

# THE OBSERVATORIES

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OF THE CARNEGIE INSTITUTION OF WASHINGTON

## Magellan 2 Tertiary Mirror Blank Final Acceptance Data Pack

Corning Inc.

September 16, 1999

99TE0011

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813 SANTA BARBARA STREET - PASADENA - CALIFORNIA 91101

TELEPHONE (626) 577-1122 FAX (626) 795-8136

# THE OBSERVATORIES

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OF THE CARNEGIE INSTITUTION OF WASHINGTON

FAX: (626) 795-8136

DATE: September 16, 1999  
TO: Mary Edwards  
AT: Corning Inc.  
FAX NUMBER: 315-379-3317  
FROM: Matt Johns (626) 304-0288 Email: johns@ociw.edu  
DOCUMENT: 99TE0010

NUMBER OF PAGES INCLUDING COVER PAGE: 3

Dear Ms. Edwards,

We accept the Magellan 2 tertiary mirror blank and authorize you to ship it to Kodak for optical finishing.



Matt Johns, Project Manager

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813 SANTA BARBARA STREET - PASADENA - CALIFORNIA 91101



TELEPHONE (626) 577-1122

# CORNING

Customer: OCIW  
 Customer Dwg: 95TE0501 Rev. C  
 Customer Spec: None  
 Customer P.O.: ~~95TE0044~~ 98TE0015  
*M Edwards*






Document No.: DP24917 Rev. Orig.  
 Corning Dwg: 24917 Rev. Orig.  
 Prepared by: Mary J. Edwards  
 Date Prepared: May 10, 1996

<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Serial no.</u>	<u>Actual</u>	<u>Date/Stamp</u>
1.0		<b>MATERIAL</b>	2		
1.1	Note 1.1	The material used shall be Corning ULE™ titanium silicate code no. 7971, mirror grade.		C of C Att. 1.1	9/16/99 
1.2	Note 1.2	The coefficient of thermal expansion (CTE) of all material shall be 0 +/- 30 ppb/°C over a temperature range of 5°C to 35°C with a 95% confidence level.		C of C Att. 1.1	9/16/99 
1.3	Note 1.3	The radial CTE range of material used in the blank shall not exceed 15 ppb/°C.		Range 2 ppb/°C	8/26/99 
1.4	Note 1.4	The axial CTE range of material used in the blank shall not exceed 15 ppb/°C.		Range 4 ppb/°C	8/26/99 

<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
1.0		<b>MATERIAL (cont'd)</b>		
1.5	Note 1.5	CTE documentation, measurement, and traceability shall be maintained.	As req'd.	9/1/99 
1.6	Note 1.6	The birefringence resulting from permanent strain shall not produce a relative retardation of the path difference exceeding 20 nm/cm of light for all material used in the blank. Polarimeter Measurements shall be taken on the three components prior to assembly.	Core maximum = <u>5 nm/cm</u> F.P. maximum = <u>3 nm/cm</u> B.P. maximum = <u>2 nm/cm</u>	8/11/99 





# CORNING







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<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
2.0		<b>FRONT PLATE - CRITICAL ZONE</b>		
2.1	Note 2.1.1	The critical zone is defined as a zone of glass 0.20" (5 mm) thick beginning at the front surface of the front plate.	As defined	6/14/99 
2.2	Note 2.1.2	Critical zone inclusions with mean diameters of less than or equal to 0.005" are to be disregarded.	As required	6/14/99 
2.3	Note 2.1.3	Critical zone inclusions shall not exceed 0.080" in mean diameter.	Max = <u>0.030"</u>	6/14/99 
2.4	Note 2.1.4	The number of inclusions per cubic inch shall not exceed 6.	Accept	6/14/99 
2.5	Note 2.1.5	The average number of inclusions per cubic inch shall not exceed 0.2.	Accept	6/14/99 

# CORNING

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<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
2.0		<b>FRONT PLATE - NONCRITICAL ZONE</b>		
2.6	Note 2.2.1	The noncritical zone is defined as all glass not contained in the critical zone.	As defined	6/14/99 
2.7	Note 2.2.2	Noncritical zone inclusions with mean diameters of less than or equal to 0.005" are to be disregarded.	As required	6/14/99 
2.8	Note 2.2.3	Noncritical zone inclusions shall not exceed 0.250" in mean diameter.	Max = <u>0.015"</u>	6/14/99 
2.9	Note 2.2.4	The average number of inclusions per cubic inch shall not exceed 0.6.	Accept	6/14/99 

