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Microplate Standardization

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Abstract

The increased use of mechanical systems, such as stackers, infeed/outfeed mechanisms, and robotic hands, to handle 96-well microplates has emphasized the need of a dimensional standard. Mechanical methods are far less tolerant of dimensional variations than manual methods. The result is less reliability in automated methods of microplate handling. The Society for Biomolecular Screening recognized the need and created a committee to establish such a dimensional standard. This report is a summary of that work.

Keywords: High-through-put screening, microplate, standardization

Introduction

Since the conception of the 96-well microplate in the early 1960s, there has not been a dimensional standard. As new plates were created, to meet specific requirements, certain dimensions have evolved. To the average user the microplates look alike, 96-wells in an 8×12 matrix on 9 mm centers. When handled manually these plates seem to be the same size. However, as automation moves in, where plates are handled by mechanical entities, they are not the same. The result is loss of reliability in running high volume assays that can utilize mechanization. Mechanization is assumed by many to mean robotic hands. The much larger problem exists with instrumentation such as pipettors, plate readers, plate washers, etc. These devices can benefit from workstation automation in the form of stackers and other types of infeed/outfeed devices.

The Society for Biomolecluar Screening (SBS) recognized this industrial need and created a committee to arrive at an acceptable microplate dimensional standard. [1] For the last year, 137 people on a world wide basis have participated in this effort. 97 were identified as users, 20 were identified as plate manufactures and, 20 were identified as instrument manufactures. 61 different types of microplates were measured to determine existing dimensions. Approximately 60% of the plates measured met the majority of the dimensions finalized in the standard for level 3. Another 15% with minor tooling changes could meet level 3 requirements.

Agreements/Disagreements

The comments received from the users were 100% in favor of the standardization effort - some vigorously so. The response from the plate manufactures was not as favorable, as was to be expected. They have a very large investment in the existing tooling. This cannot be changed without expense that would need to be reflected in plate cost to the end user.

There was concern that this standard would be an impediment to the development of unique plates. Also, that it would not cover certain types of plates. The intent of the standard is to develop a published set of dimensions that could be adhered to for conventional microplates, intended for mechanical handling. It was not intended for special plates such as strip plates or filter bottom plates. It is hoped that as new tools for microplates, of various types, are made, that the dimensions in this standard would be followed where applicable. For example, the current interest in 384-well plates could utilize the external dimensions.

The most discussion was centered around the use of the sidewall 'V' indentations. This requirement alone would require the most revision to existing tooling. Thus plates meeting level 10.3 (MP96-3) and 10.2 (MP96-2) would not have the sidewall 'V' indentations. Only plates meeting the 10.1 (MP96-1) level requirement would meet the full standard requirements.

The sidewall 'V' indentation serves two purposes. First, it allows a simple means of handling lidded plates on devices such as pipettors, plate readers, and plate washers. The lidded plate can be lowered through prongs that extend into the 'V'. The lid, not having the 'V' indentations, would be retained and rest on the prongs, while the bottom dropped through to be processed. After processing, it is returned and pushed back up through the waiting lid. It eliminates secondary lid handling devices such as sucker rubbers. Secondly, the 'V' can eliminate the cumulative error that can occur when a robotic hand is used to move a plate to and from several locations. Mating vees in the fingers would slide the plate to exactly the same location each time the hand closed on it.

The Microplate 96-well standard [2] as submitted to SBS is as follows: It is to be designated as MP96-1, MP96-2 and MP96-3 defining which portions of the standard the plate meets. It is planned that the names and definitions well be trademarked or copyrighted to prevent their use on non-conforming products.

All dimensions are shown in inches and in comparable metric dimensions.

The Standardization

1. General

1.1. The microplate shall have 96 wells in an 8×12 array, as shown by Fig. 1.

1.2. The plate shall be marked showing letter A to H located on the left hand side designating the rows of wells A to H (See Fig. 1).

1.3. The plate shall be marked with numbers 1 to 12 left to right across the top, identifying the columns of wells 1 to 12 (See Fig. 1).

1.4. Additional markings may be provided.

1.5. The plate shall have sufficient rigidity to allow its handling with automated mechanical means. The rigidity must be equivalent to that obtained by injection molding thermoplastics.

1.6. The top surface of the plate may be recessed around wells and between wells.

2. Center to Center Well Spacing

2.1. The well to well spacing in both horizontal and vertical directions is to be 0.3543 inches (9.00 mm) center to center.

2.2. The tolerance on the center to center spacing is 0.3543 inch ± 0.0030 (9.00 mm ± 0.08). The tolerances are non cumulative. This is defined as follows. Each well will be within ± 0.003 inch (0.08 mm) of its theoretical centerline position of 0.3453 inch (9.00 mm), when measured on a straight line between the first and last well in that row, or column.

3. External Footprint

3.1. The outside dimension of the base footprint shall be as follows:
Length 5.030 inches ± 0.010
127.76 mm ± 0.25
Width 3.365 inches ± 0.010
85.47 mm ± 0.25
These dimensions to be measured at the four outside corners.

