

Proof of the Patriot's Innocence

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The low pressure of the Patriot's footballs at half time was not caused by deflation. It was due to the fact that they were in a ball bag until they were tested. The insulating effect of the ball bag prevented the cold footballs from warming up and increasing in pressure. Exponent's scientists made a fundamental error when they used a cold football on a stand exposed to 72°F air to estimate the pressure of the cold Patriot's footballs. 72°F air surrounds the football on a stand and it warms up and increases in pressure rapidly compared to cold footballs in a ball bag. The low pressure of the Patriot's footballs was due to their low temperature not deflation.

Testing the Patriot's Footballs at Half time.

The most important fact in proving the Patriot's innocence is that the Patriot's footballs remained in a ball bag until the moment they were tested.

The Wells report (bottom of page 66 and top of page 67) states that it was raining at half time when the ball boys collected the Patriot's game balls from the field and placed them in a cold ball bag alongside dry footballs that were already in the bag. The cold ball bag now contains 11 cold footballs, some dry and some wet and cold air from the field. The balls were taken in the bag and placed against the back wall in the officials' locker room and remained in the bag until the moment they were tested. The Colt's footballs were treated in a similar manner

The following extract is taken from Page 5 of Exponent's appendix to the Wells report. It confirms that the Patriot's footballs were kept in a ball bag until the moment they were tested at half time.

At the start of halftime, the game balls from each team were brought into the Officials Locker Room, each team's balls in their own respective bags.

- 1. A ball was removed from the respective team's equipment bag.*

- 2. This ball was measured by the first official with his gauge and the pressure reading was recorded.*
- 3. The same ball was handed to the next official, who made a second pressure reading with the second gauge, which was then also recorded.*
- 4. The next ball was removed from the equipment bag and the process repeated from Step 1.*

The Wells report states (Page 70) that testing of the Patriots footballs started 2 to 4 minutes after the footballs in the bags were placed in the locker room and was complete in a further 4 to 5 minutes. Figure 1 Shows how the footballs in the locker room may have looked.



Figure 1

The official sat in the chair to the right of the ballbag and the footballs were tested one at a time and then handed to the second official sitting on his left for repeat testing. The Patriot's footballs were tested first.

Exponent's Fundamental Error.

This is where Exponent made a fundamental error that resulted in the Patriots being wrongfully accused of deflating footballs.

Exponent had to devise a means of establishing the pressure of footballs at the time the footballs were tested in the locker room at half time so that they could determine if the Patriots footballs had been deflated.

The fully inflated Patriot's footballs decreased in pressure from 12.5 psi to approximately 11.1 psi when they were taken from the warm locker room out to the relatively cold field and they increased in pressure when they were brought from the field to the warm locker room in a ball bag for testing at half time.

Exponent used a football on a stand to determine the heat gain and associated increase in pressure of the footballs when they were brought to locker room for testing. They called the graphical representation of the rate of increase in pressure a "transient curve".

The scientists involved in the investigation should have been able to visualize that 72°F air surrounds the football on a stand and it warms up rapidly compared to cold footballs in a ball bag.



Figure 2

Figure 2 shows the setup that Exponent used to determine the transient curve of a football on a stand and is taken from Exponent's appendix to the Wells report.

The Patriot's footballs were in a cold ball bag. The bag and contents were at 48°F. The cold bag prevented the 72°F locker room air reaching the Patriot's footballs.

The footballs warm up and increase in pressure slowly compared to the football on a stand. A transient curve for footballs in a ball bag has to be established in order to determine the true temperature rise and hence pressure increase of the Patriot's footballs when the ball bag is exposed to the warm air in the locker room.



Figure 3

Figure 3 shows the setup used for this report to determine the transient curve of footballs in a ball bag

The ball bag was partially open and an official NFL Game Ball at the top of the open bag was used so that a reasonably unbiased transient curve could be established that represented the average transient curve for all the footballs in the ball bag. A more refined test could be carried out but this will suffice to demonstrate the difference between the transient curves of a football on a stand and of footballs in a ball bag.

