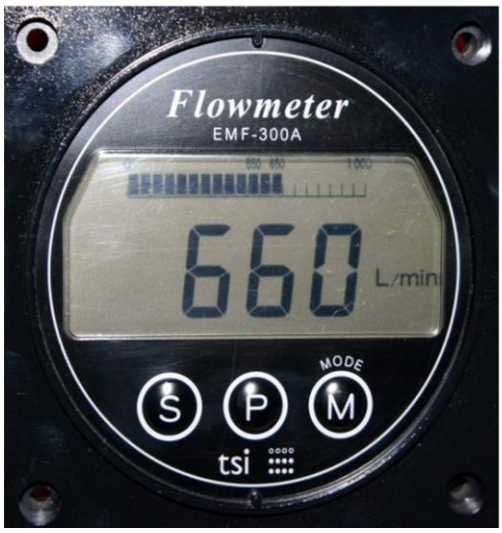
TSI FLOWMETERS

PRACTICAL GUIDANCE NOTE FOR FIRE FIGHTING STAFF

FLOW METERS = KNOWLEDGE



AND

KNOWLEDGE =

Safety, Efficiency, Control, Savings

TSI FLOWMETERS

PRACTICAL GUIDANCE NOTE FOR FIRE FIGHTING STAFF

CONTENTS

1. Objectives of the TSI Guidance Note- What you can expect to learn

At the end of the classroom and practical session recipients will be able to:-

1 Explain what a flow meter is designed to measure and the principle of operation of the flow meters as fitted to FRS pumping appliances.

2 Understand that it is flow which extinguishes fire and not pressure.

3 Understand the need to manage water use effectively and efficiently to maximize safety, environmental and cost savings.

4 Locate the Low Pressure flow meters and read-outs as fitted to FRS pumping appliances. Locate High Pressure read out(s) and Hydrant to Tank flow meter and readout (where fitted).

5 Demonstrate an ability to correctly interpret the information provided by the flow meter read-outs.

6 Practically demonstrate control of different flow rates simultaneously from the same pump whilst maintaining the safety of branch operators.

7 Demonstrate the ability to determine the capacity of a hydrant supplying the pump by use of the flow meters fitted on the deliveries or by use of the flow meter on the hydrant to tank supply (where fitted).

8 Demonstrate the ability to use the information from the flow meter readouts to ensure supply of water to the branch operator(s) does not exceed the capacity of a hydrant supplying the pump (where the pump is fitted with hydrant to tank flow meter).

9 Demonstrate the ability to interpret the information available from the flow meter readouts to inform the OiC of whether additional branch(es) can be supplied from the pump.

2. Introduction: There is something better than pressure!

Ever since Roman times' fire fighters have pumped water onto fires using pressure, without knowing how much water they were delivering. Early fire pumps relied on members of the public assisting fire fighters by cranking wooden levers to deliver a jet of water using a reciprocating pump.

In Victorian times steam pumps delivered the jet(s) but the principle was the same...it relied on pressure... and fire fighters still didn't know how much water they were delivering.

Even today, many of the 20th and 21st Century pumps are only fitted with pressure and compound gauges so fire fighters still use pressure to deliver water to the fire....and still don't know how much water is being delivered.

This isn't the fault of the fire fighter. Fire fighters can only work with the equipment they are supplied with. In almost every other aspect of Fire and Rescue Service work technology has moved on to provide the modern fire fighter with equipment more suited to today's environment. Examples include, Breathing Apparatus, Thermal Imaging Cameras, RTC equipment, Ladders, First Aid Equipment and Personal Protective Equipment. The drivers for much of this change have been improvements to fire fighter safety and improvements to efficiently deal with the wide variety of incidents attended.

The only item that has changed little over the years is the operation of the pump itself. However, modern technology has finally been made available to the fire pump. Many Fire and Rescue Services in the UK, USA and other countries are now using fire pumps fitted with flow meters, thus providing the fire fighter with **exact information** on how much water is being delivered/is available.

