

MATERIALS SCIENCE, INC.

Vacuum & Thin Film Technology

SPECIFICATION NO. 10000100, REVISION C

RECTANGULAR TARGET, BACKING PLATE

AND TARGET BONDING REQUIREMENTS

20 JANUARY 2011

**MATERIALS SCIENCE, INC.
1662 LOS ALTOS ROAD
SAN DIEGO, CA 92109
service@msi-pse.com**

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
BACKING PLATE AND BONDING REQUIREMENTS
20 JANUARY 2011**

1.0 TARGET FABRICATION REQUIREMENTS

Note:

See Target Fabrication Drawings as noted below in the Table of Standard Target Thicknesses. Target Fabrication Drawings specific to various sizes are also available.

- Method of target fabrication is the responsibility of the material supplier.
- The material supplier shall seal the finished target in an inert gas or dry nitrogen atmosphere and label the bag with the following minimum information:
 1. Inspection Date
 2. Customer Purchase Order Number
 3. Quantity
 4. Size
 5. Any Identifying Part Number
 6. Melt/Lot Number
 7. Purity
 8. Trace Elements/Dopants
 9. Other Relevant Information, ie, Resitivity, etc.
- A Certificate of Compliance is required.

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
 BACKING PLATE AND BONDING REQUIREMENTS
 20 JANUARY 2011**

TABLE OF STANDARD TARGET THICKNESSES

NOMINAL TARGET WIDTH	[REFERENCE] (Combined Maximum Backing Plate and Target Thickness	BONDED OR CLAMPED TARGET	DIRECTLY WATER COOLED TARGETS
		Generic Drawing No. 00000715	Specific for Each Source
90 mm	10mm	7mm	10mm
	0.375"	0.250"	0.375"
5"	0.500"	0.250"	0.500"
		0.375"	
6"	0.625"	0.250"	0.500"
		0.375"	0.625"
Structurally Strong Materials <u>Only</u> Bonded to a 0.125" Molybdenum Backing Plate		0.500"	

TOLERANCE AND FINISH REQUIREMENTS

- Actual target width (90mm, 5.000" or 6.000") and length to be specified by the user and called out on the purchase order to the target material supplier.
- Target width and length tolerance: ± 0.005 ".
- Target thickness tolerances: $+0.030$ ", -0.020 " relative to the specified thickness.
- Back and front surfaces must be parallel within 0.010" or less.
- A 16 (preferred) or 32 RMS finish is required on the o-ring sealing surface when the target is directly water-cooled and also on the backing plate for bonded or clamped targets. Otherwise, all surfaces shall have a 63 RMS finish or better.

NOTES REGARDING TILED, BONDED TARGETS

- The use of tiled targets with a 45° chamfer between adjoining target segments is recommended for processes that are particularly sensitive to potential film contamination resulting from inadvertent sputtering of the metallic solder or elastomer bonding materials caused by cracking and fracturing of the target material. Materials like SiO_2 , doped silicon and other brittle dielectrics are especially prone to this problem as the target is consumed.
- Some fabrication methods (hot pressing) may preclude the use of chamfered, tiled targets.
- Targets fabricated from dielectric materials should not exceed 10" in length to prevent excessive thermal expansion, leading to cracking and potential delamination from the backing plate. It is recommended that the overall target length be divided into a number of equal length tiles for these materials.