The test procedure used to establish the transient curve for the footballs in the ball bag was similar to the test procedure used by Exponent for the football on a stand.

The footballs were inflated to 12.5 psi in a 72°F room and then placed in a ball bag and left for two hours to simulate the locker room before the game. The footballs and the bag were then cooled to 48°F to simulate what happened on the field

prior to half time. At 48°F the pressure of the footballs decreased to approx. 11.1psi. They were then placed back in a 72°F room. (A graph showing the relationship between temperature and pressure can be found in the appendix to this report).

The initial pressure of the test football in the ball bag was measured and the increase in pressure of the football over time was recorded resulting in a transient curve for dry footballs in a ball bag. A transient curve for wet footballs in a ball bag was generated using the same test procedures for dry footballs.

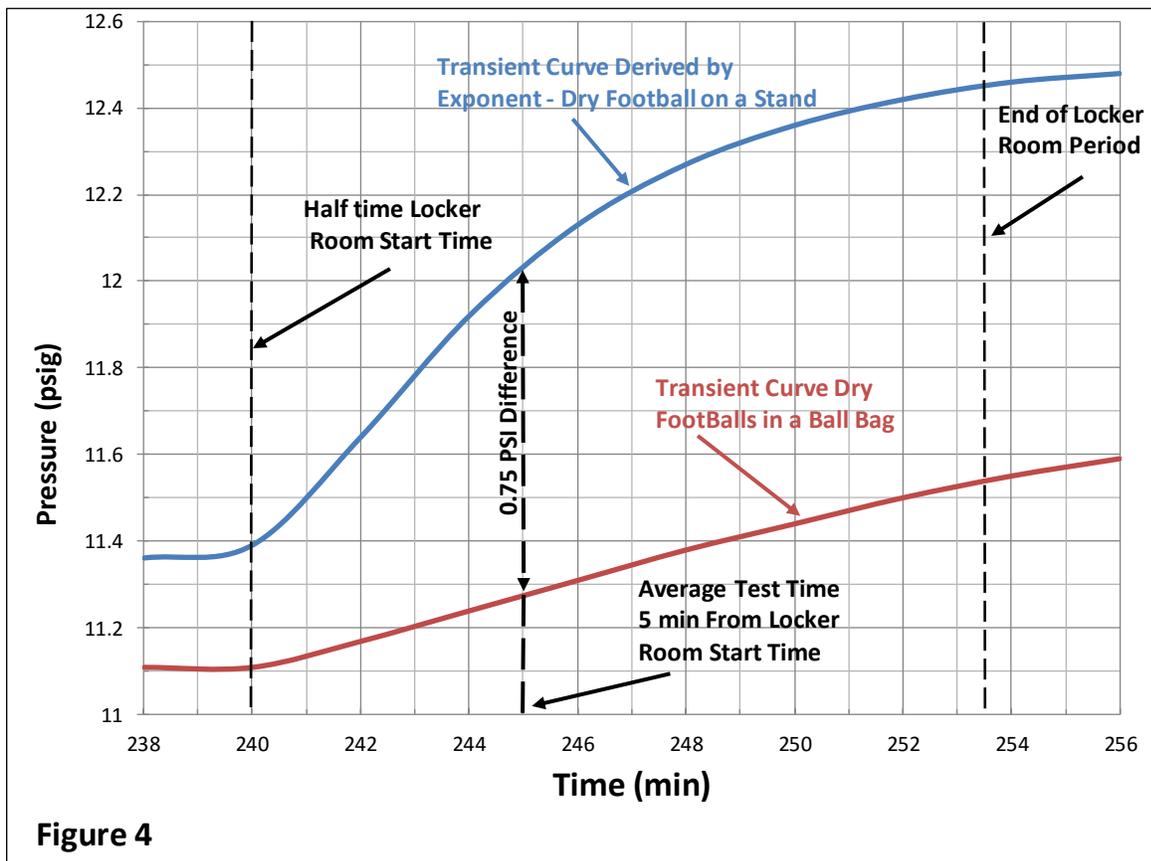


Figure 4 shows that there is an 0.75 psi difference between the dry transient curves of the test football in the ball bag and the dry football on a stand at the average test time that the Patriots footballs were tested in the locker room.

