MEMORANDUM 6-Sep-06

From: Prof. Ratcliffe
To: Midn 2/c F. M. Lastname, EM375 Section 1234

Subj: EM375 MEASUREMENTS LAB – SAMPLE REPORT

Ref: (a) "Measurements Lab" EM375 Lab. Handout
(b) EM375 Handout "Tests Between Two Populations and Samples"

Encl: (1) Mathcad Sheets for the Ball Data Reduction
(2) Mathcad Sheets for Range Data Reduction

1. Aims. There were two aims of the work reported here:

a) The production quality of valve balls was assessed by measuring a sample of the product. Statistical analysis of the measurements was used to check whether the balls were made to the correct dimensions.

b) A prototype ball launcher was tested in order to find the expected range-to-target.

2. Valve balls. Valve balls are manufactured by welding together two halves. In order to verify the dimensional consistency of the weld, diameters of the balls at and away from the seam were measured. In accordance with the reference, the dimensions were measured with vernier calipers. The mass of the balls was also measured using an electronic balance. In order to obtain good statistics for the balls, 30 different balls were measured. The data reduction, shown in encl (1), was conducted with the commercial Mathcad program. The following is a summary of the results.

Number of samples = 30			
	Mean	Standard Deviation	95% confidence interval
Diameter at seam (ins)	1.9754	0.01101	$\pm$0.0048
Diameter away from seam (ins)	1.8650	0.0061	$\pm$0.0026
Mass (g)			

3. Using the procedures in ref (b) it was concluded that at the 95% confidence interval there is no difference between the diameter measured on the seam, and the diameter measured away from the seam.

4. Ball Launcher. The model launcher was set to a launch angle of 20^{O} and the balls were launched using an initial stretch ratio of $\lambda = 2.25$. The impact point was "spotted" by eye and measured to within about 6 inches. Encl. (2) shows the raw data and the data reduction. Thompson's-τ method was used to eliminate any questionable data. The elimination routine shown in encl (2) was manually changed to reject one data point at a time. The enclosure shows the worksheet after the final elimination. Of the 35 initial launches, the elimination procedure rejected 4 measurements, resulting a final data set size of 31 ranges.

5. The 95% and 99% confidence intervals for the impact range are summarized in the following table.

Confidence Level	Range (ft)	Minimum Range (ft)	Maximum Range (ft)
95%	±0.067	32.19	32.33
99%	±0.090	32.17	32.35

6. The most likely sources of error for this experiment were the launch procedure (especially setting the launch angle), the flight of the ball itself, and spotting the range. The launch point is determined by pulling back the launcher by hand. There may be large errors in the repeatability of both the amount pulled back, and the achieved launch angle. The flight of the ball was subject to variable wind, especially since a nearby door was opened and closed during the experiment. It was difficult to spot the exact impact point, and some variability is undoubtedly due to errors in determining this point.

7. Conclusions. The following conclusions are made:

a) At the 95% level of confidence, the seam is not causing a difference in the diameter of the valve balls.

b) The mass of a typical ball is ?? g.

c) For a stretch ratio of $\lambda = 2.25$ and a launch angle of 20^{O} the impact range of the model launcher is 32.26 ft.

Colin P. Ratcliffe (original signature is required on submitted work)

Colin P. Ratcliffe, Professor