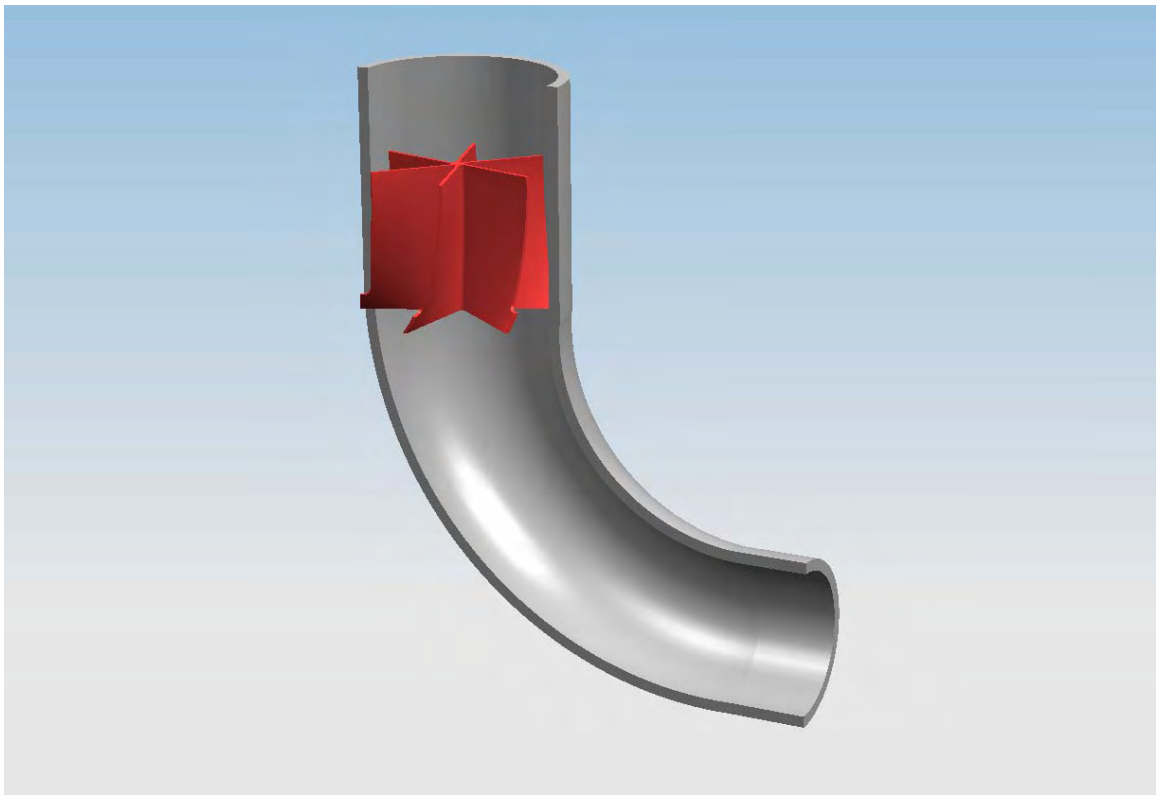
cfdesign® Upfront CFD

blue ridge numerics
3315 Berkmar Drive
Charlottesville, VA 22901

Phone: (434) 977-2764
Fax: (434) 977-2714
www.cfdesign.com



Metraflex SDF in a Reducing Elbow Simulation

James C. Neville
Project Engineer, Engineering Services
Blue Ridge Numerics, Inc.
October 10, 2006

Project Summary:

The Metraflex six-bladed SDF flow conditioner was analyzed to determine its effect in a 4" to 3" reducing elbow with a water velocity of 5 feet per second. The simulation was conducted using CFdesign version 9.0 from Blue Ridge Numerics, Inc.

Project Methodology:

The CFdesign analysis setup is shown below in Figure 1. Additional pipe lengths were modeled upstream and downstream of the elbow to ensure fully developed flow at the SDF and at the constant pressure outlet.

