

## Metraflex CRV in a Reducing Elbow Simulation

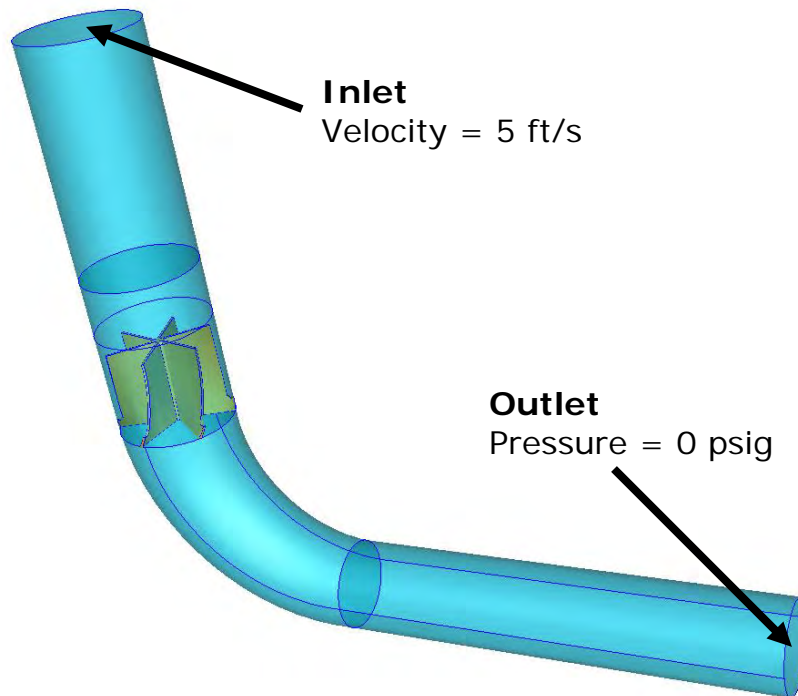
James C. Neville  
Project Engineer, Engineering Services  
Blue Ridge Numerics, Inc.  
October 10, 2006

**Project Summary:**

The Metraflex six-bladed CRV 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 CRV and at the constant pressure outlet.