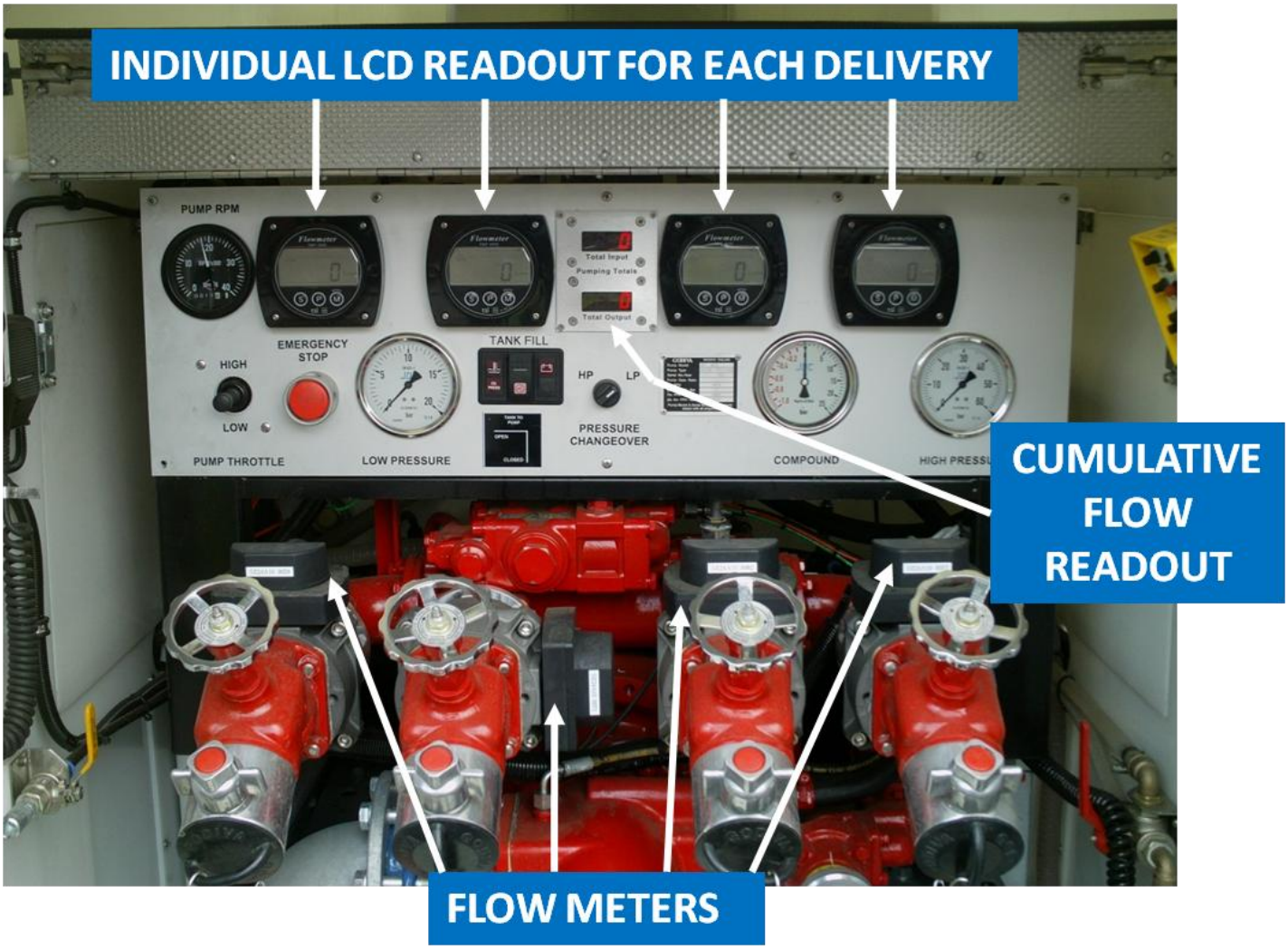
The benefits of this for fire fighters and Fire and Rescue Services are:-

- A **safer working environment** for the fire fighter, by ensuring the most effective use of the available water supplies and giving the pump operator complete **control**.
- **Reduced workload** on the pump operator by removing the need to mentally calculate pressure requirements at the branch, and
- Improved pump efficiency resulting in **reduced environmental impact** and **efficiency savings**.

In summary, the information provided by the flow meters can assist in improving fire fighter safety on the incident ground and can assist FRS's in improving service delivery to the public.

3. What is a flow meter and what does it do?

A flow meter is a device designed to measure the amount of water passing a given point at any given time. It provides information on flow in Litres per Minute (LPM) but also records the total volume of water delivered. In order to measure individual flow rates from each delivery, the flow meters are located immediately before the delivery outlet on the pump and are connected to LCD read outs which are located within the pump bay at a location to suit individual FRS requirements.



