



Error Introduced by:
Image Analysis Software
Camera & Part Holder

August 2008

“..any sufficiently advanced technology is indistinguishable from magic.” Arthur C. Clark

WORLD CLASS,

Background: Three different areas of error on the possible accuracy that can be obtained are explored:

- Image Analysis Software
- Camera and lens
- Placement of the sprinkler

Requirement: Confirm that image analysis software does not introduce additional errors into the measurements.

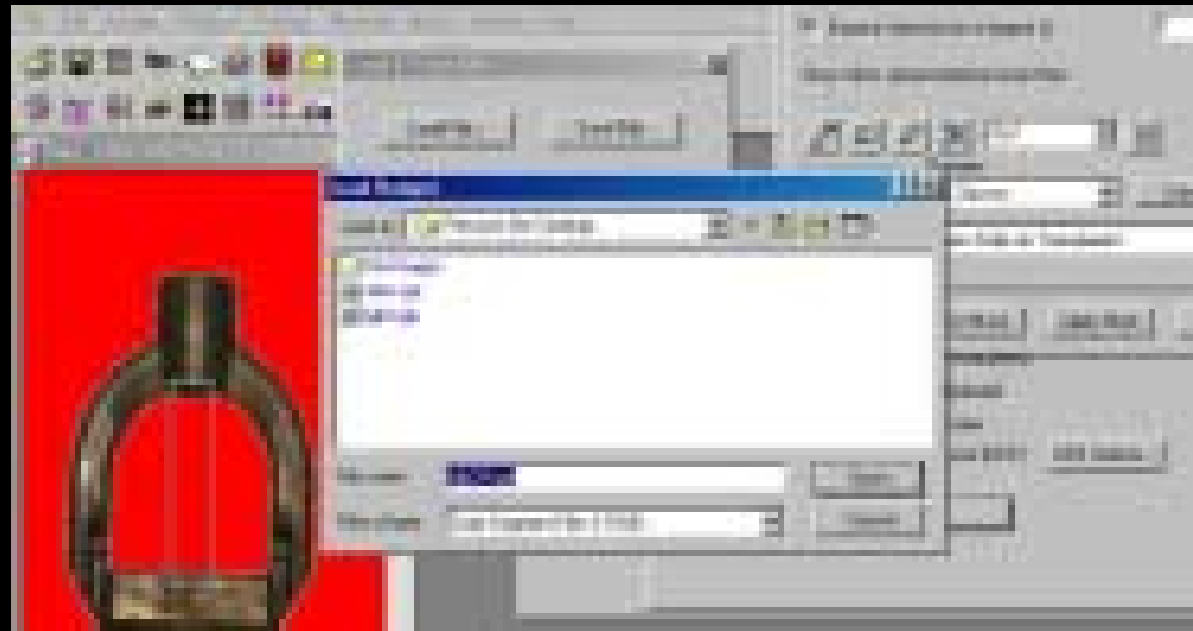


Image Analysis Software Results

- ◆ See the attached spreadsheet document
 - 26 Measurements performed 121 times

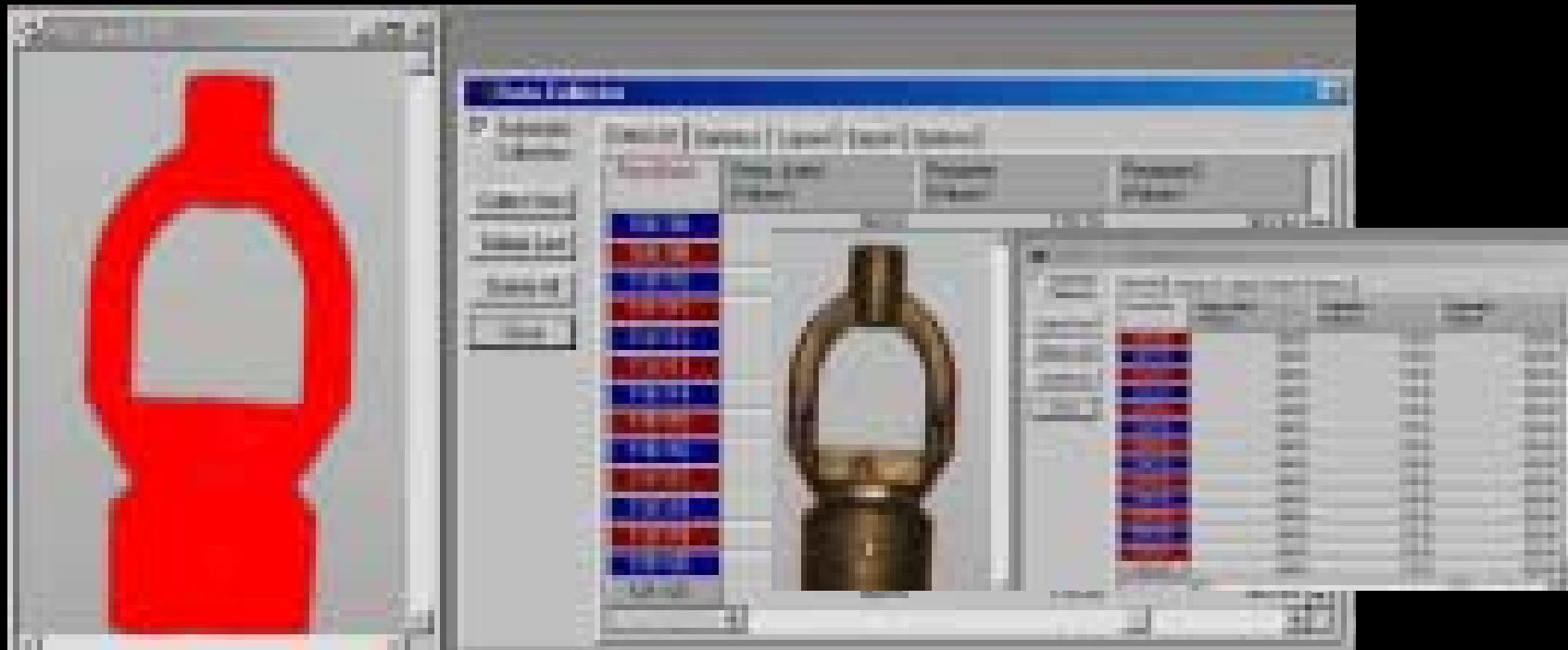