**Figure 1.** CFdesign analysis setup conditions.

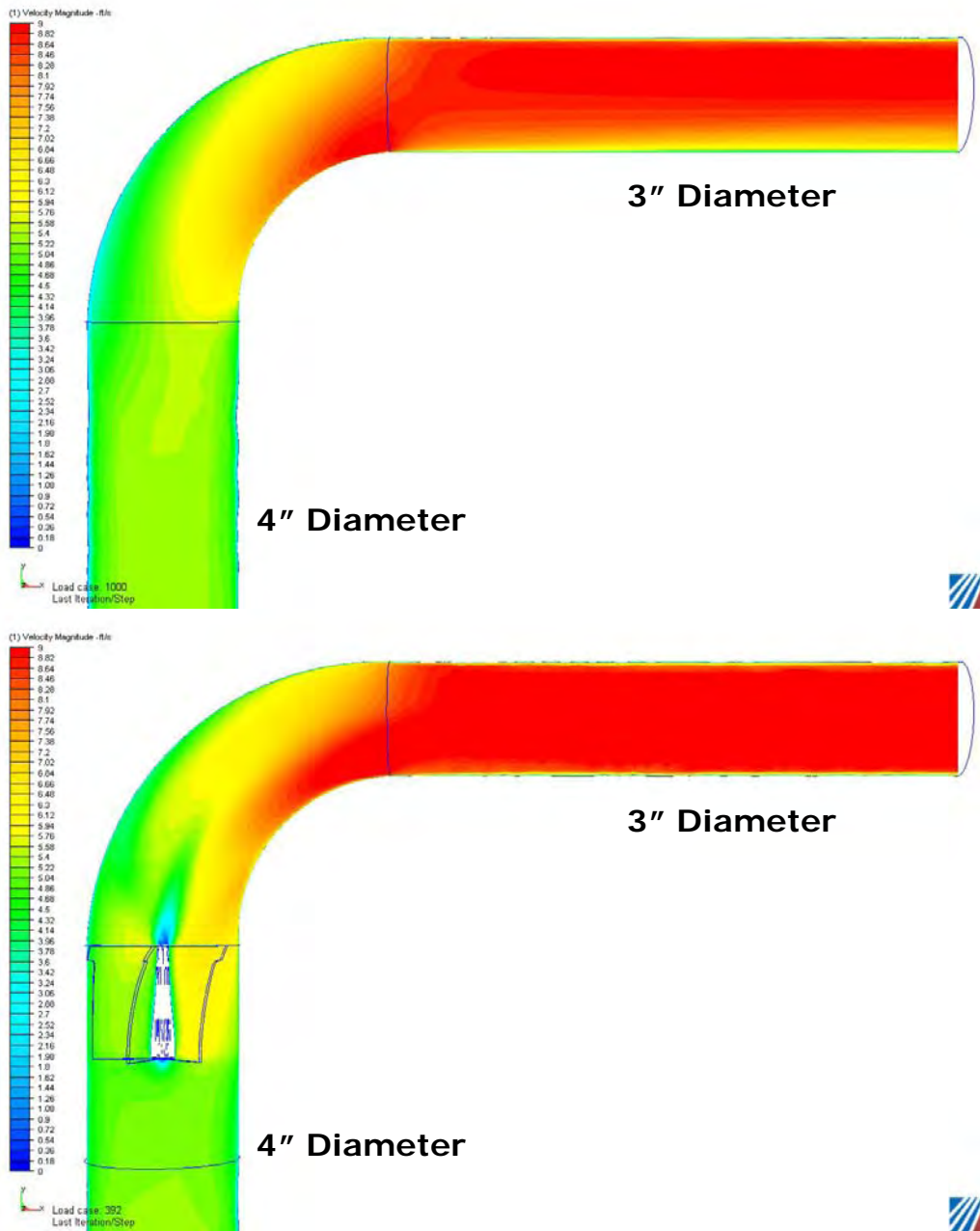
**Simulation Assumptions:**

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 CRV 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 CRV device. Note that there is very little discernable flow separation around the reducing elbow with the CRV in place. The CRV aides in providing a more uniform velocity profile beyond the reducing elbow.