Some pumps have additional read outs fitted which can provide flow information on the rate of flow coming into the pump and cumulative data for the total flow out. This gives the pump operator /OiC the full range of information required to manage water more effectively.

4. The "Techie Bit"

The flow meters fitted to FRS pumps are electro-magnetic. This type of flow meter has no moving parts and relies on the magnetic field created by the sensor and the passage of water across two diametrically opposed static sensors. The passage of water past these sensors distorts the magnetic field and creates an induced voltage which is then displayed as a flow read-out on a gauge. The greater the flow of water past the sensors the greater the "bend" in the magnetic field and therefore the greater the reading.

The main advantages of this type of flow meter are that they are 100% hydraulically efficient as there is nothing to impede water flow and they are not subject to wear and tear. This results in extremely accurate flow measurements coupled with exceptionally long unit life. The data produced by the flow meter can be stored by use of an on-board data logger and, if required, retrieved post-incident to inform on the volume of water used/duration of pump operation/ flow delivered/flow received into the pump.

TSI flow meters are the only flow meters which have no moving parts, do not restrict the water flow in any way and are accurate to + or – 2%. They have proven longevity and can provide information which can be viewed in real time either at the pump or remotely such as at an Incident Command Unit.

5. <u>Where does it all fit?</u>

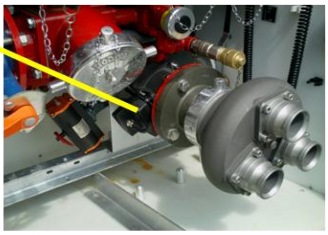
The figure below shows the various elements of a fire pump configured with low pressure, high pressure and inlet flow meters:-

READ OUTS

PUMP BAY

HOSE REEL(H.P.) FLOW SENSOR.
(PUMP BAY REAR PANEL REMOVED TO SHOW LOCATION).

DATA LOGGER (MOUNTED AT CONVENIENT POSITION ON FIRE APPLIANCE)



HYDRANT TO TANK FLOW METER AND COLLECTING HEAD.

Flow meters can measure the flow delivered from each low pressure delivery, from the high pressure hose reels and they can also measure water flow into the pump. The fact that the flow from any delivery can be controlled independently of flows from other deliveries gives the pump operator complete flexibility and control in the management of water supplies. The flow meters provide pump operators with the data required to know how much water they still have available for use by existing or additional branches, whether they need to supplement the incoming water as a matter of urgency or whether they need to reduce flow rates to branches until existing water supplies can be supplemented.

FLOW CAN BE CONTROLLED INDEPENDENTLY AT EACH DELIVERY

Put simply:

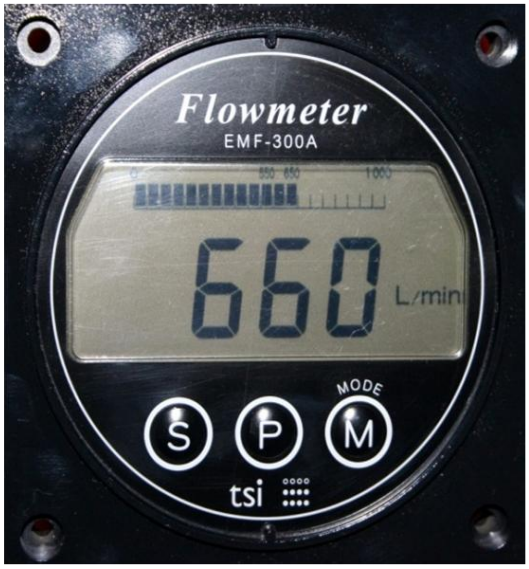
FLOW METERS = KNOWLEDGE

INDIVIDUAL DELIVERY FLOW METER

CUMULATIVE FLOW METER

AND

KNOWLEDGE =



Safety, Efficiency, Control, Savings

6 Why Fire & Rescue Services should move to using flow meters

The Fire Service Manual, Volume 1, Page 73 (F.S. Technology, Equipment & Media,Published 2001) states: -

"***It is flow rate which extinguishes fire – not pressure*.**"

All fires will eventually self extinguish by virtue of the fact that the available fuel source becomes exhausted. Fires will only be contained and extinguished successfully by intervention if sufficient quantities of water are provided at the earliest opportunity. If fire fighters rely on the use of pressure as the basis to deliver water they do not know how many litres per minute are being delivered and the amount of water delivered may be insufficient to prevent fire growth and spread.

Flow meters provide the knowledge that fire fighters require to operate more safely and effectively.