Exponent drew the invalid conclusion that the low pressure of the Patriot’s footballs was probably due to deflation. The graph makes it obvious that the low pressure of the Patriot’s footballs that were in a ball bag until tested was due to

the fact that they did not warm up and increase in pressure at the same rate as a football on a stand.

One fact is certain and that is the transient curve generated by Exponent using a football on a stand can't be used to predict the pressure of the Patriot's footballs in a ball bag and can't be used to determine if the footballs were deflated.

Evidence of the Patriot's Innocence.

On game day at half time the officials in the locker room measured the pressures of the footballs using two gauges. The average pressure of the Patriot's footballs using the logo gauge was 11.49 psi and the non-logo gauge was 11.1 psi.

The pressures are in the correct pressure range for fully inflated footballs that have cooled and decreased in pressure on the field and only increased in pressure slightly in the warm locker room due to the fact that they are insulated in a ball bag until the moment they are tested.

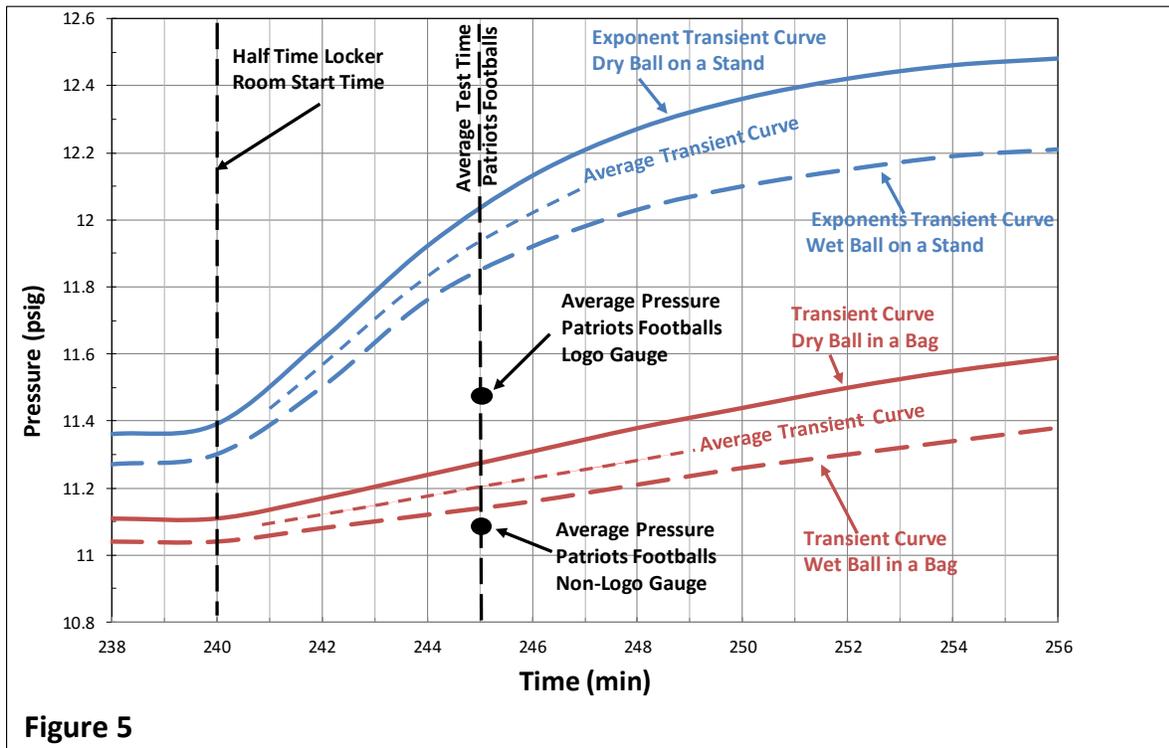


Figure 5 shows that the average pressures of the Patriot's footballs using two gauges fall either side of the wet and dry football in a ball bag transient curves.