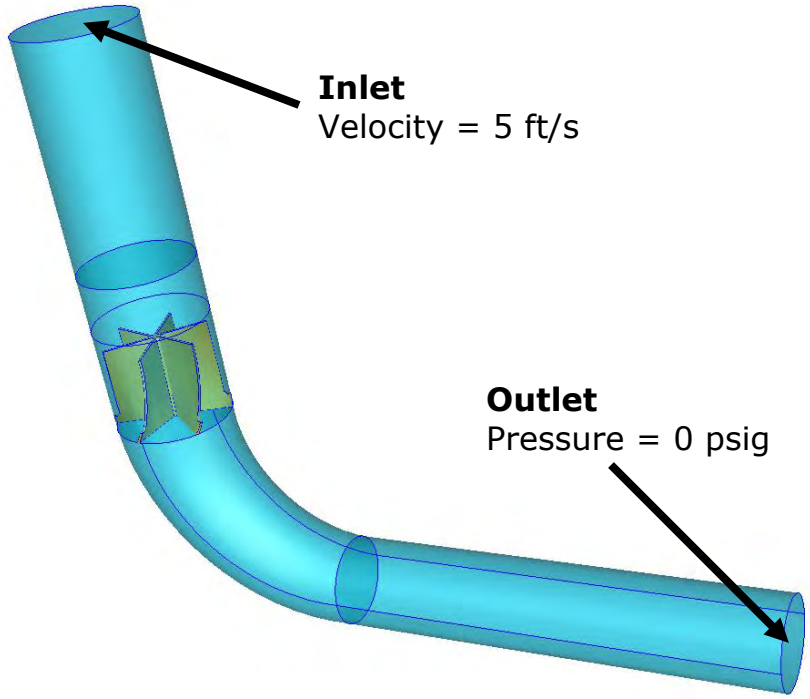


Figure 1. CFdesign analysis setup conditions.

Simulation Assumptions:

Various assumptions were made for the simulation of the elbow and are listed below:

- Steady-state conditions
- Incompressible flow
- Water modeled at standard temperature and pressure
- Constant water properties
- Thermal effects negligible

Results:

Cut-surfaces showing the velocity profile and velocity vectors with and without the SDF flow conditioner are shown below in Figures 2 and 3, respectively. A flow separation region can be seen along the bottom of the exit pipe without the SDF device. Note that there is very little discernable flow separation around the reducing elbow with the SDF in place. The SDF aides in providing a more uniform velocity profile beyond the reducing elbow.

