ATTACHMENT 11

NETCO Report NET-300054-01, Revision 0
"Inspection and Testing of Fast Start Surveillance Coupons F22-F11
from the LaSalle County Unit 2 Station"

NET-300054-01

Inspection and Testing of Fast Start Surveillance Coupons F22-F11 from the LaSalle County Unit 2 Station

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for
Exelon Generation

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by
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Review/Approval Record

Revision	Date	Prepared by:	Reviewed by:	Approved (QA):
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Table of Contents

1.0 Introduction

Twelve (12) Rio Tinto ALCAN (RTA) Fast Start Surveillance coupons from LaSalle Unit 2 were shipped to NETCO's laboratory facilities at Pennsylvania State University. These coupons were shipped in several installments from December 2009 to June 2012. Coupons F22-F11 were removed in descending numerically ordered pairs from the spent fuel pool at one half year increments. After the coupons were received, they were tested in accordance with SEP-259-13 (Appendix B).

The test results are contained in Section 3.0. NETCO's conclusions with respect to test results are contained in Section 4.0. Appendix B contains a copy of SEP-259-13, "Procedure for Post-Test Characterization of the Fast Start Surveillance Coupons," the procedure used to test the RTA composite coupons. Appendix C contains calibration documentation for all instruments, gage blocks, and mass blocks.

The coupons were in good overall condition when received by NETCO. No significant deterioration or degradation was evident. Comparison with corresponding measurements made prior to placement in the pool (pre-irradiation) confirm this observation. No surface pitting was observed. Some visible evidence of a light corrosion film was noted on some of the surfaces of the coupons.

2.0 Scope of Surveillance Coupon Testing

The coupons received by NETCO were first subjected to visual inspection and high resolution photography. This was followed by cleaning with demineralized water to remove transferable contamination.

The coupons were dried for 1 hour at 220° F to remove surface moisture. After drying, the coupons were subject to:

- Dimension measurements
- Dry weight measurements
- Specific gravity and density measurements
- Neutron attenuation testing and ^{10}B areal density measurements
- Acid cleaning and corrosion rate determination

The locations for the dimension measurements and neutron attenuation test are shown in Figure 2-1. All testing was conducted in accordance with SEP-259-13, which is included as Appendix B to this report.

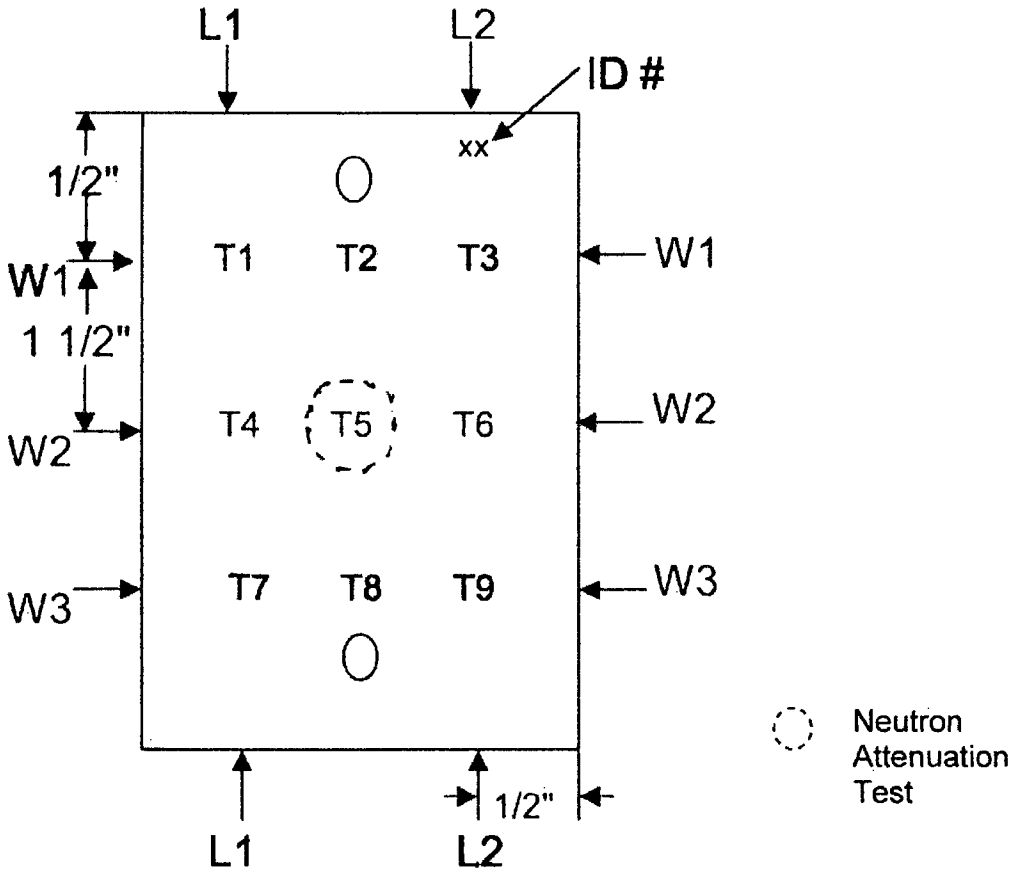

Figure 2-1: Locations for Fast Start Coupon Tests

3.0 Test Results

This testing covers the twelve (12) most recent fast start coupons. The coupons were removed from the spent fuel pool in pairs. The data and measurement results for each pair of coupons have been averaged together for comparison over time. In all cases a negative represents a loss. Table 3-1 shows the time in the pool for each of the six pairs of coupons taken from the coupon tree that was initially placed into the spent fuel pool on 11/24/2008.

Table 3-1- In pool time for tested coupons

Coupon IDs	F21&22	F19&20	F17&18	F15&16	F13&14	F11&12
Pull Date	**12/7/2009**	**6/25/2010**	**12/15/2010**	**7/11/2011**	**12/13/2011**	**6/12/2012**
Time in SFP [yr]	1.03	1.58	2.06	2.63	3.05	3.55

3.1 Visual Inspection

In this section, the condition of the coupons is described. The front side is defined as the side of the coupon with the ID number on it. The top of the coupon is the short edge closest to the inscribed ID number. The coupons are unclad and are attached to each other by stainless links through the two holes in each coupon. The chain of coupons is attached to a head piece that fits into the upper lead-in of a storage cell in the pool. The twelve (12) coupons are of similar nominal dimension and density. Nominal dimensions are 2" W x 4" L x 0.065" T. The nominal density is 2.7 g/cm^3. Weights vary due to slight differences in dimensions. Please see High Resolution Photographs in Appendix A for more details.

Table 3-2- Visual Inspection F22 & F21

F22	**General:** The ID F22 is inscribed in the upper right corner of the front side. The coupon is fully intact and is in pristine condition. There is no evidence of a light colored oxide film when viewed with the naked eye or under a microscope. Coupon F22 is similar in appearance to coupon F21. Coupon F22 is darker and less reflective than archive coupon FA4. **Front side**: The background color of this side is a medium grey. Against this background there are some scratches that appear lighter. **Back side**: The back side appears similar to the front with different scratch patterns.
F21	**General**: The inscription F21 appears in the upper right corner of the front side. The coupon is intact and is in pristine condition. To the naked eye there is no evidence of a corrosion film. F21 appears slightly darker and reflects less light than archive material not exposed to the pool water. Examination under a microscope showed no evidence of a light colored oxide. Side-by-side microscopic examination indicates the archive coupon is more reflective than F21. **Front Side**: The color of this side is uniform except where there are scratches where the color is lighter. **Back Side**: The appearance of the back side is similar to the front side.

Table 3-3- Visual Inspection F20 & F19

F20	**General:** The coupon ID F20 is inscribed in the upper right corner of the front side. The color of the coupon has darkened as a result of the time in the spent fuel pool. The coupon is slightly warped symmetrically along the longest axis, more so than F19. **Front side:** There are some scratches on the front side where the exposed area is similar to mill finish aluminum. **Back side:** Similar in appearance to the front side. There are a few more scratches on the backside; otherwise there are no other anomalies.
F19	**General:** The coupon ID number F19 is inscribed in the upper right corner of the front side. Color of the coupon has darkened after 1.5 years in the spent fuel pool. The coupon is slightly warped symmetrically along its longest axis. **Front side:** There are numerous scratches where the surface appears shiny, not unlike mill finish aluminum. Scratching is likely to have occurred when the coupon string was removed to remove the coupon. There are no other anomalies. **Back side:** Color is similar to front side; there are fewer scratches on the back side.

Table 3-4- Visual Inspection F18 & F17

F18	Coupon ID F18 is inscribed in the upper right corner. Appearance is about the same as F12.
F17	Coupon ID F17 is inscribed in the upper right corner. Appearance is about the same as F12.

Table 3-5- Visual Inspection F16 & F15

F16	Coupon ID F16 is inscribed in the upper right corner. Appearance is about the same as F12. There is a rust colored pit above the lower link hole on front side.
F15	Coupon ID F15 is inscribed in the upper right corner. Appearance is about the same as F12. There is a dark spot on the back side midway up the right edge

Table 3-6- Visual Inspection F14 & F13

F14	Coupon ID F14 is inscribed in the upper right corner. Appearance is about the same as F12.
F13	Coupon ID F13 is inscribed in the upper right corner. Appearance is about the same as F12.

Table 3-7- Visual Inspection F12 & F11

F12	The coupon ID is F12 is inscribed in upper right corner of front side. Color of all surfaces is grey with randomly distributed scratches.
F11	The coupon ID is F11 is inscribed in upper right corner below the top edge. The color of the coupon is a more or less uniform grey color with random scratches on the surfaces. The back side is similar in appearance. Hematite rust spots in the lower left quadrant. It surrounds a relatively large pit which looks like it came from a carbon steel tool chain.

3.2 Coupon Dimensions

The coupon dimensions are the length, the width, and the thickness. These dimensions were taken in several locations (as shown in figure 2-1) and for each coupon pair averaged together. The differences between the pre-irradiated and post-irradiated dimensions are then compared for each coupon group. Table 3-8 displays the changes in dimensional measurements for the coupon pairs over the approximately 3.5 years of SFP exposure time. Figure 3-1 is a graphical representation of these values.