Image Analysis Software

- ◆ Image analysis software was used to process the same image a number of times.
- ◆ 121 measurements were performed
- ◆ **Std.Dev. over all 26 measurements = 0**



Requirement: Confirm that image analysis software does not introduce additional errors into the measurements.

CONFIRMED: The image analysis software introduces zero error

Requirement: Calculate the error introduced by the current camera / lens configuration.



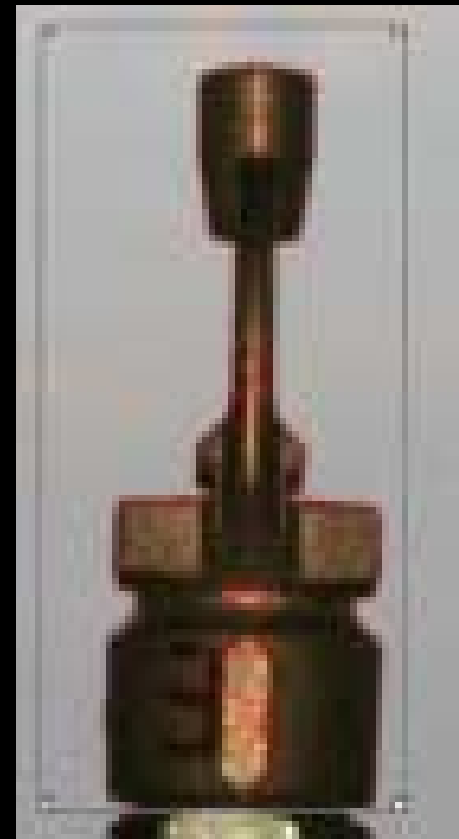
Camera / Lens Error

- ◆ Image analysis software was used to process different images of the same object, without moving the sprinkler
- ◆ All results are in MM
(7 pixels per MM)