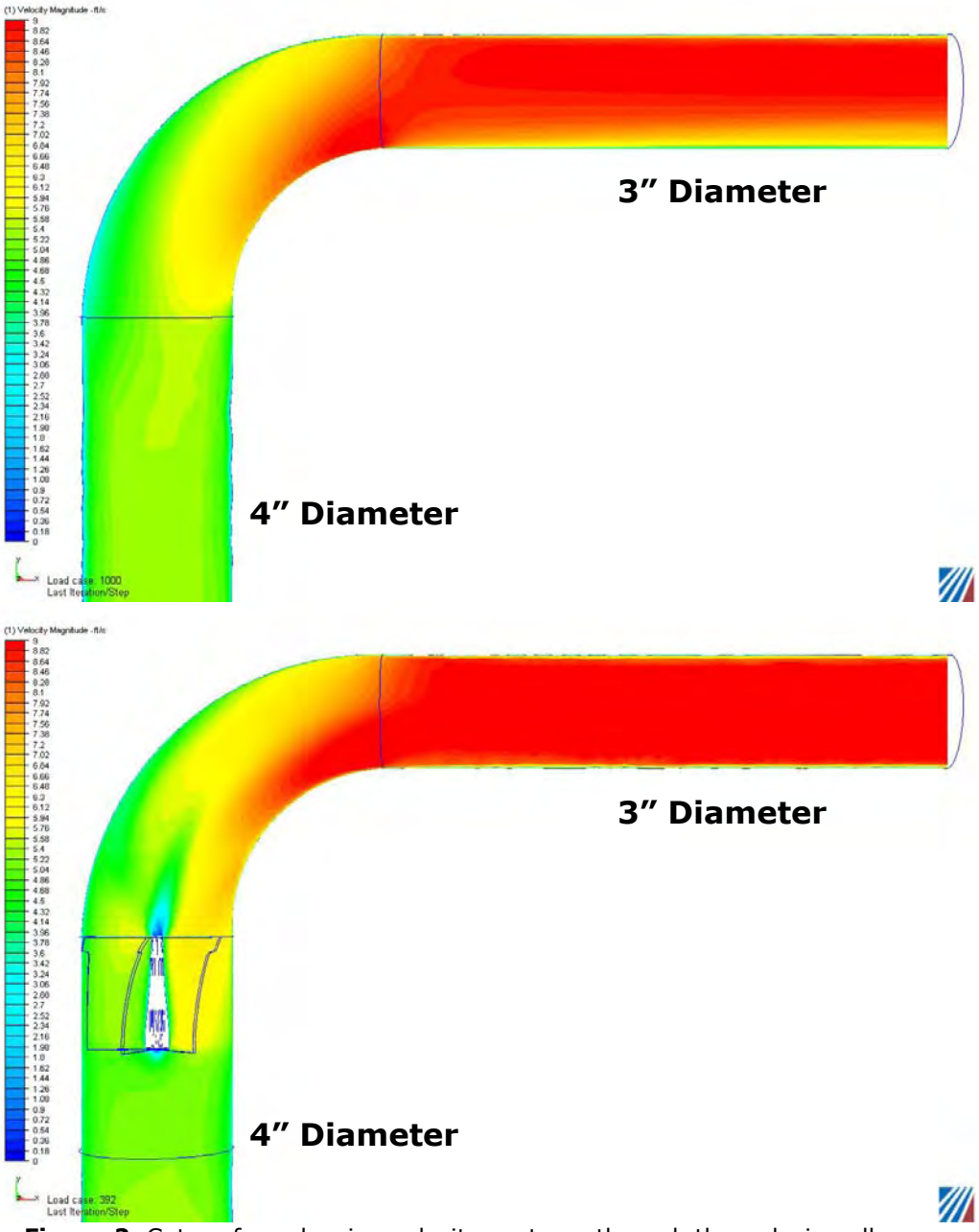


Figure 2. Cut-surface showing velocity contours through the reducing elbow.

