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WATER SUPPLY INDIA

THE USE OF A

REVERSIBLE FLOW-RATE RESTRICTOR (RFR)

IN PIPED WATER SUPPLY IN INDIA

by

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1. Introduction

01 Distribution control is the panacea for water supply equitability.
Good results can be achieved with bulk-flow water meters only under properly controlled circumstances and continuous supply.
When supply is restricted - due to drought, lack of drainage, poor environmental impact, lack of preventive health care awareness, poverty or otherwise - the RFR is the most appropriate tool to control the distribution.

02 Along with the use of the RFR an appropriate technology must be developed to implement or rehabilitate modern water supply and sanitation **progressively.**
Progressive water supply is a technology that allows the distribution to grow as the (basic) need and the absorbtion capacity of the community (drainage, income level, economic incentives, sanitation, population, etc.) increases.
In other words, progressive water supply development must be synchronised with the development of the environment and the requirements for (early) self reliance.

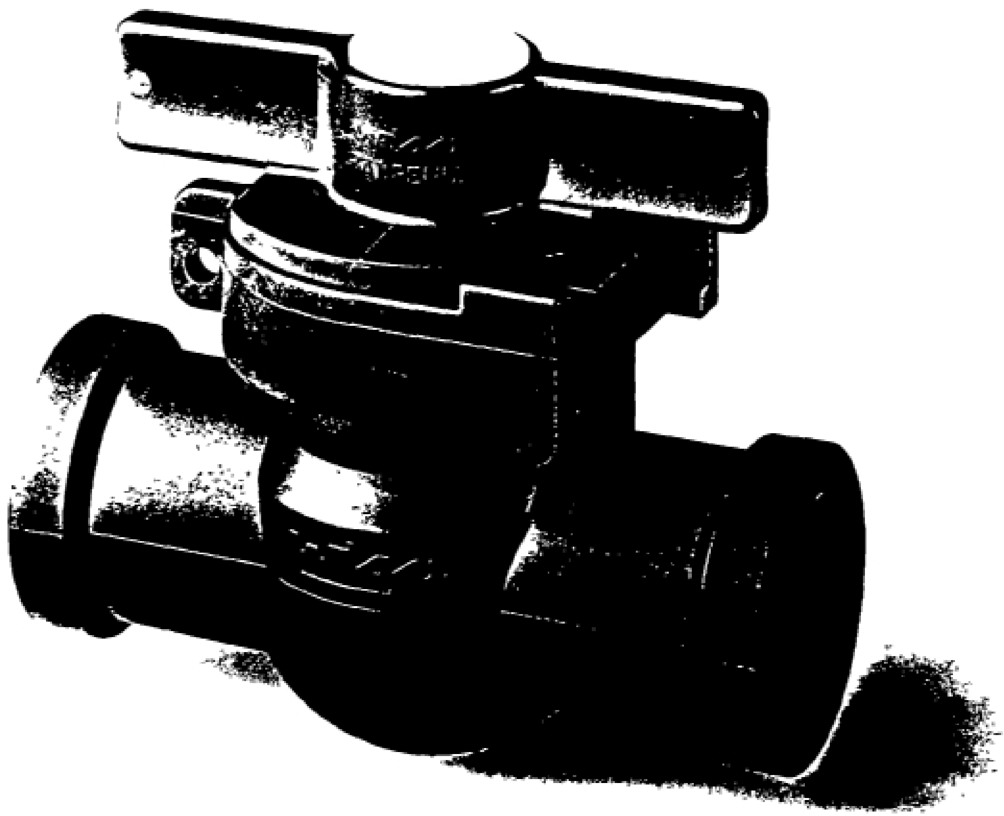
03 Besides improving water supply equitability, substantial savings can be effectuated when piped water supply is developed in tune with the prospects for self-reliance in water supply such that government subsidies for operation and maintenance can be reduced and eventually abolished.

The RFR, the development of progressive water supply and the appropriate technology that comes along with it are discussed in this paper.

2. The reversible flow-rate restrictor (RFR)

Ref: Annexe 1

WISA B.V., a 120 years old Dutch company engaged in the design, manufacturing and distribution of plastic products for use in domestic and industrial water applications, has designed specifically for the equitable distribution of precious water, a reversible flow-rate restrictor (RFR), the WISA Flowlimiter. (fig. 1)

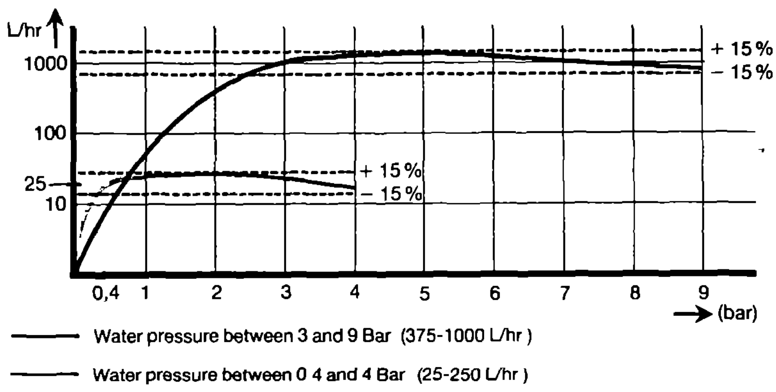


04 **Properties of the RFR**

a. Flow-rate restrictor

The WISA Flowlimiter restricts the available quantity of water to a predetermined flow in litres per hour, **independent** of the waterpressure. WISA Flowlimiters from 25 up to 250 l/hr. are functional with a maximum variance of 15% with a water pressure as low as 0.4 bar and as high as 4 bar. From 375 up to 1000 l/hr the water pressure can vary from 3 to 9 bar. (fig. 2)

Figure 2



b. Reversible

Presently available ferrules, particularly with small capacities, tend to clog fast and frequently due to impurities in the water.

The WISA Flowlimiter can be cleaned by the user. A 180^{o} twist of the spindle washes away minor obstructions that may have collected in the orifice that controls the flow.

With the ferrule quite an operation is needed by an experienced maintenance engineer to accomplish the same.

c. Stop valve function

The WISA Flowlimiter has a built in ball valve.

A quarter turn of the spindle will stop the flow altogether.

d. Watermeter function

The WISA Flowlimiter eliminates the need for metering since users can be billed for a maximum predetermined amount of water. In addition to the original cost of the water meters all subsequent costs of meter testbenches, meter repairshops and meter reading can be saved. (par. 12).

e. Simple maintenance

For flushing the distribution points after installation and for regular preventive maintenance or for removal of larger clogs blocking the orifice, a special hydrant is available. This hydrant is designed to enable maintenance without having to disconnect the Flowlimiter from the distribution network. (fig. 3)

f. Sealing

WISA Flowlimiters can and should be sealed to prevent tampering. The user cannot increase the capacity yet he can flush the device as ofter as he wants to. If the seal is broken, the capacitor can only be taken out with the ball valve in the closed position. (fig. 5)

g. Ease of installation

The WISA Flowlimiter comes with a $\frac{1}{2}$" BSP Female thread on both sides and can be coupled to any type pipe. Please refer to the productbrochure for the connection alternatives (Annexe 1).

h. Interchangeability reduces inventories

Since the body of the WISA Flowlimiter is the same for all orifices between 25 and 1000 l/hr, there is no need to maintain costly inventories of several types of ferrules.

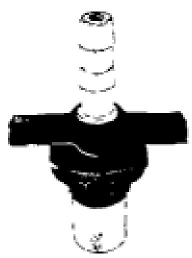


figure 3

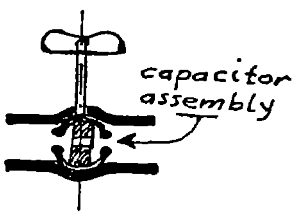
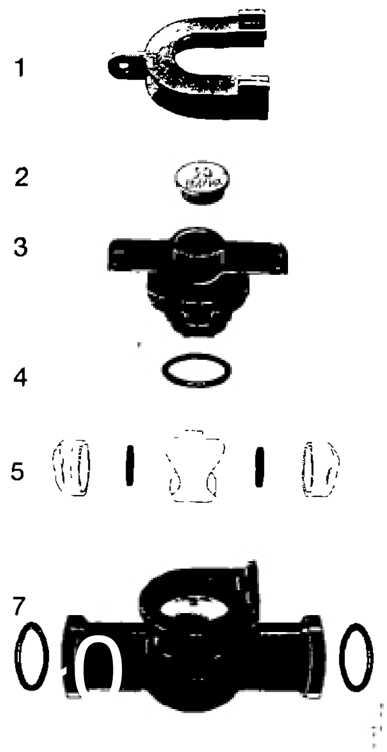


figure 4



1. Sealing sleeve
2. Cap indicating litres per hour
3. Spindle
4. O-ring
5. Capacitor assembly
6. House with ball valve 2 x ½" BSP female thread
7. O-rings

figure 5

05 One of the most significant advantages that can be achieved with the RFR is the reduction of the distribution peakflow factors.