Changes in the dimensional measurements were minimal. Since the changes are small and vary between losses and gains with no particular pattern, it is reasonable to assume that for lengths and widths this variance is likely due to roughness of the coupon edges and slight variation in the location at which the measurements were taken. The variation in the change of the thickness is due to the use of the nominal "as rolled" material thickness for the pre-irradiated thickness measurement. These changes in the thickness thus represent variation in rolling, and show that there was no significant material loss.

Table 3-8 Coupons Dimensions

Coupon IDs	F21&22	F19&20	F17&18	F15&16	F13&14	F11&12
Pull Date	12/7/2009	6/25/2010	12/15/2010	7/11/2011	12/13/2011	6/12/2012
Time in SFP [yr]	1.03	1.58	2.06	2.63	3.05	3.55
Thickness Change [in]	0.003	0.001	0.000	-0.001	0.000	0.000
Length Change [in]	0.000	-0.004	-0.001	-0.008	0.000	0.002
Width Change [in]	0.000	0.003	0.000	-0.001	0.007	0.001

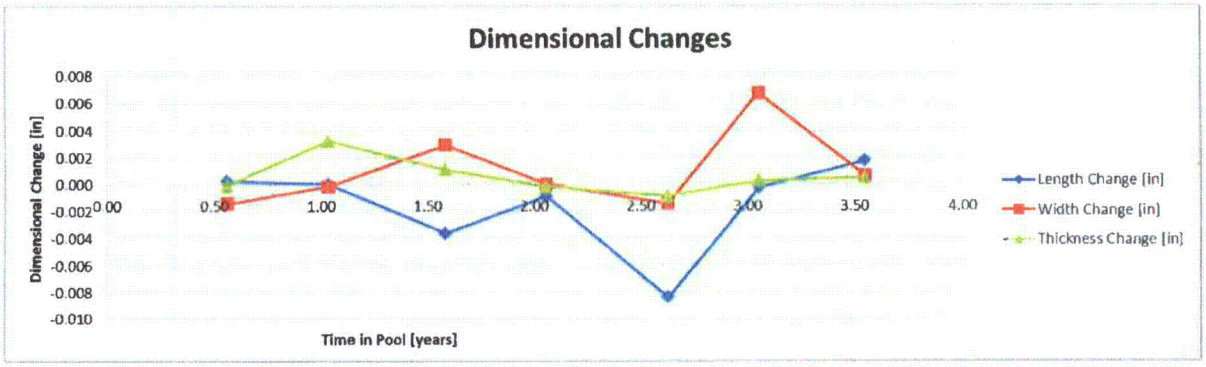

Figure 3-1- Graphical display of pair averaged dimensional changes over SFP exposure time.

3.3 Coupon Weight

Table 3-9 displays the changes in the weight measurements for each pair of coupons over the approximately 3.5 years of SFP exposure time. This difference between the weights from pre-irradiated to post-irradiated are compared for each coupon pair. Figure 3-2 is a graphical representation of this comparison.

Since the fast start coupons are fully dense (negligible porosity), they were dried for 1 hour at 220° F to remove surface moisture. Coupons were then washed in Nitric Acid to remove only the corrosion products and leave the base metal undamaged. The weight was then again taken. This "clean weight" is the weight measurement used to compare to pre-irradiation weight. There has not been a large loss in coupon weight, but as expected the coupon weight loss increases with the duration of the test.

Table 3-9 Coupon Weights

Coupon IDs	F21&22	F19&20	F17&18	F15&16	F13&14	F11&12
Pull Date	12/7/2009	6/25/2010	12/15/2010	7/11/2011	12/13/2011	6/12/2012
Time in Pool [yr]	1.03	1.58	2.06	2.63	3.05	3.55
Weight Change [g]	-0.011	-0.017	-0.030	-0.036	-0.026	-0.064

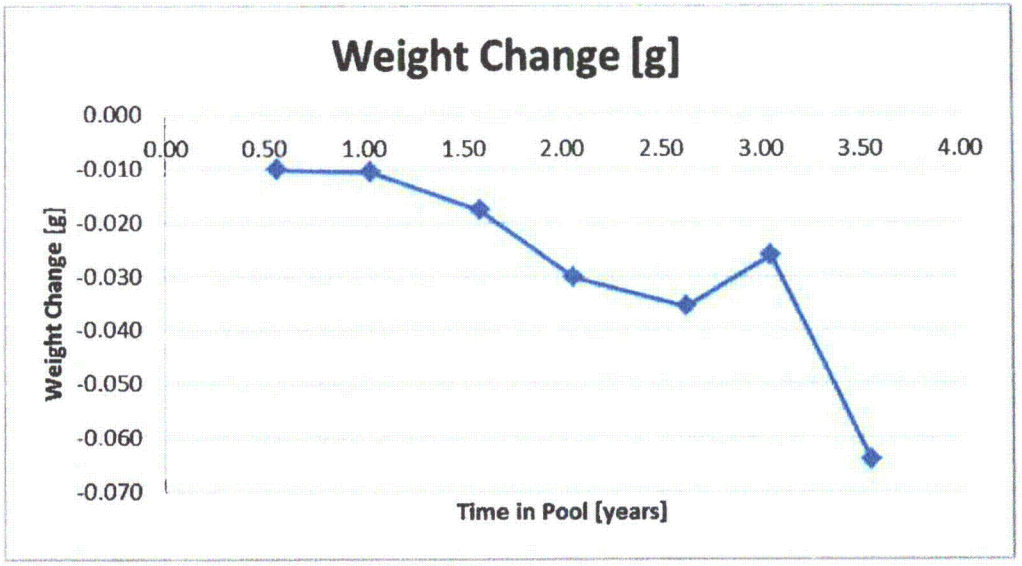

Figure 3-2- Graphical display of the pair averaged weight change for each coupon pair over SFP exposure time.

3.4 Density

The results of the density measurements for the coupons are summarized in Table 3-10. Changes in the densities of the coupons consisted of the nominal batch density compared with the post irradiation values. Significant increases in the reported densities are most likely attributed to use of the nominal batch density in the comparison.

Table 3-10 Coupon Densities

Coupon IDs	F21&22	F19&20	F17&18	F15&16	F13&14	F11&12
Pull Date	12/7/2009	6/25/2010	12/15/2010	7/11/2011	12/13/2011	6/12/2012
Time in Pool [yr]	1.03	1.58	2.06	2.63	3.05	3.55
Density Change [g/cm^3]	-0.001	0.005	0.049	0.041	0.039	-0.002

3.5 Neutron Attenuation Measurements and ^{10}B Areal Density

The boron-10 areal density of the coupon was measured via neutron attenuation testing. The test was conducted in the Neutron Beam Laboratory at the Pennsylvania State University using the PSU Triga Reactor as a source of thermal neutrons. Table 3-11 contains the change in the pre-irradiated ^{10}B areal density measurements from to post-irradiated ^{10}B areal density measurements

The Boron-10 areal density of the fast start coupons was measured at the geometric center of each fast start coupon. There is no loss in boron-10 areal density for any individual coupon.

Table 3-11 Coupon Boron-10 Areal Density

Coupon IDs	F21&22	F19&20	F17&18	F15&16	F13&14	F11&12
Pull Date	12/7/2009	6/25/2010	12/15/2010	7/11/2011	12/13/2011	6/12/2012
Time in Pool [yr]	1.03	1.58	2.06	2.63	3.05	3.55
AD Change [g/cm^2]	0.0008	0.0002	0.0002	0.0003	0.0003	0.0004

3.6 Corrosion Rates of the Fast Start Coupons

The corrosion rates for all coupons were calculated based on ASTM-G31-72 (Reapproved 2004) [1] and the weight loss data in Table 3-9. The corrosion rates [mils/year] over the exposure time of 3.5 years are shown in Figure 3-3 and listed in Table 3-12.

These corrosion rates are extremely low and confirm the visual observation that all coupons were essentially devoid of corrosion products. Though the corrosion rate varies, it varies only slightly and is consistent over the period of SFP exposure. The average corrosion rate of -0.018 mils/yr is lower than the corrosion rate as determined from accelerated corrosion testing at 195° F, performed during RTA material qualification testing NET-259, RTA Material Qualification [2].

Table 3-12 Coupon Corrosion Rates

Coupon IDs	F21&22	F19&20	F17&18	F15&16	F13&14	F11&12
Pull Date	12/7/2009	6/25/2010	12/15/2010	7/11/2011	12/13/2011	6/12/2012
Time in Pool [yr]	1.03	1.58	2.06	2.63	3.05	3.55
Corrosion Rate [mils/yr]	-0.014	-0.015	-0.020	-0.018	-0.012	-0.025

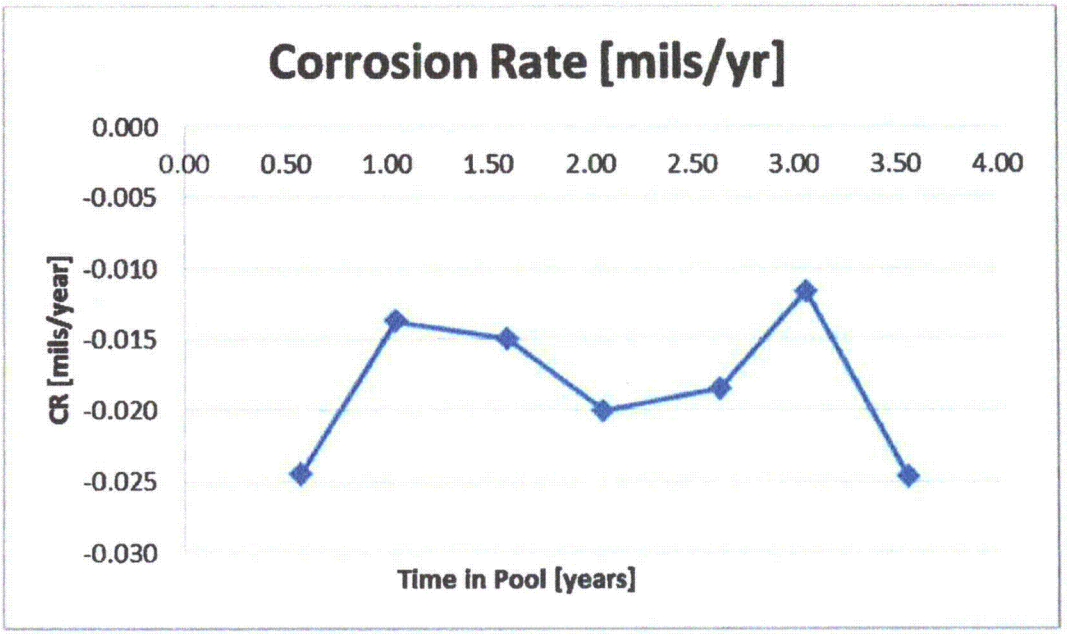

Figure 3-3 Graphical display of coupon corrosion rates over the SFP exposure time.