The low average pressures reading of 11.1 psi using the Non-Logo Gauge is within 0.1 psi of the average transient curve for footballs in a ball bag proving the Patriot's footballs were not deflated. Exponents football on stand transient curves are only included for reference purposes.

Exponent's Game Day Simulation

Exponent carried out a series of game day simulations with Patriots and Colts footballs. The simulations are described in full on page 56 of Exponent's appendix to the Wells report. Exponent states "*A comprehensive effort was undertaken by Exponent to fully simulate, as closely as possible based on available information what happened on game day. Data from such simulations can then be compared to the predictions made by the transient curves to help assess their validity.*" (The transient curves that Exponent refers to are the transient curves for a football on a stand.)

This means that the transient curves of the fully inflated footballs collected from the simulated field and placed in a ball bag have to match the transient curve of a football on a stand or Exponents theory that a football on a stand represents the "Governing Physics" is not valid and therefore the transient curve of a football on a stand can't be used to determine if the Patriot's footballs were deflated.

The simulation conditions were supposed to be the same as the game day conditions. The Patriot's footballs were inflated to 12.5 psi in a simulated locker room heated to 72°F. They were then cooled to 48°F for the appropriate time and some were sprayed with water to simulate game day conditions on the field. They were then brought back to the simulated locker room in ball bags. The footballs should then have remained in ball bags until the moment they were tested.

It's obvious from the previous comparison of the transient curves of a football on a stand and the transient curves of footballs in a ball bag that footballs in a ball bag are not going to warm up and increase in pressure at the same rate as a football on a stand.

This means that it is impossible for the game day simulation results to fall between the wet and dry transient curves of a football on a stand. Once this is

pointed out common sense makes it obvious that footballs insulated from the surrounded air by a ball bag are not going to warm up and increase in pressure at the same rate as a football on a stand.

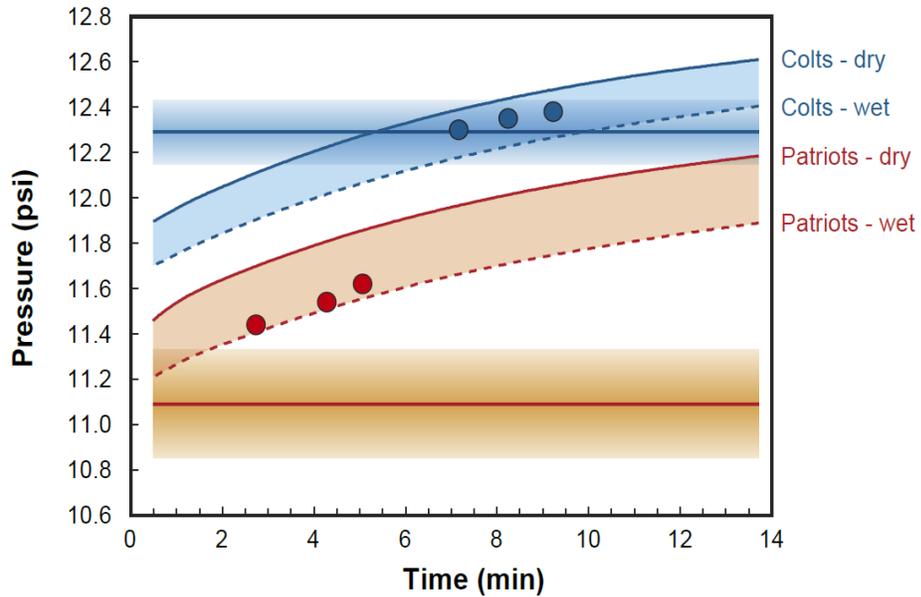


Figure 6

Figure 6 is taken from Exponent’s appendix to the Wells report. The results of their game day simulation appear to fall between the wet and dry football on a stand transient curves. The transient curves are not in the correct position.