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

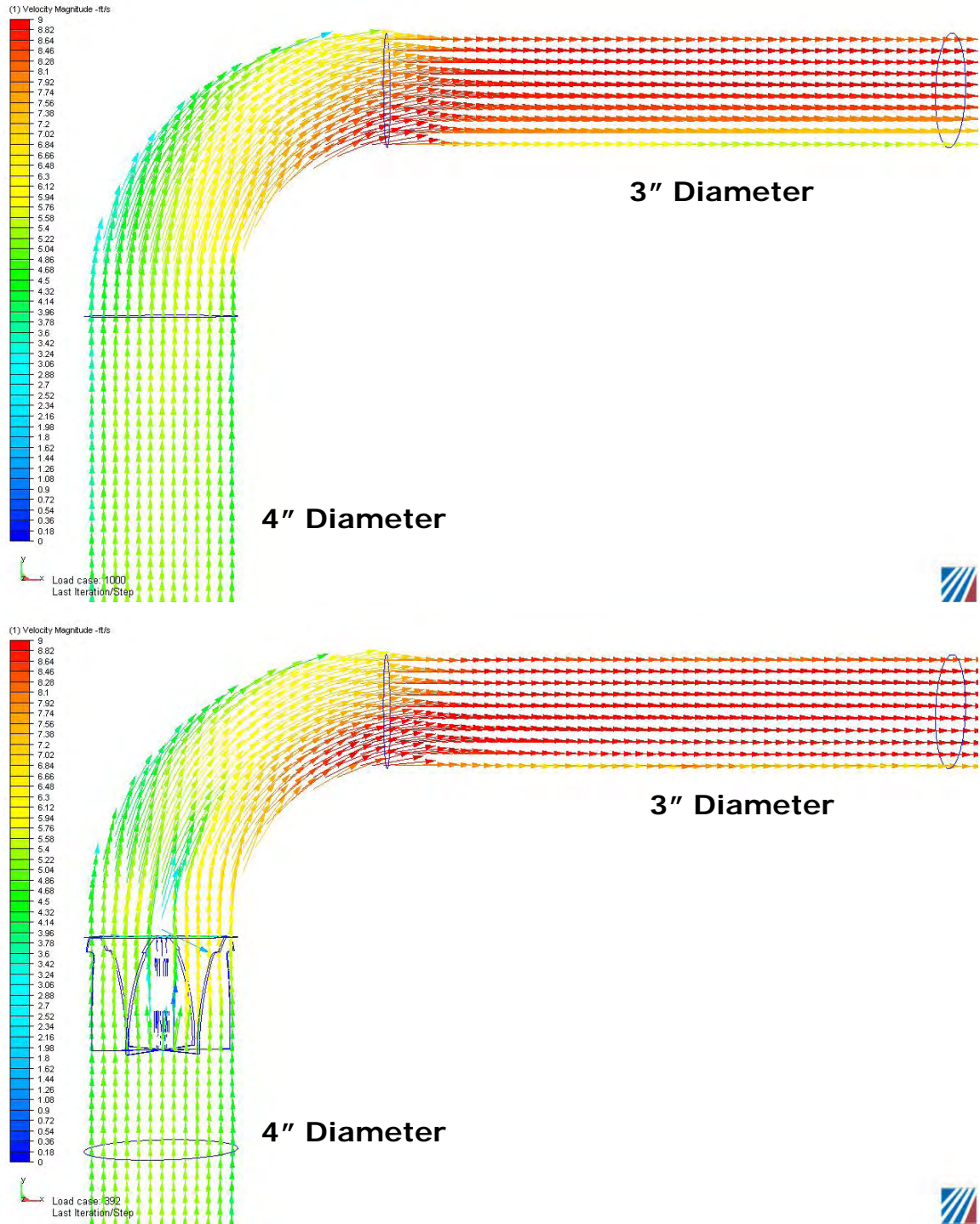


Figure 3. Cut-surface showing velocity vectors through the reducing elbow.

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 CRV is clearly evident here. While the CRV-equipped pipe also shows slightly lower velocity region in the profile, this is mostly due to the swirling flow traveling around the elbow.

