Part 2

Types of Water Mist Systems & Equipment

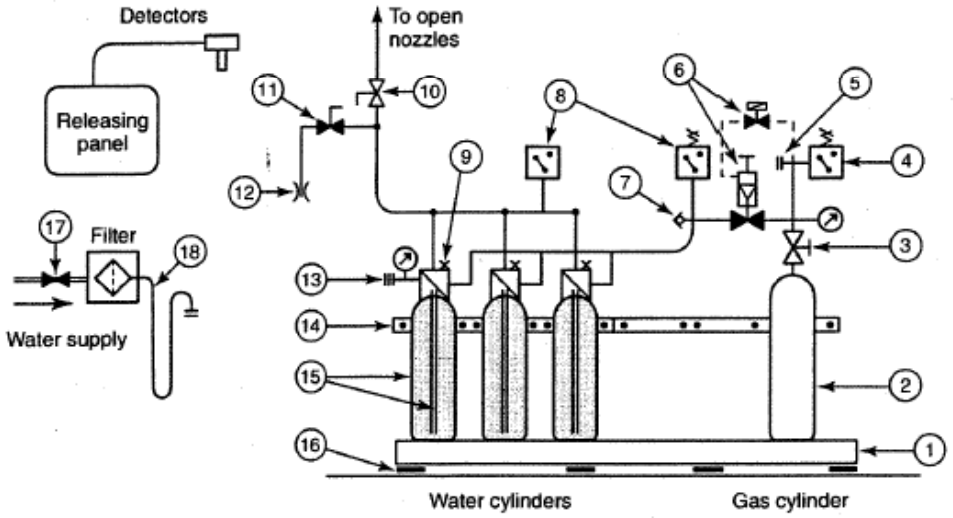
Types of Water Mist Systems by component technology

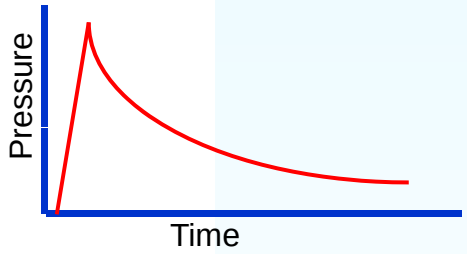
- ***See diagrams in Appendix A of NFPA 750***
- ***Compressed gas driven***
  - ~ ***Declining pressure***
  - ~ ***Constant pressure***
- ***Pump driven***
  - ~ *Constant pressure*
  - ~ *Multi-pump assemblies*