**Eroded Tiled, Doped Silicon Target
Bonded to Insert-Style Backing Plate**

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
BACKING PLATE AND BONDING REQUIREMENTS
20 JANUARY 2011**

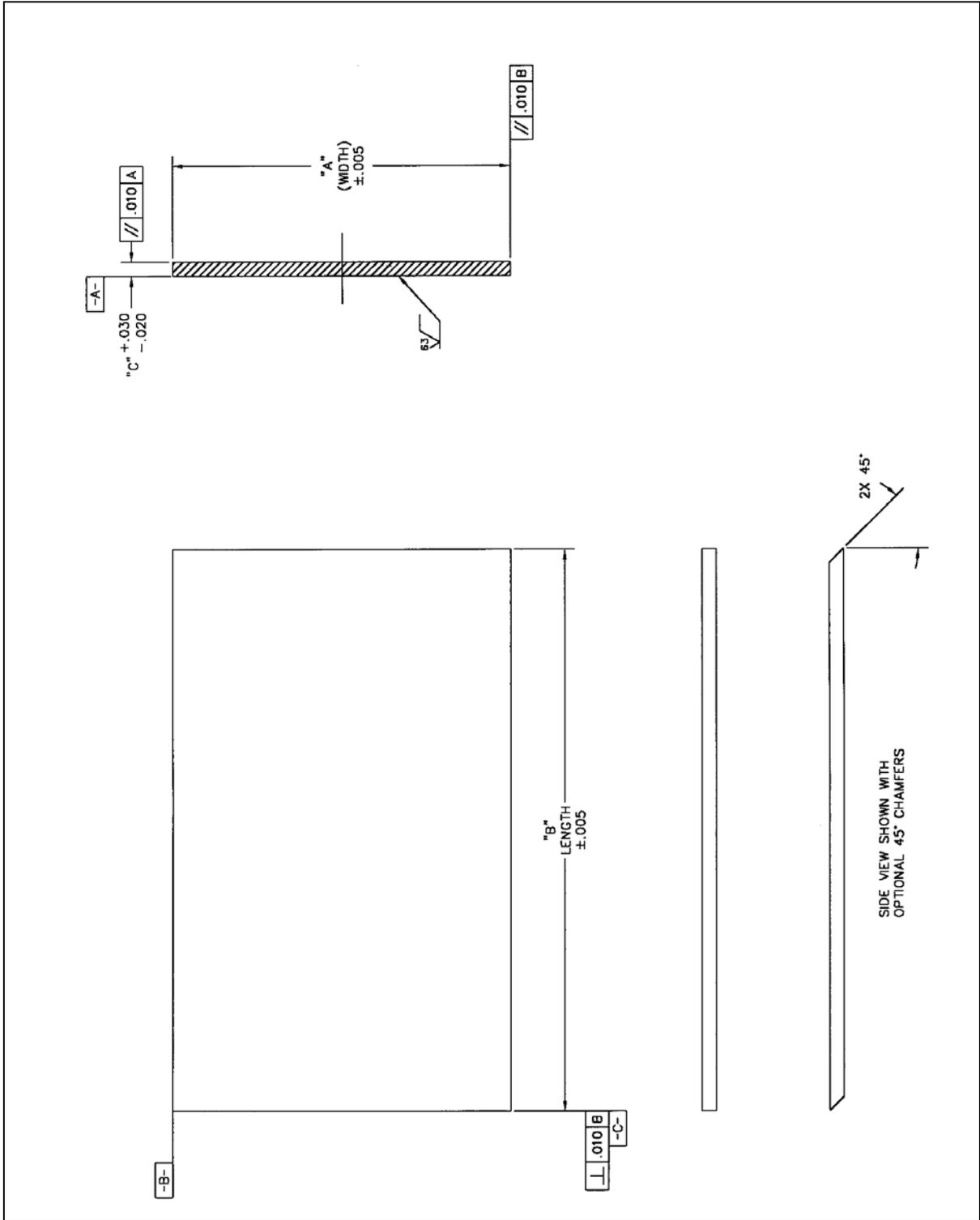
USE OF SINGLE PIECE, DIRECTLY WATER COOLED TARGETS

- When maximum power levels must be achieved, the use of stepped, directly water-cooled targets without a backing plate is recommended. Only structurally strong materials like refractory materials (i.e. titanium) should be used.



**Eroded 6" Wide Directly Water Cooled
Kamlok™ Style Target**

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
 BACKING PLATE AND BONDING REQUIREMENTS
 20 JANUARY 2011**



TARGET FABRICATION DRAWING

(See Notes on Page 3)

2.0 BACKING PLATE REQUIREMENTS

Note:

Individual backing plate drawings exist for each size cathode, calling out dimensions, material and tolerance requirements.

