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HW-7178

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100 AREAS TECHNICAL ACTIVITIES REPORT - ENGINEERING

JUNE, 1947

CORROSION AND BLISTERING - W. K. Alexander, C. P. Cabell, R. A. Rohrbacher

Summary

There were no cases of unusual blistering of slugs being followed under Production Tests. Two normal production tubes were borescoped following trouble with discharge. In Tube 3188-D a distorted slug became stuck in the region of sharp curvature near the inner end of the rear gun barrel; this is the first time this phenomenon has occurred.

Examination of irradiated slugs of rolled metal after normal exposure indicates that rolled material has no particular advantages over extruded material from the standpoint of blistering. However, no extensively blistered pieces were found in either the rolled slugs or the extruded control slugs. Remaining tubes of rolled metal are being held for more extended exposure.

Inspection of a large number of Van Stone flanges in the D and F Piles has confirmed that the inlet flanges are in generally good condition but that the rear Van Stone flanges of tubes in the 0.140-inch orifice zone of both piles were badly corroded and generally contained deep pits that extended about half-way through the flange.

The Van Stone test units are to be installed unshielded in the riser room at the rear of the D Pile, since the shielding required in the X Sample Room exceeded the allowable floor loading.

Recent experimental observations indicate that solid aluminum dummy slugs may be used in place of perforated tubular slugs in process tubes anywhere in the pile without encountering erosion by chattering.

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Details

Below are the results of exposed slug examinations during the month:

Tube #	Type	Power, MW	Exposure Days	Blistered O.K.	Sl.	Mod.	Ext.	Corr. Rates (mils/mo.) Ave.	Max.
2874-D	Corr.	54	322	0	21	11	0	0.04	0.08
3569-D	Four Inch	37	231	4	22	0	0	0.06	0.07
	Reg. Metal			5	13	1	0	----	----
2475-F	Press. Drop	25	196	4	28	0	0	----	----
2473-F	Press. Drop	25	196	6	26	0	0	----	----
2375-F	Press. Drop	25	196	3	29	0	0	----	----
2575-F	Press. Drop	25	196	4	28	0	0	----	----
2161-D	"UR"	25	152	2	28	2	0	----	----
2172-D, 2173-D, 2174-D, 2175-D	"UR"	26	145	24	104	1	8	----	----
2371-D, 2376-D	"R"	26	145	21	37	0	0	----	----
2571-D, 2572-D	"N"	26	145	22	43	0	0	----	----

In the above table "UR" refers to bonded slugs which were previously unbonded and which are believed to consist of rolled metal; "R" refers to slugs of rolled virgin metal; and "N" refers to slugs of extruded virgin metal from billets which were companion billets to those used for "R" slugs.

Inspection of Van Stone Flanges

A tabular summary of Van Stone flange inspections during June is given below:

Tube #		Orifice Zone	Est. Depth	General Condition
3157-D	Front	.200	Shallow	Very little corrosion
	Rear		Shallow	Mod. degree of preferential corrosion
3159-D	Front	.200	Shallow	Very little corrosion
	Rear		15 mils	Mod. amount of corrosion on lower half
3156-D	Front	.175	Shallow	Very little corrosion
3154-D	Front	.175	Shallow	Very little corrosion
2596-D	Front	.140	Shallow	Some corrosion and small pits
	Rear		35 mils	Bad corr. on most of flange, one very large pit
2494-D	Front	.175		Minor corr. and pits
	Rear			Bad corr. some deep pits
1874-D	Rear	.240	Shallow	Some corr. and shallow pits on flange
3074-D	Rear	.240	Shallow	Shallow pits on bottom of flange
3855-D	Rear	.175		Mod. amount of corrosion
3861-D	Rear	.175	Deep	Numerous pits at bottom of flange
3888-D	Rear	.175		Preferential corr. all around flange
3896-D	Rear	.140	30 mils	Extremely bad corr.
2052-D	Rear	.140	Shallow	Some preferential corr. small pits at bottom