4.0 Conclusions

Each of the twelve fast start coupons from the LaSalle Unit 2 SFP exhibited excellent corrosion performance. The coupons were removed in descending numerically ordered pairs at one half year increments from 12/07/2009 to 6/12/2012. All coupons show a low corrosion rate, minimal changes in dimensional measurements, coupon weights, and density measurements. Most importantly all coupons showed no measurable loss in boron-10 areal density. Overall, fast start coupons F22-F11 showed minor to no evidence of corrosion or other potentially adverse effects as a consequence of SFP residence.

5.0 References

1) ASTM G31-72 (Reapproved 2004) Standard Practice For Laboratory Immersion Corrosion Testing of Metals.
2) "Material Qualification of ALCAN Composite for Spent Fuel Storage," NET-259-03, Rev 5, Northeast Technology Corp., 7/30/09.

Appendix A

High Resolution Photographs of Fast Start Surveillance Coupons

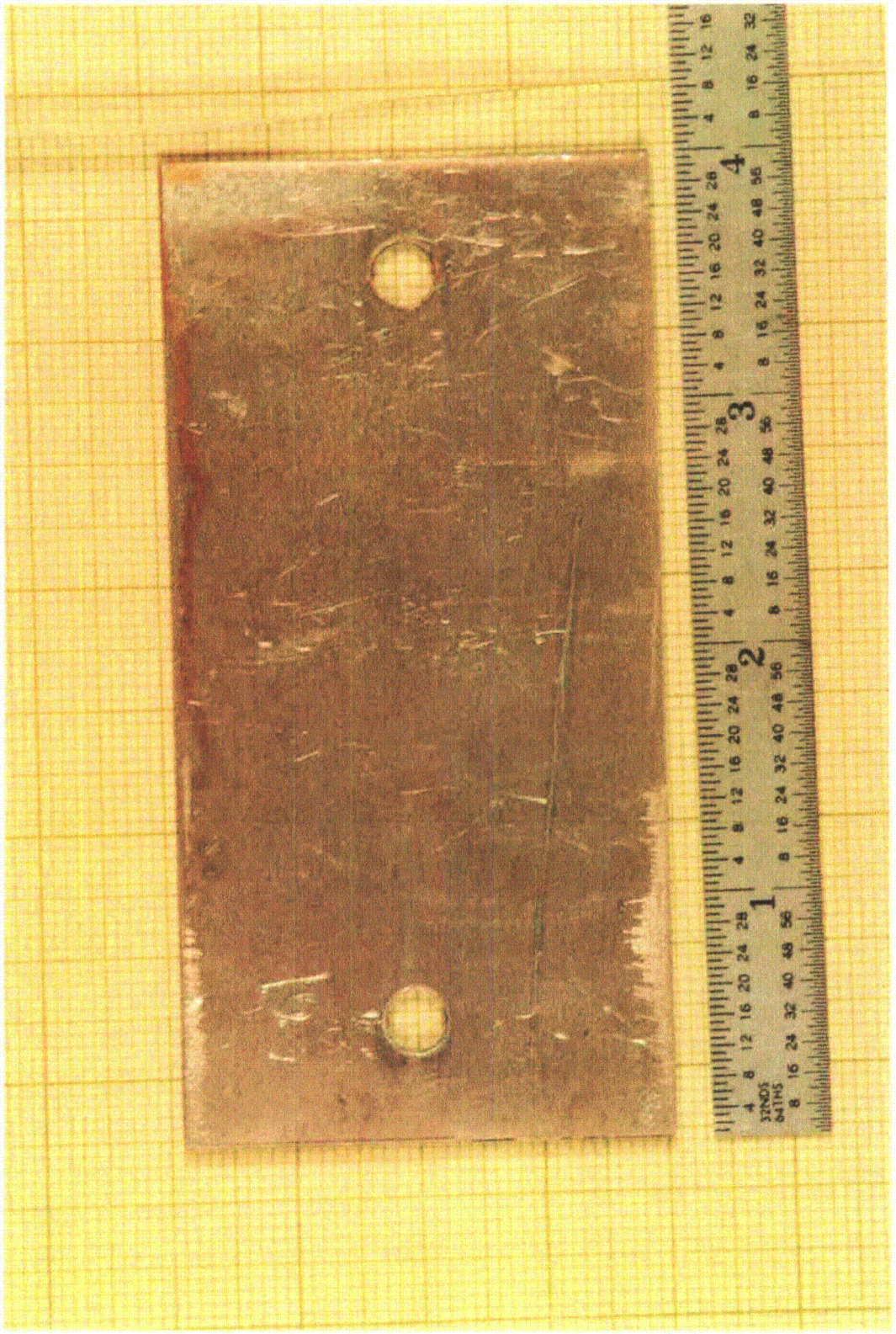

Photo 1- F22 Front View

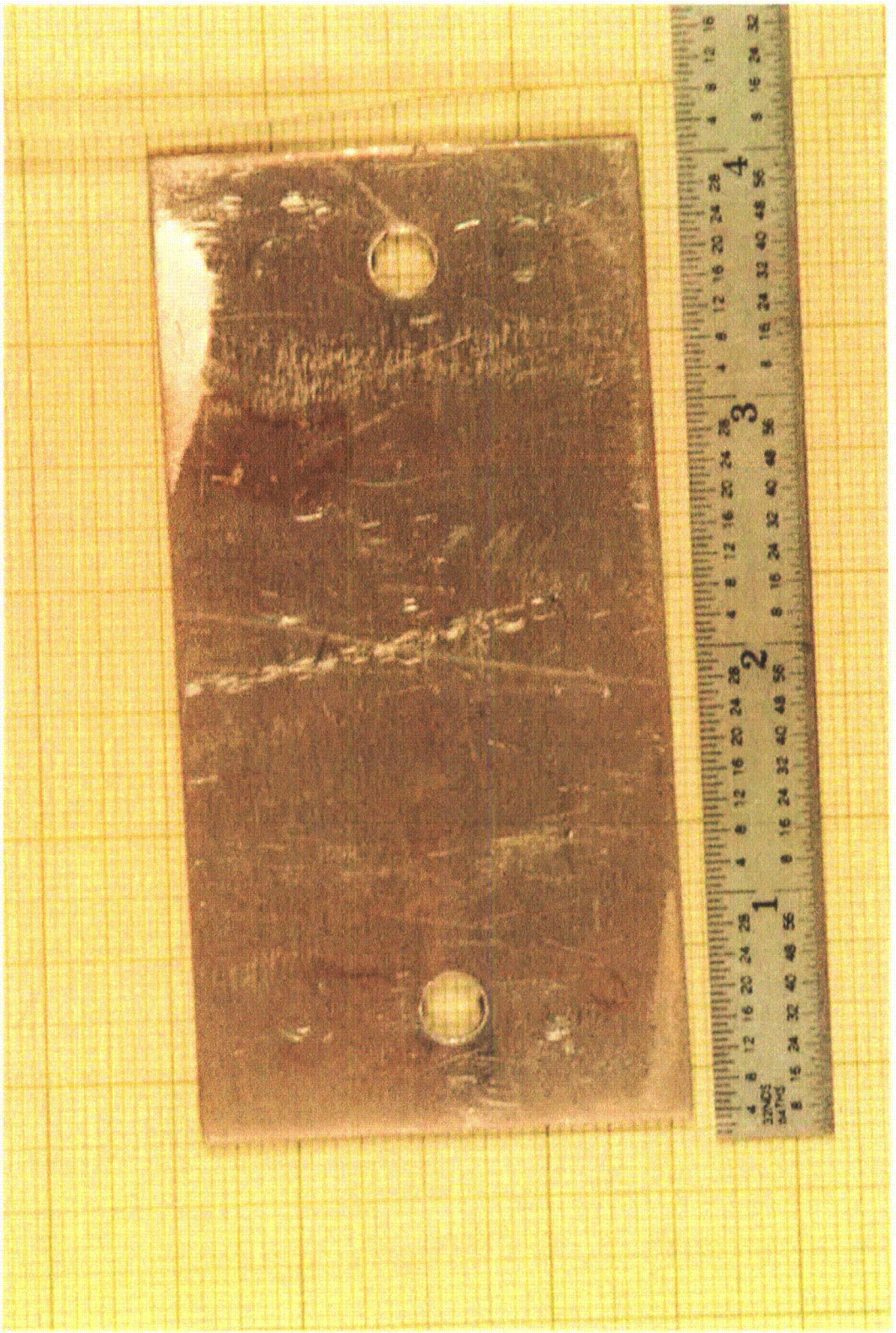

Photo 2- F22 Back View

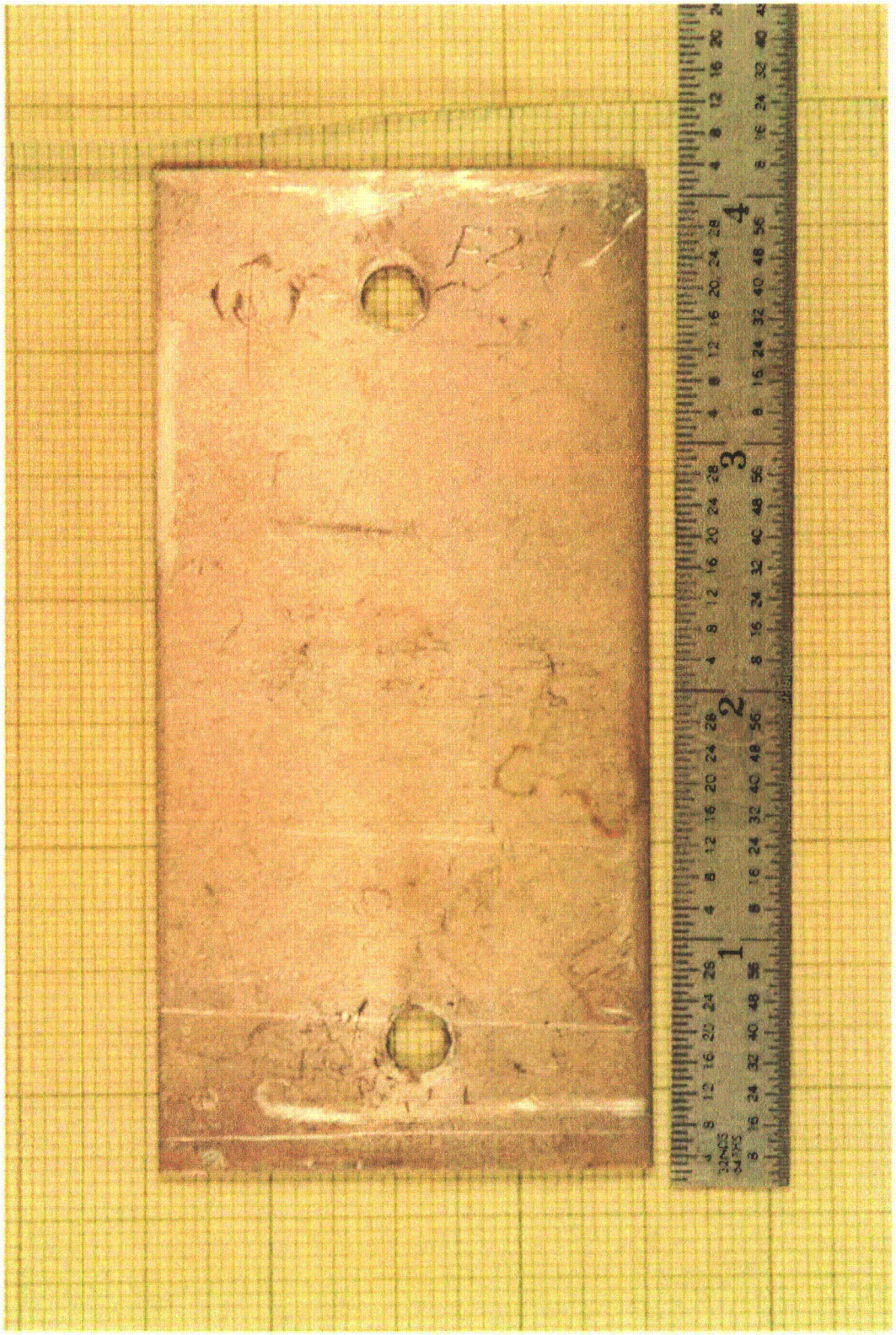

Photo 3- F21 Front View

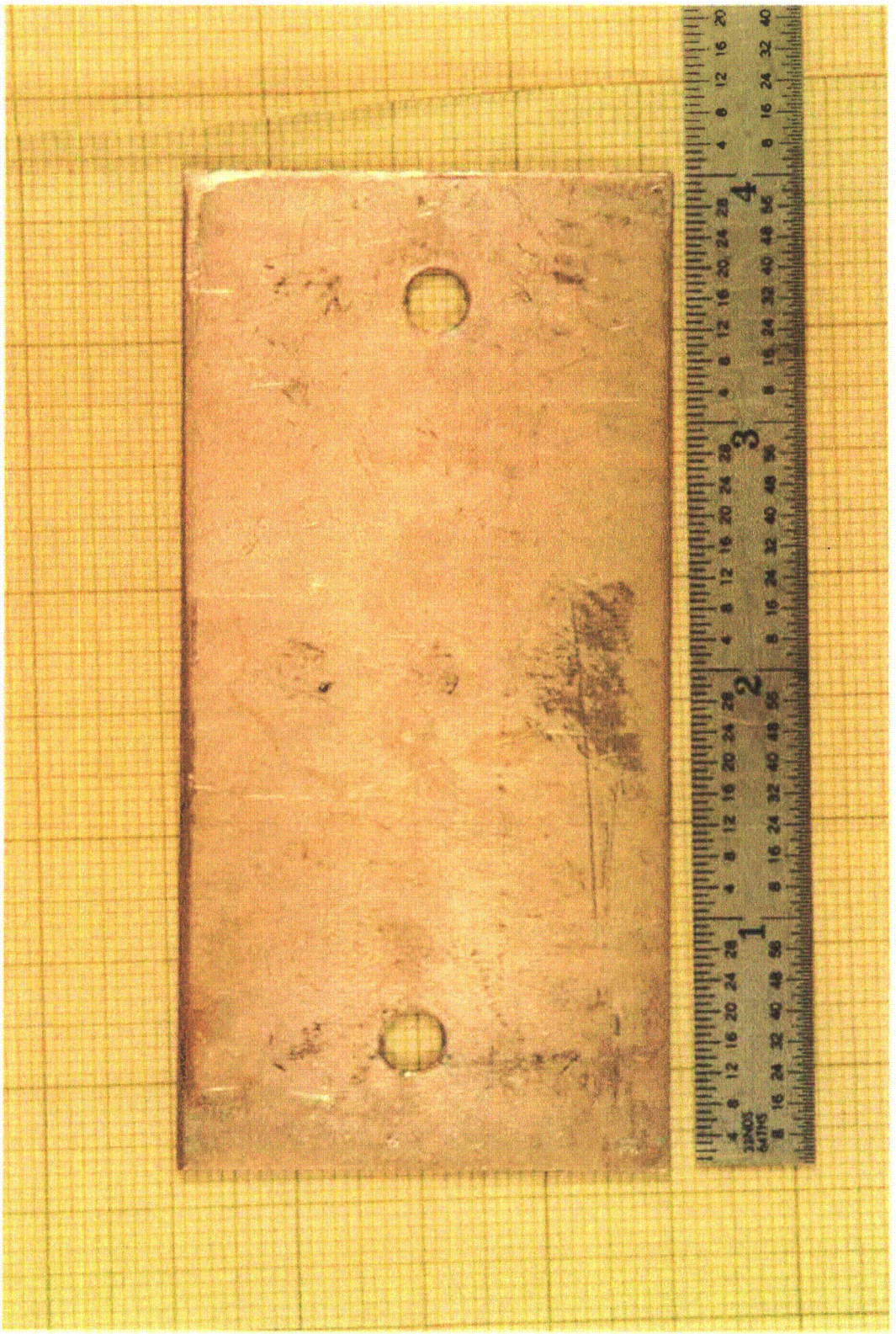

