

ARCVS TECHNOLOGY

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APPENDIX – HYDRAULIC LOSS CALCULATIONS

- **Fire Pump Suction Piping (NFPA-20)**

- **A1. PURPOSE OF APPENDIX**

To evaluate friction losses in fire pump suction piping and demonstrate the benefit of upsizing suction pipe from 150 mm to 200 mm in order to:

- Reduce head loss
- Improve NPSH available
- Ensure reliable fire pump performance

- **A2. DESIGN DATA**

- Fire pump flow rate, Q = 2850 LPM
- Q = 0.0475 m³/s
- Pipe material = MS / DI
- Internal surface = smooth (new pipe)
- Hazen–William’s coefficient, C = 120
- Suction pipe length considered = 6 m
(Typical tank-to-pump arrangement including fittings)

- **A3. FORMULA USED (HAZEN–WILLIAMS)**

$$h_f = 10.67 \times \frac{L \times Q^{1.852}}{C^{1.852} \times D^{4.87}}$$

Where:

- h_f = friction loss (m)
- L = pipe length (m)
- Q = flow (m³/s)
- D = internal pipe diameter (m)
- C = Hazen–Williams coefficient

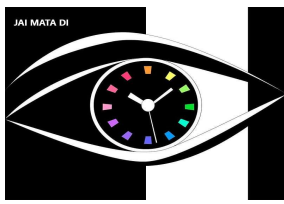
- **A4. FRICTION LOSS – 150 mm SUCTION PIPE**

- Given:
- D = 0.15 m
- L = 6 m
- Q = 0.0475 m³/s
- Calculation:

$$h_f = 10.67 \times \frac{6 \times (0.0475)^{1.852}}{120^{1.852} \times (0.15)^{4.87}}$$
$$h_f \approx 1.9 \text{ m}$$

- Result:
- Friction loss $\approx 1.9 \text{ m}$
- Velocity = 2.68 m/s

X High suction loss for fire pump application



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• **A5. FRICTION LOSS – 200 mm SUCTION PIPE**

- Given:
- D = 0.20 m
- L = 6 m
- Q = 0.0475 m³/s
- Calculation:

$$h_f = 10.67 \times \frac{6 \times (0.0475)^{1.852}}{120^{1.852} \times (0.20)^{4.87}}$$
$$h_f \approx 0.45 \text{ m}$$

- Result:
- Friction loss ≈ 0.45 m
- Velocity = 1.51 m/s

✓ Low suction loss – preferred condition

• **A6. LOSS COMPARISON SUMMARY**

<u>Parameter</u>	<u>150 mm Pipe</u>	<u>200 mm Pipe</u>
<u>Velocity (m/s)</u>	<u>2.68</u>	<u>1.51</u>
<u>Friction loss (m)</u>	<u>1.9</u>	<u>0.45</u>
<u>Relative loss</u>	<u>100%</u>	<u>24%</u>
<u>Cavitation risk</u>	<u>Higher</u>	<u>Low</u>

→ 200 mm suction pipe reduces friction loss by ~75%

• **A7. IMPACT ON NPSH (ENGINEERING INTERPRETATION)**

- Lower suction losses directly increase NPSH available
- NFPA-20 emphasizes minimizing suction losses to ensure:
 - Stable pump operation
 - Long-term reliability
 - No performance degradation during emergency conditions

✓ Upsized suction piping significantly improves hydraulic margin

• **A8. NFPA-20 COMPLIANCE STATEMENT (APPENDIX)**

“Hydraulic loss calculations confirm that increasing the fire pump suction piping from 150 mm to 200 mm reduces suction friction losses from approximately 1.9 m to 0.45 m at a flow of 2850 LPM. This design minimizes suction losses, improves NPSH available, and complies with NFPA-20 good engineering practice.”

• **A9. FINAL ADOPTED DESIGN**

- Pump suction nozzle: 150 mm
- Suction piping provided: 200 mm
- Reducer: Eccentric (flat on top)
- Hydraulic performance: NFPA-20 compliant