Types of Water Mist Systems by component technology

- ***Compressed-gas driven***
  - *Declining pressure*
  - *Constant pressure*

Gas Driven Declining Pressure Systems





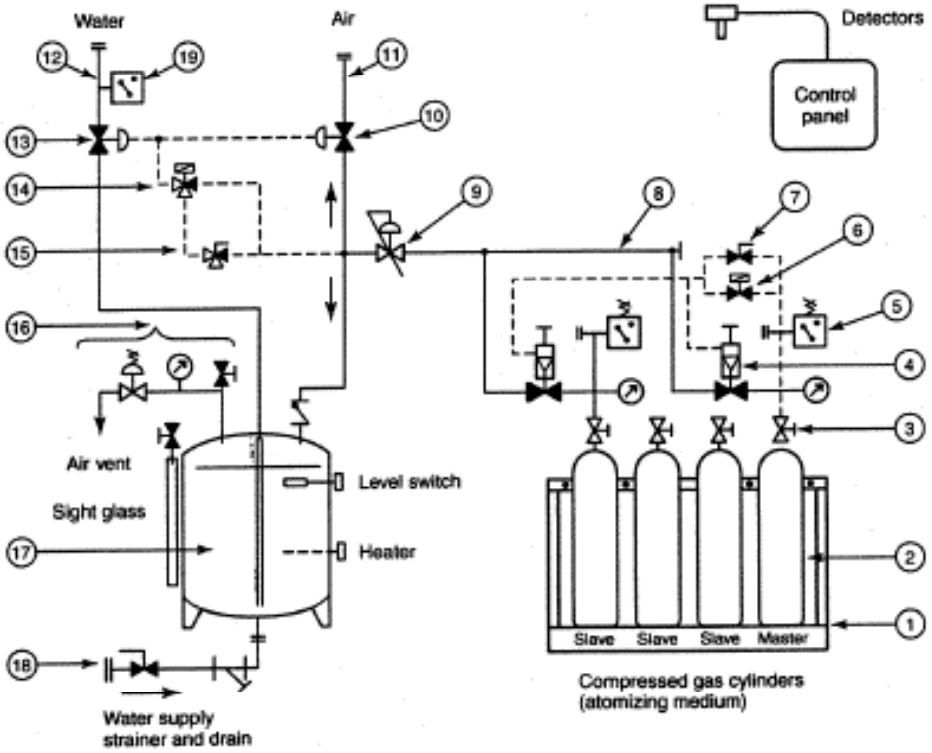
Legend

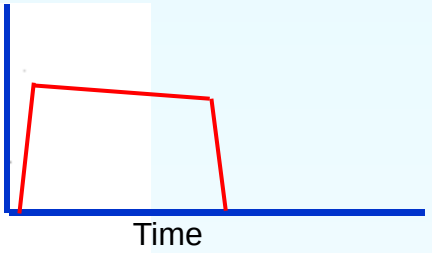
1. Steel base and frame
2. Compressed gas cylinder (driving medium)
3. Cylinder control valve
4. Pressure switch, supervise cylinder pressure
5. Burst disc
6. Solenoid operated master release valve
7. Microleakage valve
8. Pressure switches, alarm if system trips
9. Vent port, for filling water cylinders (fill until water discharges from open port)
10. Primary system or sectional control valve
11. Test connection and drain
12. Test orifice (alternative to full discharge)
13. Cylinder discharge header with filling port
14. Cylinder rack with restraints
15. Pressure-rated water cylinders with dip tube
16. Optional load cells
17. Water supply valve, normally closed
18. Filter and hose with adaptor fitting for filling cylinders

FIGURE A.11.1.6(a) Schematic Representation of a High Pressure, Gas-Driven System with Stored Water (Pre-Engineered System). [Typical]

Self-contained, gas driven system, stored water
- *limited duration (10 minutes)*
- *pre-engineered – limited area/ unit*
- *not listed for ordinary hazard*