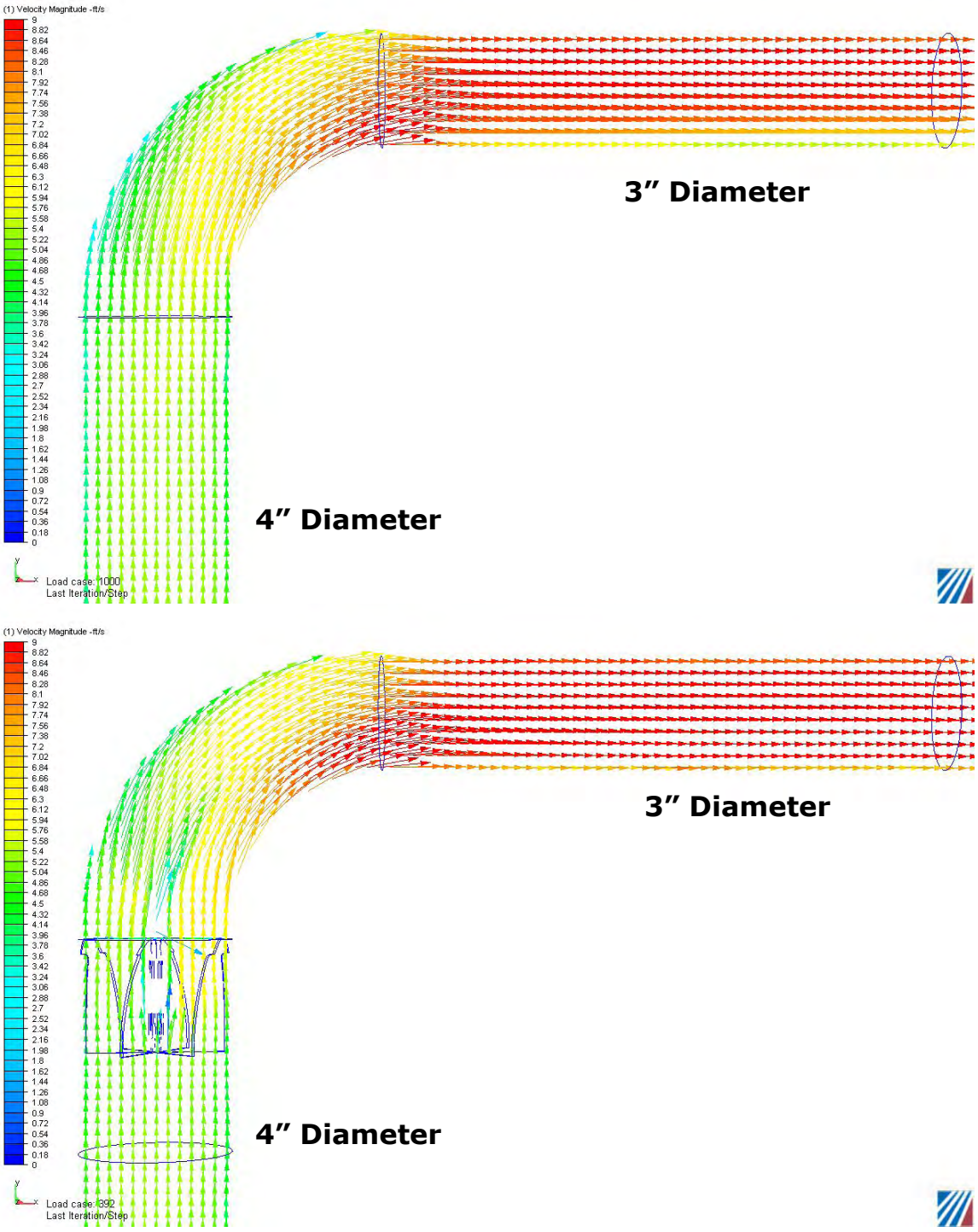


Figure 3. Cut-surface showing velocity vectors through the reducing elbow.

A cut-surface of velocity approximately three inches downstream of the elbow is shown in Figure 4 below. The low velocity region on the bottom of the exit pipe without the SDF is clearly evident here. While the SDF-equipped pipe also shows slightly lower velocity region in the profile, this is mostly due to the swirling flow traveling around the elbow.

