

Septuplex , Quintuplex , even TRIPLEX pumps

Have small, but high frequency flow fluctuations

Piping system liquid mass, viscosity, length, diameter, make flow fluctuation into pressure pulsation

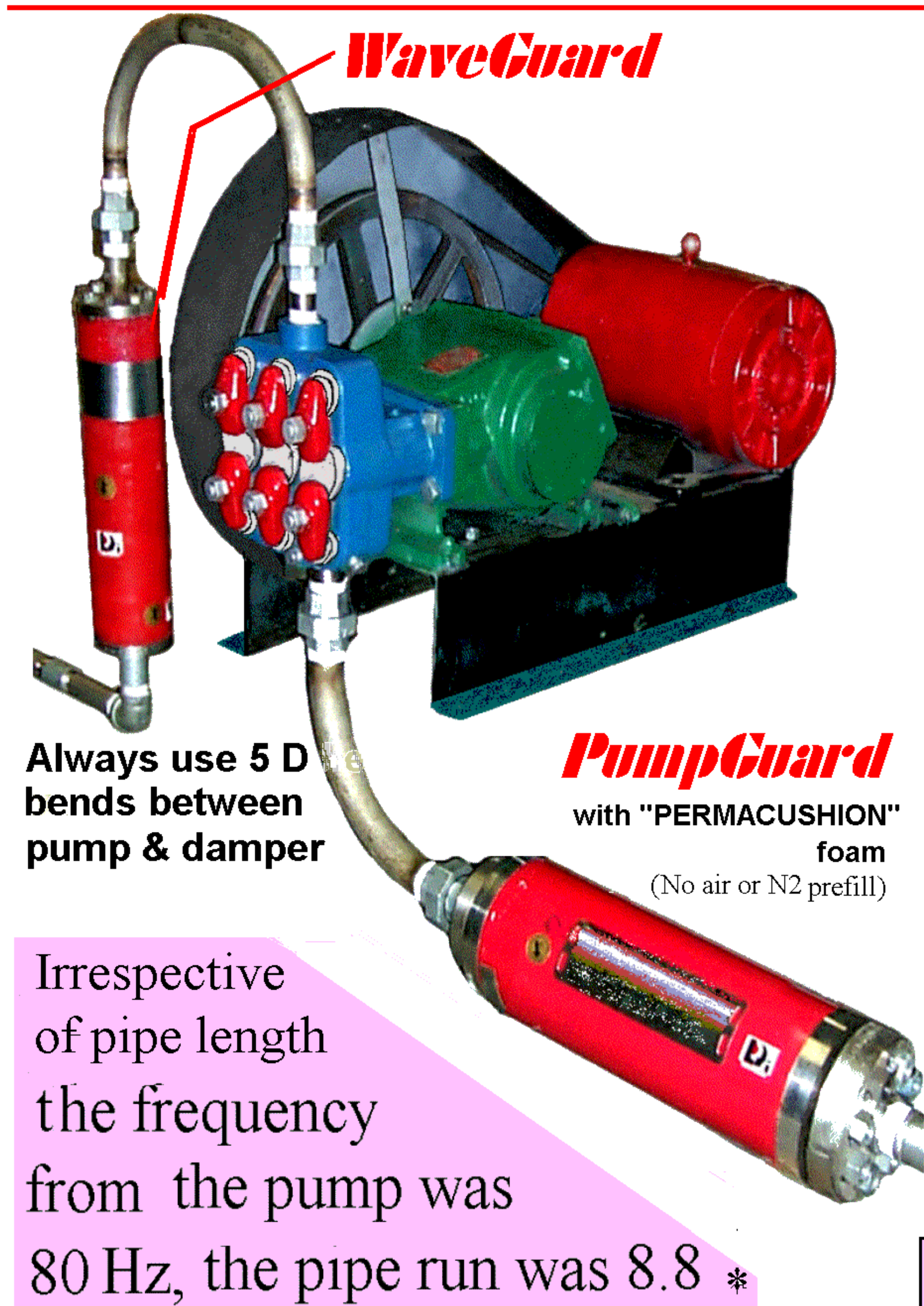
PIPE PROBLEMS ①②③ (below)

Reverse Osmosis "RO" systems, like many other systems, are packaged and have short pipes. Short pipes, like short anythings, have natural **HIGH FREQUENCIES**