Fires generate heat and this heat is measured in Megawatts. Different fire types have been scientifically calculated to determine heat output and some examples of these are given below

5 MEGAWATT RELEASE

Car fire or single office workstation fully involved in fire.


20 MEGAWATT RELEASE

90m2 open-plan Flat Fire

Much technical work has been done on the amount of water required per minute to control and extinguish fires and the mathematical calculations used are relatively complex. As a result of this work, flow rates of between 4-6 LPM have been arrived at and a "Fireground -Rule of Thumb" formula has produced (for fires up to 600m2). It is.....

FLOW RATE (LPM) = Fire Area (m2) x 5

Therefore in the example above a 90m2 Flat Fire –>450 LPM would be required **as a minimum**.

This is considered a reasonable target flow-rate for general design and practical purposes.

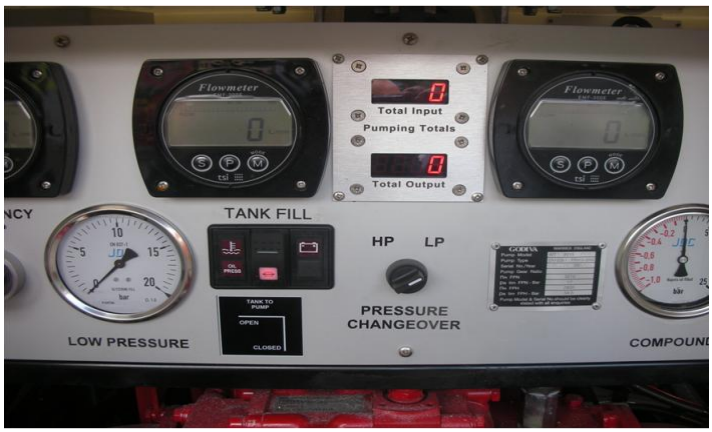
Clearly, there are many variables to consider when undertaking fire fighting such as building load, wind strength, ventilation and these will need to be taken into account and for high fire loads it is considered that the factor used should be x 6 rather than x 5.

7 Practical benefits of using Flow instead of Pressure

When pump operators deliver water using pressure, even if branch operators use branches with adjustable flow rates, the branch operator may not consistently use the branch at its maximum setting. If the branch operator becomes fatigued over time due to jet reaction, s/he may reduce the flow at the branch to provide some respite. However, this action may result in insufficient quantities of water then being delivered onto the fire. The pump operator would not be aware of any reduction in the amount of water being delivered as the pressure gauge would not register any significant change

When using flow meters, any reduction in flow made by the branch operator, or by debris on hose lines, is reflected in a reduced reading at the flow meter. This enables the pump operator to communicate with the branch operator for remedial actions to be taken and to ensure fire fighter safety is maintained.

WHERE BRANCHES ARE WORKING OUT OF SIGHT OF THE PUMP OPERATOR FLOW METERS INSTANTLY INFORM THE PUMP OPERATOR IF BRANCHES ARE CLOSED/OPENED OR BECOME OBSTRUCTED DUE TO DEBRIS ON HOSELINES



BRANCHES CLOSED OFF OR OBSTRUCTED BY DEBRIS WILL RESULT IN A ZERO READING AT FLOW METER READ OUTS

Using pressure to deliver water means that a pump operator has to deliver the same pressure to each branch from the pump. In circumstances where several branches are required and a fire fighter is (for example) working off a ladder, then the pump operator/OiC has several options:-

1 Only deliver water to the fire fighter on a ladder. (This, in effect, means only one jet can be got to work from a pump which may be equipped with three or four deliveries). The pump is therefore under-utilised and additional pumps may be required to supply further jets on the incident ground.

2 Only deliver water at a pressure that the fire fighter on the ladder can cope with. (This means that where another jet is got to work at ground level from the same pump, there is a compromise between what can be delivered to the fire fighting branch working from the ladder and the fire fighting branch working at ground level. This results in the fire fighters at ground level possibly having an ineffective/insufficient jet as the pump operator will, rightly, have to ensure the safety of the fire fighter on the ladder from the effects of jet reaction).

Using pumps fitted with flow meters allows the pump operator to set the flow exactly to each branch and, as the flow rate is constant and not delivered by fully open deliveries, this can reduce the risk of injury to branch operators from jet reaction by fluctuations in pressure ensuring the pump is used to best effect whilst ensuring the safety of all fire fighters.