The main cause of the high (3-9) peakfactors is the regular intermittance of the supply: two times a day actual supply is common in India. If only that could be changed without increasing the volume of the supply, the equitability of supply would increase simultaneously with a steep drop in the distribution peakfactors of all those mains which are now subjected to intermittent operation.

Such operations damage the mains and endanger the quality of the water (public health) because of the damages and leakage.
With the help of the RFR distribution periods can be gradually increased programmatically until 24 hr supply is within reach and peakfactors become normal. (fig. 6)

Note: Introducing the RFR into an existing water supply careful planning and (small-scale) experimentation may be required to achieve the intended goals.

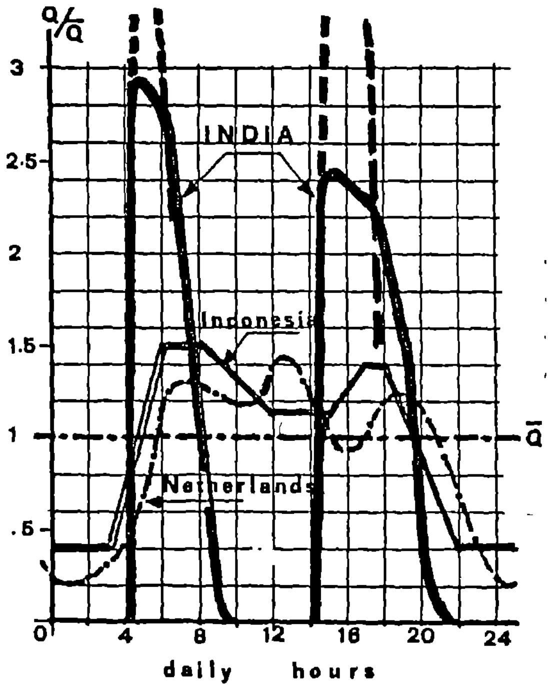


Figure 6
Consumption curves

06 Another advantage of the RFR is it's potential to simplify the operation and maintenance procedures for distribution networks and eventually reduce the cost for O/M significantly.
As the RFR reduces the pressure fluctuations in the mains, damages and leakages will decrease. If RFR's replace household water meters, meter readers, meter testbenches and meter repairshops become superfluous. Household storage may not be needed after some time while house connections will become cheaper as the supply equitability improves. And so on. See par. 12.

07 Further advantage is that the RFR will improve both the pressure levels in the distribution network as a whole and the pressures at the distribution points which in turn improve flow conditions for the RFR's.

08 The objective of a perfectly controlled distribution system with a peakfactor of at most 1.5 may not be within reach shortly.

Yet, along with the necessary inspection, the RFR will prove to be a good step in that direction. But it might be necessary to do some experimentation first to determine the right approach. Experience with the RFR has been obtained in Indonesia, where the RFR plays a key role to-day in the development of the so-called IKK (village) piped water supply projects (see ref. 5). In India, the climatic and local (cultural, religious) conditions are different.

09 What is felt to be of particular importance to India is the development of progressive or programmatic water supply and the appropriate technology required for it. (Chapter 5, page 12).

The technology that aims at self-reliance in water supply by integrating water supply, sanitation, drainage, preventive health education, training and poverty alleviation activities linked to water. It is expected that the RFR will contribute to that development. (ref. 2., 4).

Note:

As long as low permissable demands and supplies are observed, low-flow RFR's may be best used in combination with some (household) storage. The more the permissable demands cover the actual consumer demands, the more both the RFR and the water meter become superfluous.

Note:

Water supplied to the consumers of Amsterdam is not metered! Yet the consumption there is not higher than elsewhere in the Netherlands where all distribution points are metered).

The RFR vs the ferrule

10 The RFR is considered an improvement to the so-called ferrule applied and experimented with in different parts of India. The ferrule is neither reversible, (consequently difficult to flush) nor reliable as the flow-rate fluctuates with pressures in the main.

Several Water Supply Undertakings (W.S.U.) in India have experimented with the ferrule attempting to obtain proper tail-end controlled water supply.

But too often impurities in the water clogged the orifice. This increased the operation and maintenance problems.

All shortcomings of the ferrule have been eliminated in the RFR.

The RFR vs the bulk-flow watermeter

11 Unlike the RFR the water meter does not restrict the flow.
It should also be mentioned that intermittent supply reduces the reliability of the meter significantly. Every time the distribution is started a lot of air will escape from the distribution system via the metered connections. The escaping air spins the meters. A problem not applicable to the RFR.
Once produced in India the cost of a RFR is expected to be around 75% of the cost of a corresponding water meter.

12 Cost comparison

a. A rough cost comparison indicates a price tag difference between the meter and the RFR when it comes to operating and maintaining them.
Fig. 7 visualises the comparison: contrary to the RFR, bulk flow water meters - meters for short - require:
- meter test benches
- meter repair shops
- extra work to dismantle, to transport, to process and to reinstall them again
- meter reading (extra administration and personel costs)
- more complicated billing procedures, thus
- higher costs to collect the fees due.

b. Apart from the difference in purchasing costs, substantial pipeline material investments costs are at stake.

1. Min. 25% when a reduction of 50% can be achieved in (design) peakflow factors (with RFR's higher reduction rates - 3 to 6 down to 1.5! - can be realised). See par. 12 c.
2. Another 25% can be saved from the first construction phase for other purposes (integrated activities and the 2nd exploitation and programmatic development phase) if a progressive water supply development policy is adopted. See Chapter 5 (par. 27 and 30).

c. If the design peak-flow factor is reduced smaller pipe diameters can be applied as the result of which pipe material can be saved. Assume peak-flow reduction 50% (say 3 to 1.5)

Since $I = H/L = C_0 . Q^2/D^4$ (economic grade, fig. 8),
the diameter can be decreased according to the ratio $D^2_1/D_0^2 = Q_1/Q_0$.
So, the new diameter (D_1) can be calculated from $D_1^2 = (Q_1/Q_0)\,D_0^2 =$
$\frac{1}{2} D_0^2$ or $D_1 = 0.7\,D_0$ (savings 30%).
Since the weight (G) of a pipe is directly proportional to the diameter the savings in pipeline material also amounts to 30% ($G_1 = 0.7\,G_0$) Say minimum savings 25%.

Note: Since smaller diameter pipes are also cheaper to lay some savings could also be calculated for the laying of the lines.
A further saving can be effectuated, particularly in difficult terrains, when PE-pipes are used instead of PVC-pipes.