TECH NOTES : *It is not necessary to read these high lighted sections*
 RPM x Number of displacers x 2 (because there is a secondary bump from the overlap of one displacer to the next) x say a minimum of 3 valve beats, then all divided by 60 (60 seconds in a minute) , = flow fluctuation forcing frequency in Hertz, abbreviation "Hz". Compare this figure with the system length wave speed frequency Typical frequency from length of pipe system you chose, is roughly, according to the effective compressibility, 4600 ft/sec divided by twice pipe length ft. (end & back) Or $1400 / 2 \times M = \text{Min. Acoustic Hz.}$ PUMP Hz : PIPE Hz is never to be a whole Nbr.

- ① The water was not pure.
- ② The pipes vibrated, the shaking made more pressure spike, the pipe spikes built on the pump spikes & amplified
- ③ Now the high amplitude at high frequency robbed 70% of the life from the ultra filtration membrane

ANSWER To prevent the system response reflecting back to the pump, and from increasing the pressure spikes, a **WaveGuard WaG** was installed which intercepted the forcing action of the pump, and isolated it from the high frequency response of the short pipe system.



Always use 5 D bends between pump & damper

PumpGuard
with "PERMACUSHION" foam
(No air or N2 prefill)

Irrespective of pipe length the frequency from the pump was 80 Hz, the pipe run was 8.8 *

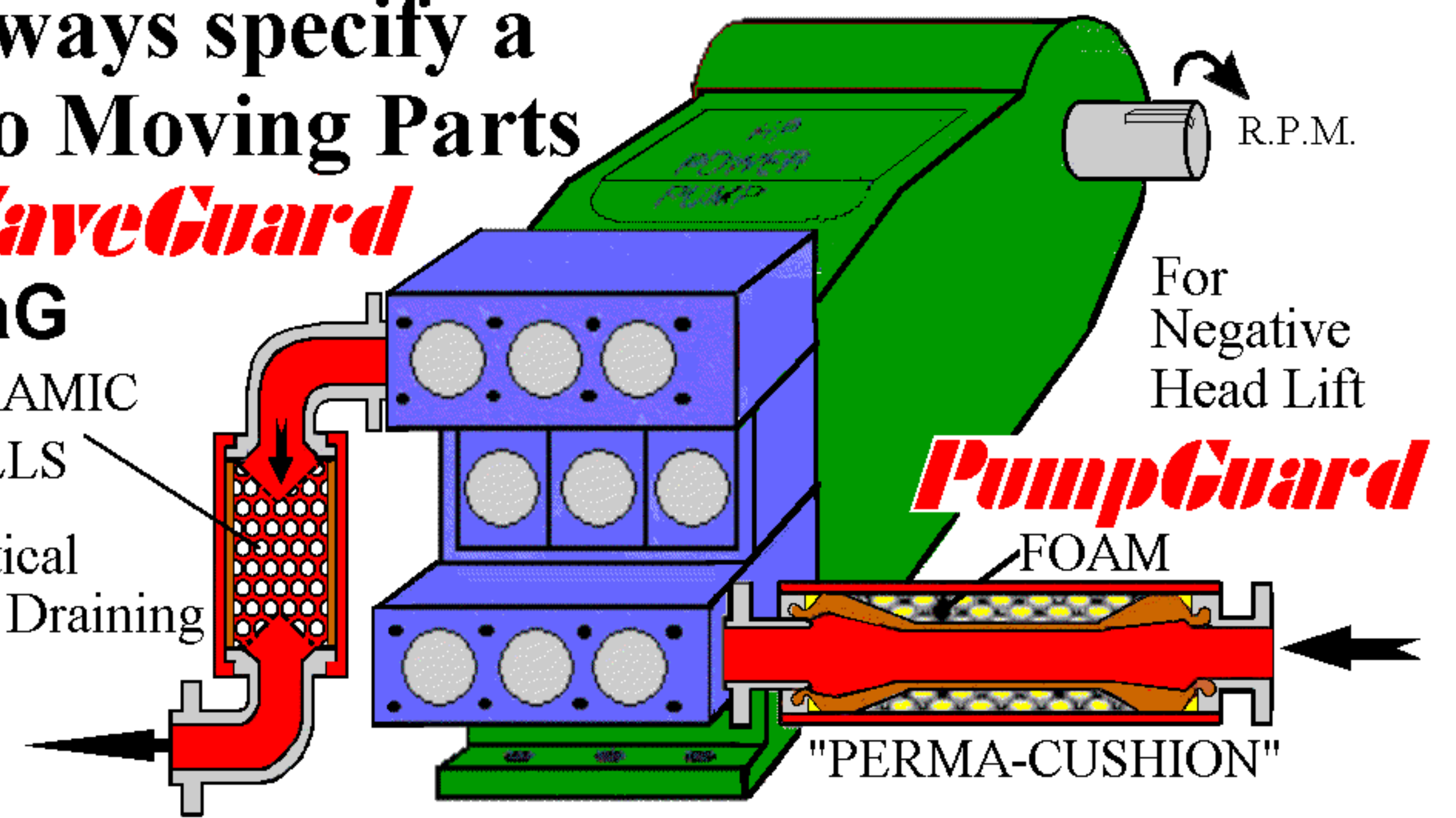
For Long Life System Components - RO Membranes and a multiplex pump