PUMP DELIVERING WATER TO GROUND MONITOR AND ONE SMALL JET WORKING ON A LADDER SIMULTANEOUSLY IN SAFETY USING FLOW METERS

In addition to the practical benefits outlined above there are many other advantages for the fire fighter and for the Fire & Rescue Service to be gained from the use of flowmeters. These are summarised overleaf.

8 Summary of the advantages of using flow meters

- **Reduction in risk of injury.** Flow meters can assist pump operators in improved control of water delivered to Branches and reduce the risk of fire fighter injury from jet reaction/ loss of control of the branch.

- **Reduction in risk of water loss.** Flow meters enable pump operators to know exactly how much water is in use (and still available for use) and therefore pump operators will not overdraw water supplies leading to loss, or compromise of, water at the branch(es) with the associated risk to fire fighters and to members of the public who may be trapped in the building. Flow meters also provide instant recognition to the pump operator of water loss at the branch (e.g. debris on hose-lines) thus allowing remedial actions to be taken speedily.

FLOW METERS FITTED TO INLET AND OUTLET SIDES OF THE PUMP ALLOW PUMP OPERATORS TO KNOW HOW MUCH WATER IS IN USE AND HOW MUCH IS STILL AVAILABLE

- **Improved working conditions.** The pump operators' working environment is significantly improved by reduction in pump noise as the pump can work at reduced revolutions (also saving fuel costs).The pump operator is not required to make mental calculations for pressure loss due to friction or loss/gain due to changes in static head. The flow rate set at the delivery is the flow delivered at the branch.

- **Improved fire extinguishment.** Application rates required to extinguish fires can be achieved using flowmeters but are unknown when delivering water using pressure alone. Meeting the application rate can result in the fire being extinguished more quickly.

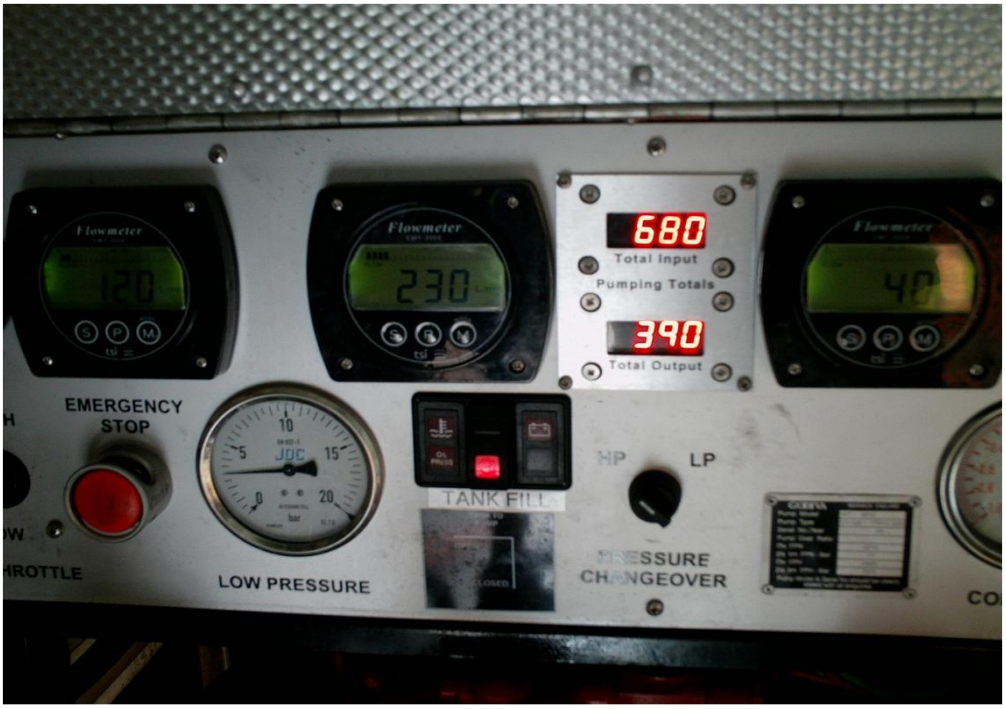
- **Reduced commercial damage.** Early application of water at the required flow rate means that the fire will not continue to grow as it will do if the required application rate is not met. Fires extinguished quickly will result in less damage thereby potentially allowing business to recover more quickly.