Fabricating New Backing Plates

- Molybdenum 361 (99.95%) is normally used on all Kamlok™ and Insert style SunSource™ GEN II sputtering source target backing plates. UNS C11000 Electrolytic Tough Pitch Copper (99.9% Cu) or UNS C10100 Oxygen Free Electronic Copper (99.99% Cu) and UNS C10200 Oxygen Free Copper (99.95% Cu) can also be used when the backing plate thickness is sufficient to minimize deflection of the backing plate that can cause target cracking and debonding. When targets are bonded to the backing plate, it's important to match the thermal expansion coefficient of the backing plate and target material as closely as possible to prevent target cracking and delamination caused by different rates of expansion during sputtering and target bonding. The metallic bonding medium (typically indium) or elastomer bond provides enough stress relief to accommodate differential rates of thermal expansion between a copper backing plate and many materials, although molybdenum is generally a better choice in most cases. Specialty glasses, Sendust and certain magnetic alloys are examples of materials which may crack during the bonding process due to thermal expansion mismatch, in which case molybdenum is required.
- When the user desires to use the thickest possible target for very brittle materials by using a thinner and structurally stronger backing plate material - Molybdenum or CRES 304 or 316 stainless steels must be used instead of copper.
- Refer to the deflection and material property charts below for various target widths and backing plate materials for guidance. The drawings provided with each sputtering source provide specific guidance for each configuration.

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
 BACKING PLATE AND BONDING REQUIREMENTS
 20 JANUARY 2011**

Backing Plate Material Properties

<u>90mm Wide Copper Backing Plate Deflection Data</u>
3mm flat copper deflects .053" [1.346mm] @70 psig (55 psig internal water pressure + 15 psi vacuum)
4mm flat copper deflects .021" [.533mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
5mm flat copper deflects .011" [.279mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
6mm flat copper deflects .007" [.179mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)

<u>90mm Wide Molybdenum Backing Plate Deflection Data</u>
3mm flat molybdenum deflects .018" [.457mm] @70 psig (55 psig internal water pressure + 15 psi vacuum)
4mm flat molybdenum deflects .008" [.203mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
5mm flat molybdenum deflects .004" [.102mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
6mm flat molybdenum deflects .002" [.051mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)

<u>90mm Wide 304 CRES (Stainless Steel)</u>
3mm (.118") flat 304 CRES deflects .034" [.864mm] @70 psig (55 psig internal water pressure + 15 psi vacuum)
4mm (.157") flat 304 CRES deflects .015" [.381mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
5mm (.197") flat 304 CRES deflects .007" [.178mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
6mm (.236") flat CRES deflects .004" [.102mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)

<u>5" Wide Copper</u>
4mm (.157") flat copper deflects .090" [2.286mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
5mm (.197") flat copper deflects .045" [1.143mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)

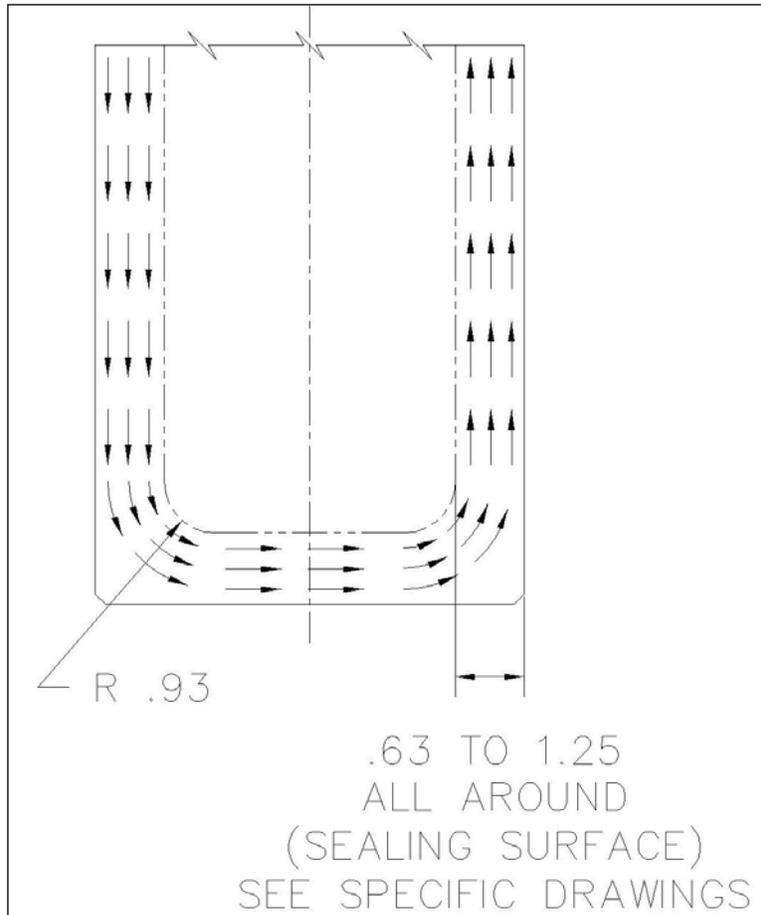
<u>5" Wide Molybdenum</u>
4mm (.157") flat molybdenum deflects .033" [.838mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)
5mm(.197") flat molybdenum deflects .017" [.432mm] @ 70 psig (55 psig internal water pressure + 15 psi vacuum)