Photo 4- F21 Back View

Photo 5- F22 & F21 comparison with archive

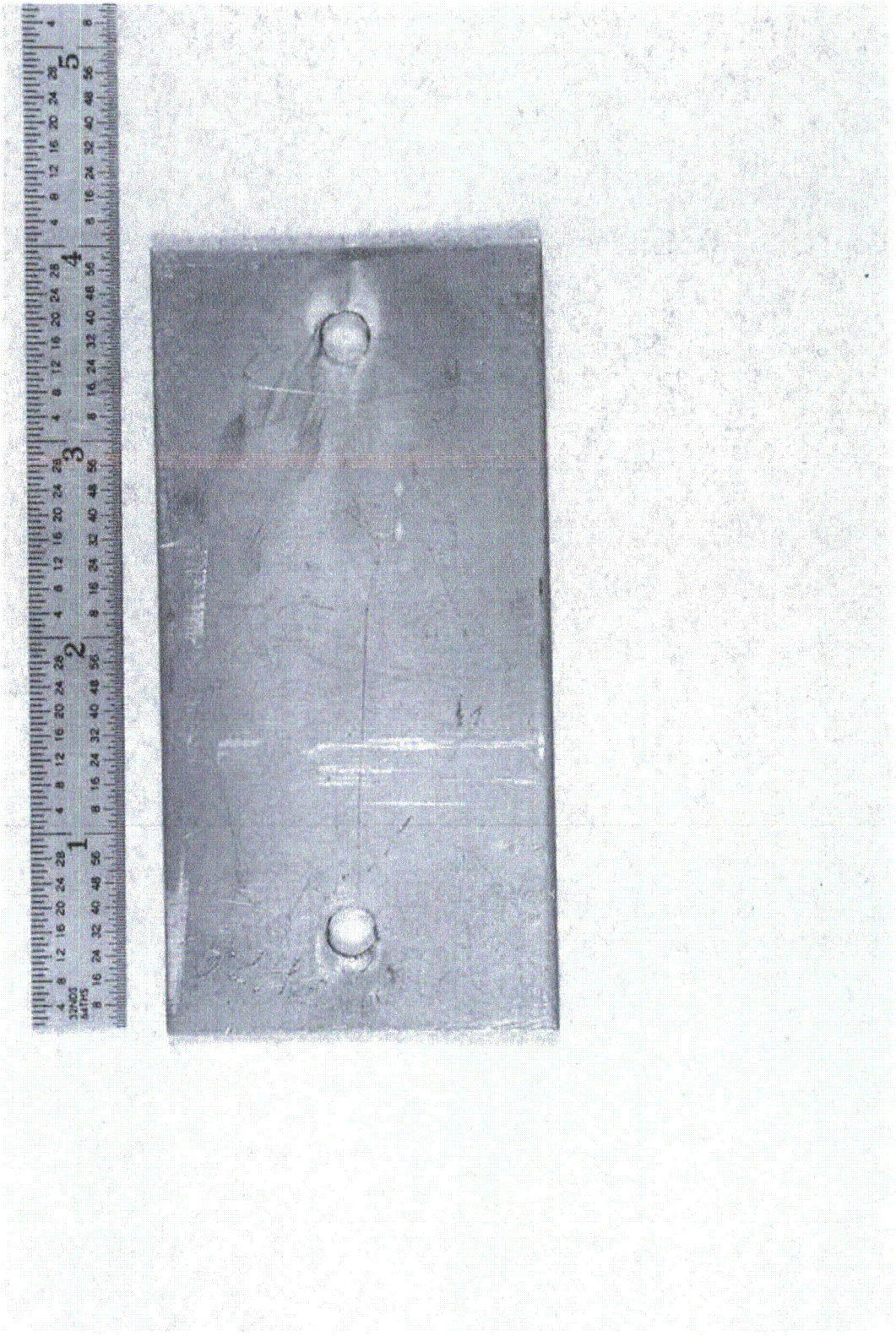

Photo 6- F20 Front View

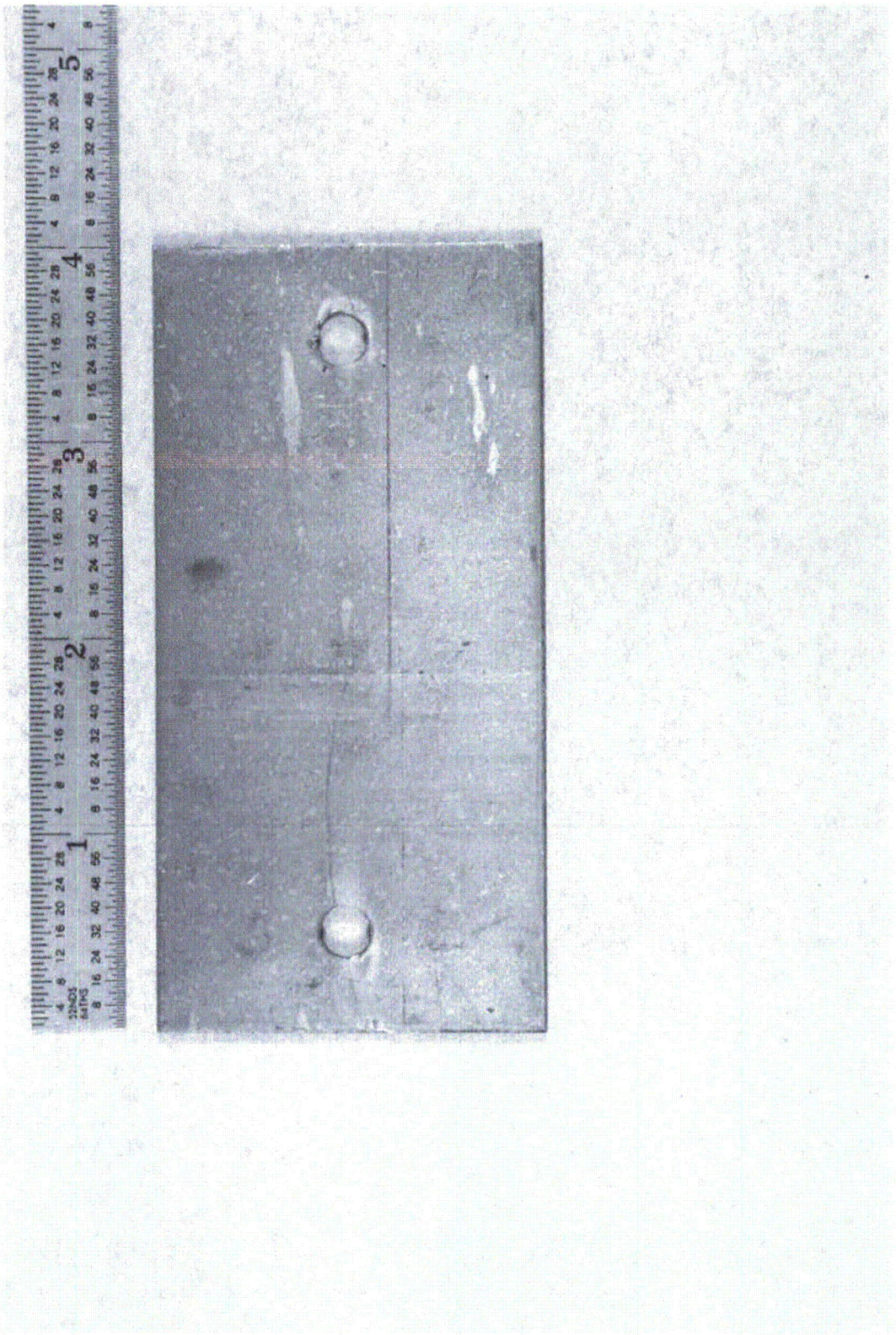

Photo 7- F20 Back View

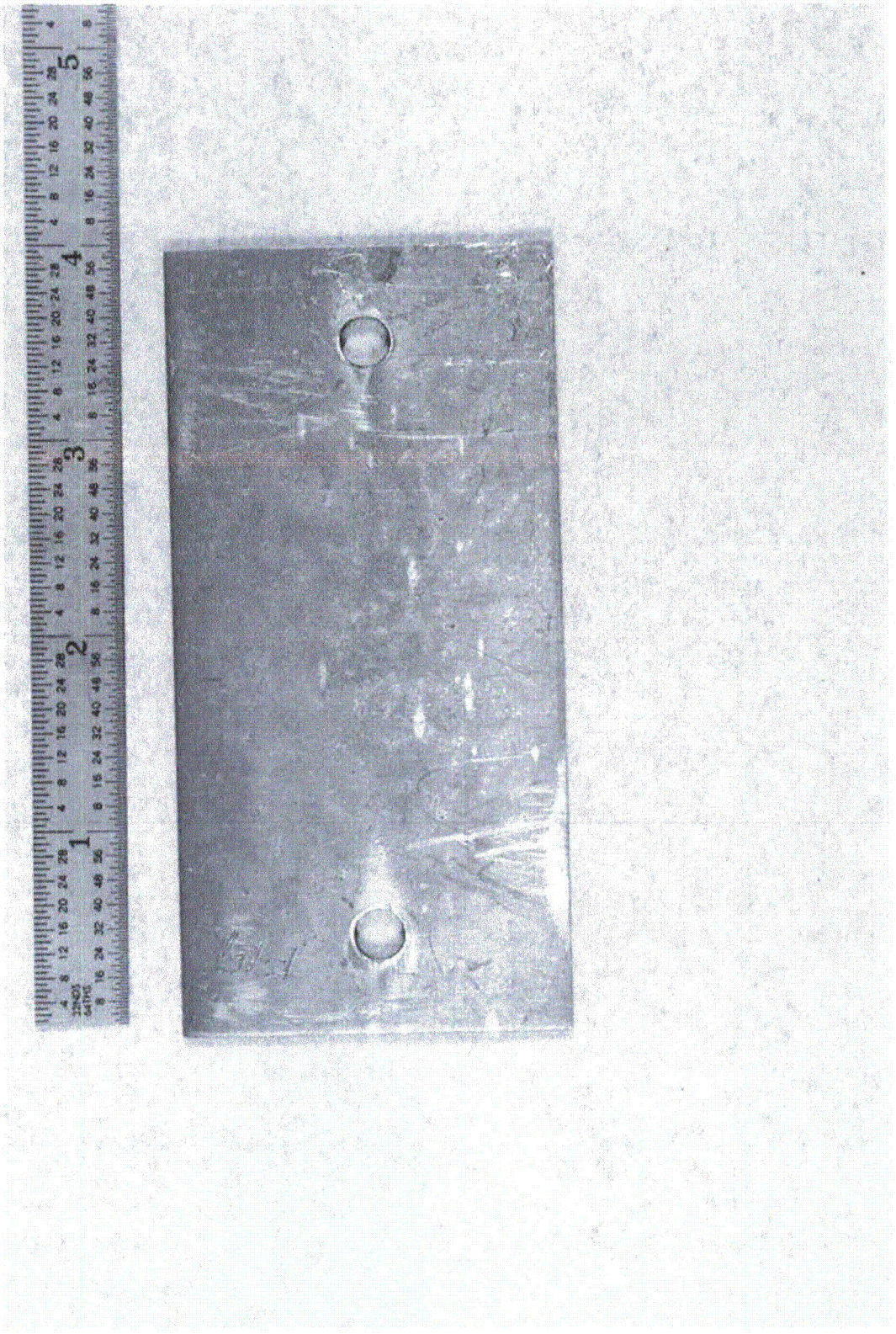

Photo 8- F19 Front View

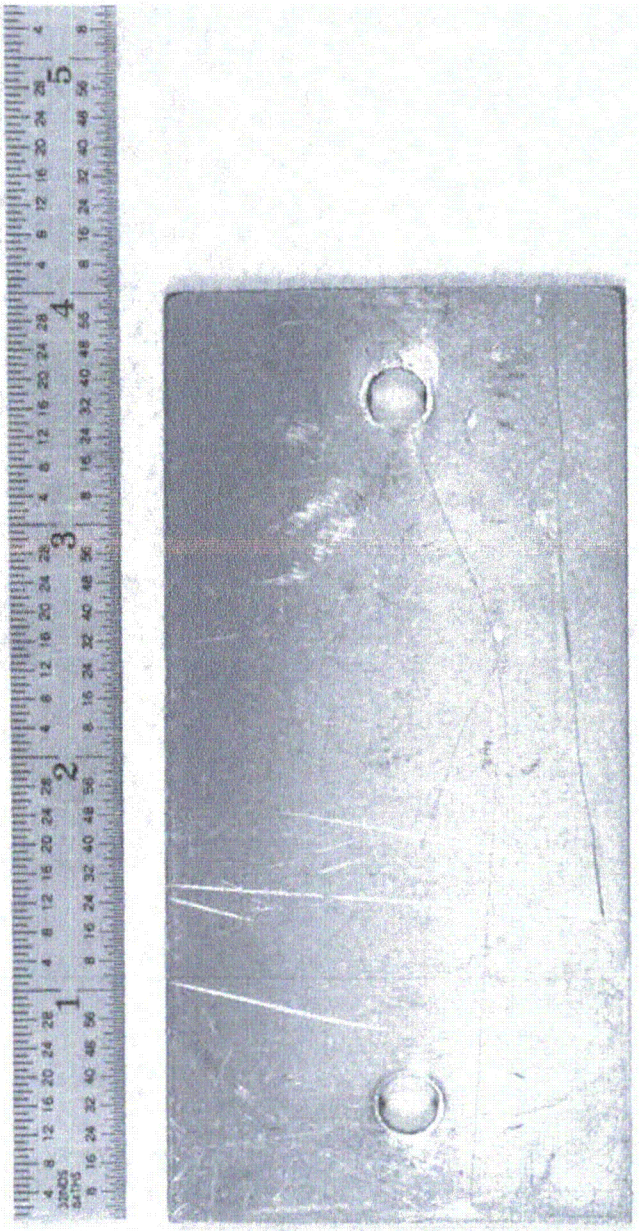

Photo 9- F19 Back View

Photo 10- F22 & F21 comparison with archive