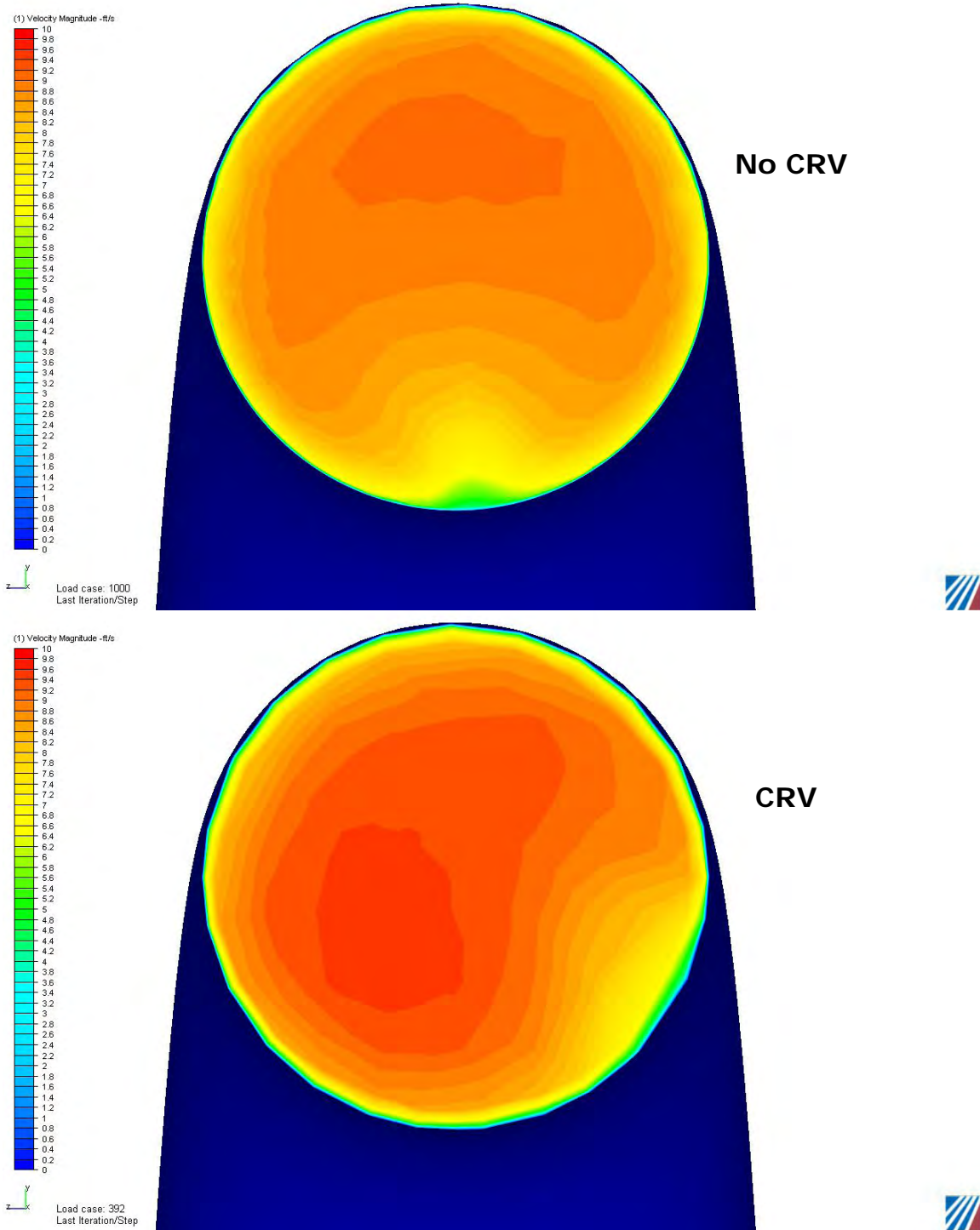
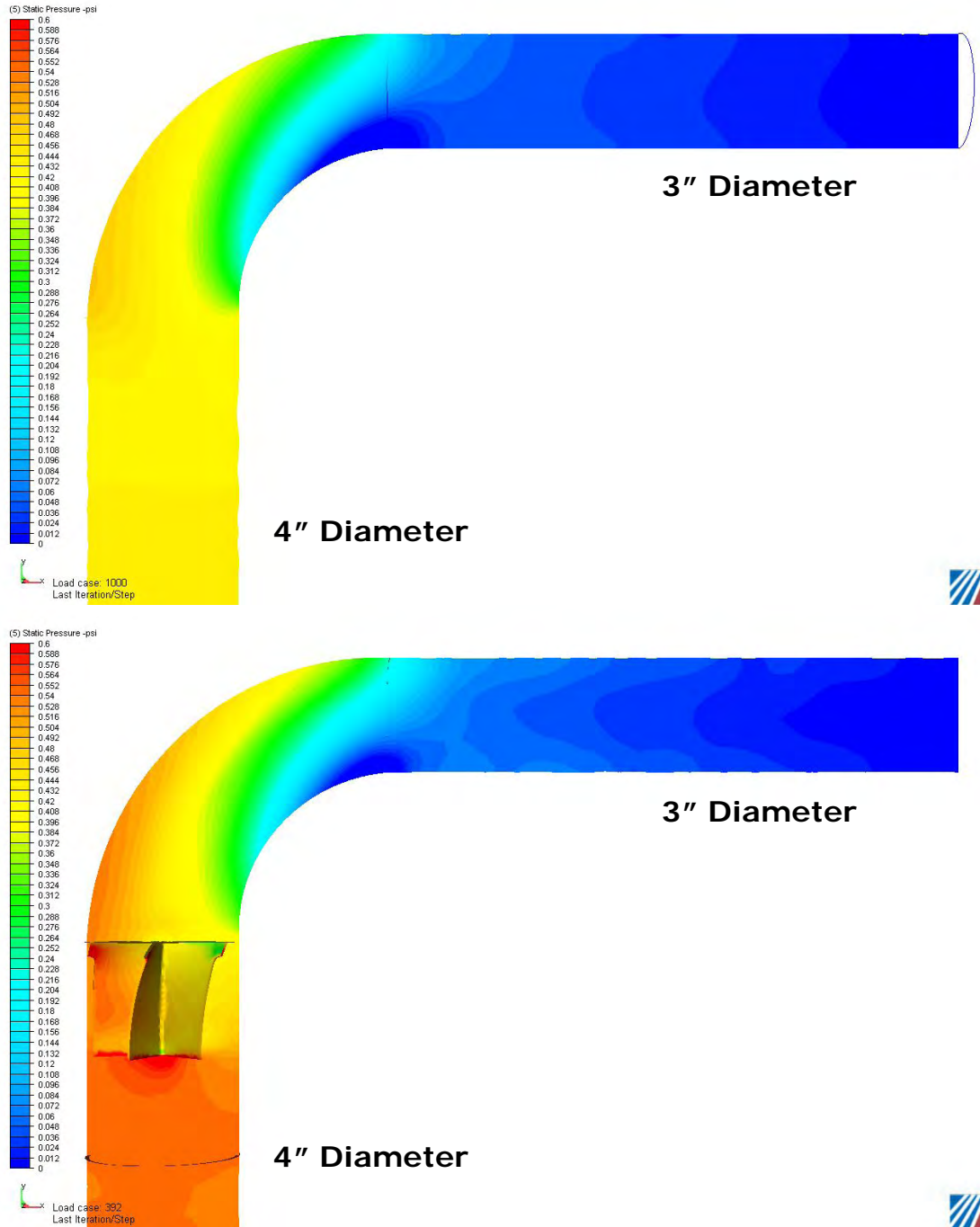


