

# 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 m<sup>3</sup>/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 (m<sup>3</sup>/s)
- D = internal pipe diameter (m)
- C = Hazen–Williams coefficient

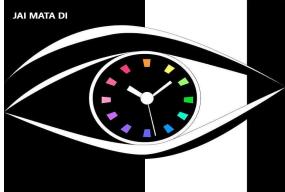
- **A4. FRICTION LOSS – 150 mm SUCTION PIPE**

- Given:
- D = 0.15 m
- L = 6 m
- Q = 0.0475 m<sup>3</sup>/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 ≈ 1.9 m
- Velocity = 2.68 m/s

 **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 m<sup>3</sup>/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

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

→ 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