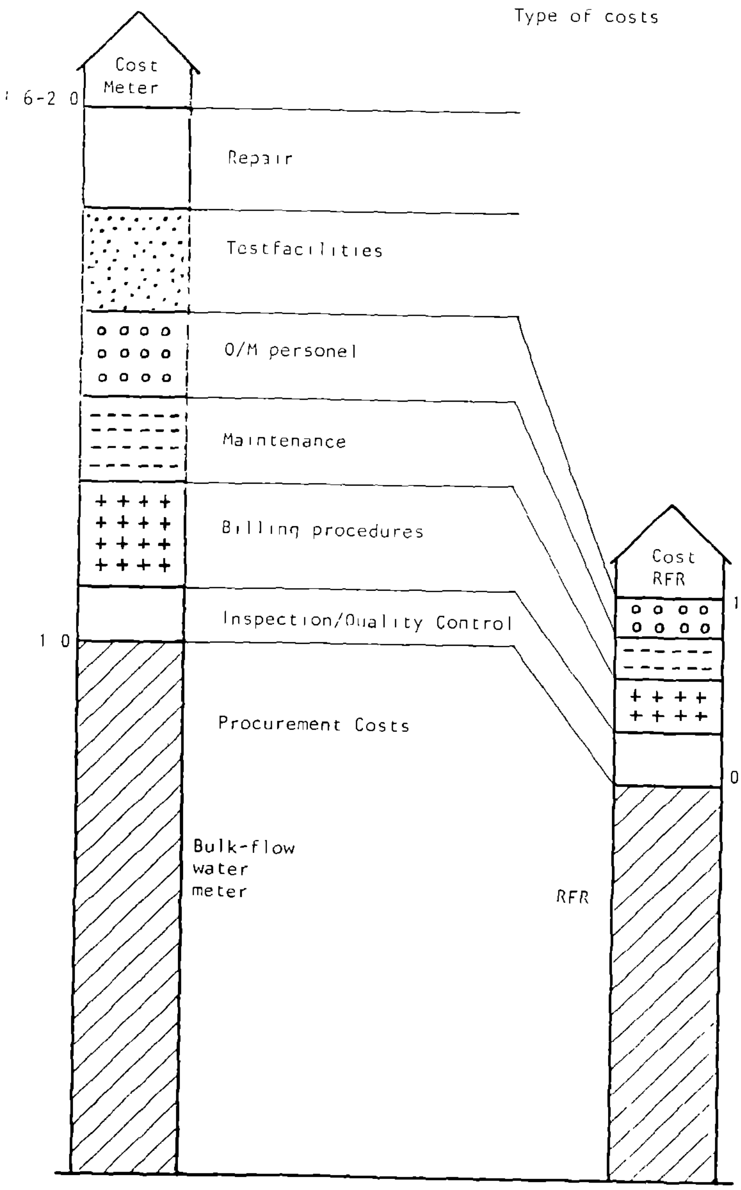


Fig. 7 - Cost comparison

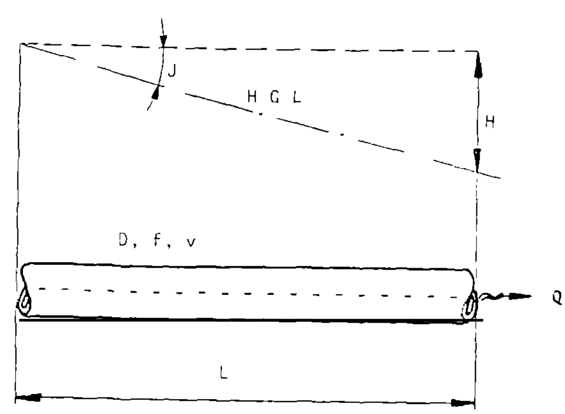


Fig. 8 - Pipe flow hydraulics

3. Least-cost solution and low-cost technology

13 The RFR contributes to a low-cost water supply technology. Because the RFR is cheaper (than the bulk-flow meter for instance), and because of the direct and indirect savings involved that result from appropriateness, improved reliability and simplified operation and maintenance procedures for piped water supply schemes. Not to mention the reduction in subsidy requirements at first and the abolition of such soon there-after. Consequently, the RFR also contributes to the least-cost solution in water supply development.
(Note: neither least- nor low-cost is synonimous for cheap).

14 Indirect savings result from reliability and fair distribution and tariff policies - fairer than ever - that can be developed with the help of the RFR.

With specific reference to rural water supply many experts agree that an integrated socio-economic approach is needed. (see ref. 1, 2 and 4).
This means that rural water supply has to be integrated with income generating activities associated with the water supply scheme. (see ref. 2).

15 The RFR makes it possible to establish a progressive distribution policy by allowing the "demands" for water to increase gradually and "at will".
The actual supply is only increased when the community can safely absorb it and - what is more - can also **safely dispose** of it (drainage) and/or utilise it appropriately (economic incentives).

16 All this, including the application of the RFR, requires careful preparation, training and testing. The RFR is useful to develop new water supply schemes but can also be used to rehabilitate existing water supply schemes (par. 40). What remains pertinent as always is adequate inspection to assure the required appropriateness and to prevent meddling with the controls by consumers.

4. Distribution control

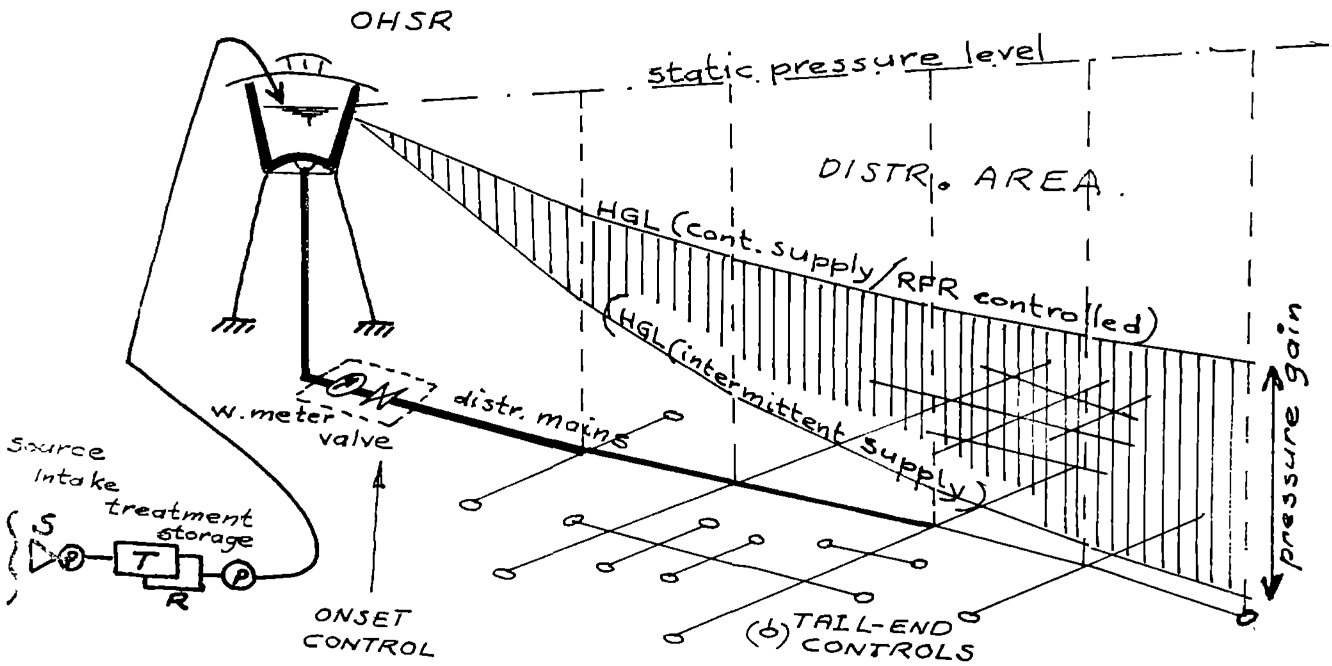


Figure 9

17 Fig. 9 depicts a simple piped water supply scheme: source-transmission-storage and distribution. Apart from measuring the production of water, the distribution need to be controlled to ensure reliability, fairness and the status of self-reliance. The following types of distribution control are distinguished:
"onset control"
"tail-end control"

18 When the distribution is controlled at the onset of a distribution network (or parts there-of) it is called "onset control". The flow may or may not be monitored. The control devices may be located on reservoir sites as can often be seen in piped rural water supply schemes.

19 When the distribution is metered or restricted at the distribution points themselves - the tailends of a distribution network - it is called "tail-end control". The control devices (water meters or flow restrictors) are located at the distribution points.

20 In order to improve water supply equitability and to comply with donor requirements first priority should be given to **"tail end control"**.

Note:

Financial donors like World Bank and donor countries (bilateral aid) often demand that at least industrial and private connections are metered and subject to tariffs. Where this is already difficult in cities, problems are paramount when it comes to metering the rural connections.

21 If the distribution points are not controlled ("open" and unmetered) the abuse of water may be rampant as the result of which a number of interrelated problems arise like

a. poor equitability (quantity and quality),
b. intermittent supply
c. higher than necessary costs due to
   - higher distribution peakfactors (3 to 9 vs normal 1.5)
   - excessive pressure fluctuations in the system (fig. 9)
   - more damage to mains
   - adverse impact on health and sanitation
   - the need for household storage (Chapters 5 and 7).

22 The cost to run such uncontrolled systems keeps on increasing and so does the quest for subsidies.

Eventually, the beneficiaries are effected and further impoverised unless appropriate self-reliance is achieved in time (par. 50).

23 The RFR will never allow more water to pass within a certain period of time than the pre-determined flow-rate.

The pressure in the distribution network (-main) can be maintained full-time whereas the owners of the connections can only draw to what they are entitled to (continuous supply).

Flat RFR-rates only can be instituted and no water meters are required.

5. Progressive water supply

Water supply policy, appropriate technology and the quest for self-reliance

24 The Water Supply & Sanitation Decade has strongly effected water supply policy in India. A diligent programme was taken up for this decade with the help of foreign donors among which the World Bank ranks high.
Both urban and rural water supply & sanitation projects have been taken up and the progress made so far is indeed impressive.
Operation and maintenance of many rural water supply projects are subsidised by the local governments. However the local authorities find it increasingly difficult to allocate the required funds and the quest for self-reliance in rural water supply increases.

25 This quest for self-reliance requires the development of an appropriate approach to water supply and sanitation based on integration and community participation. The significance of the role of local women is steadily recognised in the building of successful subsistance water supply and sanitation (see ref. 4), as well as the importance of an integrated socio-economic approach to muster mutual responsibilities, patronage and participative exploitation of rural watersupply and sanitation projects.

26 It is in this light that progressive water supply is launched here to lessen the burden caused by subsidies.
Prerequisites for successful (read: self reliant) water supply are:

a. drainage (if water supplied is not properly drained it becomes a health hazard),
b. sanitation and preventive health-care education (there is a strong relation between these two and water),
c. training (local people have to be trained in O/M),
d. religious and socio-cultural acceptance (community participation and decision making) and
e. economic incentives (probably the most important of all to ensure self-reliance at the earliest).