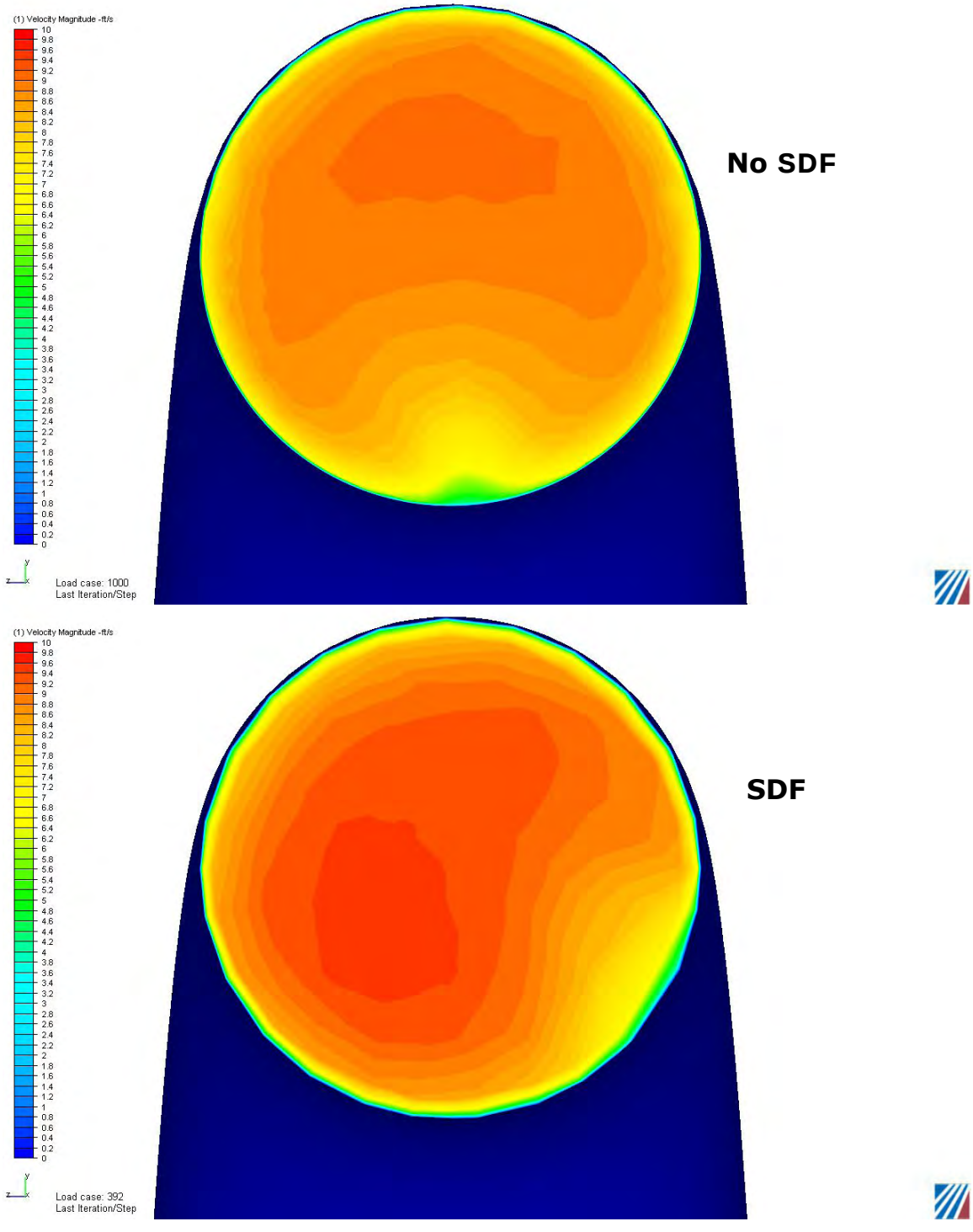


Figure 4. Velocity distribution normal to the flow 3” downstream of the elbow.

The pressure gradient for both analyses is shown below in Figure 5. The total pressure drop through the SDF and elbow was found to be 0.54 psig. Without the SDF, the pressure drop was 0.45 psig. The slight flow constriction caused by the SDF leads to a higher overall backpressure.