<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
2.0		<b>FRONT PLATE - DIMENSIONS</b>		
2.10	Zone C-6	Length of Ellipse: Measure length with verniers and record. Note: If flats are present, the maximum allowed depth of each flat from the theoretical ellipse is 0.012".	Length = <u>43.355"</u>	<u>5/27/99</u> 
2.11	Zone E-5	Width of Ellipse: Measure width with verniers and record. Note: If flats are present, the maximum allowed depth of each flat from the theoretical ellipse is 0.004".	Width = <u>30.584"</u>	<u>5/27/99</u> 
2.12	Zone D-7	Thickness: Record four (4) measurements taken 90 degrees apart at the OD with a micrometer.	0° = <u>0.581</u> 180° = <u>0.582</u> 90° = <u>0.581</u> 270° = <u>0.582</u>	<u>6/14/99</u> 
2.13	Zone D-3 Zone E-4	Outside perimeter radii: Verify with mylar template.	Accept +	<u>6/2/99</u> 
2.14	Zone E-2	Surface finish: Front plate plano surfaces to be 120 grit or better.	As required	<u>8/14/99</u> 
2.15	Note 3.1	Surface finish: All other surfaces (outer diameter) to be 50 mesh or finer.	As required	<u>8/11/99</u> 







<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
2.0		<b>FRONT PLATE - DIMENSIONS (cont'd)</b>		
2.16	Zone E-2 Note 3.4	All edges to be beveled by hand as dimensioned on the drawing. Measure each edge with a loupe and record minimum and maximum.	Front: Min = $\frac{0.140}{0.180}$ " Max =	6/14/99 C.S.M. ACCEPT 3/6
2.17	Note 3.5	There shall be no unacceptable checks or cracks in the front plate. An unacceptable check or crack is one which has one or more ends with unmodified potential for further propagation or which imparts significant structural degradation to the mirror.	Back: Min = $\frac{0.045}{0.060}$ " (faying)Max =	6/14/99 C.S.M. ACCEPT 3/6
2.18	Note 4.2	Prior to bonding: perform standard assembly acid etch of the front plate. Corning is responsible for assuring all part dimensions remain within specification after stock is removed by acid etching.	Pre-Acid etch: None Post-Acid etch: None	8/11/99 C.S.M. ACCEPT 3/6
			As required	8/12/99 C.S.M. ACCEPT 3/6








<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
3.0		<b>BACK PLATE - GLASS QUALITY</b>		
3.1	Note 2.2.2	Inclusions with mean diameters of less than or equal to 0.005" are to be disregarded.	As required	6/14/99
3.2	Note 2.2.3	Inclusions shall not exceed 0.250" in mean diameter.	Max = <u>0.040</u>	6/14/99
3.3	Note 2.2.4	The average number of inclusions per cubic inch shall not exceed 0.6.	Accept	6/14/99




Item	Reference	Requirement	Actual	Date/Stamp
3.0		<b>BACK PLATE - DIMENSIONS</b>		
3.4	Zone C-6	Length of Ellipse: Measure length with verniers and record. Note: If flats are present, the maximum allowed depth of each flat from the theoretical ellipse is 0.012".	Length = <u>43.361"</u>	<u>5/27/99</u> 
3.5	Zone E-5	Width of Ellipse: Measure width with verniers and record. Note: If flats are present, the maximum allowed depth of each flat from the theoretical ellipse is 0.004".	Width = <u>30.585"</u>	<u>5/27/99</u> 
3.6	Zone C-7	Thickness: Record four (4) measurements taken approximately 90 degrees apart with a micrometer, at both the OD and the ID.	OD: 0° = <u>0.530"</u> 180° = <u>0.530"</u> 90° = <u>0.530"</u> 270° = <u>0.530"</u> ID: 0° = <u>0.532"</u> 180° = <u>0.533"</u> 90° = <u>0.533"</u> 270° = <u>0.532"</u>	<u>6/14/99</u>  <i>will be acceptable post acid etch</i>
3.7	Zone B-3	Center hole diameter: Record diameter of center hole, by measuring at two locations approximately 90° apart with verniers.	0° = <u>3.533"</u> 90° = <u>3.534"</u>	<u>5/27/99</u> 