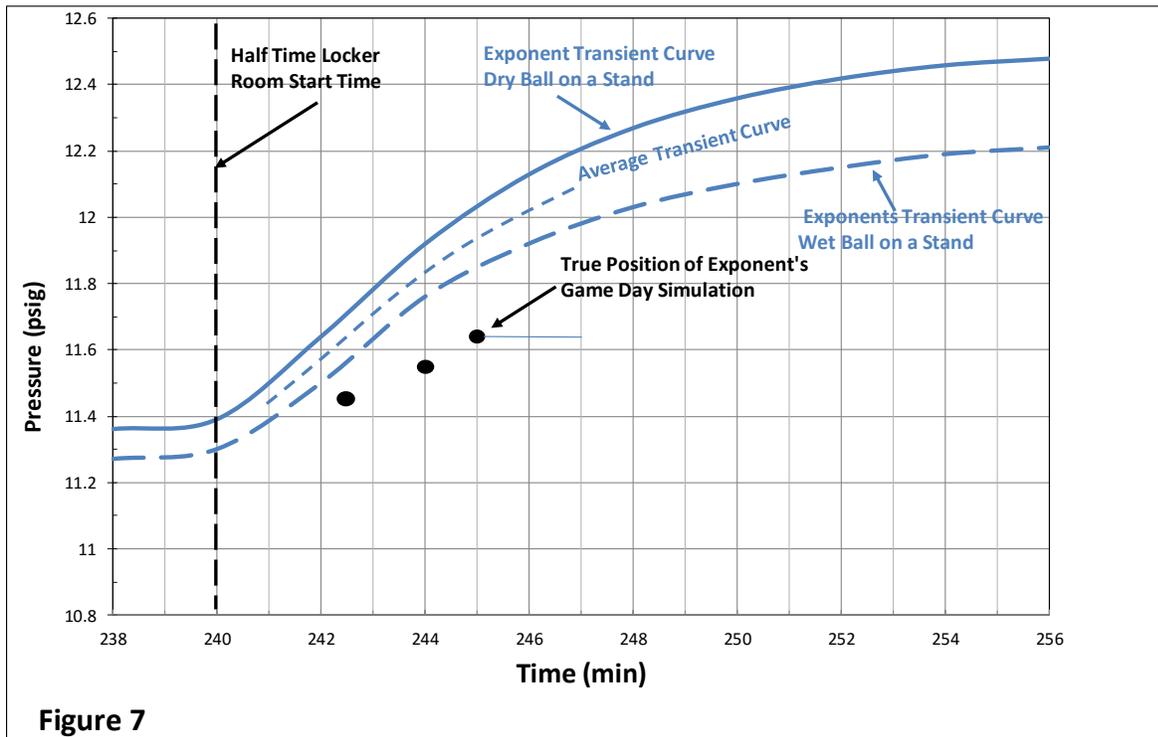


Figure 7

Figure 7 shows the true position of Exponent’s football on a stand transient curves relative to the Exponent’s simulated game day results. The simulated game day results are lower than Exponent’s wet and dry football on a stand transient curves.

There is also another issue concerning the simulated game day results. They are higher than they should be assuming the footballs were kept in a ball bag until the moment they were tested.