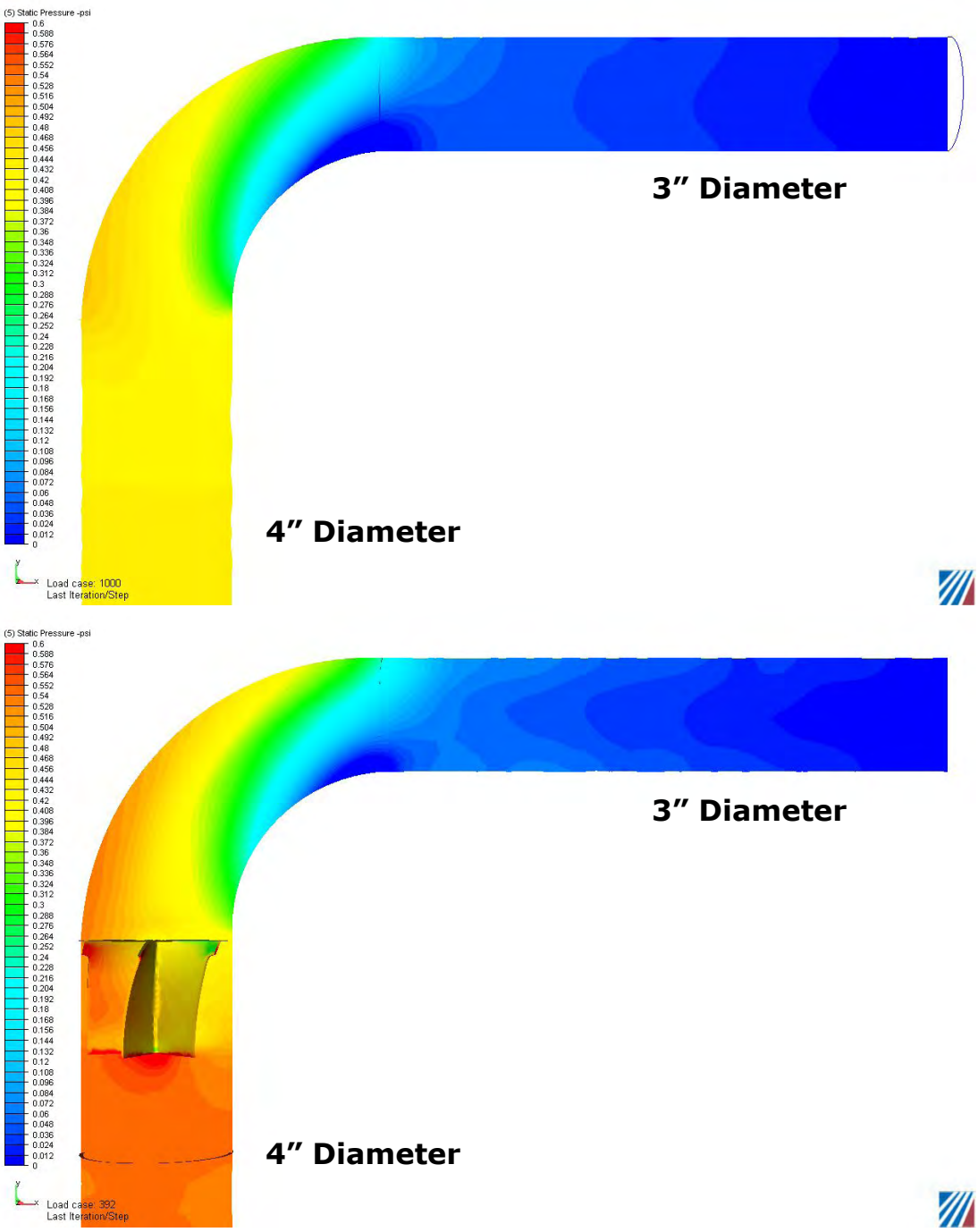


Figure 5. Cut-surface showing pressure gradients through the elbow.

Figures 6 through 9 below show particle traces released from various points on the pipe inlet. These traces show where individual fluid particles will travel as they pass through the system.

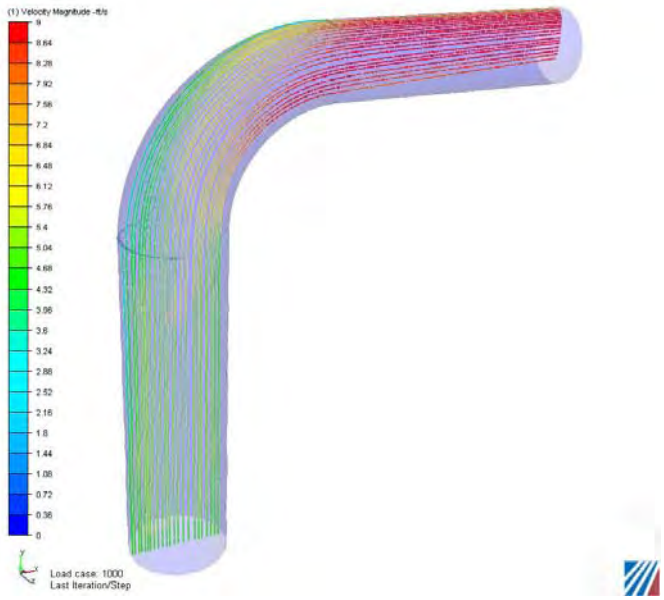


Figure 6. Fluid particle traces shown for the non-SDF analysis. Note the fluid separation around the elbow. This separation region propagates well downstream.

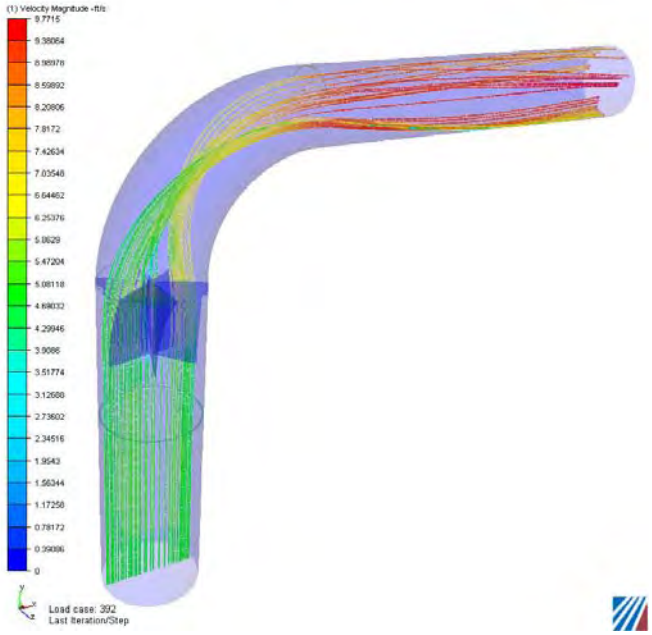


Figure 7. Induced swirl caused by the SDF as shown with particle traces.

