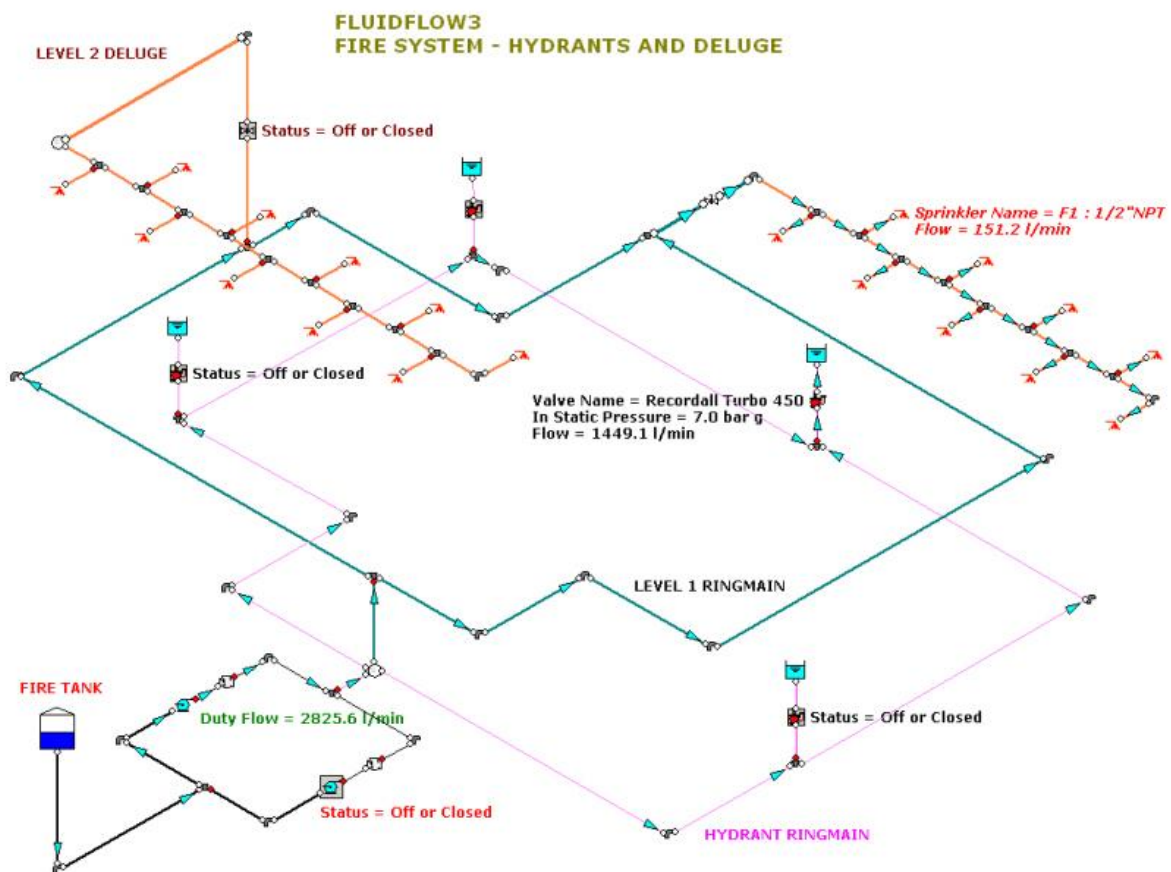




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The screen image below shows a simple boosted fire system with a hydrant ringmain and two deluge systems.

An integral part of designing fixed fire protection systems is to determine its response to sudden changes to flow conditions, be it pump start or stop, the sudden opening and closing of valves and even a sudden break in a line. The resulting surges or water hammer can be very damaging to the system. The Hytran program can simulate these conditions and help to design amelioration systems and test such equipment items as relief valves and surge tanks. The steady-state model developed in FluidFlow3 can be exported to Hytran for immediate investigation of water hammer effects.



INTRODUCTION

NFPA 15 "Standard for Water Spray Fixed Fire Systems for Fire Protection" is the industry-accepted standard for the design and testing of Firewater Protection systems. However, in the particular area of hydraulic design it makes no allowance for modern computer simulations in terms of both the possible benefits and/or limitations that such a method of analysis might provide.

Fixed fire protection systems involve large numbers of pipes, valves and fittings. It is unlikely that any current hydraulic design would be carried out using the manual calculation method described in Appendix A of NFPA 15.

Section 1.2 of the standard states ...

"Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered."

Given the accuracy of a computer simulation over a hand-calculated design, and even taking into account the differences between a computer simulation and a calculation carried out in accordance with Appendix A of NFPA 15 described below, it is argued that the computer simulation increases the probability of achieving adequate firewater distribution during system operation and does not lower the level of integrity or safety of the system.

DESIGN CRITERIA

There are a number of design criteria described in NFPA 15, which need to be compared with the methods utilised in FluidFlow3. These are:

- Pressure loss formula for pipes.
- Pressure loss formula for valves and junctions.
- Velocity head.

Pressure Loss Formula for Pipes

NFPA 15 utilises the Hazen-Williams formula for calculating the pressured drop due to flow in a straight pipe. The Hazen-Williams formula utilises a coefficient C that varies depending on the roughness and size of the pipe. The value of C can vary for new steel pipes between 120 and 140 depending on size.