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<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
3.0		<b>BACK PLATE - DIMENSIONS (cont'd)</b>		
3.8	Zone D-3 Zone E-4	Outside perimeter radii: Verify with mylar template.	Accept	6/2/99 
3.9	Zone D-7	Mounting hole diameters: Record minimum and maximum dimension of six mounting holes, by measuring each hole at two locations approximately 90° apart with verniers.	Min = <u>2.435"</u> Max = <u>2.439"</u>	5/27/99 
3.10	Zone D-7	Hole locations: Verify with mylar template.	Accept	6/2/99 
3.11	Zone D-7, Zone B3, Note 3.4	Hole bevels: Measure each edge of six mounting holes and the center hole with a loupe and record minimum and maximum of all readings. Note: Inside (faying) edge of center hole is not to be beveled.	Min = <u>0.055"</u> Max = <u>0.075"</u>	8/11/99 
3.12	Zone E-3 Note 3.4	Edge bevel: Record minimum and maximum on each edge, as measured with a loupe.	Front: Min = <u>0.035"</u> (faying) Max = <u>0.050"</u>  Back: Min = <u>0.100"</u> Max = <u>0.170"</u>	6/14/99  6/14/99 

See Nonconformance Report  
CN-NR-99-06  
Att. 3.12






<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
3.0		<b>BACK PLATE - DIMENSIONS (cont'd)</b>		
3.13	Zone E-3 Zone D-3	Surface finish: Back plate plano ground surfaces to be 120 grit or better. The mounting area on both surfaces at each of six mounting holes (as shown and dimensioned on drawing) shall be 270/325 grit or finer.	As required	8/11/99 
3.14	Note 3.1	Surface finish: All other surfaces (outer diameter and holes) to be 50 mesh or finer.	As required	8/11/99 
3.15	Note 3.5	There shall be no unacceptable checks or cracks in the back plate. An unacceptable check or crack is one which has one or more ends with unmodified potential for further propagation or which imparts significant structural degradation to the mirror.	Pre-Acid etch: None Post-Acid etch: None	8/11/99  8/16/99 
3.16	Note 4.2	Prior to bonding: perform standard assembly acid etch of the back plate. Corning is responsible for assuring all part dimensions remain within specification after stock is removed by acid etching.	As required	8/12/99 

<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
4.0		<b>CORE - GLASS QUALITY</b>		
4.1	Ref. In-process print Note 2.2.3	Inclusions such as bubbles, seeds, and opaque inclusions shall not exceed 0.080" in mean diameter. (Customer requirement is that inclusions not exceed 0.250" in mean diameter.)	Max = <u>Accept</u>	8/6/99 
4.2	Note 2.2.2	Inclusions with mean diameters of less than or equal to 0.005 inch are to be disregarded.	As required	8/6/99 
4.3	Note 2.2.4	The average number of inclusions per cubic inch shall not exceed 0.6.	<u>Accept</u>	8/6/99 

Item	Reference	Requirement	Actual	Date/Stamp
4.0		<b>CORE - DIMENSIONS</b>		
4.4	Zone C-6	Length of Ellipse: Measure length with verniers and record. Note: If flats are present, the maximum allowed depth of each flat from the theoretical ellipse is 0.012".	Length = <u>42.934"</u>	4/30/99 
4.5	Zone E-5	Width of Ellipse: Measure width with verniers and record. Note: If flats are present, the maximum allowed depth of each flat from the theoretical ellipse is 0.004".	Width = <u>30.155"</u>	4/30/99 
4.6	Zone D-7	Thickness: Record four (4) measurements taken approximately 90 degrees apart with a micrometer or verniers, at both the OD and the ID.	OD: 0° = <u>2.967"</u> 180° = <u>2.966"</u> 90° = <u>2.967"</u> 270° = <u>2.967"</u> ID: 0° = <u>2.966"</u> 180° = <u>2.967"</u> 90° = <u>2.966"</u> 270° = <u>2.967"</u>	8/9/99 
4.7	Zone B-3	Center hole diameter: Record diameter of center hole, by measuring at two locations approximately 90° apart with verniers	0° = <u>3.540"</u> 90° = <u>3.542"</u>	8/9/99 

see item 5.3

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<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
4.0		<b>CORE - DIMENSIONS (cont'd)</b>		
4.8	Zone D-3 Zone E-4	Outside perimeter radii: Verify with mylar template.	Accept	5/4/99 
4.9	Zone E-7 & Zone B-3 on Sheet 2	Strut thickness (for reference only):	Typ thickness Interior walls = $0.204''$ Exterior walls = $0.321''$	5/4/99 
4.10	Zone D-7	Flat-to-flat hex dimension (cell width): Measure with vernier or micrometer.	Typ cell width = $4.049''$	5/4/99 
4.11	Zone D-7	Core cell locations: Verify based on various cell to cell measurements.	C of C AH. 1.1	9/16/99 
4.12	Zone E-8	Cell corner radii: Verify using radius gages and record typical radii.	Typ radius: Around center hole = $1.300''$ Rest of cells = $0.118''$	5/4/99 