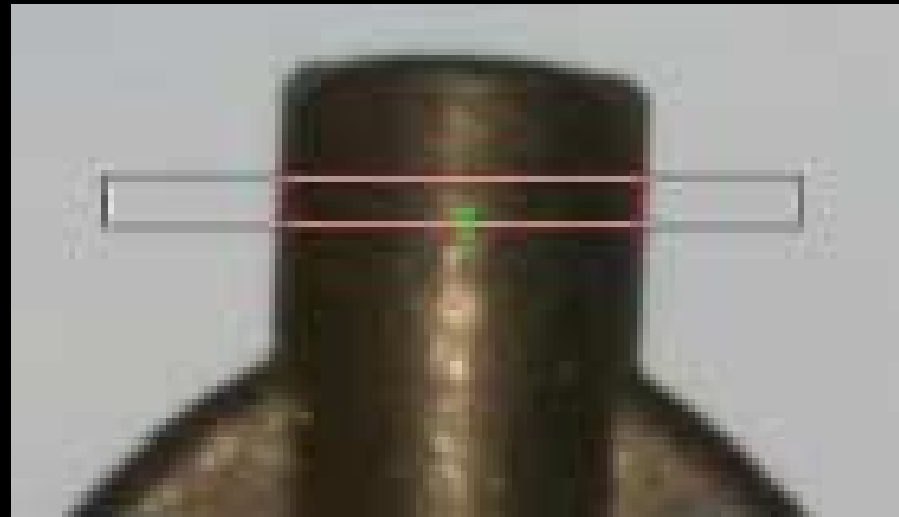


Camera / Lens Error

- ◆ The following measurements were performed:
- ◆ 1 Boss Width (D)
- ◆ 3 Spanner Flat (D)
- ◆ 4 NPT Boss Width (D)
- ◆ 5 Window Width (L)
- ◆ 11 Arm Angle (D)



1 Boss Width (D)



IMG_6385.JPG	9.8033
IMG_6386.JPG	9.8017
IMG_6387.JPG	9.8038
IMG_6388.JPG	9.8029
IMG_6389.JPG	9.8033
IMG_6390.JPG	9.8045
IMG_6391.JPG	9.802
IMG_6392.JPG	9.801712
IMG_6393.JPG	9.802017
IMG_6394.JPG	9.801773
IMG_6395.JPG	9.802506

MAX 9.89679

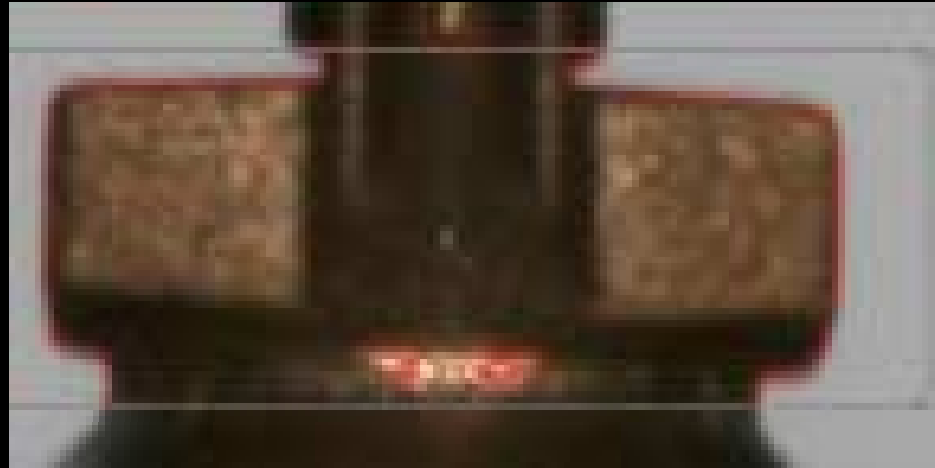
MIN 9.89234

AVG 9.893094

STD DEV 0.001316

3 Spanner Flat (D)

IMG_6550.JPG	9.620819	22.96144
IMG_6549.JPG	9.620743	23.05205
IMG_6448.JPG	9.620148	23.14296
IMG_6547.JPG	9.620148	23.05209
IMG_6546.JPG	9.620178	23.05219
IMG_6545.JPG	9.6203	23.14311
IMG_6544.JPG	9.620163	23.05222
IMG_6543.JPG	9.620255	23.05217
IMG_6542.JPG	9.620773	23.05232