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
 BACKING PLATE AND BONDING REQUIREMENTS
 20 JANUARY 2011**

Material	Cu	304 CRES	Mo	SiO2	6061-T6 Al	Notes
Thermal Conductivity (BTU/Hr ft² F)	230	10	81	-	96.55	--
Coefficient of Linear Expansion (μ in/in ° F)	9.2	9.6	3.0	-	13.1	--
Modulus of Elasticity/Young's Modulus (millions of PSI)	17	28	46	10.4	10	Cu is 43% as strong as Mo, 304 is 70%, 6061-T6 is 25% as strong.
Electrical Conductivity (%)	100	?	34	N/A	61	

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
BACKING PLATE AND BONDING REQUIREMENTS
20 JANUARY 2011**

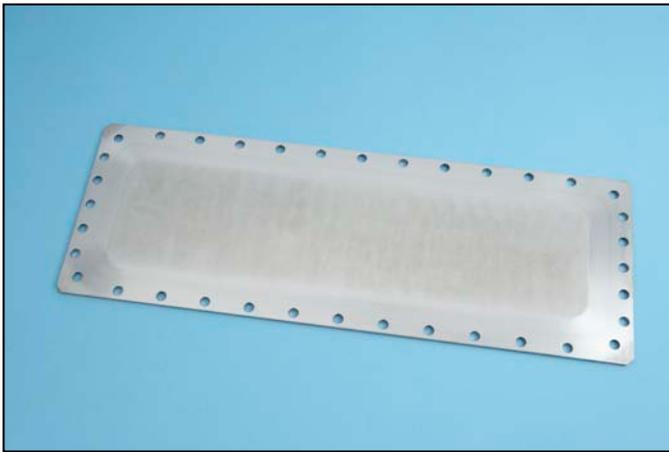
- There must be no scratches, dents, marks or other surface imperfections on any area of the target bonding surface nor on the o-ring sealing surface (water cavity side) of the backing plate.
- Use soft jaws to hold material when machining copper backing plates.
- Use a soft plastic pad or similar device to protect the surface of the backing plate during set-up. Do not center scribe directly on the target side of the backing plate material when laying out the bolt circle and other features of the backing plate. This produces an unacceptable depression in the center.