Always specify a **No Moving Parts**

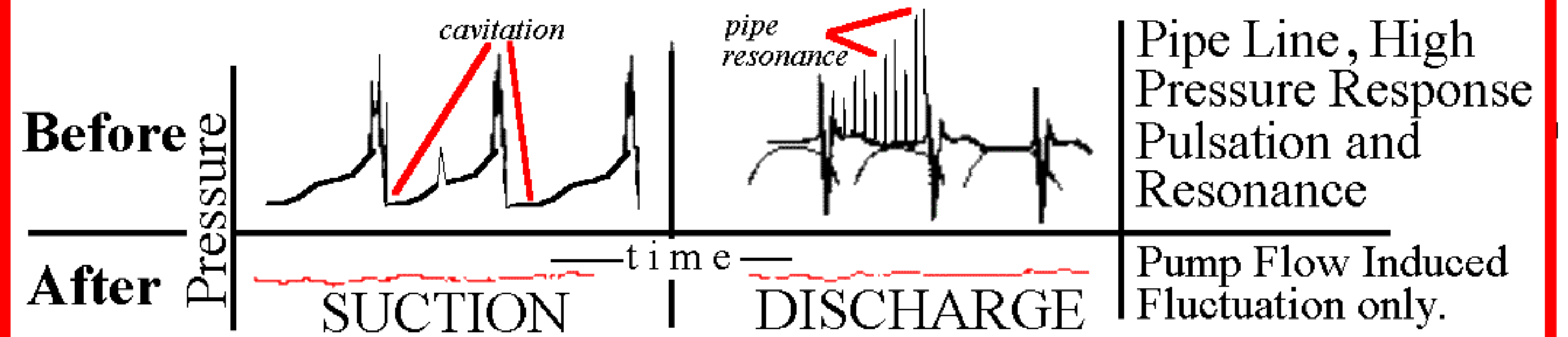
WaveGuard

WaG

CERAMIC BALLS
Vertical Self Draining



WHEN your PIPE length SHAKE RATE = PUMP RPM, The result is pulsation



The before and after oscillograph traces were taken from a deep hole boring machine, the pumpage was cutting oil. The problem was that the pressure pulsation caused cutting tool "chatter" and showed up as bad surface finish and less than 20% life of the ceramic/carbide cutting tool tips.

RESULTS ①②③+④

- ① Four times the ultra filtration membrane life.
- ② The water was pure.
- ③ The system stopped springing leaks.
- ④ **EVER BETTER**

When a **PumpGuard** cavitation preventor was added to suction it was possible to double the flow rate by changing the driven pulley.

* 8.8 Meters, say 57.7 feet there and back, at 4600 ft in a second, divide by 57.7 ft = 79.7 acoustic/pressure waves coming back onto the pump per second. They return at almost the exact instant the pump tries to send out another one. The system is an amplifier. That is one reason for RESONANCE.

PUMPS MAKE FLOW, & flow fluctuations, SYSTEMS MAKE PRESSURE, & PRESSURE PULSATION; ask pump people about flow, ASK DAMPER PEOPLE about pressure pulsation

High Hz. = Comments **Liquid Dynamics International** by - "Pulse-Doctor" Analytical, Diagnostic and Software services

Neither the PUMPGUARD cavitation preventor, nor the WAVEGUARD resonance preventor, require any pre-filling with air or nitrogen at all