- **Reduced environmental impact.** Fires attacked using the correct application rate are extinguished in a shorter timescale requiring less water overall to be used thereby reducing Carbon emissions from the fire and reducing contaminated water run-off. Using flow meters can also allow FRS's to inform the relevant environment agencies/water undertakers of the amount of water used at an incident.

- **Reduced time fire fighters are exposed to risk.** Quicker extinguishment reduces time fire fighters are involved in fire fighting and therefore exposed to the risks involved in dealing with operational incidents.

USING FLOW METERS TO DELIVER THE REQUIRED FLOW APPLICATION RATE CAN RESULT IN FIRE FIGHTERS BEING EXPOSED TO RISK FOR SHORTER TIME PERIODS

- **Reduced resource requirements.** Flow meters give OiC's the flexibility to use jets from all deliveries on one pump with deliveries being set at a flow rates independent of each other. This flexibility allows for safe working regardless of where the branches are located and could result in less resources being required, especially at larger incidents, thereby enabling better fire cover provision at times of high operational workload and reductions in associated fuel and wear and tear costs.



FLOWMETERS SHOWING DELIVERY OF WATER TO THREE BRANCHES SIMULTANEOUSLY WITH DIFFERENT FLOW RATES TO EACH

- **Reduced water wastage.** Flow meters allow accurate use of water at all types of incident including those involving chemicals, and for decontamination purposes. At protracted incidents involving cylinder cooling the amount of water flowed onto cylinders in known and can be kept to the optimum.

- **Accurate and timely water information at smaller incidents.** Knowledge of the total amount of water being delivered makes for easy calculation of the expected duration the tank supply will last and also serves to inform pump operators/OiC's of whether they can deliver any further jets without compromising the existing ones. This valuable information can lead to improved fireground decision making such as not having crews run out further jets only to find that there is insufficient water available to supply them.

- **Accurate and timely water information at larger incidents.** The flow meter information can be made available to Officers at a remote point such as Incident Command Unit or Control Room (Using TSI Flowmeters “Water Smart Information System” [WSIS] software) thereby allowing accurate and up-to-the-minute analysis of all water being used on the fire ground. This facilitates informed decision-making regarding additional resource requirements/best use of pumps already in attendance.

- **Ancillary Uses.** The information provided by flow meters provides for improved decision making in other less common types of incident and for administrative functions. Such as: -

    - **Ship Firefighting.** Portable flow meters can be used on the outlet side of ejector pumps to give accurate information as to the volume of water is being discharged from it. The flow rate provided by flow meters on the pump supplying the ejector pump can be taken from the flow rate indicated by the flow meter on the outlet side of the ejector pump, to inform the OiC/Stability Officer of the amount of water being removed from the ship, thus improving stability and fire fighter safety.

SHIP FIREFIGHTING PRESENTS STABILITY HAZARDS. FLOW METERS CAN ASSIST IN PROVIDING ACCURATE INFORMATION AS TO THE QUANTITY OF WATER BEING PUMPED ON & OFF THE SHIP

    - **High Rise Incidents.** Where pumps fitted with flow meters are used to charge rising mains at high rise buildings it is clear that the riser is fully charged once the flow reads zero. It is also obvious when a landing valve is open as flow will continue to show at the readout rather than a zero reading being achieved. Equally, when the riser is charged the pump operator can ensure sufficient flow rates are provided to branch operators which is not possible when using pressure alone.

    - **Hydrant flow recording.** Hydrant flow information can be gathered whenever crews access hydrants, recorded and stored at Fire and Rescue Service Headquarters and used to provide a complete picture of flow rates from hydrants through the FRS area.

9. Practical scenarios using flow meters.

SCENARIO 1.

TITLE: PRESSURE CONTROL VERSUS FLOW CONTROL.

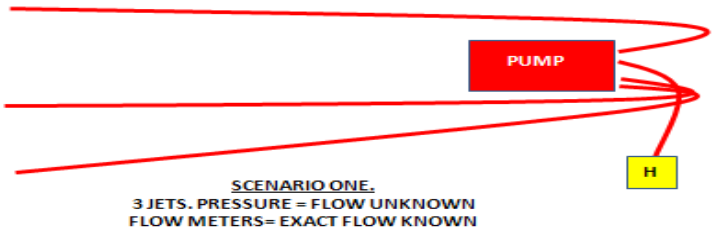
A DEMONSTRATION OF THE KNOWLEDGE LIMITATIONS AVAILABLE TO THE PUMP OPERATOR WHEN USING PRESSURE COMPARED WITH WHEN USING FLOW METERS.