Gas Driven Twin Fluid Water Mist System





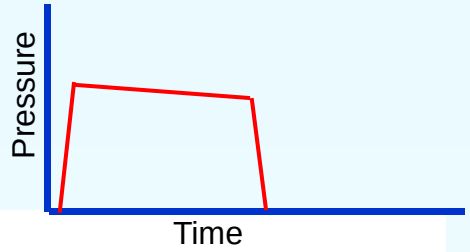
Alternative Plant Air Source

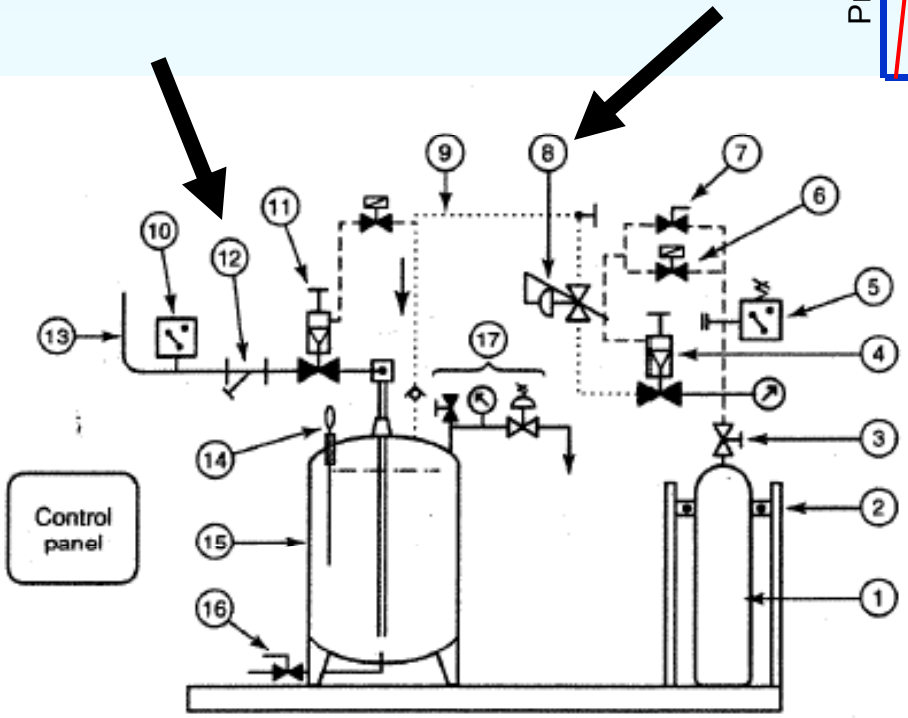
Legend

1. Steel base and frame
2. Compressed gas cylinders (atomizing medium)
3. Cylinder control valve
4. Pneumatic cylinder release valve
5. Pressure supervisory switch with burst disc
6. Solenoid operated master release valve
7. Manually operated master relief valve
8. ½ in. high pressure tubing manifold
9. Air pressure control valve (high to low pressure)
10. Air-actuated globe valve (cycle air line)
11. Air line to twin-fluid nozzles (low pressure)
12. Water line to twin-fluid nozzles (low pressure)
13. Air-actuated globe valve (cycle water line)
14. Low pressure solenoid valves (for operating air-actuated globe valves)
15. Manual release valve (opens globe valves)
16. Pressure gauge, pressure relief valve, and vent valve
17. Low pressure rated water tank
18. Drain and refill connection and strainer
19. Pressure switch, alarm on discharge

FIGURE A.11.1.6(c) Schematic Representation of a Low Pressure Twin-Fluid Water Mist System. [Typical]

Gas Driven Mist System
Constant Pressure





Legend

1. Compressed gas cylinder
2. Steel frame and cylinder restraints
3. Cylinder control valve
4. Pneumatic cylinder release valve
5. Pressure switch disc with burst disc
6. Solenoid operated master release valve
7. Manually operated master release valve
8. Pressure regulating valve, high to low
9. Air-line tubing
10. Pressure switch, alarm on discharge
11. Primary system control valve
12. Strainer on discharge valve
13. Water line to nozzles
14. Water level indicator (dipstick)
15. Pressure rated water storage tank (30 bar)
16. Drain and refill connection with strainer
17. Pressure gauge, pressure relief valve, and vent valve

FIGURE A.11.1.6(d) Schematic Representation of a Single-Fluid Water Mist System. [Typical]

Gas Driven Pump (decaying pressure)