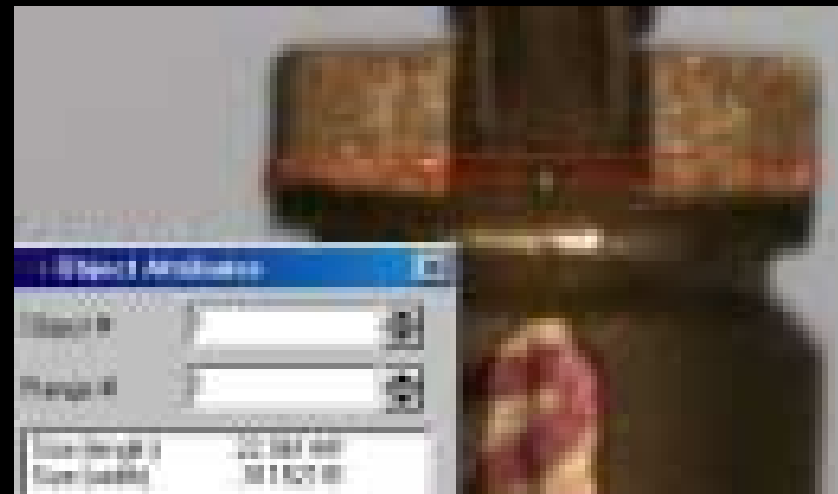


MAX 23.14311

MIN 22.96144

AVG 23.06228

STD DEV 0.054572



4 NPT Boss Width (D)

IMG_6560.JPG	9.89241	23.596603
IMG_6559.JPG	9.892853	23.596664
IMG_6558.JPG	9.892838	23.596741
IMG_6557.JPG	9.892868	23.596603
IMG_6556.JPG	9.892426	23.596664
IMG_6555.JPG	9.89234	23.596649
IMG_6554.JPG	9.892929	23.596603
IMG_6553.JPG	9.89679	23.59668
IMG_6552.JPG	9.892777	23.596649
IMG_6551.JPG	9.892716	23.596619



MAX 23.596741

MIN 23.596603

AVG 23.596648

STD DEV 0.00004

11 Arm Angle (D)

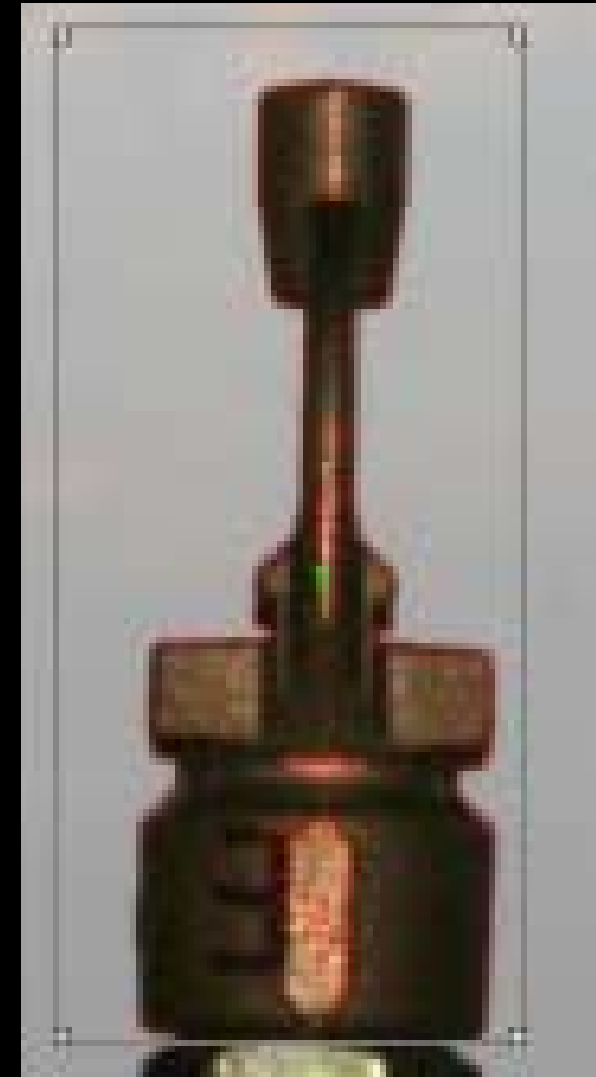
No 2	IMG_6550.JPG	9.620819	22.96144	23.687485	2.34871
No 2	IMG_6549.JPG	9.620743	23.05205	23.687469	2.33359
No 2	IMG_6448.JPG	9.620148	23.14296	23.688339	2.33551
No 2	IMG_6547.JPG	9.620148	23.05209	23.596588	2.34681
No 2	IMG_6546.JPG	9.620178	23.05219	23.687332	2.3543
No 2	IMG_6545.JPG	9.6203	23.14311	23.596573	2.35617
No 2	IMG_6544.JPG	9.620163	23.05222	23.687454	2.34642
No 2	IMG_6543.JPG	9.620255	23.05217	23.596634	2.33547
No 2	IMG_6542.JPG	9.620773	23.05232	23.59668	2.35782

MAX 2.35782

MIN 2.33359

AVG 2.34609

STD DEV 0.00932



Requirement: Error introduced by the current camera configuration:

The camera, under the current capture technique, introduces the following errors:

- ◆ 1 Boss Width = 0.001 mm (100X)
- ◆ 3 Spanner Flat = 0.05 mm (40 X)
- ◆ 4 NPT Boss Width = 0.00004 mm (1 000X)
- ◆ 11 Arm Angle = 0.009 degrees (50X)

Requirement: Calculate the error introduced by the current sprinkler holder configuration.