PURPOSE OF EXERCISE

The purpose of this exercise is to demonstrate that, when pump operators use pressure alone as the basis to deliver water, they have no knowledge of the amount of water being delivered and therefore no knowledge of whether a required application rate is being achieved. When delivering water using flow meters the pump operator has full knowledge of the flow from each delivery and the total flow being delivered and therefore whether the application rate required is being achieved.

DESCRIPTION OF EXERCISE

- Run out three delivery hose lines and attach hand controlled branches.
- Engage PTO and set pump to 2000 RPM.
- Increase RPM and use pressure to deliver water to all branches.
- Note that no one knows how much water is being delivered to any branch.
- Use flow meters to deliver three different flow rates to the three branches
- Note that pump operator knows exactly how much water is being delivered via each delivery and in total.



LEARNING OUTCOME

This exercise demonstrates the limitations of using pressure as the delivery method. The pump operator will see that when s/he relies on pressure to deliver water, s/he has no knowledge of the amount of water being delivered and therefore is unable to determine whether the required application rate has been achieved. When using flow meters to deliver flow the pump operator has full control of the flow rates delivered to the branches and can ensure that the required application rates are achieved.

SCENARIO 2.

TITLE: FLEXIBLE FLOW RATES WITH SAFETY.

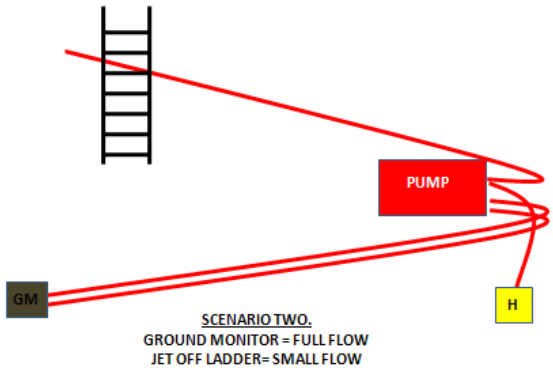
A DEMONSTRATION OF THE USE OF VARIABLE FLOW RATES THROUGH BRANCHES/NOZZLES WHILST MAINTAINING SAFETY OF FIRE FIGHTING PERSONNEL WORKING AT DIFFERENT HEIGHTS.

PURPOSE OF EXERCISE

The purpose of this exercise is to demonstrate that when using flow meters to deliver water, branches/nozzles of greatly differing outputs and be used concurrently whilst maintaining a safe working environment for fire fighting personnel and without compromising the output performance of any individual branch/nozzle.

DESCRIPTION OF EXERCISE

- Engage PTO and set pump to 2000 RPM.
- Run out two delivery hose lines and attach Ground Monitor.
- Flow water to Ground Monitor to give effective jet using partially opened deliveries and flow meters to control flow rate, increasing pump RPM as required.
- Run out one delivery hose line from a separate delivery to a position aloft (e.g. upper floor/ladder) and attach one hand controlled branch.
- Deliver small but effective fire fighting jet using flow meter and partially opened delivery whilst maintaining significant flow rate to Ground Monitor.
- Note that all fire fighters can work safely with variable flow rates for different branch combinations.



LEARNING OUTCOME

This exercise demonstrates that by using flow meters personnel working at height can do so safely with an effective fire fighting jet under their full control whilst the pump can be utilized to deliver significant flow rates to a large flow nozzle.

Scenario 3.

TITLE: RECOGNITION OF WATER LOSS.

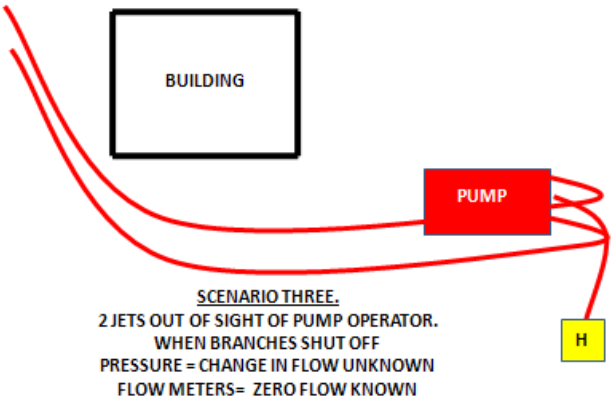
A DEMONSTRATION TO SHOW THAT, WHEN RELYING ON PRESSURE GAUGES, THE PUMP OPERATOR DOES NOT KNOW WHEN WATER HAS BEEN LOST AT ONE OR MORE BRANCHES AND THAT WHEN DELIVERING WATER USING FLOW METERS LOSS OF WATER IS INSTANTLY RECOGNISABLE, ALLOWING REMEDIAL ACTIONS TO BE TAKEN THUS ENSURING FIRE FIGHTER SAFETY.