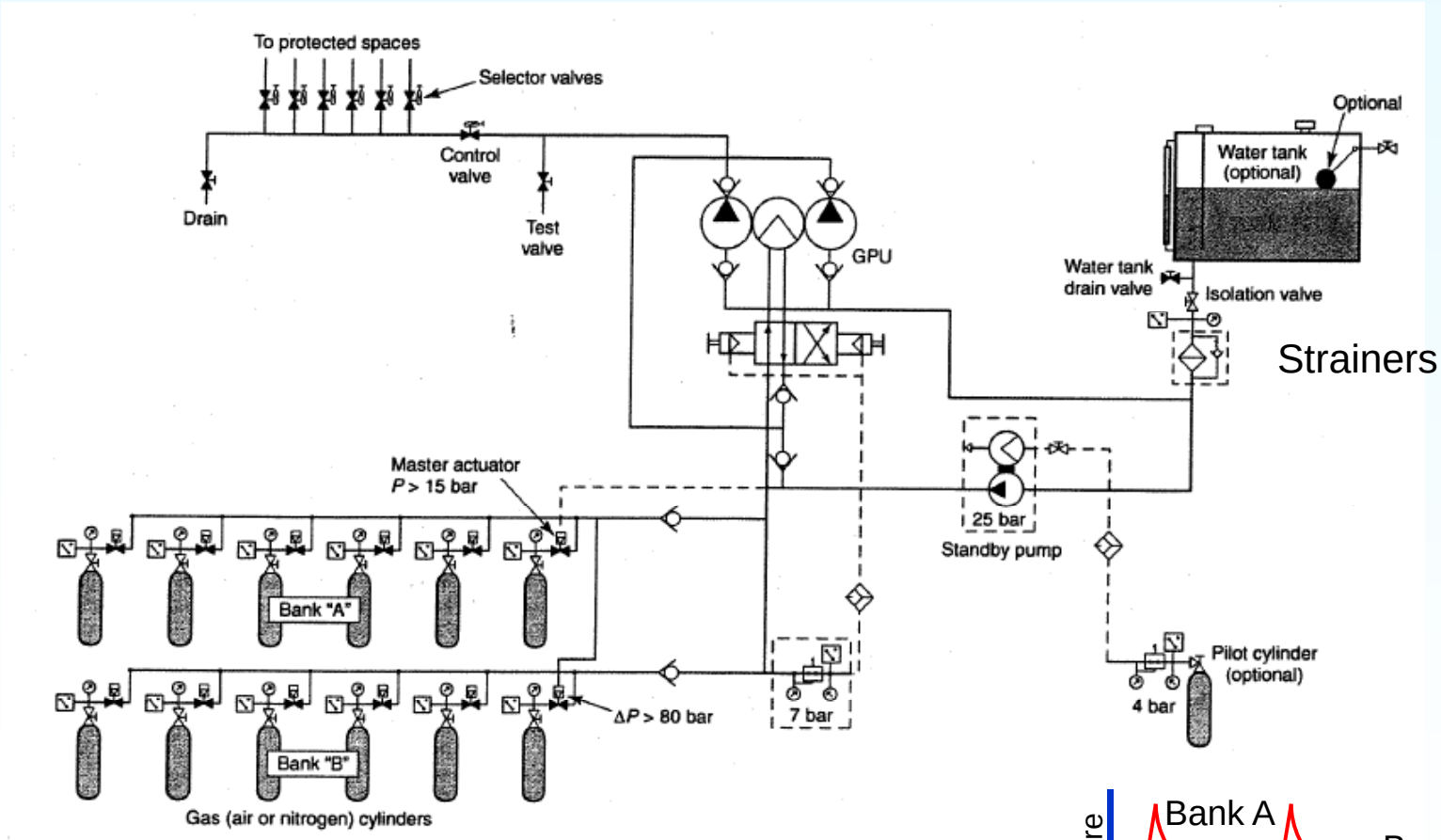
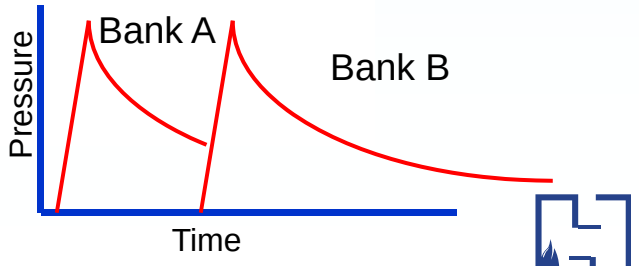