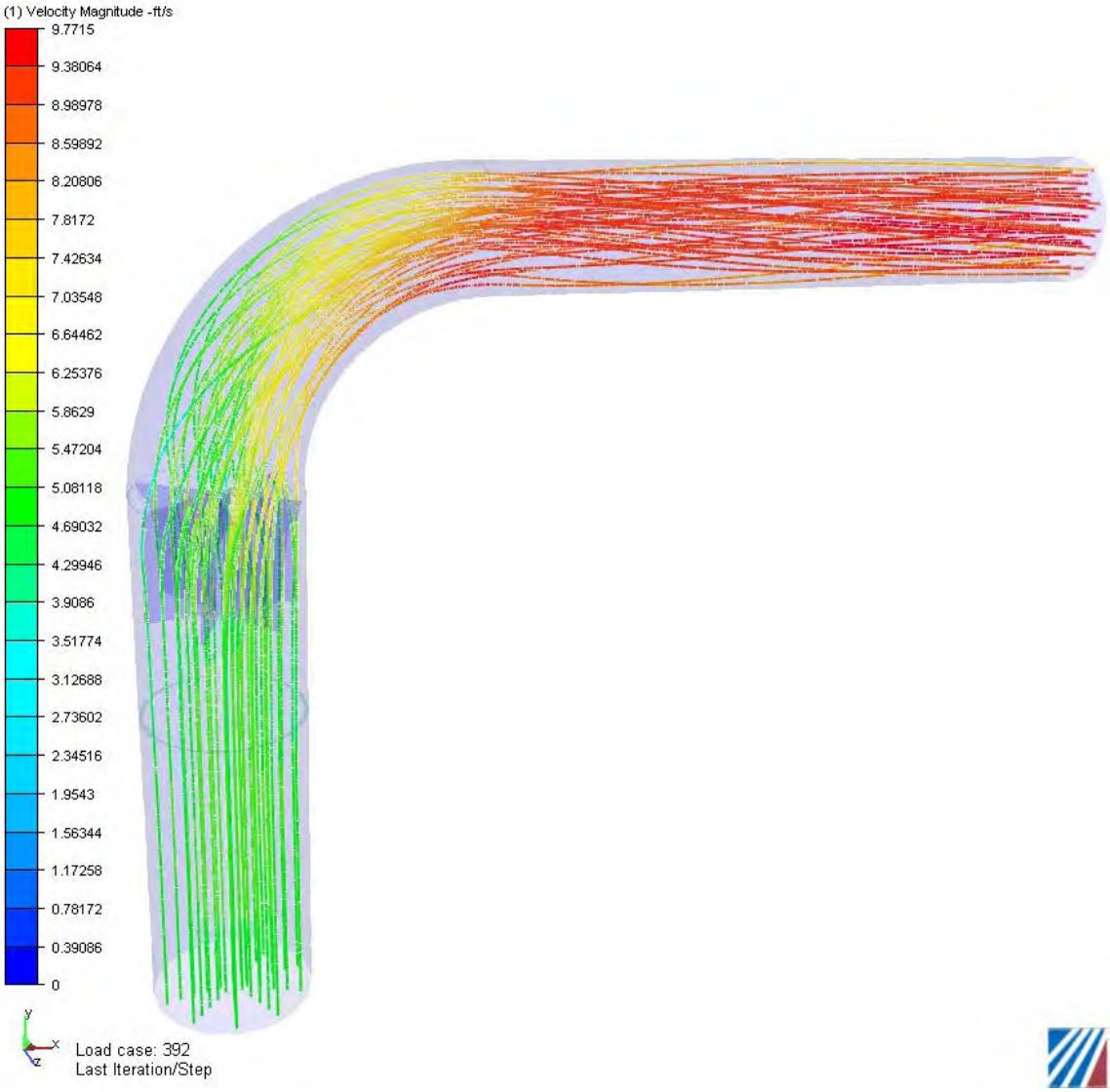


Figure 8. Particle traces showing the effectiveness of the SDF.

Figure 9. Particle traces shown from a top-down view.

Conclusions:

The Metraflex SDF flow conditioner is shown to provide a near uniform velocity distribution downstream of the elbow. The SDF is effective in eliminating the large recirculation regions that would develop downstream of the elbow without a flow conditioner.