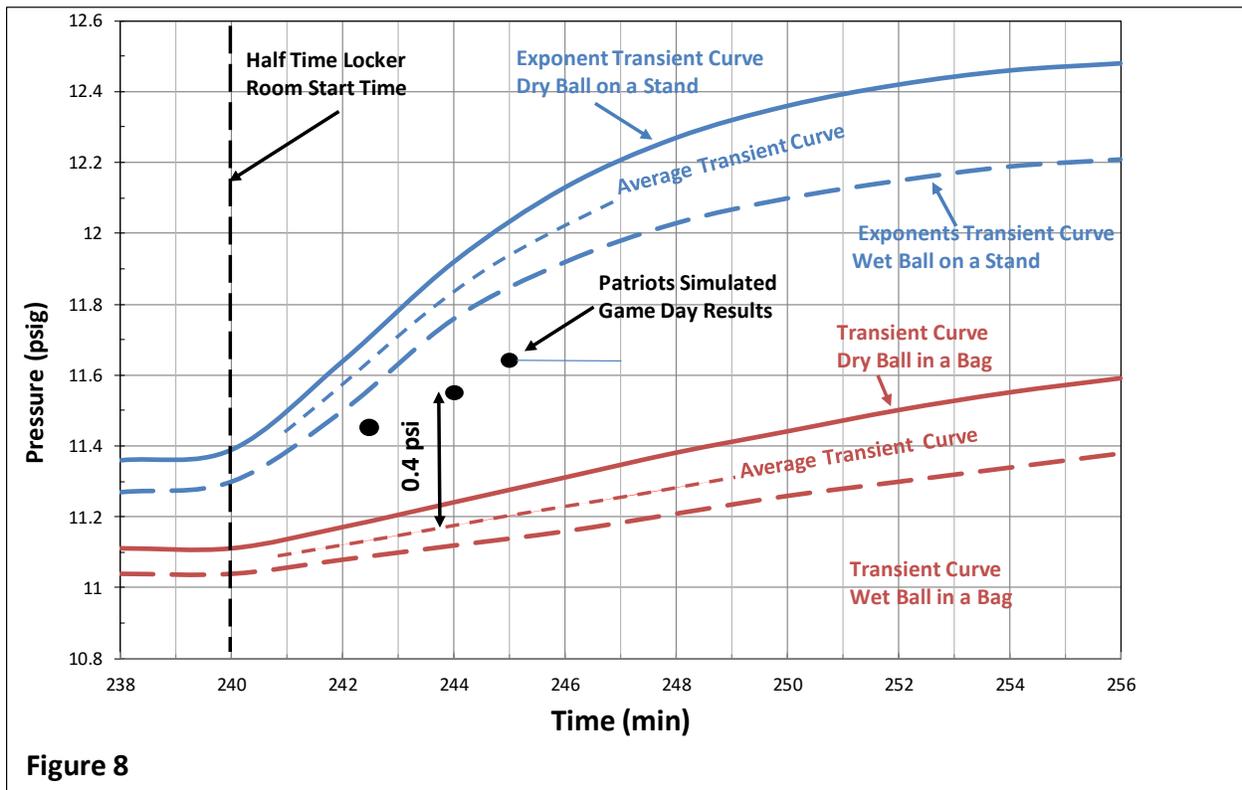


Figure 8 shows that the Patriot’s simulated game day test results are 0.4 psi higher than they should be assuming the game day test procedures were followed where the balls are kept in a bag until the moment they are tested.

The results should fall between the transient curves for footballs in a ball bag.

The footballs in this simulation may have been removed from the ball bag when they were in the simulated locker room some time before they were tested which enabled them to warm up and increase in pressure at a higher rate than footballs

kept in a ball bag. This means that in all probability the footballs in the simulation were not treated in the same manner as the Patriot's footballs on game day.

The Wells report and Exponent's appendix make it very clear that the Patriot's footballs in the locker room at half time on game day remained in a ball bag until the moment they were tested.

One fact is certain, the experimental results outlined earlier in this report show that it is impossible for footballs in a ball bag to warm up and increase in pressure at the same rate as a football on a stand and therefore if the game day simulation is carried out as Exponent stated to *"simulate, as closely as possible based on available information what happened on game day"* it's impossible for the results to match Exponent's transient curves of a football on a stand as depicted in figure 6.

It follows that any team that has its footballs examined in this manner will come up short since it is impossible for footballs kept in a ball bag until tested to match the temperature and associated pressure increase of a football on a stand.

Pressure Drop of Colts Footballs Compared to Patriot's footballs

Questions have been raised as to why the pressure drop of the Patriot's footballs was significantly more than the Colt's footballs.

Exponent stated that there was a greater average pressure drop in the Patriot's footballs than there was in the Colt's footballs.

Exponent concluded that there was no set of credible environmental or physical factors that completely accounts for the additional loss in air pressure exhibited by the Patriots game balls as compared to the loss in air pressure exhibited by the Colts game balls which led them to conclude that the Patriot's footballs must have been deflated.

There are two reasons for the difference.

One obvious reason is that the Colt's footballs were tested later and had a chance to warm up and increase in pressure. There is also no guarantee that the Colt's

footballs remained in the ball bag insulated from the locker room air during the time that the Patriot's footballs were being tested. Some could have been taken out of the top of the ball bag and examined by curious officials.