27 Where people are used to consume little (less than 5 lpcd in drought prone areas) protected water supply must be stepped up gradually. If a backward environment is not properly prepared to receive say 75 lpcd, it is a crime to - all of a sudden - supply such an amount. Of course, the beneficiaries are happy at first. But soon, the same water becomes the abode of death when it is not properly drained or utilised. Never should water supply be allowed to develop epidemics or otherwise play health-havocs with the beneficiaries. On the contrary, the developer must make sure that water supply contributes positively to the sensuous balances of communal life.

28 Here is where the RFR comes in as an appropriate tool to develop water supply progressively. Both the water supply engineers and the beneficiaries have to be made aware of the good logic of such a policy and the need to develop the appropriate technology that comes along with it.
To-day, appropriate technology guidelines regarding the RFR are needed for public taps, house and other connections and the execution of appropriate integrated approaches to piped water supply when the application of the RFR is envisaged. Some research will be needed to formulate the above.

29 Continuous 16-24 hr supply may look difficult to realise when permissable flow-rates demands are low. Yet, the expectations both financially and health-wise are so challenging that the RFR must be tried out (like in Indonesia):

a. At least 25% of the investments can be postponed and saved for the exploitation and progressive development phase
b. The savings should be invested in the development of the necessary integrated activities and/or,
c. (partly) be invested in other activities to muster self-reliance, so that
d. subsidies for operation and maintenance will decrease and eventually become redundant.

30 If a new water supply scheme is to be developed progressively two phases should be distinguished for the implementation of the scheme:
a. The first construction phase (say 75% to be implemented) and
b. The exploitation and progressive development phase (25% construction).

31 Depending upon the outcome of feasibility, design and planning, the first phase will only cover sufficient construction work to exploit the scheme successfully for a number of years progressively (increasing the supply gradually as discussed above and providing new connections whenever appropriate).

As soon as the local circumstances (ecology, public health, health education, income level, community participation, drainage etc.) allow it, new construction work can be taken up to complete the scheme to it's design-capacity.

32 Progressive water supply development is a form of basic needs engineering. It's principles are not only applicable to piped water supply (both urban and rural) but also to integrated handpump schemes and other developments like (mini) irrigation and social housing projects.

6. Existing piped water supply schemes

33 **Urban vs rural water supply**

Because of the difference between urban and rural development in India, the imperatives required for a successful implementation and exploitation of urban and rural water supply are so diverse that a clear distinction must be made between the development of urban and of rural water supply.

For many a rural community, water supply (both piped water supply and handpumps) has a deep bearing on their life and it's ecological balance whereas in cities piped water supply is already normal.

Consequently, rural water supply has to be treated as a socio-economic happening with a positive bearing on the environment and its ecological balance whereas urban water supply can be treated as a technical entity if proper drainage (sewerage) is available.

34 Often urban oriented Water Supply Undertakings entrusted with the task to develop rural water supply, need training in appropriate rural water supply technology, progressive water supply and rural O/M techniques. An integrated socio-economic approach requires preventive health care education and community participation, simple drainage techniques and other allied activities, the training of local operators, inspection techniques and the development of self-reliance aspects (economic incentives linked to water).

35 **Existing rural piped water supply schemes**

Any type of piped water supply can be found in rural India:

a. large comprehensive schemes covering many villages and large areas,
b. medium size, like the so-called pump-and-tank schemes covering a few villages and the
c. individual schemes which cover only one village.

36 On almost all of them O/M-procedures can be improved with the help of the RFR under the condition that proper inspection is maintained to prevent meddling with the RFR's and the distribution system.

Water supply rehabilitation activities include besides the installation of the RFR's, repair and cleaning (flushing) of the mains. A public information campaign is needed to obtain the necessary public support.

37 Especially rural water supply schemes are executed as tree systems with storage installed on one or more of the branches. Many schemes are not metered but open ended.

If the quality of the mains is doubtful, trials may be required on certain branches of the system before the decision is taken to rehabilitate the scheme with the help of RFR's.

38 **Existing urban water supply schemes**

Unlike rural and semi-urban (township) water supply, all major city water supply distribution systems look alike: water is pumped to overhead service reservoirs (OHSR) from where the water is distributed twice daily under peakflow conditions.

Much water is collected in private storage tanks. Often, the pressures in the mains are so low that only groundleveltanks can be reached from where the owners themselves pump the water up into rooftanks. Regardless of the high investments made by the owners much water is lost in the process. The quality of the water remains unsafe as the result of private storage (open tanks) and the regular intermittence of the supply (polluted water re-enters the pipe through cracks and leaks as soon as the pressure in the mains becomes atmospheric.)

39 The RFR provides a remarkably resilient way of solving the set-backs of intermittent supply and of improving water supply equitability. Conditions are of course that an appropriate policy is accepted for integrated progressive water supply development, including training and effective inspection aimed at sustaining subsistance in water supply distribution.

40 **Rehabilitation with RFR-control**

Rehabilitation of piped water supply schemes with RFR's is not necessarily difficult but should not be underestimated either. The new perspectives offered by the RFR can be divided into two categories:

a) consumer perspectives (reliable supply at higher pressures) and
b) administrative perspectives (better water supply equitability at lower costs).

41 In order to develop the best rehabilitation process it is necessary to have a good understanding of what the RFR actually does: it restricts the flow-**rate** at the distribution points as the result of which:

a. the consumption is ceiled: the consumer can only collect so much water as he is entitled to receive (consumer's interest) within a certain period of time, and
b. the distribution periods can be increased even without increasing the volume of water to be supplied, if so desired (both a consumer and an administrative interest).

With these two possibilities the die is cast and if the challenge is accepted, the rewards are:

a. reduction in peakflow, in pressure fluctuations and in shockwave effects in the distribution system, as the result of which:
b. the occurrence of damages and leakages lessens
c. the mains will last longer (mains are overdesigned) and the system will function longer before augmentation is required
d. the pressure level in the distribution network will rise due to lower flow velocities and along with that - last but not least -
e. the pressures at all distribution points will increase.

42 Practical problems will arise when 1) the required pressure for the RFR (0,4 bar) can not be realised; 2) the flow-rate of the RFR is so low that for practical purposes the owner of the connection will resort to storing water in his house and 3) the fluctuations in demand can not be leveled to meet the RFR supply-rate.

How to go about solving such problems:

ad 1 Consult fig. 2: if the required pressure is too high to maintain 15% accuracy one may:

a) Accept a point lower on the curve. See fig. 10.
In that case the controlling accuracy is less and it all depends on the actual pressure fluctuations in the main whether one will favour this solution, or
b) install more than one RFR in a parallel connection, or
c) a combination of both a) and b).

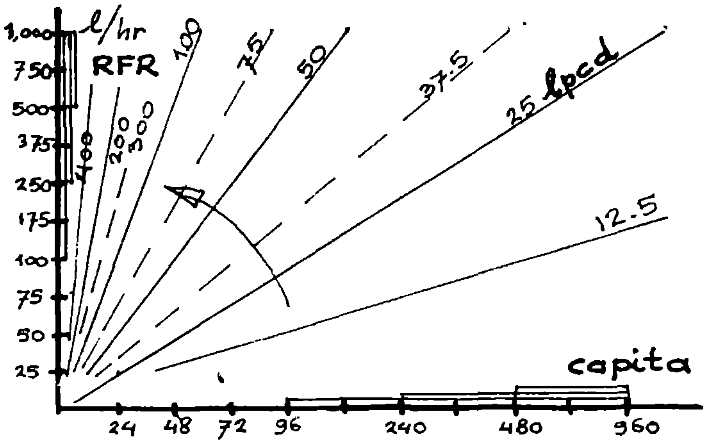


Figure 10
Capacity curves
Continuous supply

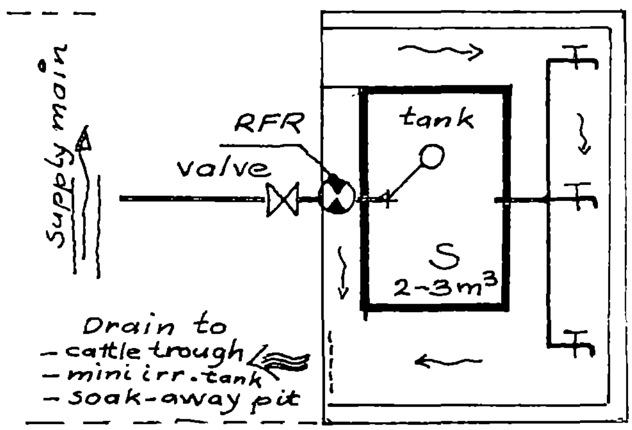


Figure 11

A 200 person 3-tap public fountain for low cap.(10-50 lpcd) RFR 100-375 l/hr

ad 2 If the allowable flow-rate is too low (25 l/hr will take one hour to fill a bucket!) one may consider to control several connections by one RFR. (fig. 11)
If owners sharing one RFR agree about a schedule of supply a larger capacity RFR can be installed to serve all. (par. 55)

ad 3 Here the consumer (factory, hospital, hotel etc.) may be obliged to install some leveling storage capacity of it's own. (par. 61)

As long as low-flow conditions prevail a combination of RFR and some storage will be appropriate. Yet, household storage will be reduced significantly where flow restriction is effectively applied.
See chapter 7, Examples and fig. 13 - 17).