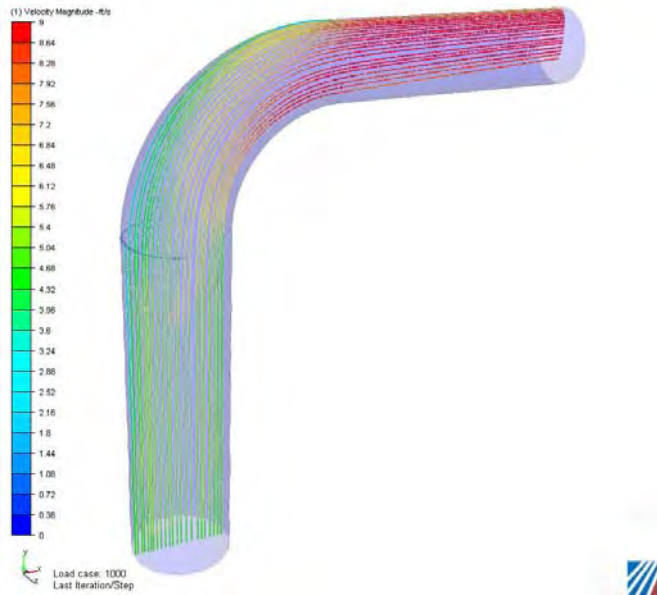
Figure 4. Velocity distribution normal to the flow 3" downstream of the elbow.