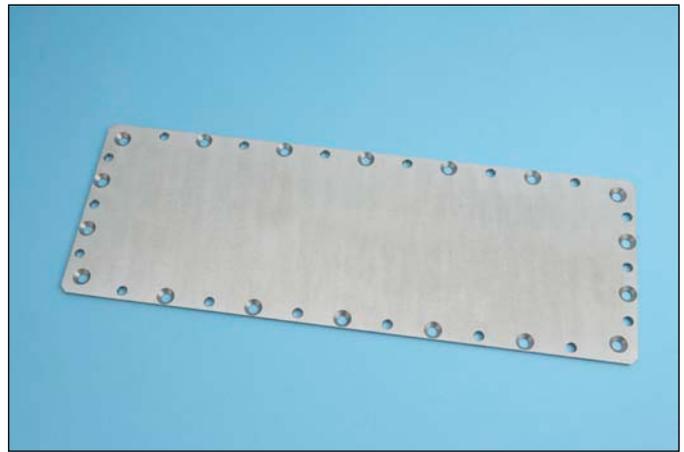
RADIAL POLISHING OF O-RING SURFACE

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
BACKING PLATE AND BONDING REQUIREMENTS
20 JANUARY 2011**

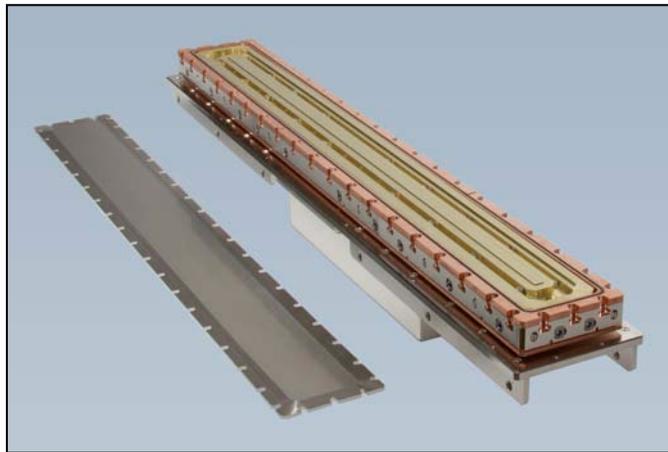
- The o-ring (water to vacuum sealing surface) must be 32 RMS or better. Operations which might result in contaminants becoming embedded in the material shall not be used. These include grinding with resin bonded wheels and polishing with rouge, emery cloth, crocus cloth or similar abrasives. Hand polishing small radial scratches from the sealing surface with Scotchbrite is acceptable, providing the polishing motion is parallel to the o-ring. (See diagram for clarity).



**Water Cavity Side Showing O-ring
Sealing Surface – Insert Style Backing Plate**



**Target Bonding/Clamping Side – Insert
Style Backing Plate – Surface Finish is
Common to all Styles**



**Water Cavity Side Showing O-Ring
Sealing Surface – Kamlok™ Style Backing Plate**

- Do not use an orbital sander to finish surfaces on the backing plate.

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
BACKING PLATE AND BONDING REQUIREMENTS
20 JANUARY 2011**

Re-using Debonded Backing Plates

- Backing plates which have been used with bonded targets can be re-used, as follows:
- The bonding and opposite surface must be parallel within 0.010” or less.
- The bonding surface flatness must be 0.015” per inch or less F.I.M.
- Sputter burn-through into the bonding surface up to 0.030” is acceptable on Insert-Style backing plates. Deeper voids require that the bonding surface be refinished as new. Sputter burn-through is not acceptable on Kamlok™-Style backing plates because of the fact that it is critical to maintain the specified backing plate thickness.
- Insert-Style backing plates may be re-used for their rated thickness until they become 0.060” undersized due to re-surfacing. Kamlok™ Style backing plates **must** maintain the specified tolerances on the backing plate drawing to ensure reliable sealing of the backing plate against the sputter source cathode body.

3.0 BONDING REQUIREMENTS

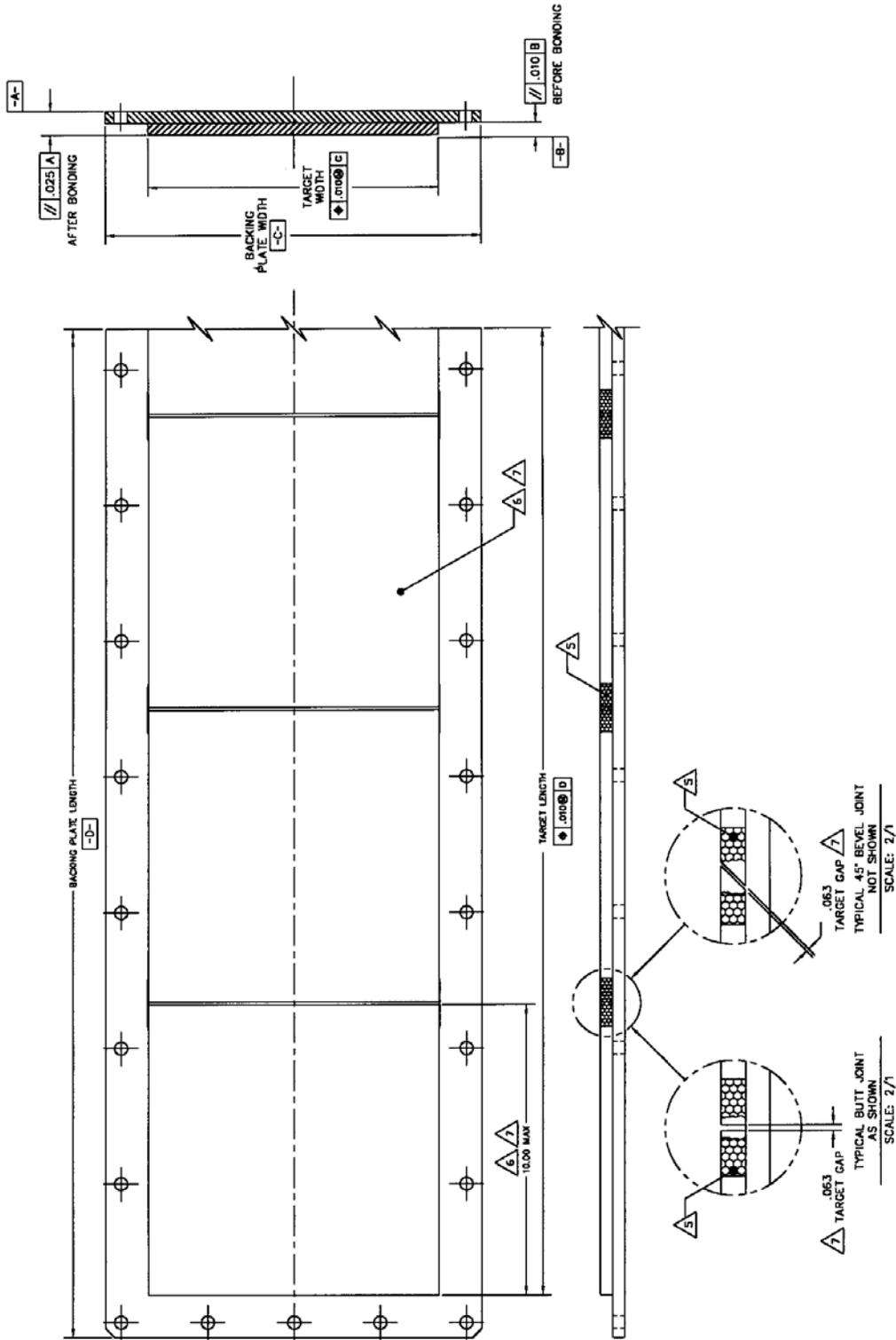
See Target Bonding Requirements Drawing, Rectangular, No. 00000714