PURPOSE OF EXERCISE

The purpose of this exercise is to demonstrate that when using pressure to deliver water, the pump operator is unaware of loss of water at one or more branches and that when using flow meters loss of water is instantly recognizable thereby allowing the pump operator to take any necessary actions to maintain fire fighter safety.

DESCRIPTION OF EXERCISE

- Run out two hand controlled firefighting jets at ground level with branches out of sight of pump operator.
- Engage PTO and deliver water via the pump using only pressure gauges.
- Close off one branch and observe the pressure gauge. Note minimal change.
- Close off second branch. Note minimal change.
- Note that pump operator does not know when there is no flow at either branch.
- Open branches and, using flowmeters, set flow rates at each branch.
- Branch operator one to close branch. Pump operator to note zero flow at flow meter.
- Branch operator two to close branch. Pump operator to note zero flow at flow meter.
- Pump operator will be able to note which branch(es) have no flow and can take action to find out why.



LEARNING OUTCOME

This demonstrates that by using flow meters the pump operator can immediately recognize potential water loss to any given branch and can take steps to ensure safety of branch operators.

Scenario 4.

TITLE: RECOGNITION OF FLOWRATE REDUCTION AT THE BRANCH.

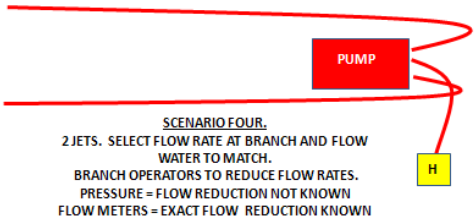
A DEMONSTRATION TO SHOW THAT, WHEN DELIVERING WATER USING FLOW METERS, THE PUMP OPERATOR CAN INSTANTLY RECOGNISE THAT THE BRANCH OPERATOR HAS REDUCED THE FLOW RATE AT THE BRANCH AND THAT WHEN DELIVERING WATER USING PRESSURE GAUGES THE PUMP OPERATOR IS UNABLE TO NOTICE FLOW REDUCTION AT THE BRANCH AND IS THERFORE UNAWARE THAT REQUIRED APPLICATION RATES ARE NOT BEING ACHIEVED.

PURPOSE OF EXERCISE

The purpose of this exercise is to demonstrate that when flow meters are used to deliver water, the pump operator is instantly aware of reductions in flow caused by the branch operators and can take steps to maintain adequate application rates by communicating with branch operators and that when using pressure to deliver water the pump operator will not be aware of such reductions.

DESCRIPTION OF EXERCISE

- Set hand controlled branch nozzles to a preset setting on each of the branches.
- Flow water using flow meters to the same flow rate as that selected on each branch.
- Branch operators to reduce preset to lower presets and pump operator can observe the flow rates decrease at the flow meters.
- Repeat above exercise but do not use flow meters.
- Note difficulty in observing any change at pressure gauge on the pump when branch flow rates are reduced.



LEARNING OUTCOME

This demonstrates the fact that, when using flow meters the pump operator can instantly recognize when the branch operator reduces flow rates and can take action to ensure adequate flow is maintained. This may include direct communication with the branch operators to get them to reset the branch to the original flow or may require the pump operator to communicate with the OiC to consider the use of additional branches. If pump operators are relying on the pressure gauge only, branch operators can reduce required flow rates for fire fighting when they reduce preset flow rates at the branch without pump operators/OiCs knowledge thereby reducing the flow to below the required application rate.

10. Disclaimer

The purpose of this guidance note and the associated practical session on the training ground is to create an awareness of the advantages flow meters have over the use of pressure in the effective management of water usage. It also provides an opportunity for attendees to use an appliance fitted with TSI flow meters.

TSI Flowmeters Ltd and associates working on behalf of TSI Flowmeters Ltd. fully accept that Fire & Rescue Services are the recognised experts in practical fire fighting and it is **not** the intention of this note and associated practical session to determine what operational procedures are adopted by any Fire and Rescue Service. All views/opinions expressed are those of the author/TSI Flowmeters Ltd.

The adoption of any operational procedure is a matter for individual FRS's.