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

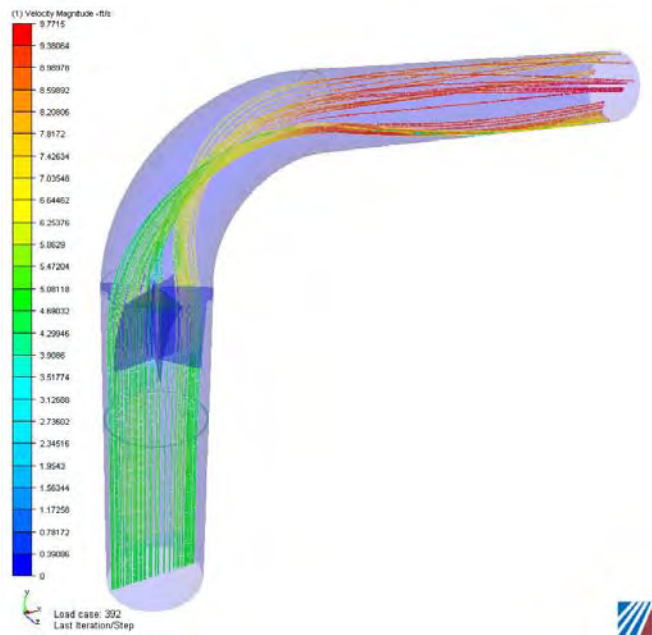


**Figure 5.** Cut-surface showing pressure gradients through the elbow.

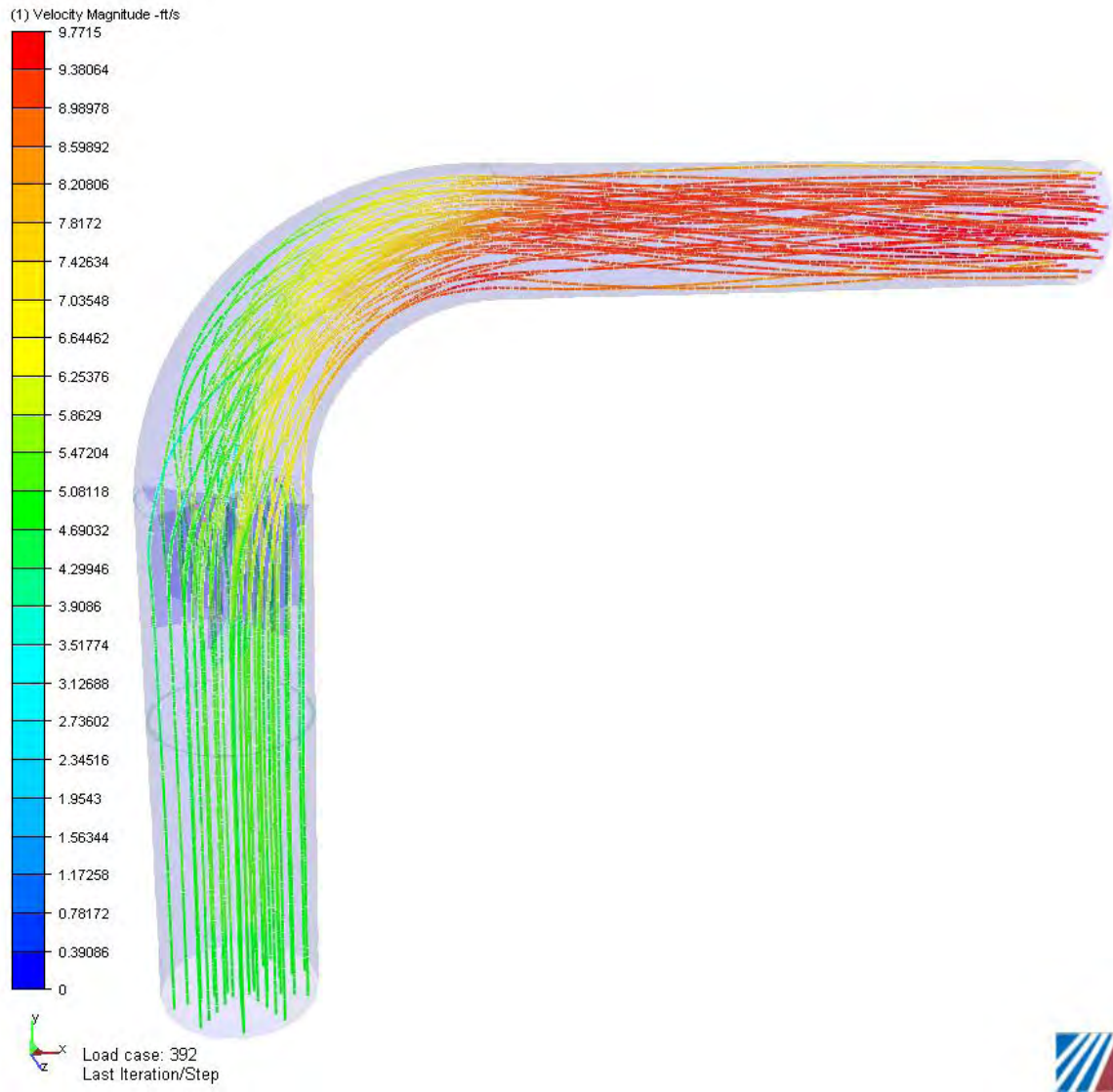
Figures 6 through 9 below show particle traces released from various points on the pipe inlet. These traces show where individual fluid particles will travel as they pass through the system.



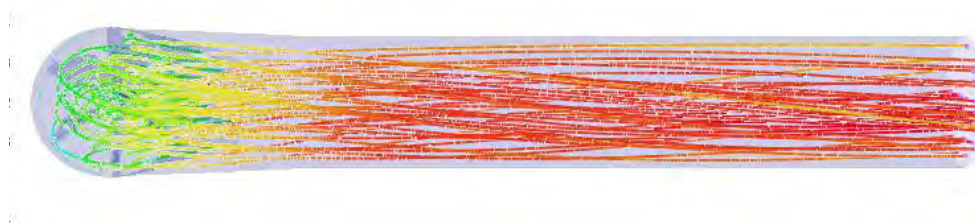
**Figure 6.** Fluid particle traces shown for the non-CRV analysis. Note the fluid separation around the elbow. This separation region propagates well downstream.



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



**Figure 8.** Particle traces showing the effectiveness of the CRV.



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

**Conclusions:**

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