The second reason is less obvious. Only four Colt's footballs were tested. If 11 Colt's footballs had been tested, then the balls further down in the ball bag that were insulated from the locker room air and were colder would have brought down the average temperature and hence pressure of the Colt's footballs.

It is now obvious that the difference in pressure drop between the Colt's and the Patriot's footballs is due to the fact that all of the Colt's footballs were not tested.

Summary

Proof of the Patriot's Innocence

The Patriots did not deflate footballs. The scientists at Exponent made a fundamental error when they used the transient curve of a football on a stand to determine the heat gain and associated increase in pressure of the cold footballs when they were brought from the cold field to the locker room in a ball bag.

The most important fact in proving the Patriot's innocence is that the Patriot's footballs remained in a ball bag until the moment they were tested.

Exponents scientists should have realized that a cold football out in the open warms up rapidly compared to cold footballs in a ball bag. The ball bag insulates the footballs from the surrounding air and they warm up slowly. The facts show that a football on a stand transient curve is irrelevant since it cannot be used to determine the pressure increase of footballs in a ball bag.

The use of a football on a stand transient curve caused Exponent's scientists to draw the false conclusion that the low pressure of the Patriot's footballs was due to deflation.

A separate transient curve for footballs in a ball bag proves that the low pressure of the Patriot's footballs was not due to deflation it was due to the fact that they

were insulated from the warm air in a ball bag and did not warm up and increase in pressure.

Exponent's Game Day Simulation

Exponent states "a comprehensive effort was undertaken by Exponent to fully simulate, as closely as possible based on available information, what happened on Game Day. Data from such simulations can then be compared to the "predictions" made by the transient curves to help assess their validity".

One fact is certain, the experimental results outlined earlier in this report show that it is impossible for footballs in a ball bag to warm up and increase in pressure at the same rate as a football on a stand.

Somehow the impossible is achieved and the results of the simulation make it appear that footballs that should have been in a ball bag until they were tested warm up and increase in pressure at the same rate as a football on a stand.

In order to achieve this impossible feat, the football on a stand transient curves are moved down and in all probability (this is pure conjecture) the footballs in the simulation are removed from the ball bag as soon as they enter the simulated locker room so that they can warm up at the same rate as a football on a stand.

There is no doubt that the game day simulation was not carried out as closely as possible to simulate what happened on game day. It is impossible for footballs in a ball bag to warm up and increase in pressure at the same rate as a football in on a stand that is in direct contact with the warm air in the locker room.

The facts indicate that any team with fully inflated footballs investigated in a similar manner to the Patriots would have been found guilty of deflating footballs.

Colt's Footballs.

Exponent stated that there was a greater average pressure drop in the Patriot's footballs than there was in the Colt's footballs which led them to conclude that the Patriot's footballs must have been deflated.

There are two reasons for the difference:

First, the Colt's footballs were tested later and had a chance to warm up and increase in pressure.

The second reason is less obvious. Only four Colt's footballs were tested. If 11 Colt's footballs had been tested, then the balls further down in the ball bag that were insulated from the locker room air and were colder would have brought down the average temperature and hence pressure of the Colt's footballs.

It is now obvious that the high pressure of the Colt's footballs is due to the fact that the Colt's footballs were tested later and the average pressure of all of the Colt's footballs was not taken into account.

Conclusion

The low pressure of the Patriot's footballs was not due to deflation it was due to the footballs being kept in a ball bag until they were tested. The ball bag insulated the Patriot's footballs from the warm air in the locker room and they only experienced a slight increase in temperature and hence increase in pressure from the low pressure they experienced due to the cold conditions on the game field.

One fact is certain and that is the transient curve generated by Exponent using a football on a stand can't be used to predict the pressure of the Patriot's footballs in a ball bag and can't be used to determine if the footballs were deflated.

A transient curve for footballs in a ball bag has to be established in order to determine the true temperature rise and hence pressure increase of the Patriot's footballs.

The facts show that any team with fully inflated footballs investigated in a similar manner would have been found guilty of deflating footballs.