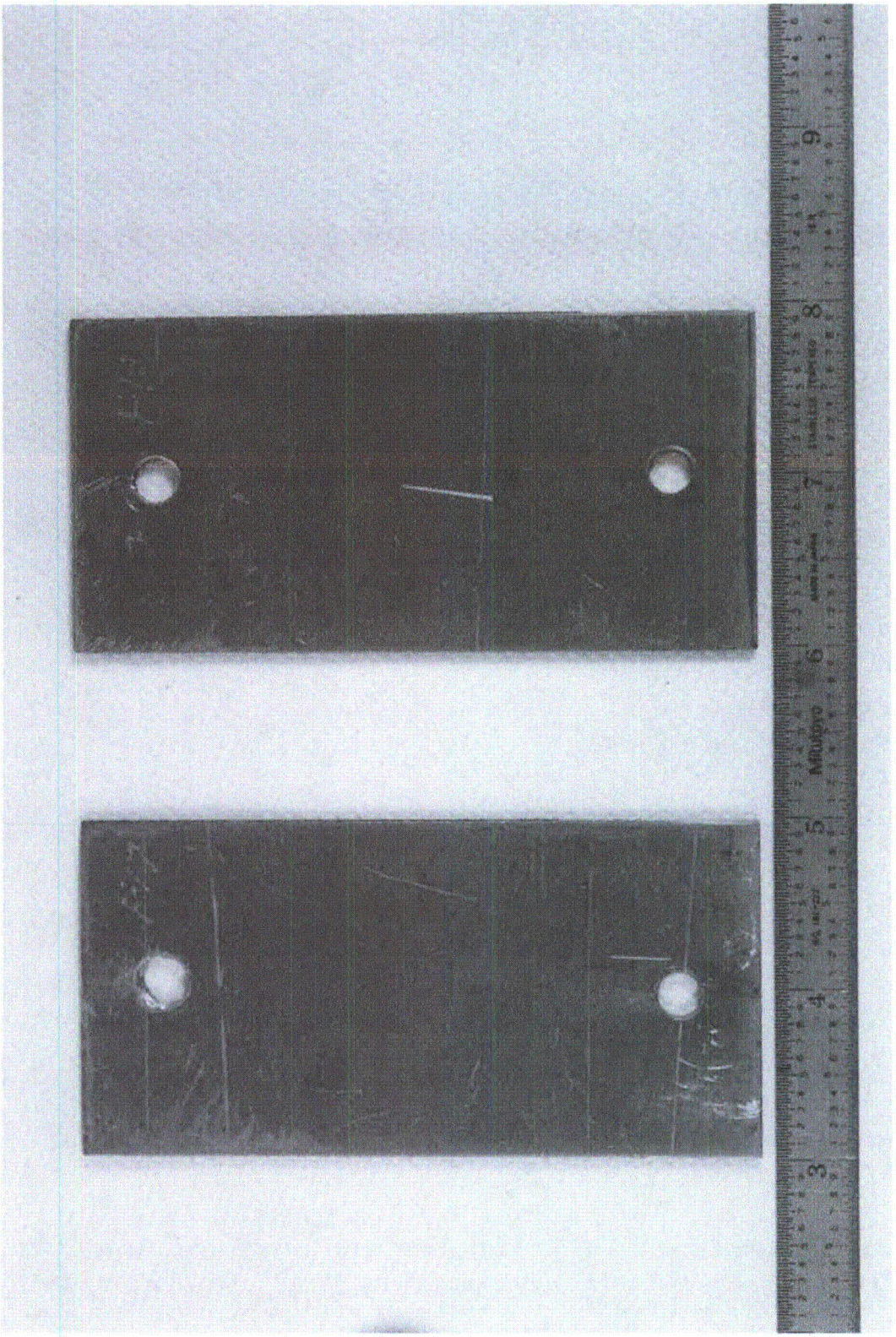

Photo 11- F18 & F17 Front View

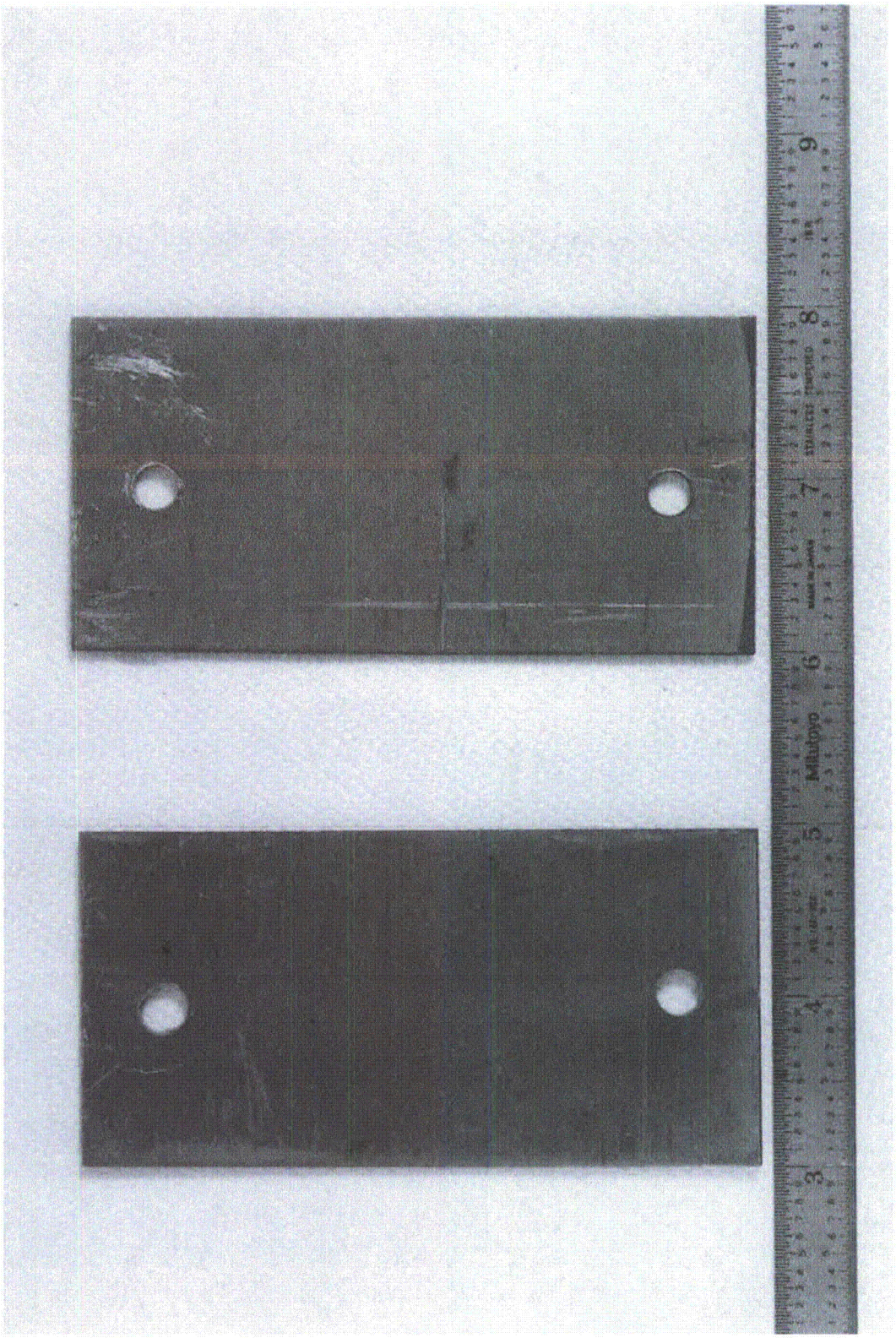

Photo 12- F18 & F17 Back View

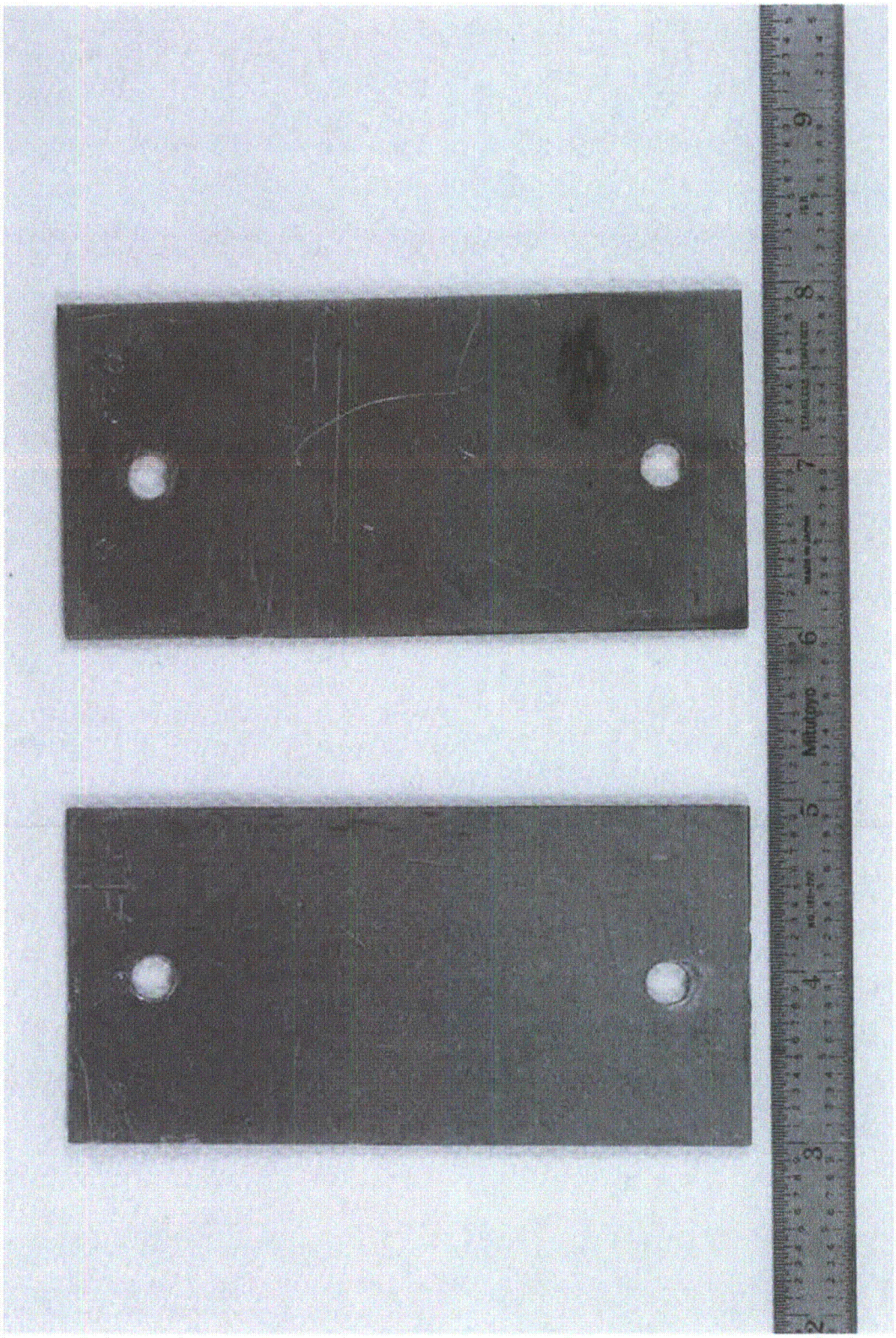

Photo 13- F16 & F15 Front View

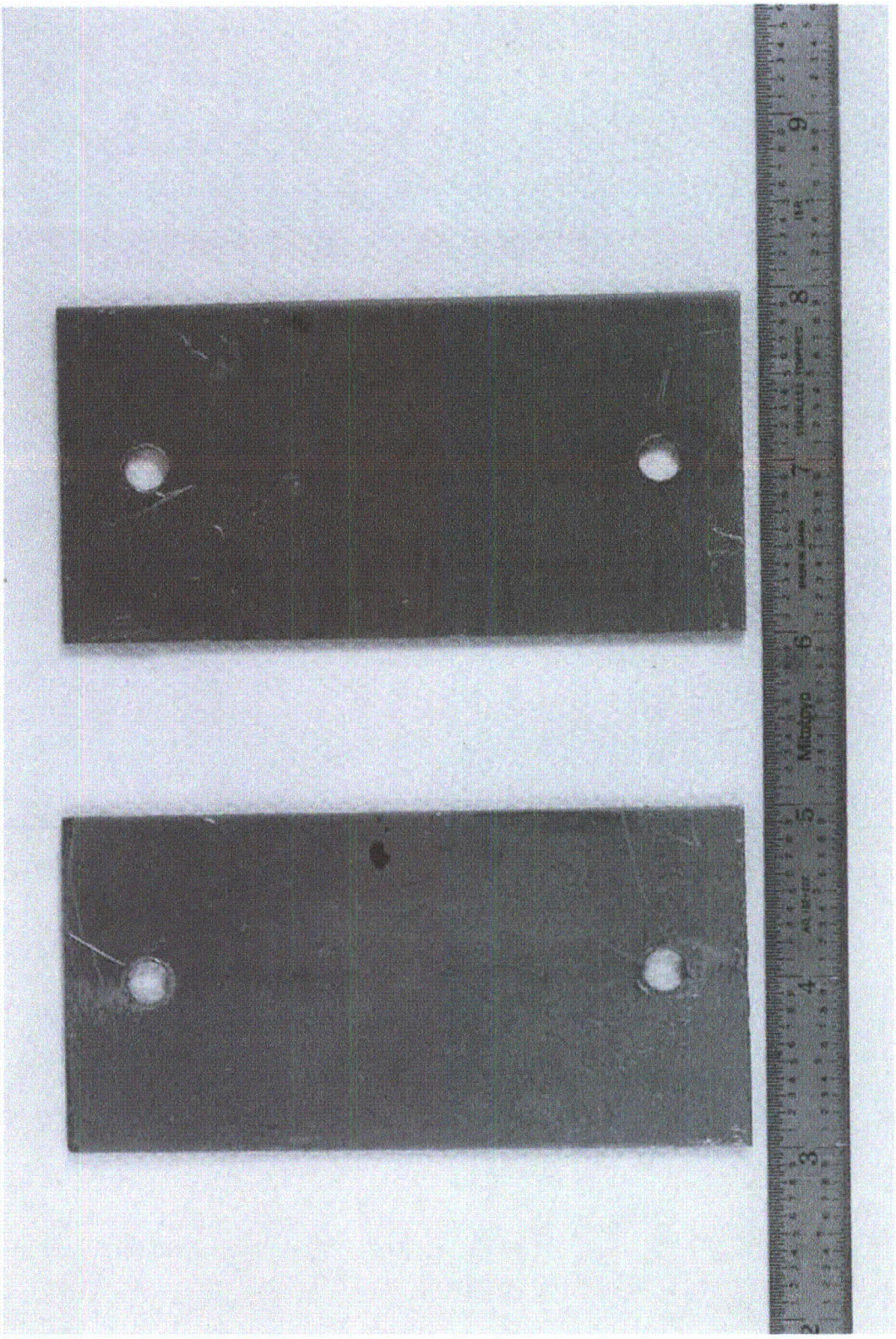

Photo 14- F16 & F15 Back View

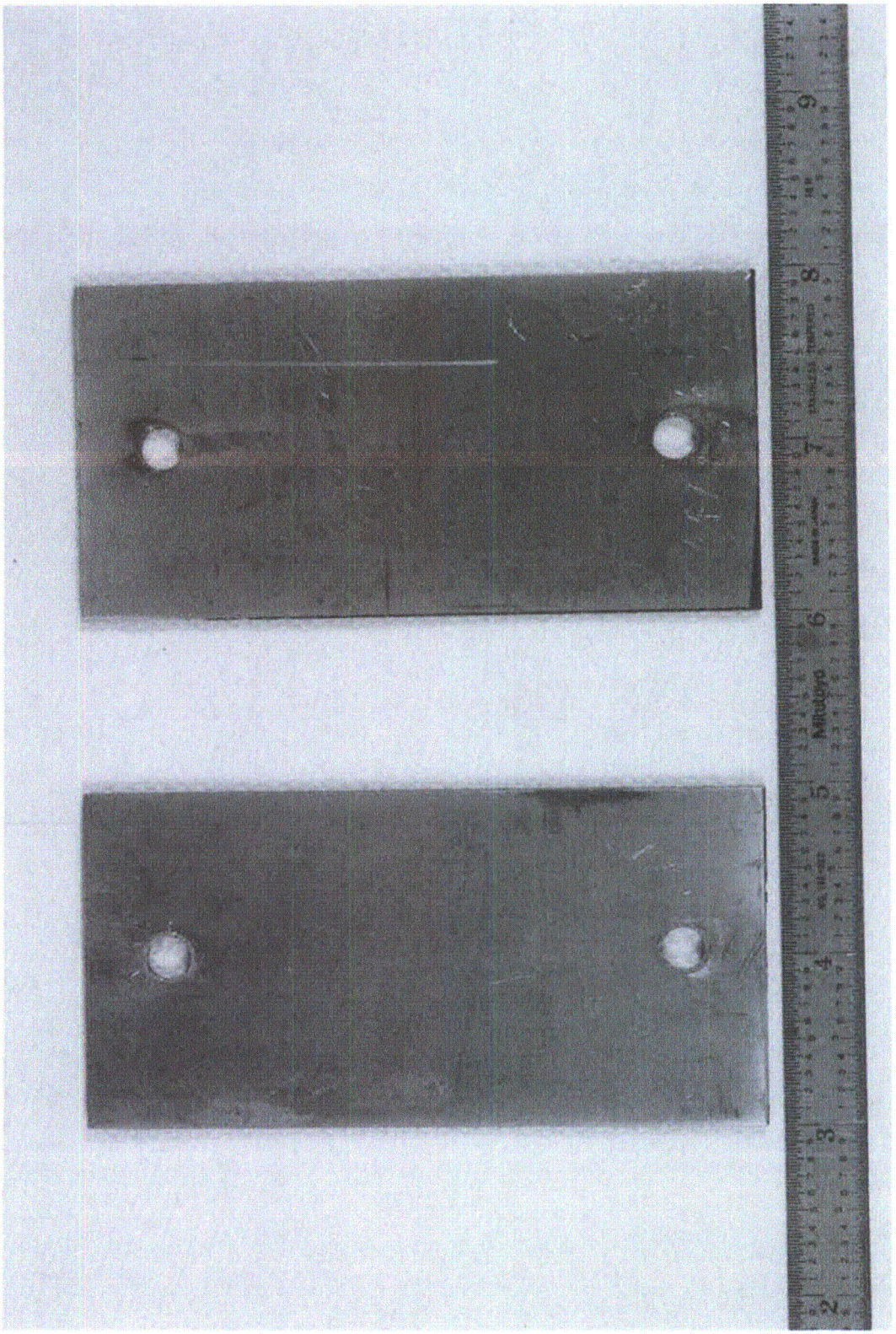

Photo 15- F14 & F13 Front View

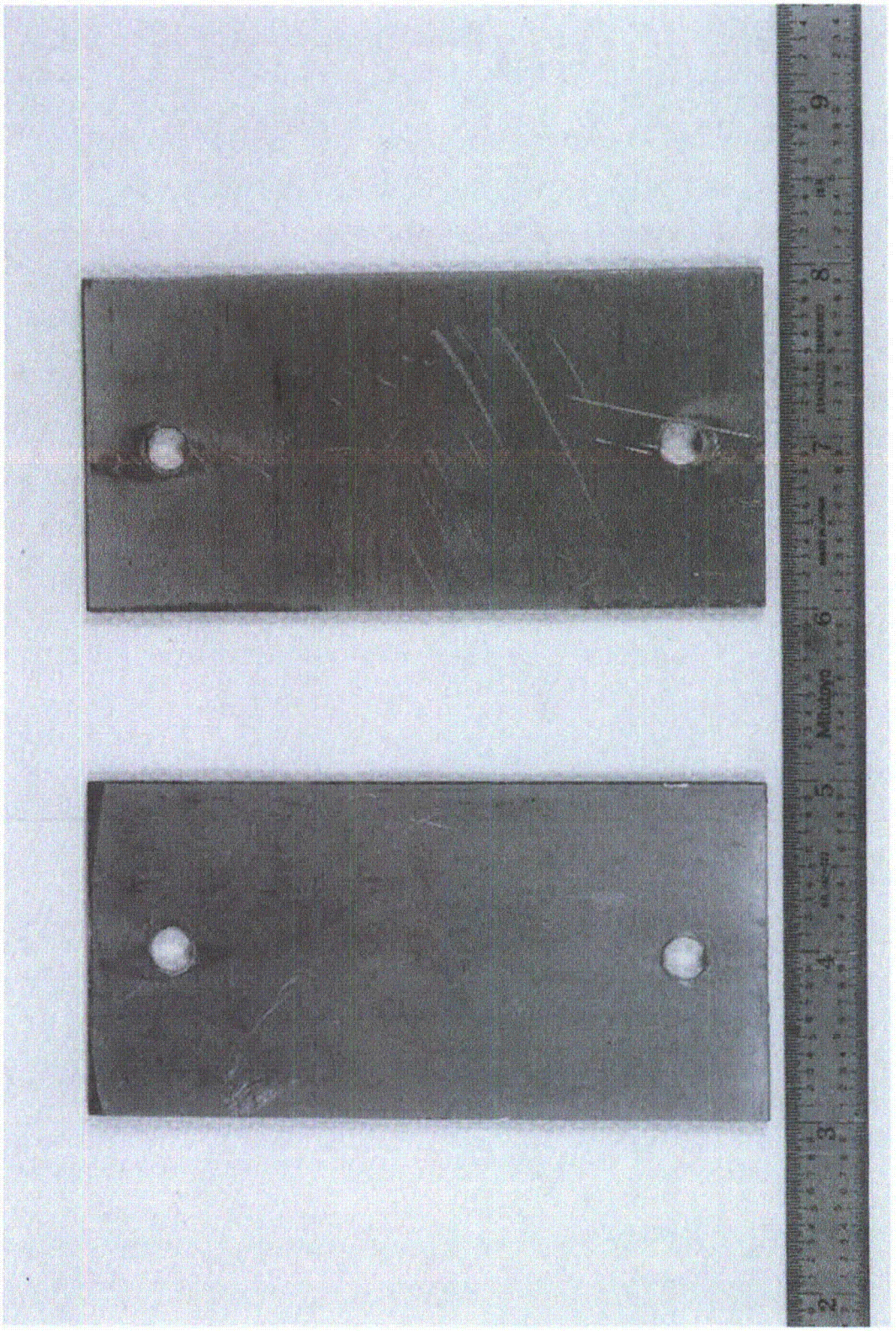