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Item	Reference	Requirement	Actual	Date/Stamp
4.0		<b>CORE - DIMENSIONS (cont'd)</b>		
4.13	Note 3.3 Ref. In-process print	Vent holes: Record typical diameter and location of hole centers relative to midplane of core as measured with a scale.	Typ dia (entrance) = <u>0.550"</u> Typ dia (exit) = <u>0.530"</u> Typ distance from hole center to midplane = <u>0.100"</u>	5/4/99 8/9/99
4.14	Note 3.1	Surface finish: All core surfaces to be 50 mesh or finer.	As required	8/9/99
4.15	Note 4.1	The contour fit of the core to the front and back plates shall not exceed 0.003" before bonding the plates to the core. Measure with feeler stock and record.	F. P. max = <u>&lt; 0.002"</u> B. P. max = <u>&lt; 0.002"</u>	8/11/99
4.16	Note 3.7	The average contact area due to chipping of the core at each core-to-plate interface shall be greater than 75% of the nominal strut thickness per linear inch along the interface. Locate and measure minimum area with a loupe and record.	Front Plate: <u>&gt; 99%</u> Back Plate: <u>&gt; 99%</u>	8/11/99
4.17	Note 3.2 Ref. In-process print	Grooves at center of core: Record typical groove width and depth as measured with a scale.	At front plate: Typ width = <u>0.14"</u> Typ depth = <u>0.15"</u> At back plate: Typ width = <u>0.14"</u> Typ depth = <u>0.15"</u>	8/11/99








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<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
4.0		<b>CORE - DIMENSIONS (cont'd)</b>		
4.18	Note 3.5	There shall be no unacceptable checks or cracks in the core. An unacceptable check or crack is one which has one or more ends with unmodified potential for further propagation or which imparts significant structural degradation to the mirror.	<i>Initial inspection: 2 unacceptable cracks repaired 7/1/99 (AT) 2nd Att. 4.18 Pre-Acid etch: None See Att. 3.12 Nonconformance Report CN-NE-99-06 Post-Acid etch: None</i>	<i>6/30/99 8/11/99 8/16/99</i>
4.19	Note 4.2	Prior to bonding: perform standard assembly acid etch of the core. Corning is responsible for assuring all part dimensions remain within specification after stock is removed by acid etching.	<i>As req'd.</i>	<i>8/12/99</i>





<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
5.0		<b>FRITTED MIRROR ASSEMBLY - (cont'd)</b>		
5.5	Note 4.4	The bond material shall be Corning "U-type" frit. All frit must be qualified in accordance with Canton procedures #55036, 55037, and 55038.	C of C Att. 1,1	9/16/99 
5.6	Note 4.5	Each core-to-plate interface shall exhibit a minimum acceptable bond greater than 90% over each strut. Each core-to-front plate and core-to-back plate interface shall exhibit an average acceptable bond greater than 95% over the entire interface. Measure area most affected by voids with a loupe and record.	Front Plate: Min individ struts: <u>84%</u> Avg. interface: <u>&gt;99%</u> Back Plate: Min individ struts: <u>&gt;84%</u> Avg. interface: <u>&gt;99%</u>	8/31/99  See Att. 3,12 Nonconformance Report CN-MR-99,06
5.7	Note 3.5	There shall be no unacceptable checks or cracks in the blank. An unacceptable check or crack is one which has one or more ends with unmodified potential for further propagation or which imparts significant structural degradation to the mirror.	Final: None	9/1/99 