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Tube#		Orifice Zone	Est. Depth	General Condition
2091-D	Rear	.175	Shallow	Some preferential corr. all around flange
3861-D	Front	.175		Slight pitting on flange
3896-D	Front	.140		Slight pitting at bottom of flange
4561-F	Front	.140		Fair shape, some corrosion
	Rear	.140	35 mils	Numerous deep pits, entire flange attacked
4668-F	Front	.140		Fair shape, some small pits
	Rear	.140	35 mils	Some very deep pits, other corr. moderate
4679-F	Front	.140		A few moderate pits
	Rear	.140		No extremely deep pits but badly corroded
4586-F	Front	.140		Fair shape, some small pits
	Rear	.140	35 mils	Several large deep pits
4392-F	Front	.140		Fair shape, some small pits at bottom of flange
	Rear	.140	25 mils	Some pits, moderate amount of corrosion
4355-F	Front	.140		Some preferential corr. One fairly deep pit
	Rear	.140	25 mils	Badly corroded

Photographs of the rear Van Stone flanges of six tubes in the F Pile were taken during the shut-down of June 25 and of one tube in the D Pile on June 17. These tubes were Numbers 3157-D, 4355-F, 4392-F, 4561-F, 4586-F, 4668-F, and 4679-F. A report including these photographs is to be prepared.

A micrometer depth gage was devised and found useful for measuring depth of pits in some Van Stone flanges where the pits were suitably located. Tube 4586-F had pits 20 to 25 mils deeper than the exposed surface, and Tube 4668-F had pits 20 mils deeper than the exposed surface. The cladding was measured as 4 mils thick on these tubes, so the pitting on the rear Van Stone flanges of Tubes 4586-F and 4668-F is reported to be at least 30 and 25 mils deep, respectively.

Van Stone Flange Test Units

It was found that the shielding required for the test apparatus to be installed in the 105-D "X" sample room would be so heavy that it would exceed allowable floor loading. Therefore, it was decided to place the hot flow laboratory in the riser room at 105-D.

The change to the riser room has several advantages. It will be a much safer installation, since the entire unit will be contained behind the discharge-area shielding. It will be a less expensive procedure, since shielding will be eliminated. It should be a more trouble-free installation, since all effluent will be discharged into the cushion chamber and thence into the retention basin; this will eliminate any possibility of gas-surges back through the sewers. Finally, it will more closely duplicate rear-face conditions than the first proposal, since the local level of radiation around the Van Stone flange will be quite high.

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Discharge of Stuck Slugs - Problem Assignment No. 7-P

A section of process tubing was placed in a gun barrel and one of the new "300 Area Type" lead slugs was mushroomed in it at a force of 8500 pounds. It was found possible to push out the slug with a force of 2500 pounds. The tube in this test did not jam in the gunbarrel, and could be moved freely by hand after the slug had mushroomed. A similar test is planned with the process tube surrounded by graphite.

Design was started on an "expanding mandrel" for supporting a process tube. This device will be useful in testing the tensile strength of a tube, in testing various proposals for supporting the charge end of a process tube, and if successful can be developed into equipment to be turned over to the "P" Department for supporting process tubes where high pushing forces are required.

Two groups of tests were run on the new "300 Area Type" lead dummy slugs being fabricated by the "P" Department and a report issued stating that the slugs are acceptable. A test procedure for use in the 300 area was drawn up.

Chattering - Production Test 105-69-P

Six tubes which had been charged with solid aluminum dummies at startup in 1945, and operated with 0.140-inch orifices, were changed to larger orifices on February 26, 1947. These tubes were discharged on June 25 and were borescoped from both the charge and discharge elevators. None of the tubes showed any indication of chattering. The tubes inspected, together with the orifice which had been used since February 26, are as follows, 4355-F, 4392-F (0.175-inch orifice); 4561-F, 4586-F (0.200-inch orifice), and 4668-F, 4679-F (0.240-inch orifice).

Special Borescoping

Tube 4392-F was borescoped on June 25 to determine the location and extent of damage done by the piece which was found stuck in it during discharge. The upstream end of the stuck slug was 19 feet 8 inches from the upstream Van Stone flange. The tube was badly scratched from the point of contact to the downstream end. Tube 3188-D, which apparently stuck temporarily after twelve slugs of regular metal were charged, was borescoped from the rear to determine if the cause of sticking could be found. At a point eight feet from the rear flange wide streaks and scratches started and continued toward the rear. This scratching became worse, and between six and seven feet from the rear, gall marks estimated to be 25% the thickness of the tube and 1/4-inch wide were found. This galling decreased until only light scratches were visible for the last five feet.