Sprinkler Holder Error

- ◆ Image analysis software was used to process different images of the same object, replacing the sprinkler in the same position on the holder each time

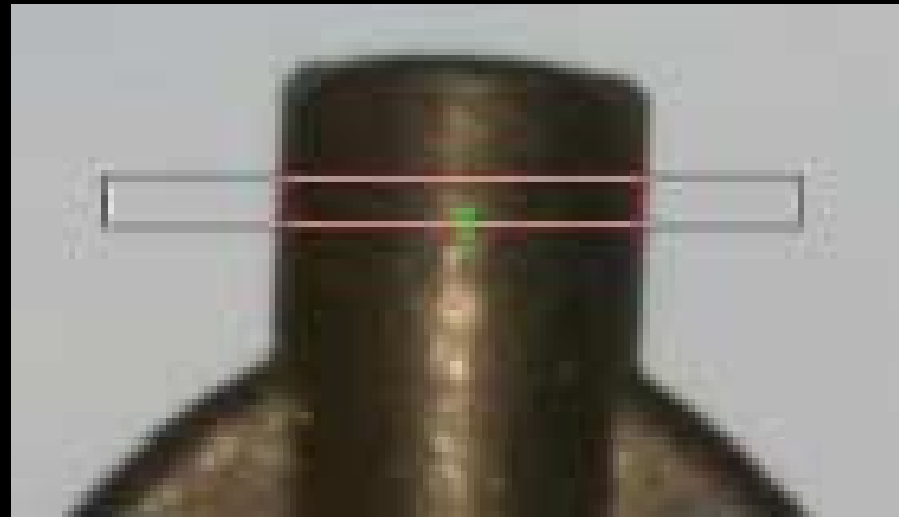


Sprinkler Holder Error

- ◆ The following measurements were performed:
- ◆ 1 Boss Width (D)
- ◆ 4 NPT Boss Width (D)
- ◆ 5 Window Width (L)
- ◆ 6 Window Height (L)
- ◆ 7 Deflector Boss Length (D)

1 Boss Width (D)

1	IMG_6398.JPG	9.900665
2	IMG_6399.JPG	9.90979
3	IMG_6400.JPG	9.902832
4	IMG_6401.JPG	9.892059
5	IMG_6402.JPG	9.898117
6	IMG_6403.JPG	9.896362
7	IMG_6404.JPG	9.898239
8	IMG_6405.JPG	9.907791
9	IMG_6406.JPG	9.895783
10	IMG_6407.JPG	9.898514



MAX 9.909 MIN 9.892 AVG 9.90001

STD DEV 0.0054

◆ Less 0.001 mm camera error = 0.004 mm

4 NPT Boss Width (D)

1	IMG_6398.JPG	9.900665	23.50592
2	IMG_6399.JPG	9.90979	23.505966
3	IMG_6400.JPG	9.902832	23.506348
4	IMG_6401.JPG	9.892059	23.505814
5	IMG_6402.JPG	9.898117	23.506317
6	IMG_6403.JPG	9.896362	23.505829
7	IMG_6404.JPG	9.898239	23.507782
8	IMG_6405.JPG	9.907791	23.505997
9	IMG_6406.JPG	9.895783	23.506439
10	IMG_6407.JPG	9.898514	23.506424



MAX 23.5077 MIN 23.5058 AVG 23.5062
STD DEV 0.00058

◆ Less 0.00004 mm camera error = 0.00054 mm

5 Window Width (L)

1	IMG_6398.JPG	9.900665	23.50592	19.15367
2	IMG_6399.JPG	9.90979	23.505966	19.15457
3	IMG_6400.JPG	9.902832	23.506348	19.1501
4	IMG_6401.JPG	9.892059	23.505814	19.14993
5	IMG_6402.JPG	9.898117	23.506317	19.14958
6	IMG_6403.JPG	9.896362	23.505829	19.14973
7	IMG_6404.JPG	9.898239	23.507782	19.14954
8	IMG_6405.JPG	9.907791	23.505997	19.15273
9	IMG_6406.JPG	9.895783	23.506439	19.1553
10	IMG_6407.JPG	9.898514	23.506424	19.15002