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<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
6.0		<b>QUALITY ASSURANCE</b>		
6.1	Note 4.6.1	A minimum of eight (8) Corning standard 0.075" thick T-samples (dwg number 20562-C configuration -004) shall be fired with the blank for joint strength testing. The samples shall be bonded with the same batch of frit slurry used for the blank. Four (4) T-samples shall be fired with the frit bonds at the bottom of the strut and four (4) samples shall be fired with the bonds at the top of the strut (inverted). The minimum break strength of any of the T-samples shall be 5000 psi due to adhesive or cohesive failure of the frit.	Min. 5998 psi Ave. 7135 psi Att. 6.1	9/1/99 
6.2	Note 4.6.2	Identical surface preparations, use of the same frit slurry mixture, and coincident firing are required.	C of C Att. 1.1	9/16/99 
6.3	Note 4.6.3	A map of all T-sample furnace locations shall be provided.	As required Att. 6.3	9/1/99 
6.4	Note 4.7.1	A minimum of eight (8) wafer seal test samples shall be assembled and fired with the blank using the same batch of frit slurry. The measured strain mismatch from any test sample shall be +25 to -75 ppm when calculated back to zero expansion glass.	Min. -16 ppm Max. -12 ppm Att. 6.4	9/1/99 

<u>Item</u>	<u>Reference</u>	<u>Requirement</u>	<u>Actual</u>	<u>Date/Stamp</u>
6.0		<b>QUALITY ASSURANCE (cont'd)</b>		
6.5	Note 4.7.2.	A map of the wafer sample furnace locations shall be provided.	As required Att. 6.3	9/1/99 
6.6	Note 5.1	Corning shall complete a data pack for each mirror (ref. Document no. DP24917 from Canton document control center).	As required	9/16/99 
6.7	Note 5.2	All measuring instruments must be calibrated in conformance with MIL-STD-45662.	C of C Att. 1.1	9/16/99 
6.8	Note 5.3	Corning shall maintain a system for nonconformances. Nonconformances shall be recorded on form Q506-949 and submitted to customer for approval.	As required See Att. 3.12 Nonconformance Report CN-NF-99-06	9/16/99 
6.9	Note 5.4	Acceptance inspection shall be conducted by the customer at the Canton Plant.	N/A	9/16/99 WAVE REQUIREMENT - Maxwell 9/16/99

## CORNING INCORPORATED NON-CONFORMANCE REPORT

	REPORT #: CN-NR-99-06
	ORIGINATOR: B. Todd
CUSTOMER:	Observatories of the Carnegie Institution of Washington (OCIW)
P.O.#:	98TE0011
ITEM DESCRIPTION:	Magellan Tertiary Mirror Blank
DRAWING #:	Corning Dwg 24917 Rev. 1 / OCIW Dwg 95TE0501 Rev. C
EFFECTIVITY:	Serial Number 2

### DESCRIPTION / CAUSE OF DEVIATION:

Item 3.12: Corning drawing note 3.4 and zone E-3 require the edge bevel on the back of the back plate to be 0.118 +/- 0.027" chamfer. In one area approximately 1.8" long, the edge bevel is 0.170". This was done inadvertently while smoothing out a small chip on the edge.

Item 4.18: Initial inspection after the inspection etch of the waterjetted core revealed two small checks, located as shown on attachment 4.18. These were repaired in accordance with standard repair procedures using 320 grit media. Repaired dimensions are as shown on attachment 4.18.

Item 5.6: The minimum acceptable bond allowed by Corning drawing note 4.5 is 90% for each strut. Around the perimeter of the blank, where the outer wall is thicker (8 mm) than the interior struts (5 mm), there are 12 struts on the front plate interface and 9 struts on the back plate interface that are between 84% and 90% bonded as shown in attachment 5.6. During the frit firing, the frit volume decreases, and where large areas are bonded this causes the frit to pull apart and leave voids in the interface in order to relieve the strain caused by the shrinkage. This is a common occurrence to some extent with struts wider than 5 mm, and is also the reason for the grooves in the central hub region of the core, where the area is even wider than 8 mm. The 90% specification is at the edge of the process capability. All other characteristics of the frit, frit qualification, and the frit firing are acceptable and within Corning standards.

### JUSTIFICATION FOR ACCEPTANCE:

Item 3.12: No impact on performance – cosmetic only.

Item 4.18: No impact on performance or integrity – standard repair.

Item 5.6: Although the minimum percent bond spec is not met on several of the perimeter struts, the average percent bond is well above the minimum requirement of 95% for each core-to-plate interface. The 90% spec can not realistically be met on such wide bond areas. Since the design of the mirror incorporates wider struts than many lightweight mirror designs, there is more total core area bonded over the aperture than in other designs. Corning also has historical data on T-samples with bonds from 60% to 90% which were tested and met the T-sample strength requirement. As such there is no impact on mirror performance.

