Support Beam Test

Once our design was fabricated, the three support beam options needed to be tested. The following test questions were asked and determined for each option:

- 1. Does the cylinder hit the Hummer?
- 2. Does the roof open to at least 90-degrees?
- 3. Is there any yielding on the support beams?

When Support Option 1 was tested, two of the three answers to the test questions were negative. In this case, the cylinder was held at a 30-degree angle, so it did not come into contact with the Hummer. The most noticeable problem, however, was that the roof only raised approximately 75-degrees. It was observed that as the roof swung open, the wheel began to slide too far down the roof and the piston arm became fully extended. A solution to this problem would have been to purchase a pneumatic cylinder with a longer stroke length, however, this would add to the overall length of the cylinder. We are trying to keep the cylinder as small as possible, so this was really not an option. Also, the vertical and angular support beams were clearly yielded. This was a problem because we want to design something that can work for a long period of time. Not something that will need maintenance or repairs. For these reasons Support Option 1 was not considered for the final design.

When Support Option 2 was tested, only one test question was negative. In this case, the cylinder was free to rotate and the roof to piston arm connection was rigid. This allowed the cylinder to raise the full 90-degrees with still some stroke length to spare. The support beams also showed no signs of yielding or strain at all, so they were absolutely strong enough. The problem with this setup was that the back of the cylinder came too low as the roof was swinging open. At that particular height, it would come into contact with the Hummer. For these reasons, Support Option 2 was not considered for the final design.

Support Option 3 was theorized to be the best option and the testing supported that. The beams handled the load fine and the roof lifted over 90-degrees. Also, since this setup causes the cylinder to rotate less and start higher, it will not come into contact with the Hummer. It only required 7.5 inches of stroke, so a smaller cylinder could have actually accomplished the job. This idea is also the best use of the force of the cylinder because when the roof is fully open and requires the most force, the piston arm is perpendicular to the triangular support, so its mechanical advantage is highest at this point. So at the moment the trailer requires the most force, the cylinder can provide the highest mechanical advantage. For all of these reasons, Support Option 3 was used for the final design.

Safety Test

One of the two most important goals for this design was to increase the safety of setting up and tearing down the roof. To accomplish this, the safety hose fitting (Figure 8-21) will be used. This fitting will allow the air to flow from the compressor into the cylinders to raise the roof. However, it will dampen the flow from the cylinder back into the compressor. This will cause the roof to fall slowly whether or not it is connected to the compressor. Once the final design was complete, several different tests were conducted to make sure that the roof would never fall uncontrollably. For example, one test entailed us lifting the roof to its maximum height and then simultaneously unplugging both quick connect hose connectors (Figure 8-20) from the cylinders. This simulated if the compressor unexpectedly shut down or if the hoses were somehow damaged. The roof stayed at 90-degrees for a few moments, and then slowly closed. The closing process took 1-2 minutes to complete, so if anyone were in the way, they would have plenty of time to reach safety. Another test conducted was to increase the pressure at a very fast rate and then decrease it at a very fast rate. The cylinder responded well by lifting the roof to its maximum position and then slowing dropping it to its rest position. The cylinders responded well for all of the tests, so they were all considered successful.