions.

The incident commander should, if possible, have a spare pump of the same capacity available, with crew, ready to set into the relay.

Careful consideration should be given to the substitution of portable pumps for a major pump. For example, if a 2250 L/min pump operating in a twin line relay has to be replaced with portable pumps then, if the performance of the relay is not to be compromised, one portable pump will need to be substituted in each line.

16. Safety Precautions

Among the factors which should be considered in the interests of safe systems of work are:

(a) Positioning warning signs and coning off for the protection of firefighters from passing traffic;

(b) The wearing of hi-viz clothing;

(c) Carefully pre-planning the route of the relay and positioning the hose lines and appliances so as to cause the minimum obstruction to passing traffic;

(d) Protection of personnel from long-term exposure to the noise of pumps;

(e) Clearly defined and well-practised means of communication between relay operators;

(f) After the hose has been laid and before it is charged, a check should be made to see that it is lying at the side of the road and is causing no obstruction to traffic. The opportunity should be taken to remove any kinks before charging;

(g) When it is necessary to take hose across a road, ramps or bridging units should be used.

References

Fire Service Manual Volume 1, Hydraulics, Pumps and Water Supplies.

Note

The Fire Service Manual shows comparisons of flowrates from single and twinned hose lines in water relays, if candidates require a greater insight and understanding.