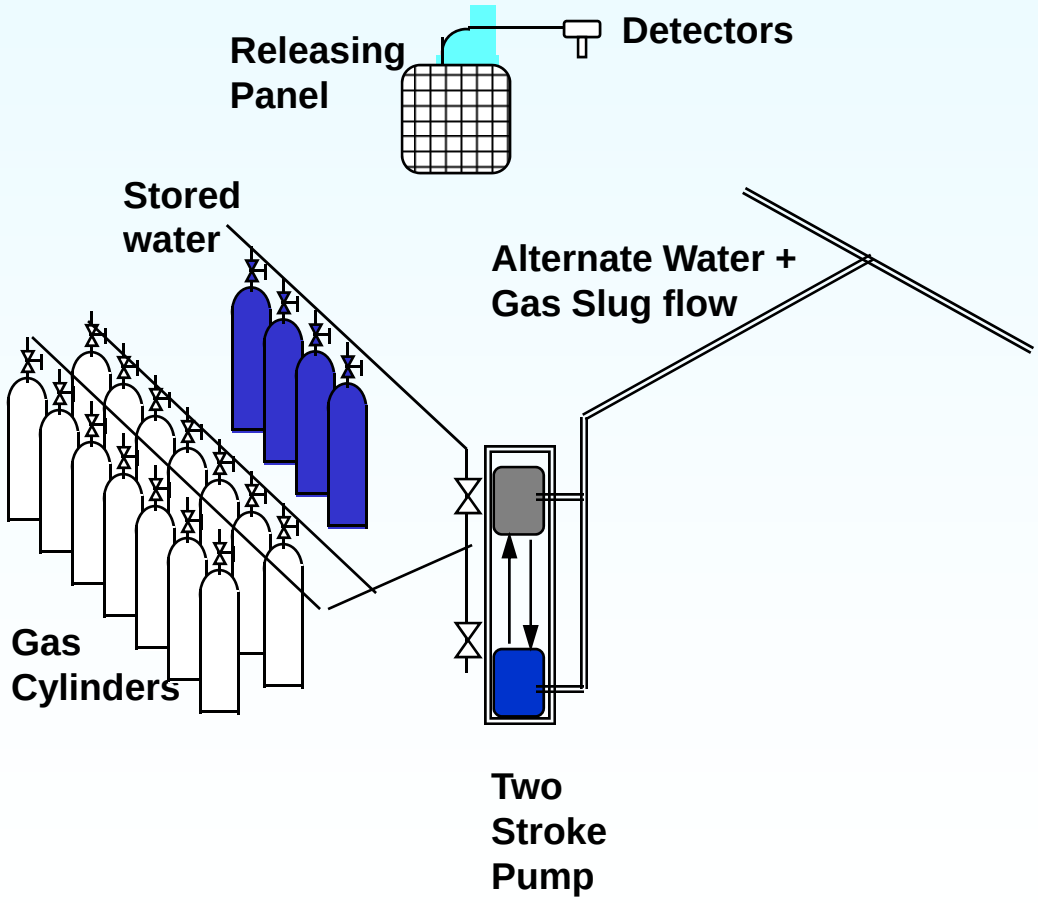
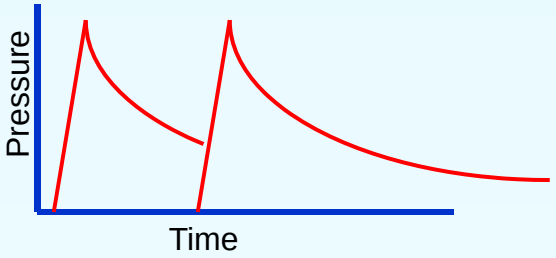