Photo 15- F14 & F13 Back View

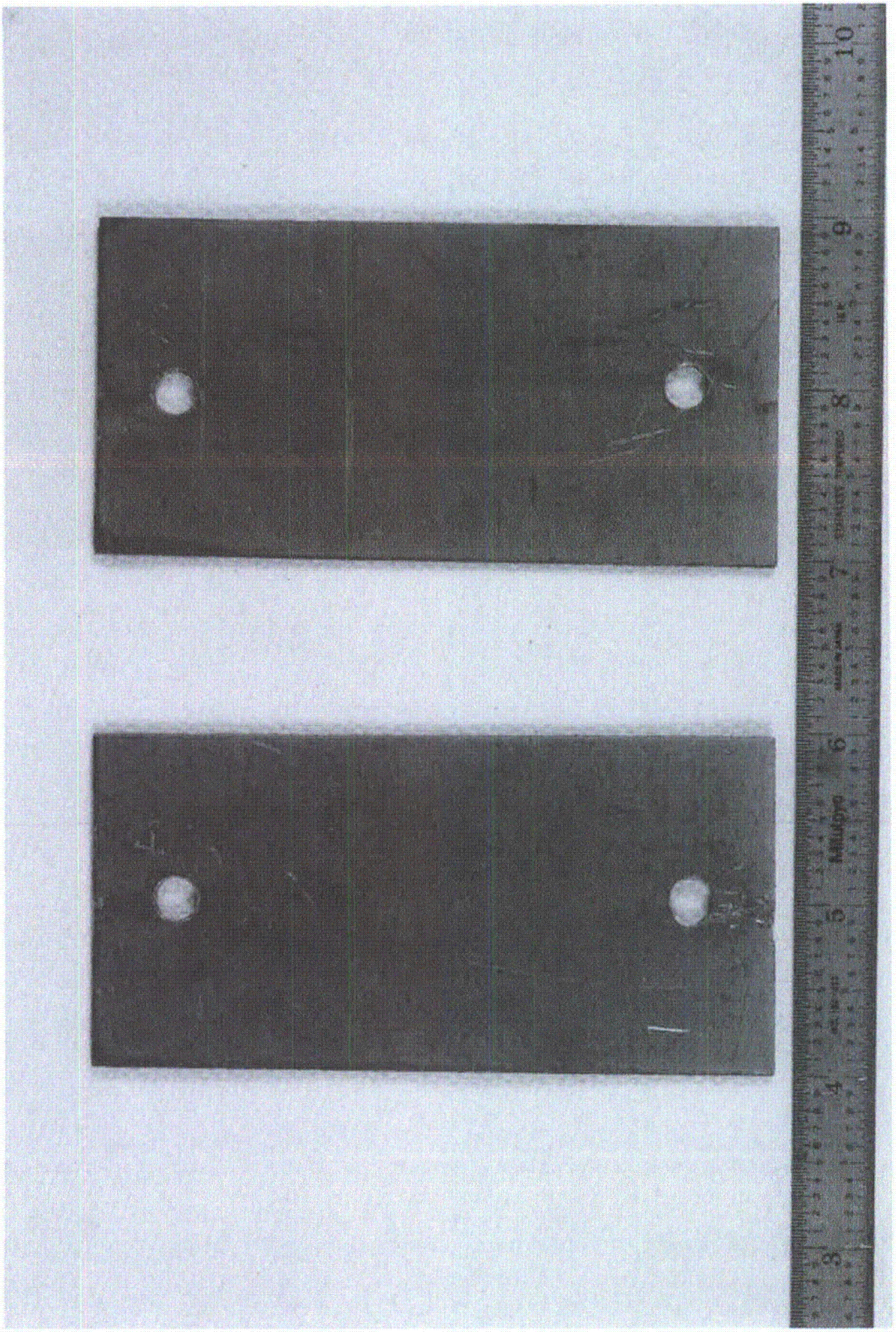

Photo 16- F12 & F11 Front View

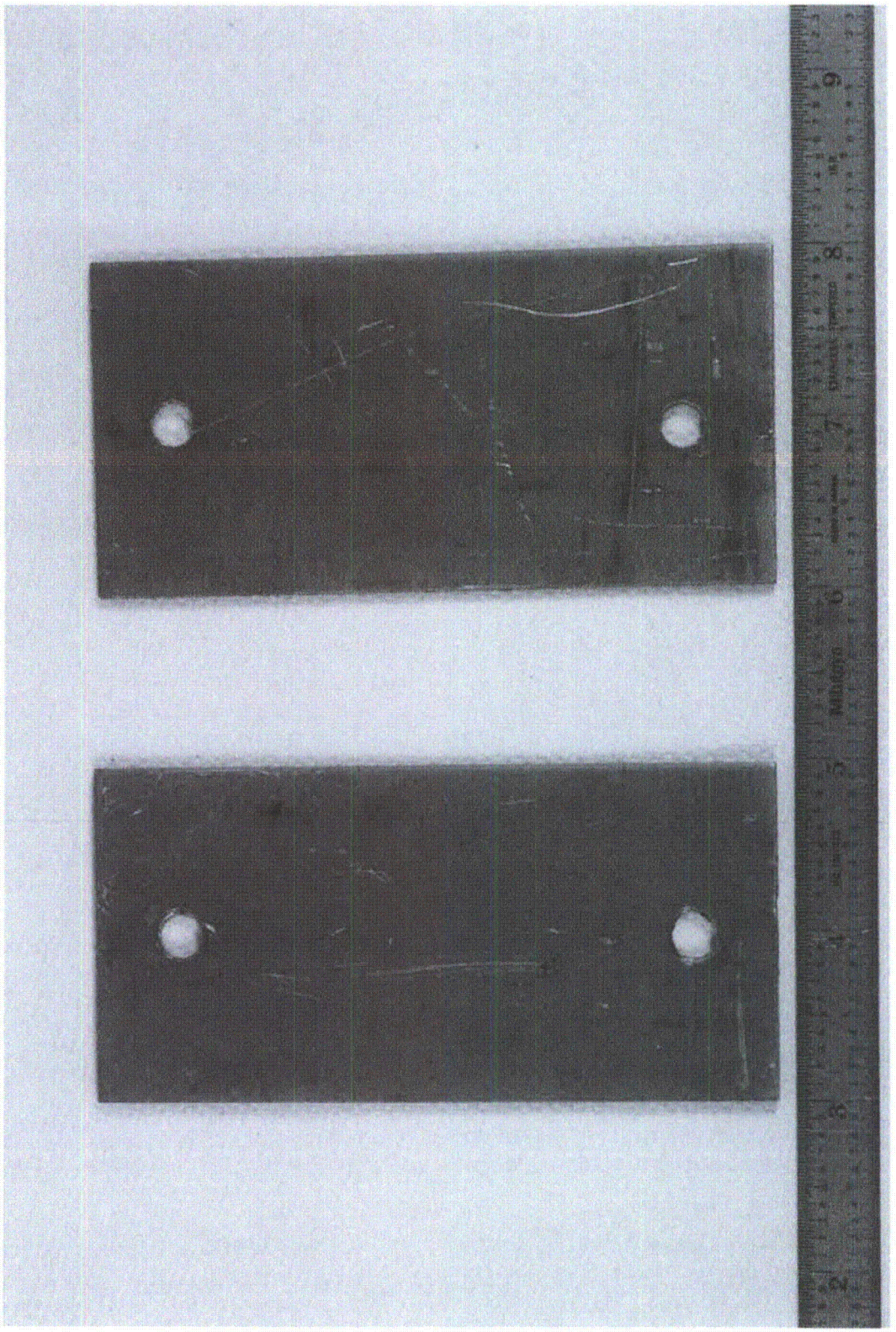

Photo 17- F12 & F11 Back View

Appendix B

Procedure for Post-Test Characterization of the Fast Start Surveillance Coupons, SEP-259-13, 6/30/09

Appendix C

Certification of Calibration for Gage Blocks and Standard Masses