On June 11, the No. 8 Horizontal Rod thimble at 100-F was borescoped to determine how much damage had been done by the sticking rod. The kick plate was badly galled over its entire length. The galled portion was about 1/4-inch or more in width and approximately 1/8-inch in depth. The first graphite block on the track appeared to be slightly higher than the second graphite block. This would aggravate the above condition. The remaining portion of the thimble which was examined, about 16 feet, looked alright.

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Tube Traverses

Tubes 4674-D and F were traversed on June 3rd and 25th, respectively, to measure vertical bowing. The maximum differences in elevation found were 47 and 44 sixteenths inches, respectively.

GRAPHITE EXPANSION - W. E. Lewis, J. T. Carleton

Summary

Jacking tests on central tubes in the D Pile indicate a rate of reduction of clearance between the gunbarrels and the graphite of only zero to 0.1-inch after almost one year of operation. This low rate of endwise expansion of pile graphite could be explained by slippage between graphite layers in the central zone of the pile.

Physical inspection of the pile and readings from plumb bobs both indicate outward motion of the top front corner of the far side shield. Additional instrumentation is being installed.

Details

The gun barrel sum-clearances and overall lengths of Tubes 2373-D, 2474-D, 1874-D and 3074-D were measured during June. These measurements as compared to two previous sets of measurements are given below in 32nds of an inch.

Tube No.			2373-D	2474-D	1874-D	3074-D
Reduction in Tube Length	July August	1946	0	0	0	0
	January February	1947	0	1	0	0
	June	1947	1	1	2	2
Gun Barrel Sum Clearance	July August	1946	16	19	18	
	January February	1947	15	18	19	BINDS
	June	1947	13	17	18	

The rate of reduction of gun barrel sum-clearance of these central tubes is lower than that previously reported for fringe tubes. This could be explained by slippage between graphite layers in the central zone of the pile.

In connection with tube replacement the wall thickness of several spare gun barrels was measured. The inside of some gun barrels was found to be as much as 0.060 inches eccentric from the outside. This would cause binding when a new tube is inserted through the gun barrel into the graphite because there is a nominal clearance of only 0.015 inches between tube and gun barrel and

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between tube and graphite.

Outward movement of the top front corners of the far side shield is indicated by plumb bobs at both D and F piles. The appearance of the neoprene seal and general alignment support the conclusion that the dowel pins between the top and far side have sheared from the front corner back beyond the middle of the shield. Under these conditions the top front corner of the far side would be held in place by the rigidity of the shield alone. Micrometer brackets are being installed at both D and F Piles to check the movement indicated by the plumb bobs.

IRRADIATION STUDIES - J. C. Chatten and S. S. Jones

Summary

Design and development work connected with the underwater laboratory is proceeding on the combination tensile and bend testing machine, the hardness testing machine, and the machine for quantitative measurement of slug blistering. The hardness testing machine is expected to be ready for use in September, 1947.

Design of facilities for opening irradiated receptacle slugs is progressing with effort directed toward having the facility ready for operation by October 1, 1947.

The temperatures of the thermocouple slugs have remained substantially constant, though there has been a slight upward drift during the last few months unexplainable by variation in inlet water temperature or change in average tube activity.

Details

Underwater Laboratory

The combination Tensile and Bend testing machine is being designed for deformation of Uranium after exposure in piles. Design and fabrication of stress and strain measurement equipment has been requested from the General Engineering and Consulting Laboratory in Schenectady. C. E. Lacy reported on his return from a visit to Schenectady that Kuehni was working on the design phases of this problem and we could expect a proposal during the first week in July, 1947. Engineering work on this machine will continue here when Schenectady design is received and approved. Meanwhile, orders are being placed for fabrication and procurement of component parts of this machine which will not be altered by design furnished by the General Engineering and Consulting Laboratory.