FIGURE A.11.1.6(h) Gas Pump Unit for Machinery Spaces and Gas Turbine Enclosures. [Typical]



Gas Driven Pump Unit





Pro's

FM Approvals

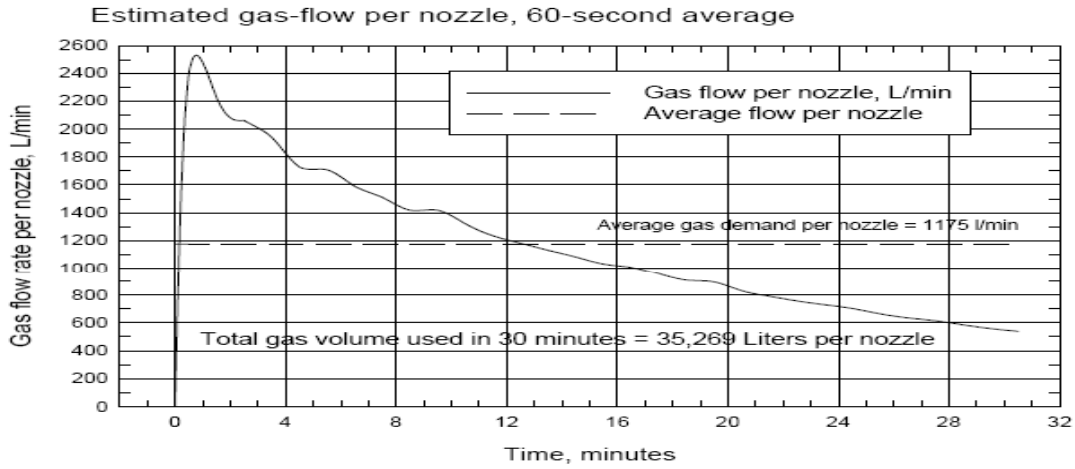
To 500 m3 volume

30-minutes duration

No electric power required

Stored gas supply (atomizing media)

Estimating gas quantity requirements



Manufacturer's design, installation and operating manual specifies gas demand based on empirical testing
Verify final installation – measure full duration of discharge

Gas driven water mist systems

- ***Typically (but not always) <u>pre-engineered</u> for fixed volume or space***
  - *small machinery compartments – turbine enclosures*
- ***Many applications – wet benches, mobile machinery, industrial cooking equipment …***
- ***Number of gas cylinders and volume of water sized for 10-minutes of protection - additive***
- ***Declining pressure throughout 10, 20 or 30 minute discharge***

Types of Water Mist Systems by component technology

- ***Pump driven***
  - *Constant pressure*
  - *Centrifugal (Intermediate P)*
  - *Positive displacement (High P)*
  - *Multi-pump assemblies*

High Pressure Water Mist Systems

- ***Use positive displacement pumps to achieve high pressures (500 to 3000 psi) (32 to 200 bar)***
- ***Technical Challenge***
  - *How to match "constant output" pumps to a "variable demand" system (1 nozzle to many nozzles…)*
- ***Approach***
  - *Use multiple small pumps + unloader valves*
    - $Q_{total} = \Sigma (q_1 + q_2 + q_3 + ... + q_n)$
  - *Programmable Controller*

Positive Displacement Pump Assemblies
Other Considerations

- ***Power requirements***
  - *Voltage affects motor size, hence skid dimensions*
  - *Full load amp draw, soft start, sequencing*
  - *Locked rotor current*
    - *(based on individual motors or entire group?)*
- ***Controllers***
  - *Meet NFPA 20 requirements ?*
    - *automatic start and stop of individual motors*

Pump Equations – Metric Units		Pump Equations – US Units	
$kW = \frac{Ql \times H}{600 \times Em \times Ed}$	*Eq. 1*	$bHP = \frac{Qg \times P \times 2.31}{3960 \times Em \times Ed}$	*Eq. 4*
$H\,\max = \frac{kW \times 600 \times Em \times Ed}{Ql}$	*Eq. 2*	$P\,\max = \frac{bHP \times 3960 \times Em \times Ed}{Qg \times 2.31}$	*Eq. 5*
$Amp = \frac{kW \times 1000}{Em \times Pf \times V \times \sqrt{N}}$	*Eq. 3*	$Amp = \frac{bHP \times 746}{Em \times Pf \times V \times \sqrt{N}}$	*Eq. 6*
kW = motor power in kilowatts		bHP = brake horsepower	
H = discharge pressure in bar		P = discharge pressure in psi gauge	
Ql = discharge flow in L/min		Qg = discharge flow in gallons per minute	
600 = coefficient of 598.8 ~ 600		3960 = coefficient for US units	
Em = efficiency of motor (0.88 to 0.92)		Em = efficiency of motor (0.88 to 0.92)	
Ed = efficiency of drive gear (< 0.85)		Ed = efficiency of drive gear (< 0.85)	
Pf = Power factor (~ 0.85 depends on motor)		Pf = Power factor (~ 0.85, depends on motor)	
Amp = full load amp draw		Amp = full load amp draw	
V = volts		V = volts	
N = number of phases in supply (N = 3)		N = number of phases in supply (N = 3)	