7. Examples of RFR-controlled piped water supply schemes

43 **Progressive water supply / rural**

Primary prerequisites to rural water supply are drainage, basic knowledge of hygiene, public preventive health care training and the necessary sanitary facilities like showers, laundry places, cattle troughs and possibly also toilets. In backward areas the people must be taught how to drain and to re-use the waste water from water supply schemes. All such activities take time. It is absolutely essential that the beneficiaries and the target groups select their own priorities.

44 Community awareness may have to be built in order to develop water supply in harmony with it's environment. Otherwise community participation may not be satisfactory. Condition for successful participation is being informed and having the right understanding of the pro's and con's.

45 It is the developers responsibility to ensure that protected water supply can not develop filthy environmental conditions, epidemics and new deseases. This means that water supply has to be developed progressively if the environment needs time to adjust to it. Appropriate progressive integrated development is often the "conditio sine qua non" for success and self reliance.

46 After identifying the necessary prerequisites (drainage, sanitation, preventive health-care education, economical incentives, community participation etc.) which may vary with climate, - particularly with respect to arid, semi-arid and wet regions - a planning is drafted in which a proper sequence of allied activities that have to be executed to ensure successful water supply. The assistance of sociologists may be required.

47 After the feasibility study has been completed, the general frame work for such a planning may be as follows. (See ref. 2).

A. Preparation (SEAT-unit and W.S.U.)* / Design phase

a) Socio-economical activities:
- information drive
- community involvement
- decision making

b) Technical activities:
- preliminary designs and proposals

c) Technical designs (W.S.U.) and an integrated development plan (W.S.U./SEAT-Unit)

B. Implementation (SEAT-unit, W.S.U. and contractors) phase

A progressive water supply project will be executed in phases. At first approximately 75% will be implemented. The remaining 25% will be executed during the exploitation and progressive development phase (par. 29).
SEAT-unit continues to work with the beneficiaries in the villages concerned and leads the development of the socio-economical activities, community participation, training, non-formal education and the development of economical incentives.

Note: The W.S.U. tenders contracts and supervises the execution of the works. The SEAT-unit may be a special section of the W.S.U. or it is formed and trained by a lead-agent (government or non-government organisation). Both SEAT-unit and W.S.U. officials work closely together.

Important is the right sequence of activities: the community must be informed about the water supply plans and decide about the location of the taps and house connections before the water supply is executed. The populace must share in the execution of the project as much as possible. Drainage and income generating activities must be started in time, i.e. before the project is completed. The same is valid for training, health education, etc.

C. Exploitation and progressive development phase (SEAT/W.S.U.)

The SEAT-unit remains for some time in the villages. At least until the scheme is self-reliant.
When the implementation phase is completed and the scheme is started-up, the W.S.U. must exploit it as economically as possible, meanwhile steadily increasing production and supply, in tune with the development of the environment.

* SEAT-unit Socio-Economical Appropriate Technology Unit
W.S.U. Water Supply Undertaking

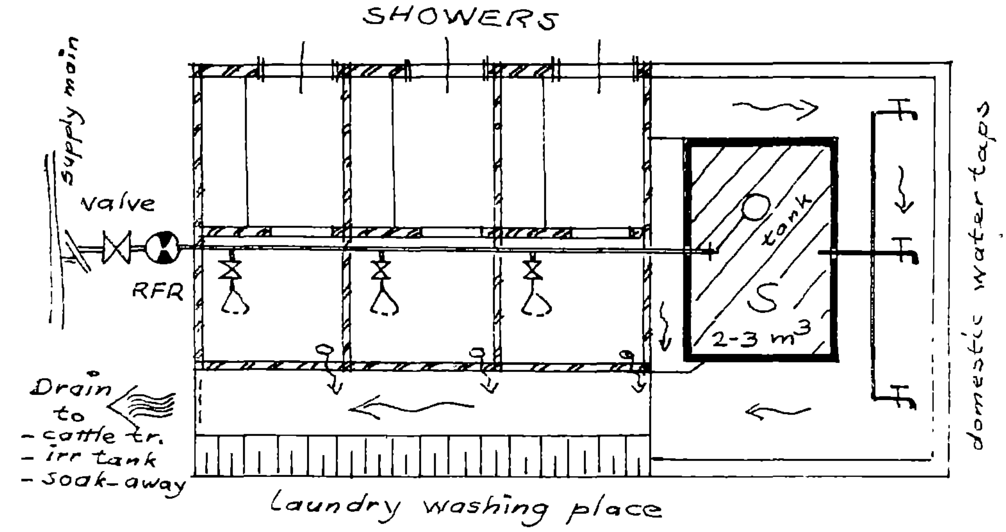


Figure 12

A 200 person public fountain with showers and laundry place
Cap. 50 - 150 lpcd (RFR 375 - 1,000)

48 Example: Water supply initiatives have been approved to provide 2 villages and a hamlet (pop. 1,000) with piped water supply (pump-and-tank-scheme). The area is poor and drought-prone, the villagers consume less than 5 lpcd and groundwater is deep.

Note: The need for progressive development of water supply is evident. There is no drainage (no need for it), no sanitary facilities (no need for it either as long as the hot sun kills the germs effectively), no trees nor fire wood nearby and thus no agriculture. Cattle, goats and camels form the lifeline. Indeed, what the villages need is water!

However, their own priority is not drinking water but water for vegetables, fodder and firewood (mini irrigation). Drinking water they can get from far and irrigation water can also be drunk!

49 Comment: Plans are to provide 75 lpcd. Without proper drainage 75 m^3 water would collect on the unpaved village pacca roads. And that every day ! The result is of course an environmental mess of dirt, excreta, water and mud in which flies, musquitos, contageous viruses, germs and worms breed to cause epidemics and new deseases.

50 If O/M of the scheme is subsidised:

a. The beneficiaries develop no heart for their water supply and
b. the water supply will soon become a nuisance instead of an incentive for new developments.

Eventually the costs for O/M will increase, government looses interest and stops the subsidies and the villages are worse off than ever before.

Conclusions

51 The conclusion is that a policy of progressive integrated development must be adopted that leads to complete self-reliance in water supply.

This means:

a. that water supply should be stepped-up gradually from say 15 lpcd to 75 lpcd in approximately 5 - 10 years depending upon the development of the allied activities such as drainage, cattle watering and the re-use of waste water for vegetable gardening, fodder farming and the growth of seedlings for firewood;

b. public training and non-formal education in preventive health care, vegetable and other gardening;

c. community participation - particularly women - to be stimulated and all other

d. economic incentives to improve low income levels (family).

52 The adopted policy could eventually be as follows:

a. With the help of an experienced N.G.O.* (lead-agent) a SEAT-unit is formed and put into operation in the villages to:
   - guide all socio-economic activities required
   - coordinate training activities and
   - develop the appropriate technologies needed.

b. The contractor(s) will use local labour for trenches, etc.

c. The W.S.U. and the SEAT-unit are responsible for the technical training of local operators and other training needs re the economic incentives (vegetable gardening), fodder, firewood farming, O/M of drains, throughs etc. and health education.

d. Schedule of RFR-controlled house connections:

first year	only public taps, no house connections
1 - 5 year	10% populace covered by house connections
5 - 10 year	50% populace covered by house connections

After 10 - 15 years the remaining part of the project (25%) may be completed depending on the progress made in terms of self-reliance.

* N.G.O. = Non Government and Voluntary Organisations

e. Schedule of consumption rates:

first year	10 - 15 lpcd. Assuming proper progress in waste water utilisation
1 - 5 year	25 - 30 lpcd.
5 - 10 year	30 - 50 lpcd.
10 - 15 year	50 - 75 lpcd.

f. Schedule of supply hours

0 - 5 years 05.00 - 21.00 hrs (16 hrs/day).

After 10 5 or earlier: 24 hr supply.

Public taps (fig. 11 page 18 and 12 page 21)

53 The RFR-controlled public fountain: max. 200 persons/fountain.

First year: 200 x 15 = 3,000 l/fountain/day

16 hrs/day: 200 l/hr, apply 250 l/hr RFR

so 12 persons can fill a bucket of 20 l each in one hour (5 min./bucket); or 25 buckets of 10 l each (size of ave. container)

200 persons means in practice approx. 40 women fetching 50 l each and every day

(4 - 6 containers per woman in say 2-3 hauls/day): including waiting time at the fountain say 2 hrs/woman/day.