Figure A-7-2 (e) in NFPA 15 provides a head drop nomograph for varying flows through steel pipes of different diameters. The Figure states that the value of C is constant for all diameters at C=120.

By contrast, the Pipe Friction Handbook by the Australian Pump Manufacturers Association Ltd provides values of C, which vary with pipe diameter. Values for new steel pipe closer to 140 are given. Since the range in value of C between 120 and 140 can make a significant difference in pressure loss, this inconsistency is significant.

An alternative method of calculating the pressure loss due to flow in a pipe is the Darcy-Weisbach equation (sometimes referred to as the Moody diagram method). This approach relies on knowledge of the absolute roughness of a pipe to determine a friction coefficient. Outside the water and fire protection industries, the Darcy equation is universally used and the method highly accurate.

A comparison between test values from Figure A-7-2 (e) in Appendix 'A' and the same calculation in Piping Systems FluidFlow and FluidFlow3 using either method gave almost identical results for C values of 120.

Pressure Loss Formula for Valves and Junctions

NFPA Table A-7-2 (g) gives equivalent lengths for various valves and pipe fittings. The equivalent length method utilises the concept of a length of straight pipe which produces the same pressure loss as the valve or fitting it is simulating. A drawback with this method is that a different equivalent length is required for each "size" of fitting, i.e. there is one equivalent length for a bend in a 100mm pipe and a different equivalent length for the same type of bend in a 150mm pipe. Other drawbacks with the equivalent length method are:

- Table A-7-2 (g) requires that the equivalent lengths be corrected for values of C different from 120.
- Elbows are referred to as "standard" and no account is given for longer radius bends if used.
- The method does not take into account fittings with changing diameters, for instance a tee junction with a branch diameter different from the barrel diameter.

- Values are generic, it they do not necessarily apply to a particular manufacturer's valve or junction.
- The list of valves and fittings is extremely limited, i.e. only a generic "swing check" valve is given and the table actually notes that the given value is to be considered "average".

Modern computer simulation techniques utilising a schematic flow sheet representation of a pipe network can provide a more accurate and sophisticated modelling of valves and junctions, for instance the Ft method described in Crane or the methods developed by Idelchik which take into account unequal tees, wyes and bends of different r/D values.

Velocity Head

Water flowing in a pipe has an energy component due to its velocity - a kinetic energy. If this velocity is reduced, the kinetic energy is converted to pressure energy. Theoretically this additional pressure energy would be available to discharge slightly more flow through a nozzle than would be the case if the velocity head was ignored. NFPA 15 states that velocity head can be either included in a calculation or ignored.

Velocity head becomes significant only if the velocity of flow is quite high, say well above 3.5 m/s. High velocities are to be avoided because of increased frictional resistance. In a Piping Systems FluidFlow or FluidFlow3 simulation, a maximum pipe velocity can be set such that a warning is enunciated for every pipe where the velocity exceeds the set maximum. This feature allows the design engineer to conveniently monitor the whole system for excessive velocities.

SUMMARY

FluidFlow3 and Piping Systems FluidFlow are both suitable for the design and simulation of fixed fire protection and spray/sprinkler systems and can produce designs that satisfy the requirements of NFPA. FluidFlow3's advanced user interface and flowsheet display make this the ideal software both for the design and reporting of a fire protection system.

FLUIDFLOW3 AND PIPING SYSTEMS FLUIDFLOW - FIXED FIRE PROTECTION DESIGN

CAPABILITES

Network

Large complex networks can be designed with multiple pumps (series, parallel, booster) and other equipment. Ringmains, hydrant systems and deluge systems. Any configuration of pipes with loops, grids, etc. Pumps can be switched on/off. Any system of units.

Graphical user interface (flowsheet)

Data entry via an input palette visible at the same time as the flowsheet. Flowsheet and all input and calculated data viewed on the one screen. Equipment performance warnings (eg nozzles performing outside range) flag component red and enunciate a warning. FluidFlow3 allows both orthogonal and isometric display of the flowsheet; Piping Systems FluidFlow - orthogonal only.

Most remote nozzle identification

This is achieved by inspection of results. The ability to view a nozzle's calculated performance simply by hovering the mouse pointer over any component on the flowsheet makes identification of the most remote nozzle very simple.

Automatic pipe sizing

Maximum velocity can be set in the Warnings option. If this velocity is exceeding, pipes will be flagged red and a warning delivered. Alternatively Piping Systems FluidFlow and FluidFlow3's "List" command and the Report Preview allows pipes and associated data to be listed in accordance with size or component identification and velocities quickly viewed. Adjustments could then be made. FluidFlow3 automatically advises on the most economic size for a pipe.

NFPA rules

NFPA data on fittings and pipes can be easily added to Piping Systems FluidFlow and FluidFlow3's database. Consequently compliance with these rules (and any other set of rules) can be achieved.

Pipe breaks, blockages and zone isolation

Both programs allow for this.

Orifice Plates

Non-recoverable pressure drop calculated according to ISO standards.

Reports

Comprehensive reporting capability via a user definable report layout within Piping Systems FluidFlow and FluidFlow3. In-built Bill of Materials· Export to Excel· FluidFlow3 allows reports in PDF, Word or HTML format

Multiple pumps - series, parallel and booster

FluidFlow3 allows pump speed and impeller diameter to be varied and affinity laws applied.

Lined and unlined pipes

Yes

Moody or Hazen Williams formula

Yes

Reports - Excel link

Yes