Efficiency = (Em x Ed) = 0.9 x 0.8 = 0.72 ---> <u>0.70</u>

Piping for Water Mist Systems

Less than 175 psi

- NFPA 750 allows copper tubing and stainless steel piping suitable for general FP service and rated for 175 psi (See Table 2-3.3.1 in NFPA 750)

Greater than 175 psi

- NFPA 750 requires that pipe or tube be in accordance with ANSI B31.1- power piping code
- ***Pipe strength calculations***
  - *Max pressure for given wall thickness*
  - *Required wall thickness for operating pressure*

Piping: Continued

Low & Intermediate Pressure Systems

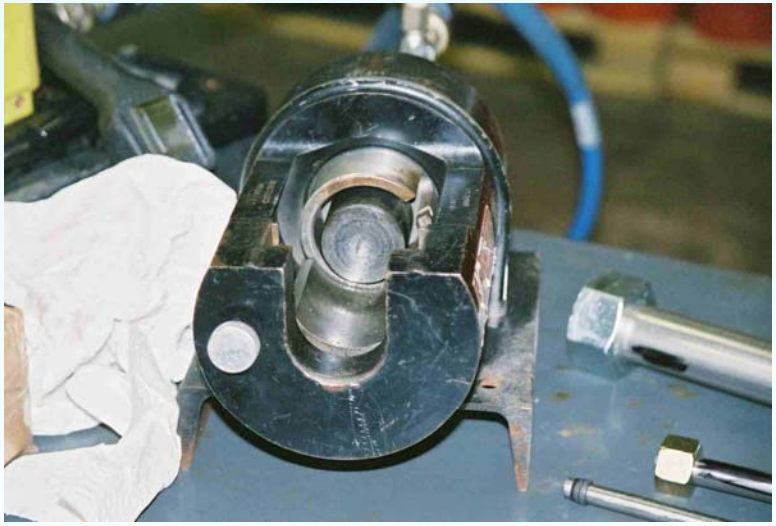
- *May use steel threaded pipe & fittings.*
- *Grooved fittings can also be used as long as pressure ratings are not exceeded*

High Pressure Systems

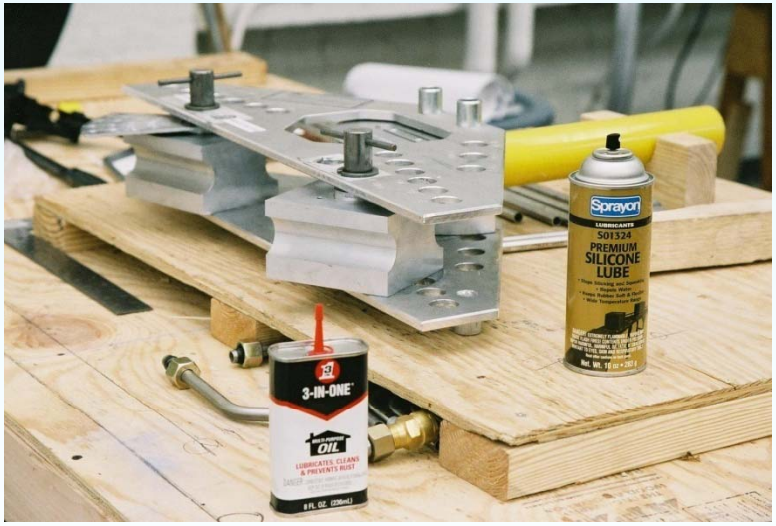
- *Stainless Steel tubing with compression fittings typical.*
- *Diameter typically smaller than that of low pressure due to lower water demand*
- *Closely spaced tube clamps*

Welding – adapting between pipe and tube

Tools for high pressure tubing



Hydraulic press for mounting ferrules of compression fittings



Pipe bending machine

Order of presentation

1. *Introduction & Fundamentals* *(20min)*
2. *Types of Water Mist Systems and Equipment* *(15 min)*
3. *Codes, Standards, Test Protocols* *(15 min)*
4. *Future directions* *(10 min)*
5. *Discussion, questions* *(10 min)*