A tentative shipping date of August 1, 1947 has been set by the Wilson Mechanical Instrument Company for a Universal Testing Unit (Rockwell Hardness). This machine is being purchased for adaptation to underwater hardness determinations on irradiated uranium. Engineering design on the adaptation is proceeding here from drawings of the U. T. U. furnished by the Wilson Company. Every effort is being made to have the installation set up and ready for operation upon the arrival of the Hardness Machine in August.

The Instrument Development Group is working on the design of a machine to reproduce the surface contour of irradiated uranium slugs. A table top apparatus

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simulating the action of the recording devise of this proposed machine has been developed. This apparatus seems to have considerable merit and to be adaptable to underwater use. A small Atlas Bench lathe has been ordered. When the lathe is received, a recording mechanism using the principles mentioned above will be incorporated and the assembly fitted for underwater operation. The equipment as contemplated will reproduce contour to within ± .005".

A program of production tests for underwater hot laboratory investigations of properties of irradiated materials is being developed together with the Metallurgical and Research groups. It is felt that the underwater laboratory facilities as mentioned above should be considered as a research tool making it possible to produce quantitative data on the physical properties of irradiated materials at high levels of activity. With this in mind, it is obvious that the work of the underwater hot laboratory must be closely coordinated with the existing programs of "cold" metallurgical work.

Can Opener for Receptacle Slugs:

Engineering Design is being directed towards having a can opener ready for operation by October 1, 1947. This apparatus will consist of several lead casks, the largest weighing approximately 3500 pounds, designed for remote removal of irradiated samples from a receptacle slug. At this time, it is planned to locate the apparatus in the vicinity of the 105-F transfer area existing R. R. tracks to make use of the heavy hoisting facilities there. This job is not being designed for underwater operation since certain samples must be kept dry.

Briefly the operation as planned consists of transferring the receptacle slug from basin to cutting cask, clinching the receptacle slug inside the cutting cask, revolving the slug, and cutting off the cap by use of a rolling pipe cutting tool. The cap would be retrieved into a third cask and the sample into a fourth. The original transfer cask would be used to return the empty receptacle slug underwater.

Measurement of Slug Axial Temperature: (Production Test No. 105-80-P)

The orifice on Tube 2679-F, containing the second thermocouple slug assembly, was changed from 0.175-inch to 0.240-inch on June 6 in order to investigate the variation in slug axial temperature resulting from purging of the tube. Tube 1367 still has a 0.175-inch orifice.

The slug axial temperatures under equilibrium conditions are shown in Table I. The ratio of slug temperature elevation above local water temperature to water temperature rise has in general shown a slight increase (less than 10%) in magnitude during the last three months, in addition to changes resulting from orifice changes. This may be caused by small changes in (a) thermal conductivity of the irradiated uranium, (b) calibration of the thermocouple, or (c) activity distribution along the tube as a result of rod movement. The increase in apparent thermal resistance is somewhat greater than appears by comparison with previously reported data because of a small change in the method for estimating the local water temperature.

TABLE I

SLUG AXIAL TEMPERATURE

Tube No.	1367	2679	1367	2679
Date	June 10		June 24	
Exposure Meg. W. Days / Adj. Ton	231	98	252	120
Test Duration - weeks	21.7	9.3	23.7	11.3
Slug Axial Temp. °C.	118	115	123	116
Inlet Water Temp. °C.	14.5		16.0	
Local Water Temp. °C.				
from adjacent tubes	32.1	27.9	33.8	29.4
from test tubes	36.5	32.0	38.3	33.0
Slug Temp. above Local Water (Δt_s)				
based on adj. tubes	85.9	87.1	89.2	86.6
based on test tube	81.5	83	84.7	83
Local Water Temp. above Inlet Water (Δt_s)				
based on adj. tubes	17.6	13.4	17.8	13.4
based on test tube	22.0	17.5	22.3	17.0
Ratio ($\Delta t_s/\Delta t_w$) = R				
adj. tubes	4.88	6.50	5.01	6.44
test tube	3.70	4.74	3.80	4.88

Water Flow Through Special Loadings:

Data on water rates through flow laboratory tubes loaded in a manner similar to Tubes 1367-F and 2679-F (containing thermocouple slugs) were reported last month. An analysis of the original data indicates that the pressure drop from the header to the inlet nozzle is proportional to the square of the flow rate; when the flow is expressed as g.p.m. and the pressure drop is in lbs./sq. in. this proportionality constant is 0.378, 0.735, 1.21, and 2.78 for orifices of diameter 0.240, 0.200, 0.175, and 0.140 inches, respectively. Because of the resistance of the pigtail, cone screen, and empty orifice holder, the above values should be somewhat greater than the theoretical proportionality constant for the orifice alone. These theoretical values, as given in Document 7-2092, Woods to Squires, July 16, 1945, are 0.315, 0.700, 1.23, and 3.11, for the same respective orifice diameters. The two sets of numbers are in reasonable agreement but the reason for the definite divergence as a function of orifice size is not known.

The pressure recovery from Panellit connection to inlet nozzle is 6.2%, 5.8%, and 5.3% of the pressure drop from header to inlet nozzle, or 5.8%, 5.5%, and 5.0% of the pressure drop from header to Panellit connection, for the 0.240, 0.200, and 0.175-inch orifices, respectively. Corresponding values for the 0.140-inch orifice zone are erratic, and vary from 2.6% to 4.6% of the pressure drop.

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The pressure drop from inlet to exit nozzle is proportional to the 1.8 power of the flow rate; when the flow is expressed as g.p.m. and the pressure drop is in lbs/sq. in., this proportionality constant divided empirically by 0.662 is 1.07 for a standard charge, 0.76 for the loading used in Tube 1367-F, and 0.80 for the loading used in Tube 2679-F. Corresponding values predicted from Document 7-7092 are 1.07, 0.70, and 0.84, respectively. In predicting the proportionality constant for the loading of Tube 2679-F, it was estimated that each solid slug inserted in the middle of a column of perforated slugs had a pressure effect about equivalent to use of three additional solid slugs on the end of a solid column; this was apparently too conservative an approximation for the predicted pressure drop is greater than the observed pressure drop even though the effect of the capillary tube which carries the thermocouple leads and the effect of any film which might be present had been neglected.

Steel Shielding Slugs: (Production Test No. 105-105-P)

Twenty-one steel slugs were canned successfully and shipped to 105-F. Three sets of aluminum tubes containing copper wire were assembled for measuring neutron flux variation in the outer perforate section of the tubes. These slugs are to be charged into Tubes 3173-F and 3161-F on July 2nd.

Heat Generation in the Graphite: (Production Test No. 105-104-P)

Piping connections have been made for connecting the special pigtail pressure taps to Heise gages in the control room. This special pigtail is to be installed on Tube 3066-F on July 2nd.

Miscellaneous:

The results of calculations on pressure drop in pile cross-headers have been reported in Document HW-7015, Woods and Jones to Wilson, July 2, 1947.

W. K. Woods

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Technical Department

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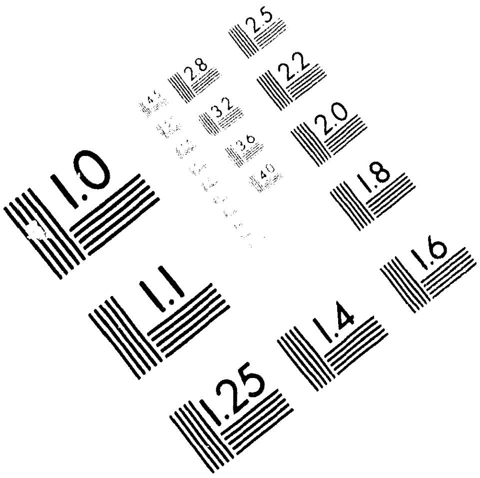