MAX 19.1553

MIN 19.14954

AVG 19.15152

STD DEV 0.002



6 Window Height (L)

1	IMG_6398.JPG	9.900665	23.50592	19.15367	21.634216
2	IMG_6399.JPG	9.90979	23.505966	19.15457	21.615906
3	IMG_6400.JPG	9.902832	23.506348	19.1501	21.650757
4	IMG_6401.JPG	9.892059	23.505814	19.14993	21.651489
5	IMG_6402.JPG	9.898117	23.506317	19.14958	21.634888
6	IMG_6403.JPG	9.896362	23.505829	19.14973	21.612305
7	IMG_6404.JPG	9.898239	23.507782	19.14954	21.62146
8	IMG_6405.JPG	9.907791	23.505997	19.15273	21.634888
9	IMG_6406.JPG	9.895783	23.506439	19.1553	21.609192
10	IMG_6407.JPG	9.898514	23.506424	19.15002	21.612915

MAX 21.651489

MIN 21.609192

AVG 21.627802

STD DEV 0.015



7 Deflector Boss Length (D)

Sprinkler No 2

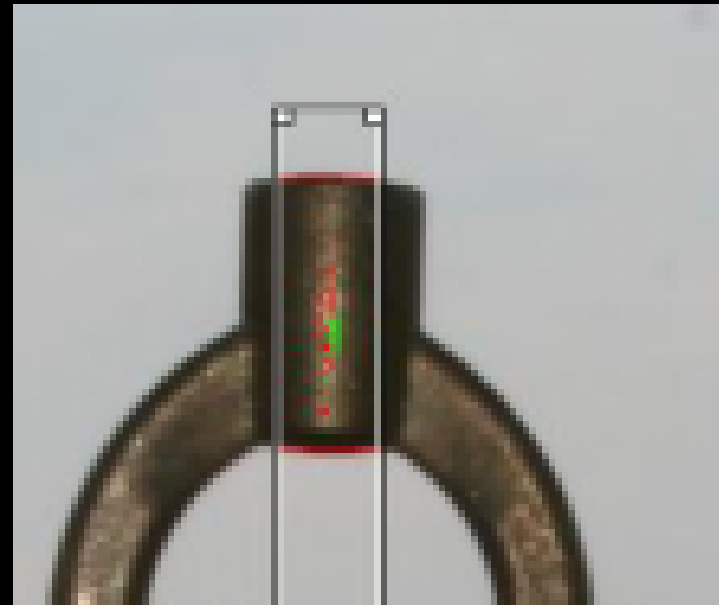
1	IMG_6398.JPG	9.900665	23.50592	19.15367	21.634216	15.247559
2	IMG_6399.JPG	9.90979	23.505966	19.15457	21.615906	15.222656
3	IMG_6400.JPG	9.902832	23.506348	19.1501	21.650757	15.276001
4	IMG_6401.JPG	9.892059	23.505814	19.14993	21.651489	15.20105
5	IMG_6402.JPG	9.898117	23.506317	19.14958	21.634888	15.202026
6	IMG_6403.JPG	9.896362	23.505829	19.14973	21.612305	15.247314
7	IMG_6404.JPG	9.898239	23.507782	19.14954	21.62146	15.251221
8	IMG_6405.JPG	9.907791	23.505997	19.15273	21.634888	15.24707
9	IMG_6406.JPG	9.895783	23.506439	19.1553	21.609192	15.262085
10	IMG_6407.JPG	9.898514	23.506424	19.15002	21.612915	15.247803

MAX 15.276001

MIN 15.20105

AVG 15.240479

STD DEV 0.02



Requirement: Error introduced by the sprinkler holder:

The sprinkler holder introduces the following errors:

- ◆ **1 Boss Width = 0.004 mm (100X)**
- ◆ **4 NPT Boss Width = 0.00054 mm (1 000X)**
- ◆ **5 Window Width = 0.002 mm (500X)**
- ◆ **6 Window Height = 0.015 mm (150X)**
- ◆ **7 Deflector Boss Length = 0.02 mm (50X)**

IN SUMMARY: Three different areas of accuracy were explored:

- Image Analysis Software introduces no error;

- The camera / lens introduces a small error and largest error is the sprinkler holder

IN SUMMARY:

With careful placement of the sprinkler, an accuracy between 50 – 1 000 X that required can be obtained.