RECOMMENDED CORRECTIVE ACTIONS:

Item 3.12: None

Item 4.18: None - checks already repaired.

Item 5.6: Corning to recommend specification change for any future procurement of this mirror design.

Approvals:

Corning Engineering	<u><i>Ming Wong</i></u>	Date:	<u>9/2/99</u>
Corning Quality	<u><i>R. Sanchez Fernandez</i></u>	Date:	<u>9/4/99</u>
Customer Engineering	<u><i>Matt Jule</i></u>	Date:	<u>9/15/99</u>
Customer Quality	<u>NA</u>	Date:	

PLEASE RETURN A SIGNED COPY TO CORNING QUALITY UPON ACCEPTANCE

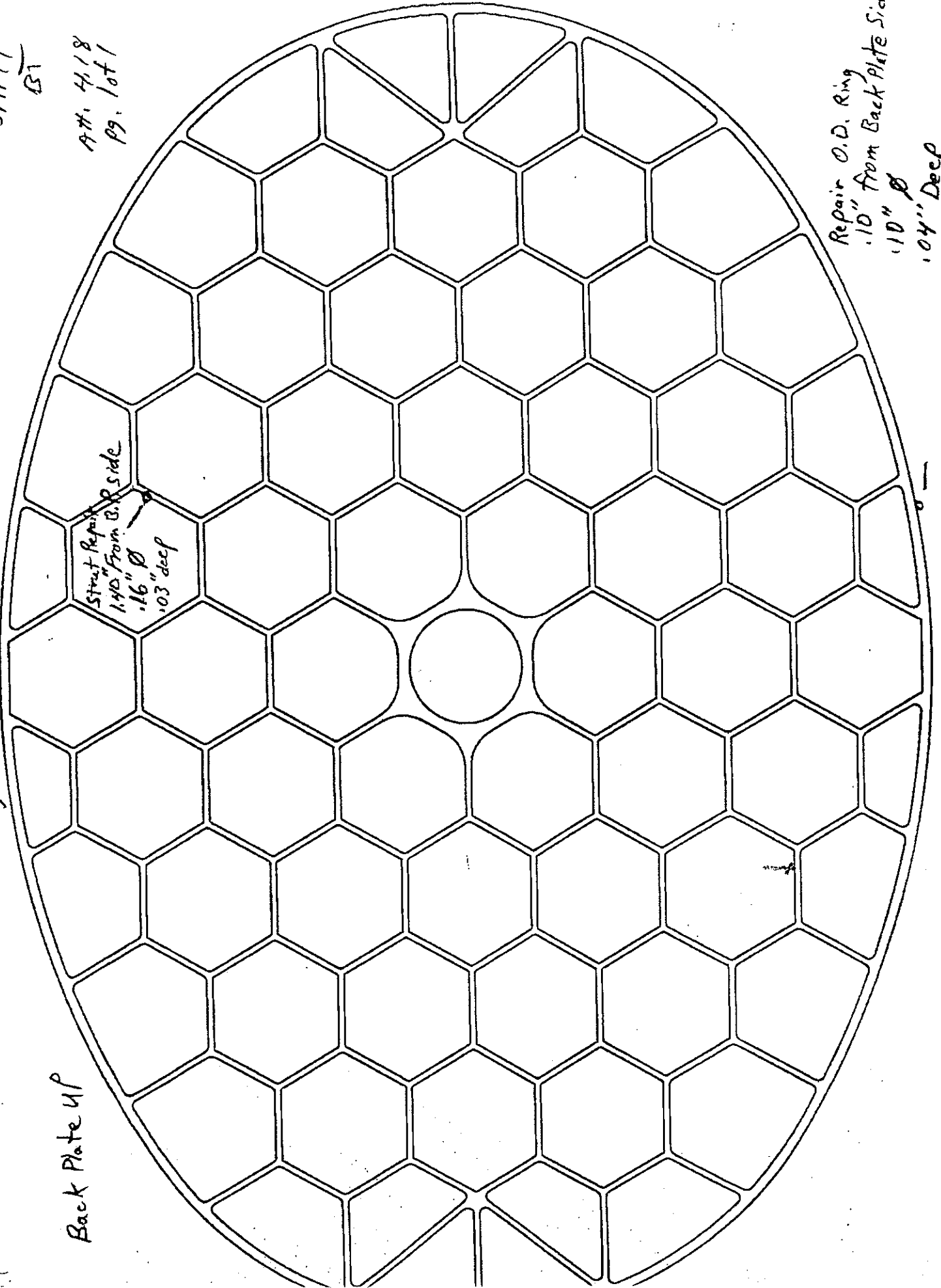
8/19/99  
BT  
Att. 4/18  
pg. 1 of 1

Repair O.D. Ring  
.10" from Back Plate Side  
.10"  $\phi$   
.04" Deep

Magellan S/N 2

Strut Repair  
1.40" from B.P. side  
.16"  $\phi$   
.03" deep

Back Plate UP