1-5 years 200 x 30 = 6,000 l/fountain/day.

16 hrs/day: 375 l/hr RFR

In order to reduce waiting times at peak hours (morning and evening) the fountain could be designed with a small reservoir (2000 l) serving a manifold with 3 valved taps.

5-10 years 200 x 50 = 10,000 l/fountain/day etc.

54 **House connections** (hc) (fig. 13, 14 and 15)

1 - 5 years: 30 lpcd, 5 persons/household; 150 l/day/hc

a) 16 hr supply: 10 l/hr - so a 25 l/hr RFR may serve 2 houses, but private storage will be required

b) Five hc per RFR: 750 l/day/ 5 hc or $\frac{750}{16}$ = 50 l/hr RFR

Storage (500 l.) could be combined.

55 Note:

a. The more house connections are controlled by one RFR the larger the capacity of the RFR, the more the need for storage decreases.

b. If no storage is installed and all house connections use valved taps a larger size RFR could be considered based on say 10-12 hrs actual tapping.
So 700 : (10-12) = 75 l/hr.

c. 50 - 100 l can be stored in small portable containers, toilet, shower and kitchen containers. So, for the first years more than a number of portable containers may not be needed. On the other hand, house connections may not be considered before permissible demands rise above say 50 lpcd.

d. Health, conditions will significantly improve only when public showers are installed (fig. 12) and water flows directly to the houses. So, the urge is on to provide house connections. However, unlike the stone houses many a pacca hut is not fit to have running water, showers and toilets.

Consequently piped water supply itself leads to the need of better houses and improved living conditions.

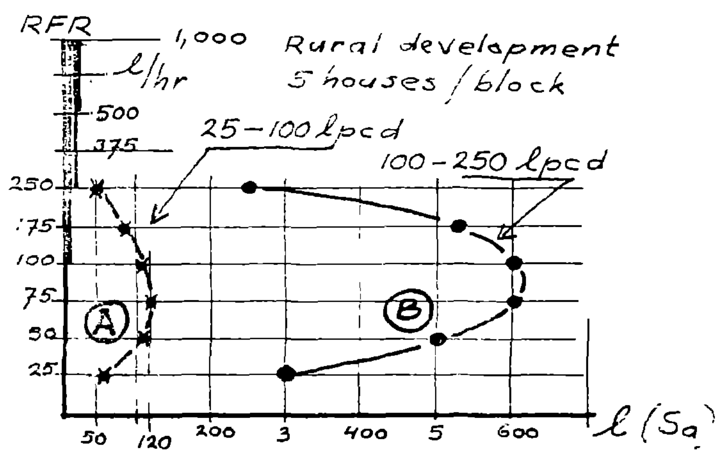


Figure 13
Storage requirement per house

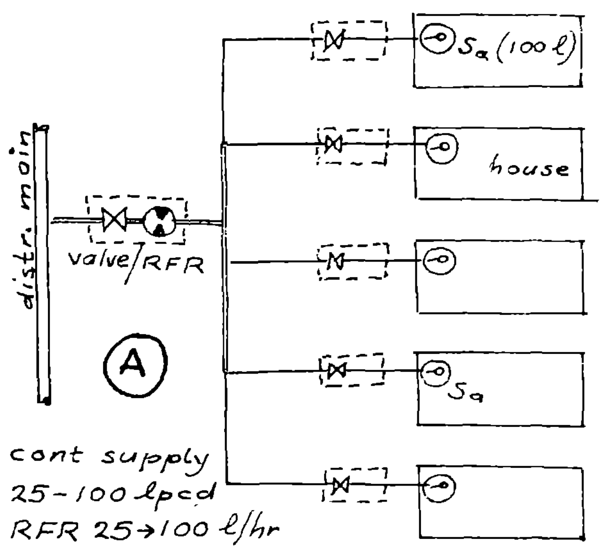


Figure 14

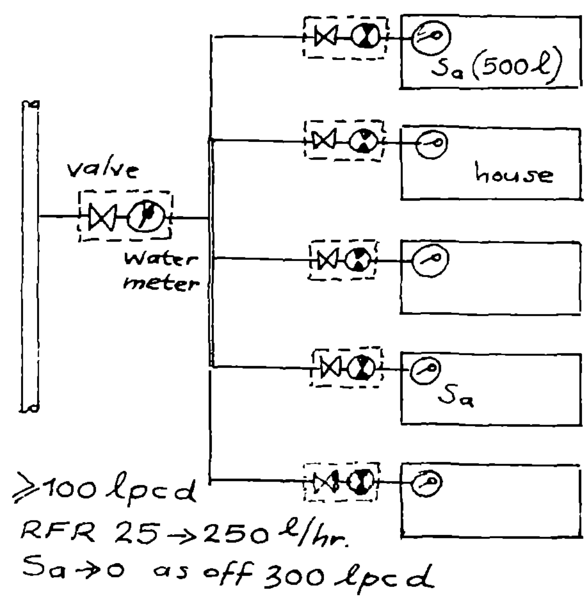


Figure 15

56 **Progressive water supply / urban**

Fig. 9 shows the expansion of an urban water supply network.

Assumptions:

- OHSR - overhead service reservoirs
- Flat residential pressure zone with
  a hospital
  a factory
- 1000 people
- Design period 30 years
- Sewer system operational

Total requirement in m^3 per day:

	Initial	Future
residential	50	100
factory	12	30
hospital	10	18
	72	148

Policy: initially intermittent supply for 16 hrs/day.
after 5 years: 24 hr supply at 148 m^3/day.
tail-end control with RFR's or water meters.
no public taps, only a few street fountains and fire hydrants.

Implementation

57 Note:

a. within 5 years a supply of 72 m^3/day over 16 hours is increased to 148 m^3/day in 24 hrs. At first sight one may conclude that flow patterns and peakflow factors need not be effected because the average supply-rates hardly change over the first 5 years: 72.000/16 = 4,500 l/hr and 148.000/24 = 6,000 l/hr.

b. This is true, but - as for the residential areas at least - most water will be consumed during the day.
Assume that households consume water during 6 hrs a day (open taps). With 16 hr/day supply at 50 lpcd and 5 people per household a 5 x 50 : 16 = 15 l/hr RFR would be required. The smallest RFR is 25 l/hr and the required household storage amounts to (16 - 6) 25 = 250 l.
As soon as 24 hr supply is applied an empty 250 l tank will be filled during the night in 10 hrs.

c. If the factory and the hospital are 24 hrs in operation storage will be needed on the premisses. This may or may not be necessary after 5 years when water is supplied for 24 hrs (high capacity RFR's).

For large consumers and odd irregular demands RFR-control may be less appropriate.

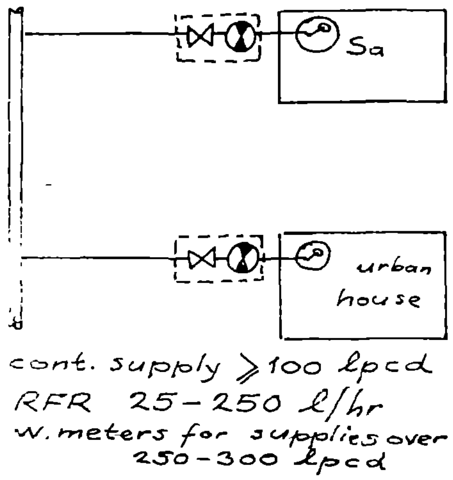


Figure 16

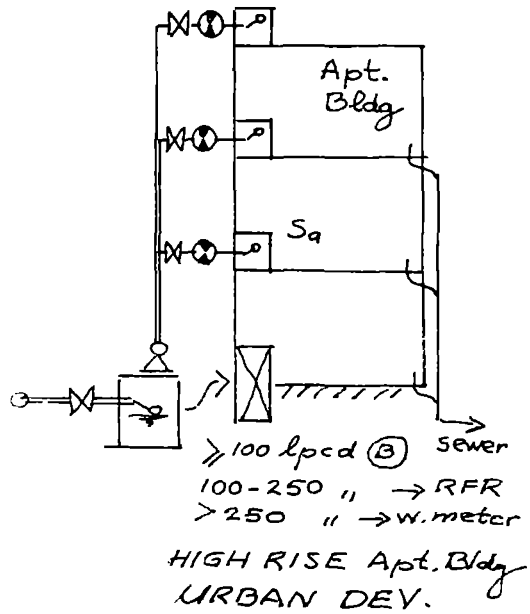


Figure 17

58 **Household connections (generally contemplated)**

Assume 5 people / house connection:

initial/future consumption, 5 x 50/100 = 250/500 lpcd

initial/future average flow-rate, 250 : 16/500 : 24 = 15,6/20,8 l/hr.

The smallest RFR gives 25 l/hr.