- The side of the backing plate opposite the o-ring sealing surface is the bonding surface.
- When bonding tiled metal targets, the length and number of tiles is subject to user discretion. Material availability and the fabrication capabilities of individual suppliers may dictate the specifics. Maintain a gap of .063" between adjacent target tile sections.
- Do not exceed target lengths of 10" when bonding dielectric and ceramic targets to prevent excessive thermal expansion. Maintain a gap of .063" between adjacent target tile sections.
- Gaps between the side edge of target tiles are to be sealed with short sections of 1 mil thick polyimide (Kapton) film tape with silicone adhesive to prevent solder or elastomer material from flowing out of gaps during bonding and use. Remove after bonding.
- The target must be centered relative to the backing plate width and length within 0.010".
- The target bonding and sputtering surfaces must be parallel to each other within 0.010" or less prior to bonding.
- After bonding, the target sputtering surface must be parallel to the backing plate vacuum sealing surface within 0.025" or better.
- Target thickness tolerances prior to bonding: +0.030", -0.020" relative to the specified thickness.
- Metallic solder bonding, using indium (minimum 90%) or silver alloys or elastomer bonding is preferred. Often it is necessary to deposit adhesion layers on the target and backing plate bonding surfaces prior to making the solder bond. Good adhesion of this layer is critical to achieving a good bond. Epoxy bonds are emphatically forbidden!
- There must be no voids in the solder edge at the target/backing plate interface. This junction must be smooth, continuous and completely filled with solder.

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
BACKING PLATE AND BONDING REQUIREMENTS
20 JANUARY 2011**

- Solder or elastomer bond thickness should be 0.010" \pm 0.003" for metal targets and 0.020" \pm 0.003" for ceramic and dielectric targets.
- The entire bonding region must be completely filled with solder or elastomer. Significant voids (greater than 0.010" diameter) are unacceptable and should be completely eliminated whenever possible as they lead to hot spots, spitting and melting of the solder or elastomer bond causing partial or complete target delamination due to poor thermal transfer between the target and backing plate. Even if all voids are less than the maximum specified, the issues noted above may still occur. It's best to make certain that the entire bond is void-free.
- Trim all excess solder or elastomer from the edge of the target and backing plate surfaces after bonding.
- The bonded assembly should be bagged (sealed in plastic), filled with dry nitrogen, argon or other inert gas and labeled as sealed in inert gas or dry nitrogen atmosphere.

**SPECIFICATION NO. 10000100, REV. C RECTANGULAR TARGET
 BACKING PLATE AND BONDING REQUIREMENTS
 20 JANUARY 2011**



TARGET BONDING REQUIREMENTS
 (See Notes on Preceding Pages)