SAFETY FACTORS FOR AWWA PLASTIC PIPES: WHAT ENGINEERS SHOULD KNOW

The first AWWA plastic pipe standard was published in 1975. The standard was AWWA C900 for 4- to 12-inch PVC pipe. At that time, AWWA was a conservative organization which required a safety factor (SF) of 2.5 for the C900 standard – the highest for all water pipe materials in North America. Other organizations like ASTM and CSA used 2.0 for their standards.

SF REVISED FOR PVC PIPE ONLY AFTER DECADES OF PROVEN PERFORMANCE

In 2007, after 32 years of proven municipal usage at SF = 2.5, AWWA revised the C900 standard to a lower SF of 2.0. In addition, AWWA was able to rely on a 55-year history of PVC pipe usage at SF = 2.0.

UNDERSTANDING "SF" AND OTHER TERMS AS APPLIED TO WATER PIPE

For an introduction to the concepts of SF and design factor (DF), click here. The safety factors discussed in this document are against pressure pipe failure. The pipe's long-term ultimate pressure capacity is called the "Hydrostatic Design Basis" (HDB). HDB is roughly equivalent to the yield strength in iron/steel pipe. An SF is applied to the HDB to provide the stress used for pressure pipe design. The result is called the "Hydrostatic Design Stress" (HDS).

HDPE AWWA C906 SF LESS THAN 2.0: AN INDUSTRY DEPARTURE

The AWWA C906 standard for HDPE water pipe was first published in 1990. That edition and three subsequent revisions all used SF = 2.0. The current C906 includes a new material for which there has been a substantial change: the SF is only 1.6. While the standard uses the term "design factor" instead of safety factor, a quick review of the HDB and HDS provides the SF:

- HDB = 1,600 psi
- HDS = 1,000 psi
- SF = HDB/HDS = 1,600/1,000 = 1.6

This significantly lower SF (20% reduction) has been allowed for a material that does not have a 55-year history of use for municipal applications that existed for PVC or other pipe materials.

RECOMMENDATION: STAY WITH SF = 2.0

The 1.6 SF used for C906 falls outside AWWA's conservative tradition for transmission/distribution pipe standards that have served North American utilities well. The PVC Pipe Association recommends design engineers recognize this disparity and continue to use a SF = 2.0 for their projects. In PPI TR-3, the HDPE pipe industry also acknowledges that under many conditions, lowering the SF "may significantly reduce pipe durability" and suggests a more conservative design factor or design coefficient be used.

The table below shows PVC and HDPE products that have equivalent pressure classes using SF = 2.0:

EQUIVALENT PRESSURE CLASSES			
PVC		HDPE	
Dimension Ratio	Pressure Class	Dimension Ratio	Pressure Class
DR 18	235 psi	DR 7.3	250 psi
DR 21	200 psi	DR 9	200 psi
DR 25	165 psi	DR 11	160 psi
DR 32.5	125 psi	DR 13.5	125 psi
DR 41	100 psi	DR 17	100 psi
DR 51	80 psi	DR 21	80 psi

References: AWWA C900: Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm), AWWA C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks, PPI-TR-3: Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe, Plastics Pipe Institute (2023).