When 4 - 5 households (20 - 25 people) share a RFR and a storage tank the supply can be further improved as follows:

25 x 50 : 16 = 40 l/hr, so, a 50 l/hr RFR applies and a (16-6) 50 = 500 l tank (or 5 x 100 l tanks as shown in fig. 14.

Note:

1. The more the allowable consumption increases the better it is. The larger the RFR (more than 50- 75 l/hr) the least is the urge for private storage. Eventually the RFR becomes superfluous.
2. Sharing RFR and storage may be considered and an appropriate technology may be developed for that purpose.
3. It may not be possible to make private storage needs superfluous with low-capacity RFRs. What counts is the favorable effect of the RFR on water supply equitability.

59 In this example the progressive development of permissable demands can be realised by gradually increasing the distribution periods without changing the capacitor assemblies in the RFR. The result is that peakflows diminish pressures increase and a fair distribution of the available water can be ensured at flat tariff rates only. So the administration can be simplified as no water meter reading is required.
Progressive water supply in this example boils down to only changing (gradually stepping up) of the distribution periods from 16 hrs/day to continuous supply.

60 As soon as supply hours are increased beyond the hours of actual consumption (say from midnight to 06 hrs) the W.S.U. should allow for slightly (25-35%) larger RFR's to be installed to compensate for the nightly hours of low demand, if no household storage is applied.

61 **Industrial connections controlled by RFR**

If RFR-controlled supply is considered (maximum flow-rate 1 m^3/hr) most industries will have to install storage if working hours last beyond supply hours, no matter how reliable the intermittent supply may be.
Parallel connections of RFR's may be considered for capacities beyond 1 m^3/hr.
Because of odd consumption patterns (critical consumption rates and volumes) and higher tariffs it may be more appropriate to meter industrial connections rather than to control them with RFR's.

Figures

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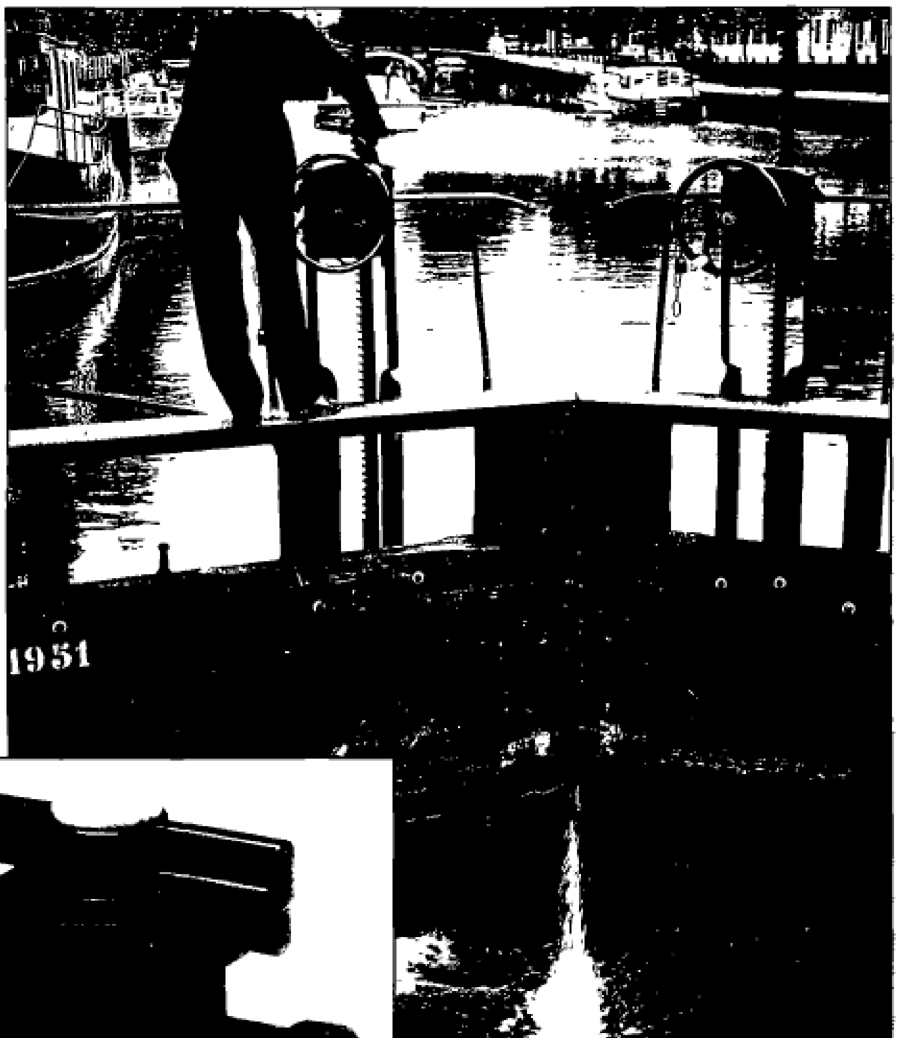
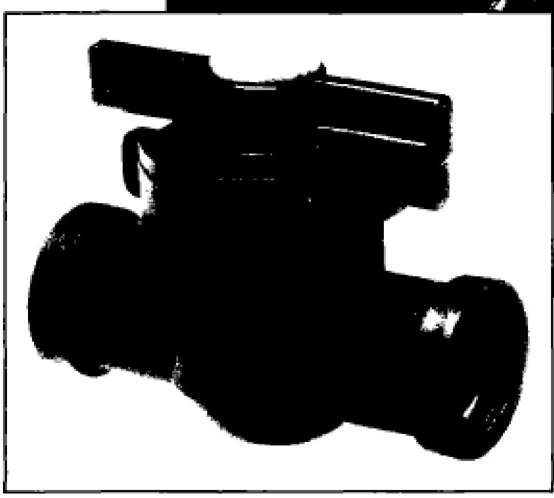
FLOWLIMITERS





The panacea for your water distribution system

MADE IN HOLLAND

WISA FLOWLIMITERS

The answer to all your water distribution problems

WISA Flowlimiters combine the functions of flowlimiter (flowrestrictor), stop valve and watermeter in one simple unit designed to solve **all** your water distribution problems.
The **WISA Flowlimiter** is easy to install and simple to maintain and can be sealed to prevent tampering.

The **WISA Flowlimiter**, designed by water control specialists, is built of the finest materials to exacting specifications.

It's a flow limiter .....

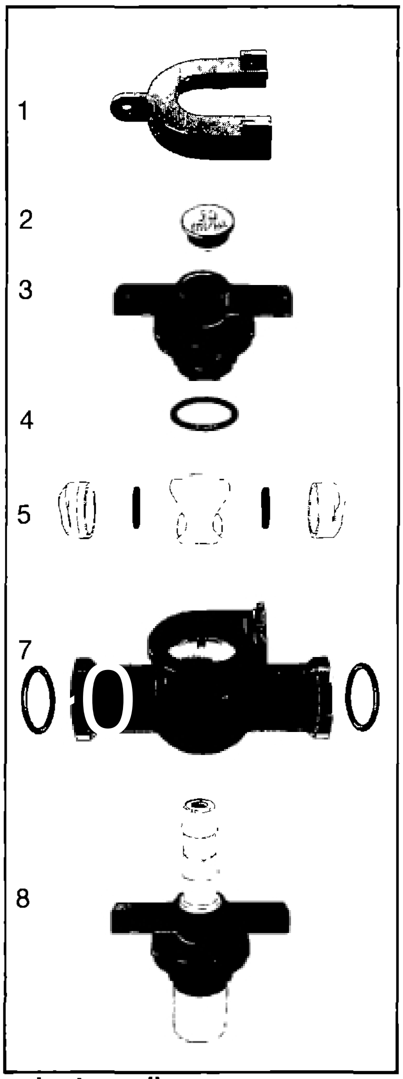
In many parts of the world, an adequate supply of potable water is the difference between life and death. Water must be distributed **equitably** to all users. The **WISA Flowlimiter** limits the available quantity of water to a predetermined flow in liters per hour.

It's a stop valve .....

The **WISA Flowlimiter** has a build in ball valve. A quarter turn will stop the flow of the water.

It's a watermeter .....

The **WISA Flowlimiter** can eliminate the need for water metering in cases where users can be billed for a maximum predetermined amount of water per household. Then there is no meter to tamper with or service.



patent pending

Ease of installation

The **WISA Flowlimiter** comes with a ½" BSP Female thread on both the inlet and outlet sides. It can be coupled to any size pipe, using WISA's PE clamp couplers or other standard couplers.
The **WISA Flowlimiter** comes with two O-rings to ensure a 100% tight fitting with the connector without damaging the threads.

Technical Specifications

The **WISA Flowlimiter** standard range consists of flow capacitors ranging from 25 litres/hr to 1.000 litres/hr.
Flow capacity can be in- or decreased by means of a simple exchange of separately available flow capacitors.
The **WISA Flowlimiter** operates with a variable waterpressure between 0.4 and 4 bar (25-250 litres per hour) or 3 - 9 bar (375-1000 litres per hour).