Background of Author

Before I retired I was a Principal Research Scientist with International Paper and BBA Nonwovens. I am inventor or co-inventor of over 40 patents.

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This report can be found on the web site www.DeflategateDeflated.com

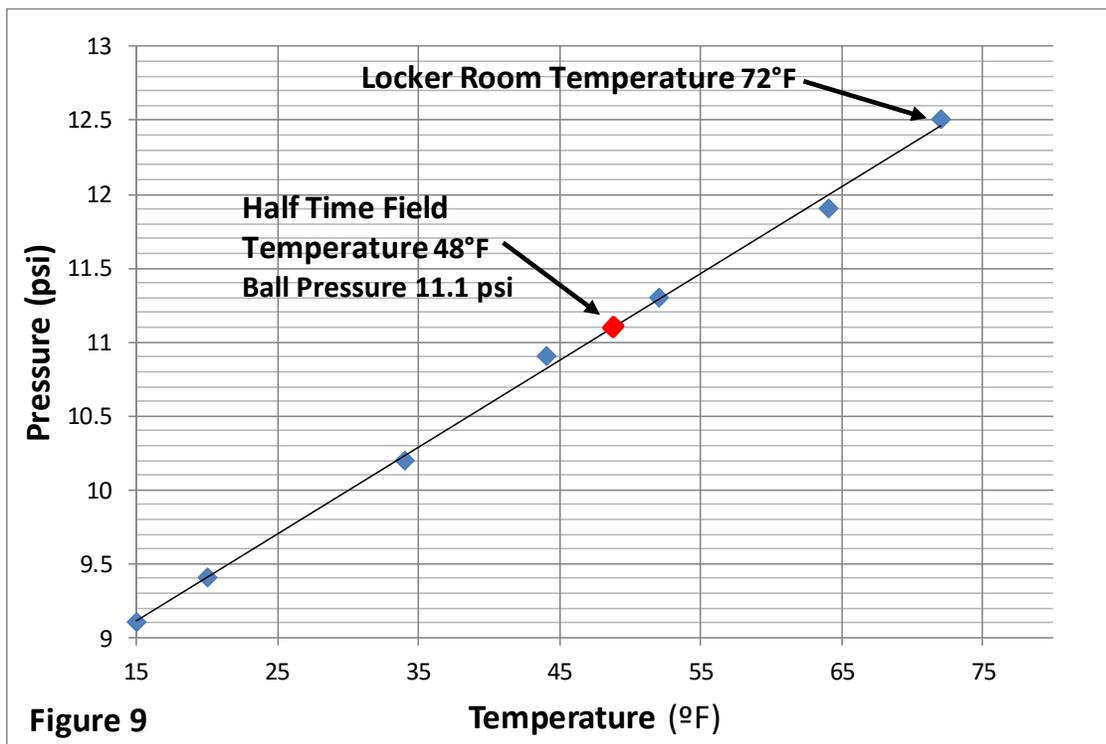
Equipment

The pressure of the football was measured with a Dwyer model DPGA-05 digital pressure gauge permanently connected to an official NFL game ball with a flexible tube. The temperature of the fridge was controlled with a Johnson Controls A419 ABG-3C electronic temperature control.

Air was circulated in the fridge with an 8-watt pancake fan to eliminate any temperature gradient. The fridge temperature was monitored with two thermocouples connected to digital readouts.

Temperature vs Pressure

The graph (Figure 9) shows how temperature affects the pressure of a football. The results were not calculated they were derived experimentally using an official NFL football.



On game day, the Patriot's footballs were inflated to 12.5 psi in the 72°F locker room before the game. The temperature on the field at half time was 48°F which caused the pressure of the footballs to decrease to 11.1 psi.

As mentioned previously several sets of experimental results confirm that the pressure of a dry football inflated to 12.5 psi at 72°F will decrease to 11.1 psi when the temperature is decreased to 48 °F. This is lower than the calculated pressure and lower than the pressure used by Exponent. It is not entirely unexpected when all of the variables such as the flexibility of the leather, stitches, laces and the bladder are taken into account.