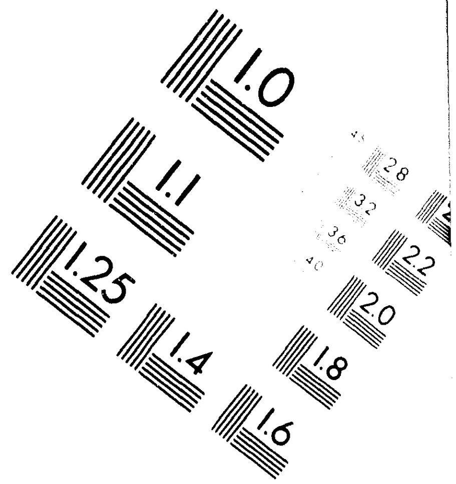

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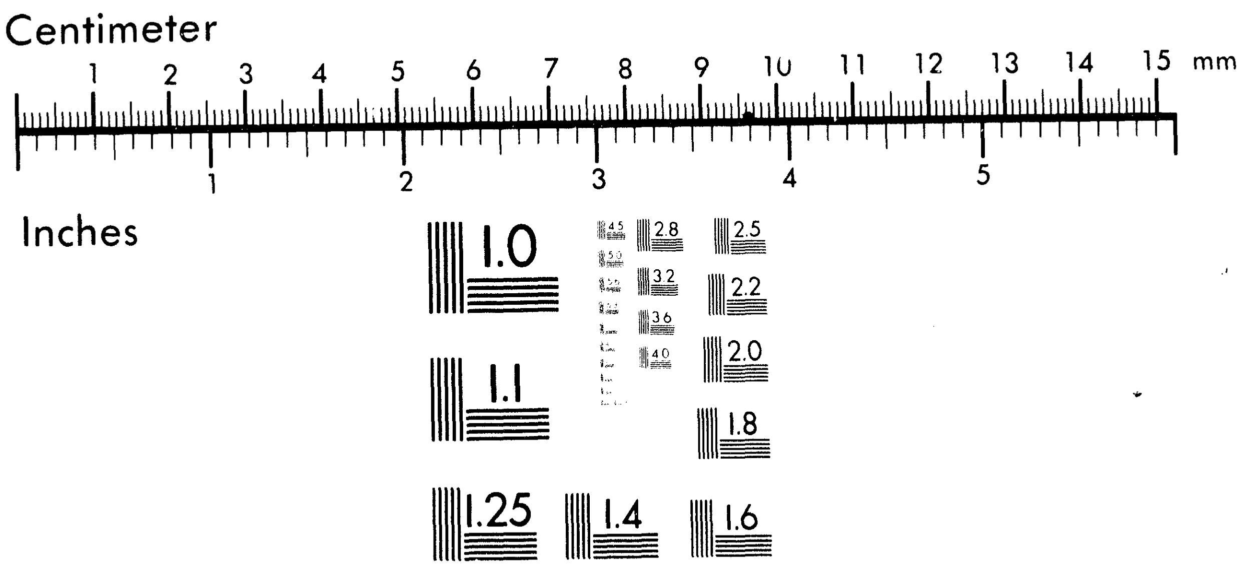

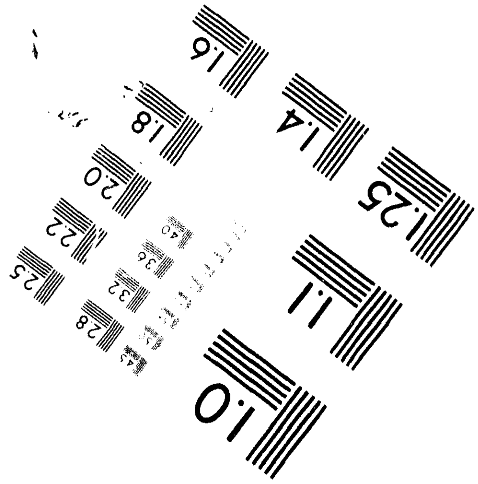

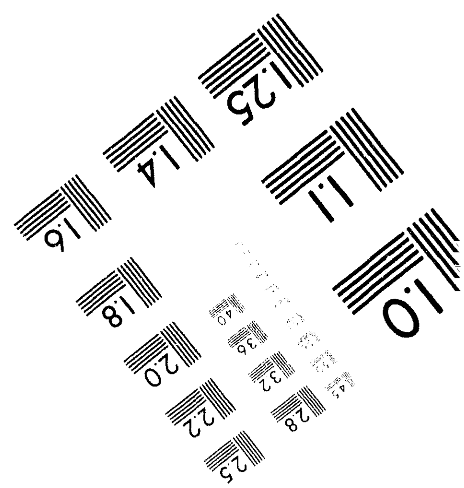

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