1. Sealing sleeve
2. Cap indicating litres per hour
3. Spindle
4. O-ring
5. Capacitor assembly
6. House with ball valve 2 x ½" BSP female thread
7. O-rings
8. WISA-Hydrant

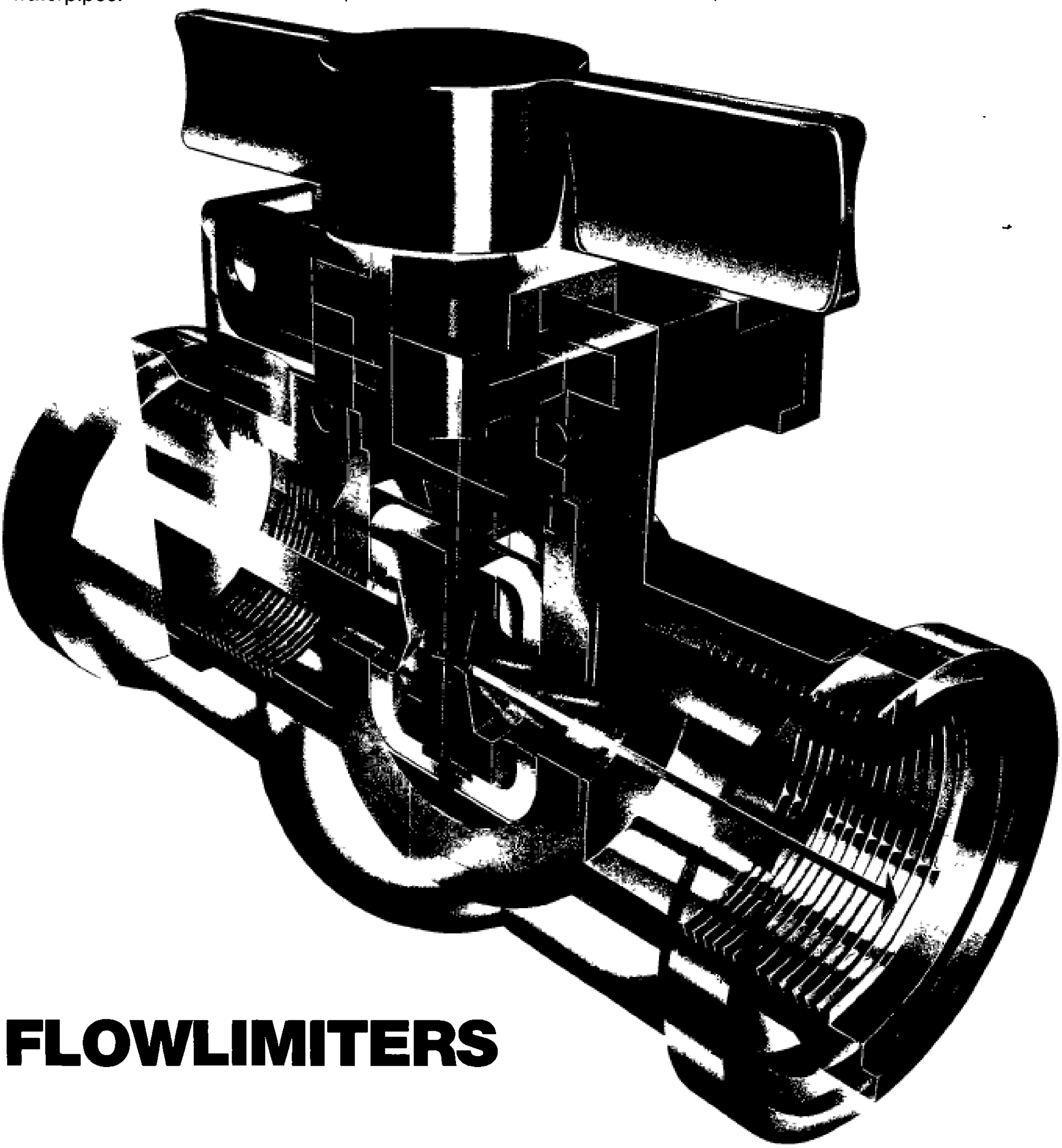
Simple maintenance

Flowlimiters presently available in the marketplace tend to clog quickly requiring repeated maintenance to keep them operating effectively.
The **WISA Flowlimiter** can be cleaned by the user without breaking the seal. A quick and simple 180° twist of the spindle washes away minor obstructions.

The **Wisa - Hydrant** can be used when a turn of the spindle does not dislodge the obstruction or for regular preventive maintenance.
A hose of 14 mm (½″) can be connected to minimize soilage. The installation can be cleared without disengaging the **WISA Flowlimiter** from the waterpipes.

Further advantages

The high reliability and easy maintenance of the **WISA Flowlimiter** means you can keep your stock of spare parts to a minimum. If conditions require that waterflow levels increase or change, there is no need to rework the **WISA Flowlimiter** installation. Only the flow capacitor assembly connected to the spindle and the cap on the spindle must be changed.
Both have the same colour to prevent errors during the retrofit.



FLOWLIMITERS

Litres/ hour	Article no. Flowlimiter	Flowcapacitor Assembly
25	52 30.04	52.35.04
50	52 30 08	52 35 08
75	52 30 12	52.35 12
100	52 30.17	52 35 17
175	52 30 29	52 35 29
250	52 30 42	52 35 42
375	52 30.63	52 35.63
500	52 30 83	52 35 83
750	52 31 25	52 36 25
1000	52 31 66	52 31 66
Hydrant	52 30.00	

Water control is a Dutch tradition

For centuries, a life and death struggle has existed between nature and the Low Countries. Holland has succesfully "turned the tide" with its dikes, polders and, more recently, the Delta Works, a technical feat of the highest order.

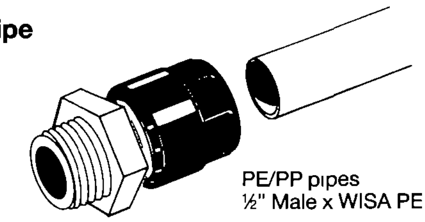
Potable water has been readily available in Holland for more than a century and WISA is proud of its technical contribution in the field of water control in Holland Since its founding in 1865, WISA has specialized in the design and precision manufacture of water control products.

Other WISA products:
cisterns
float valves
flush mechanisms
clamp couplers
check valves

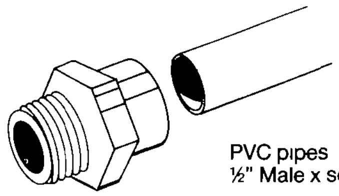
WISA B.V.
P.O. Box 2194,
Driepoortenweg 5,
6802 CD Arnhem, Holland
Telephone: 85 - 629020*
Telex: 45511 wisa nl

Connecting possibilities

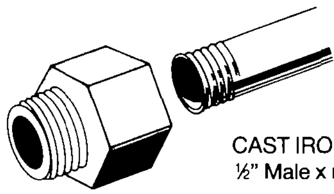
A. To pipe



PE/PP pipes
½" Male x WISA PE clamp couplers 16-20-25-32



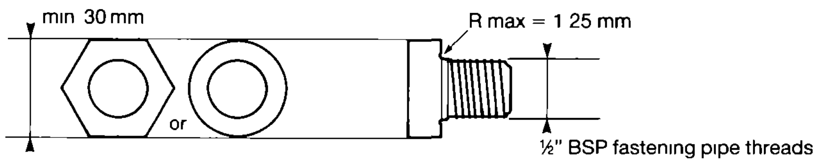
PVC pipes
½" Male x solvent sockets 16-20-25-32



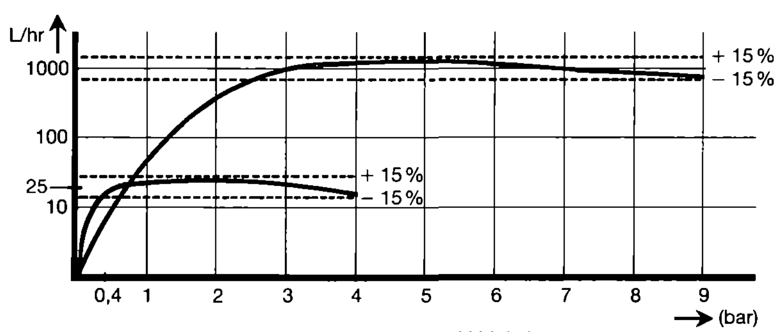
CAST IRON pipes
½" Male x metal coupler Female ½"-1½"

B. To Flowlimiter

Connection to the Flowlimiter should always be trough a coupler



Characteristics



——— Water pressure between 3 and 9 Bar (375-1000 L/hr)

——— Water pressure between 0 4 and 4 Bar (25-250 L/hr)