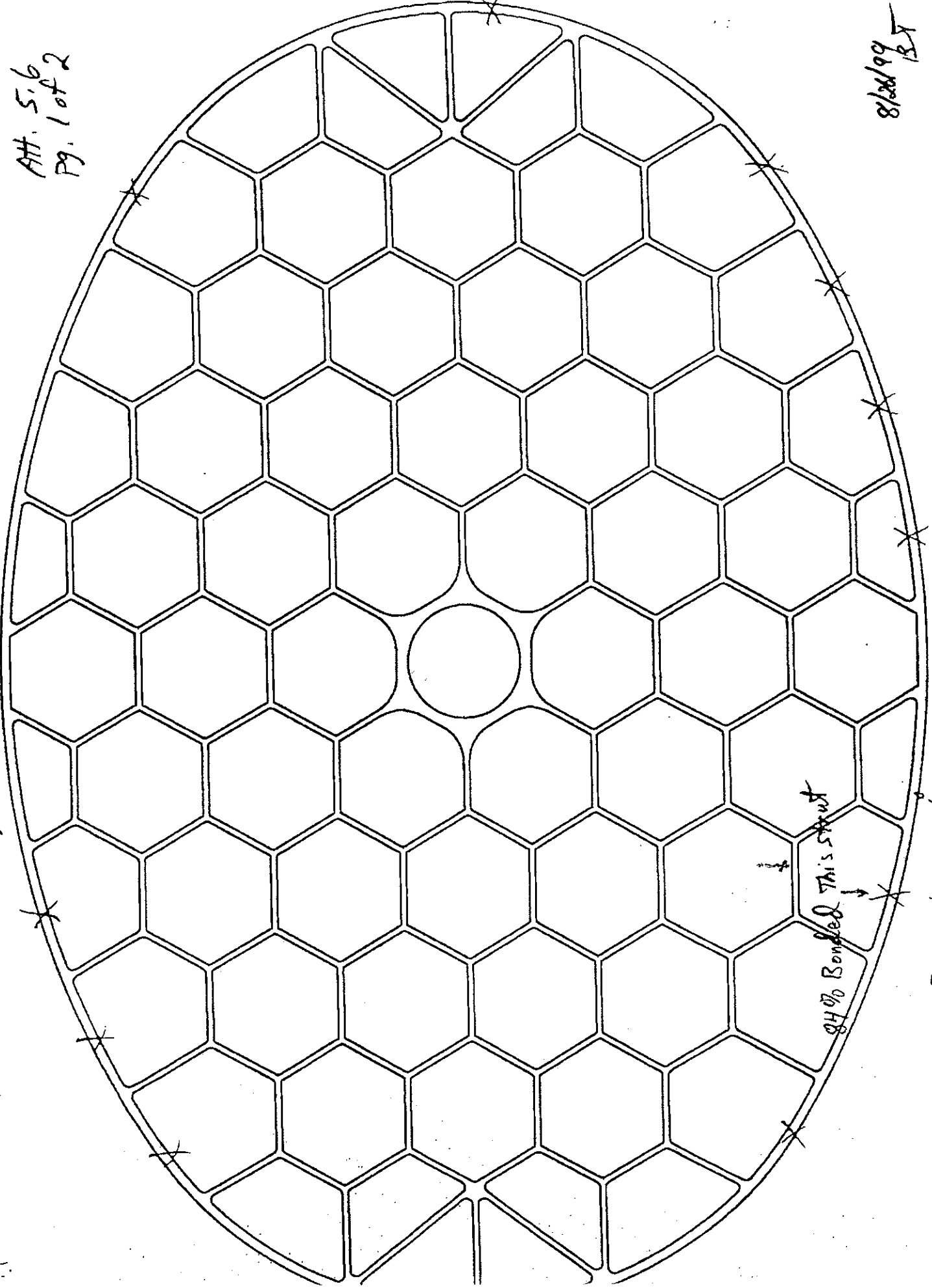


Front Plate UP

Att. 5.6  
Pg. 1 of 2

8/26/99  
BT

Magellan S/W 2 F.P. Bonds



84% Bonded This stout

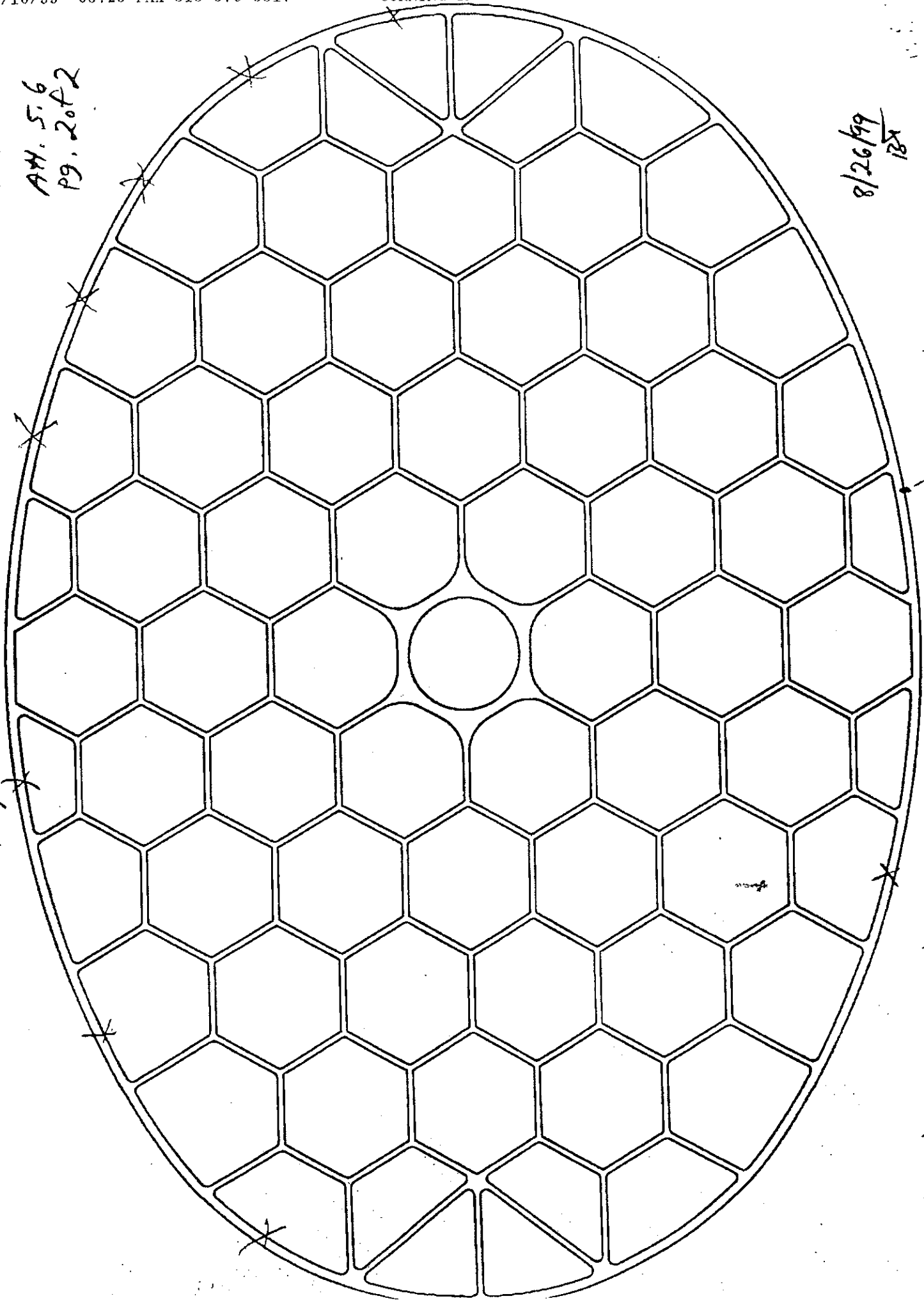
- distance between 84 to 90% bonded

Back Plate Up

AM. 5.6  
Pg. 2 of 2

8/26/99  
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Magellan s/n 2 B.P. Bonds



X - center of grid