3.2. The sides and ends will be straight within ± 0.020 inch (± 0.50 mm). This is defined as the maximum variation from a theoretical line connecting the applicable outside corners. When the plate width or length is measured at its point of maximum deflection, it will be as follows:
Length 5.030 inches ± 0.020
127.76 mm ± 0.50
Width 3.365 inches ± 0.020
85.47 mm ± 0.50

3.3. The centerline of the outside footprint dimensions shall be coincident with the centerline of the well to well spacing.

4. Plate Height for Standard Wells

4.1. The plate height shall be 0.565 inches ± 0.010 (14.35 mm ± 0.25). This is measured from the bottom resting plane to the top stacking surface. The top stacking surface is defined as that surface upon which another plate would rest when stacked one on another.

4.2. The maximum allowable projection above the top stacking surface is 0.030 inch (0.75 mm).

4.3. When resting on a flat surface, the top surface plane of the plate must be parallel to the resting surface within 0.030 inch (0.75 mm).

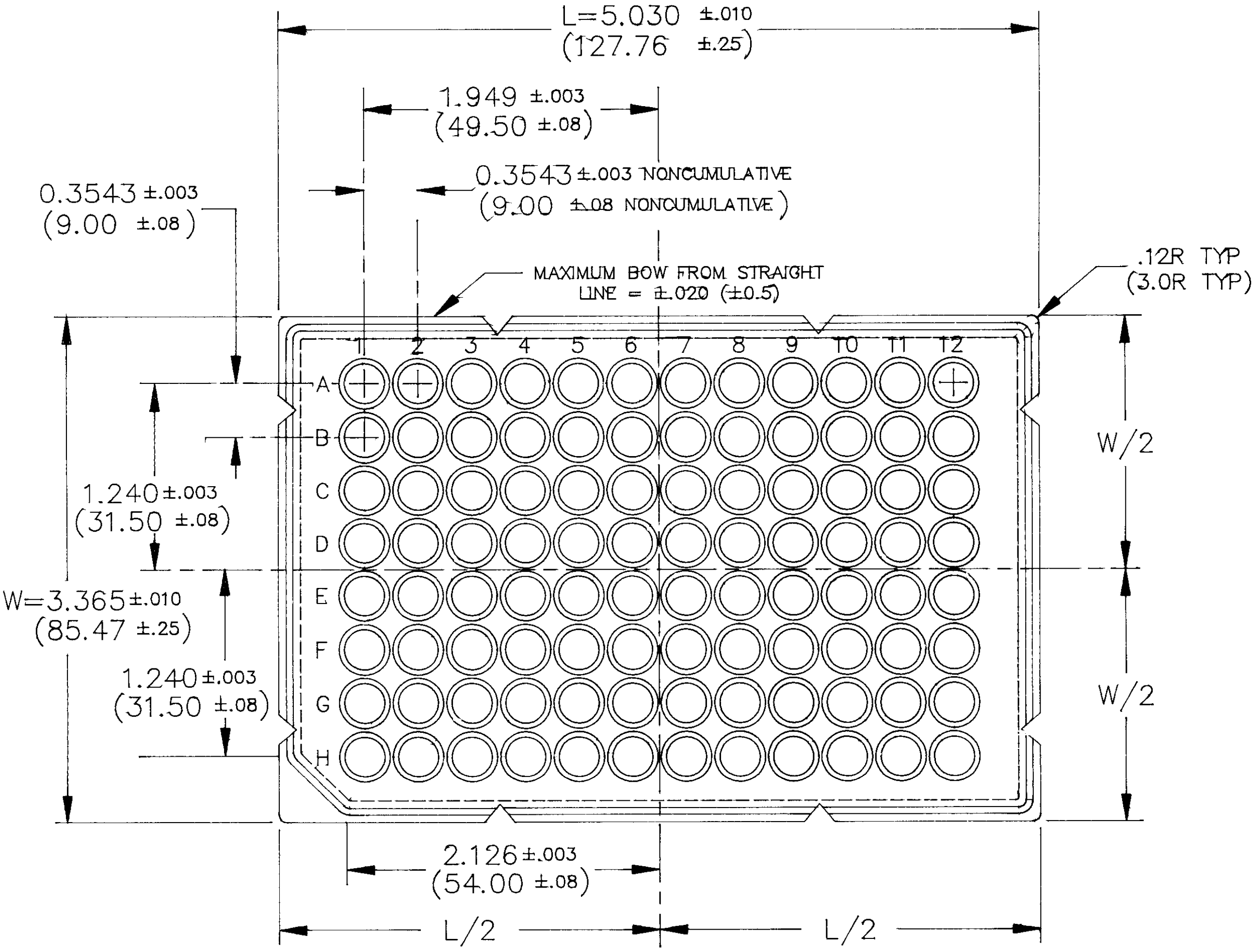

Figure 1. *General layout – top view. Dimension in inches and (mm).*

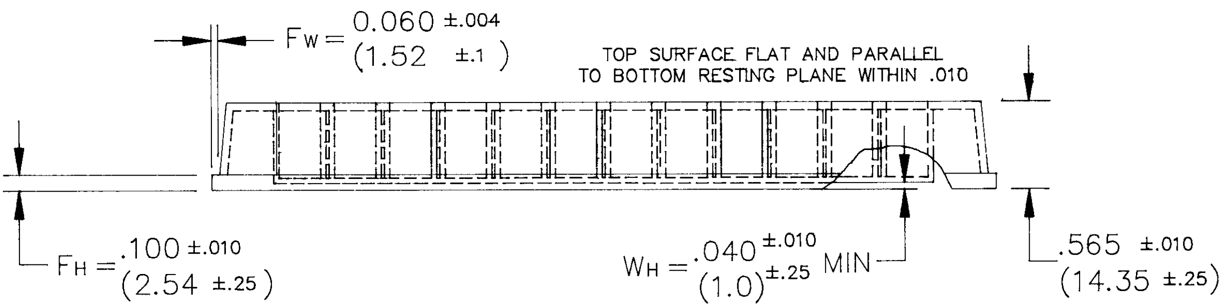

Figure 2. *General layout – side view. Dimension in inches and (mm).*

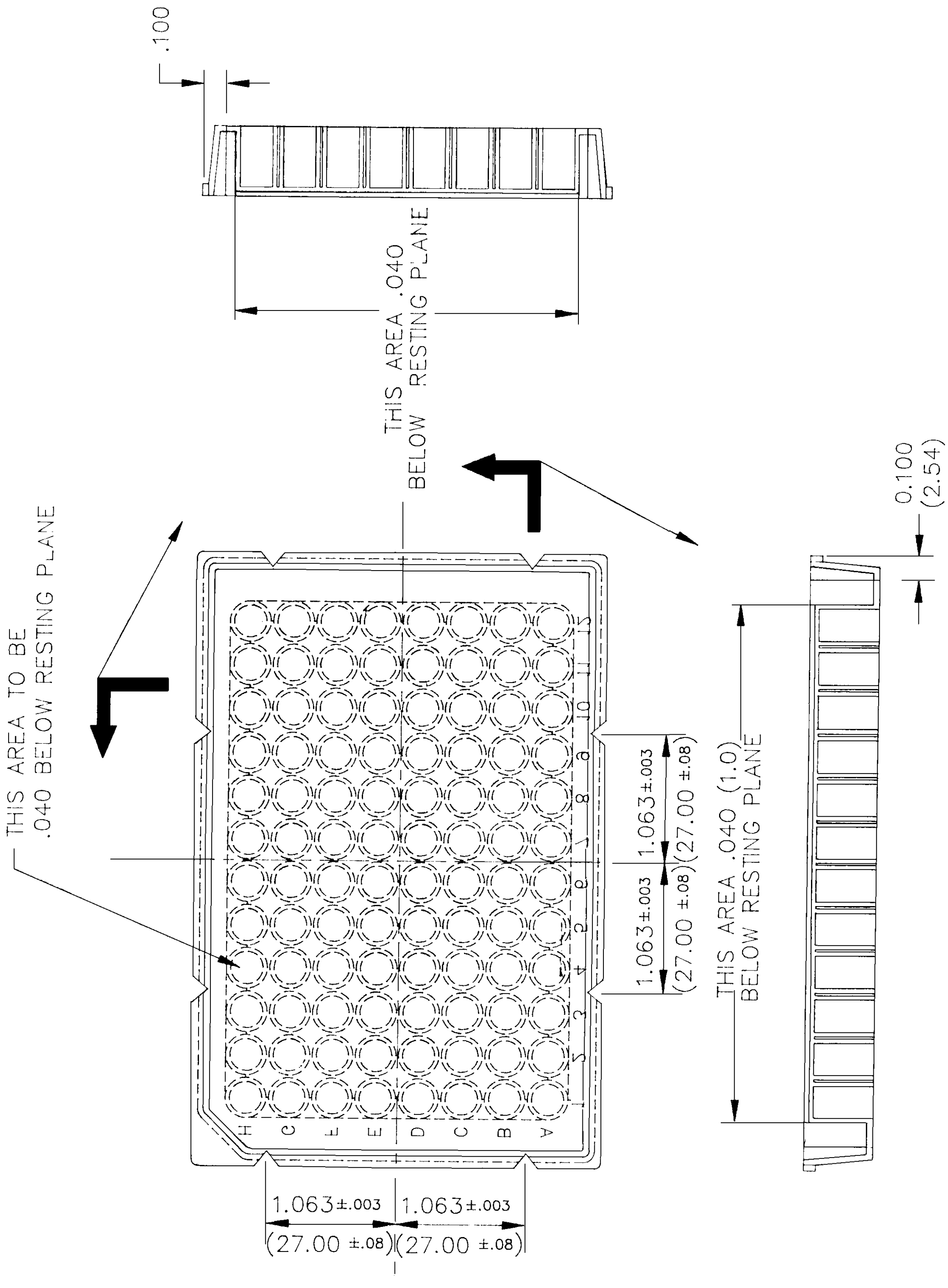

Figure 3. *General layout – bottom view. Dimension in inches and (mm).*

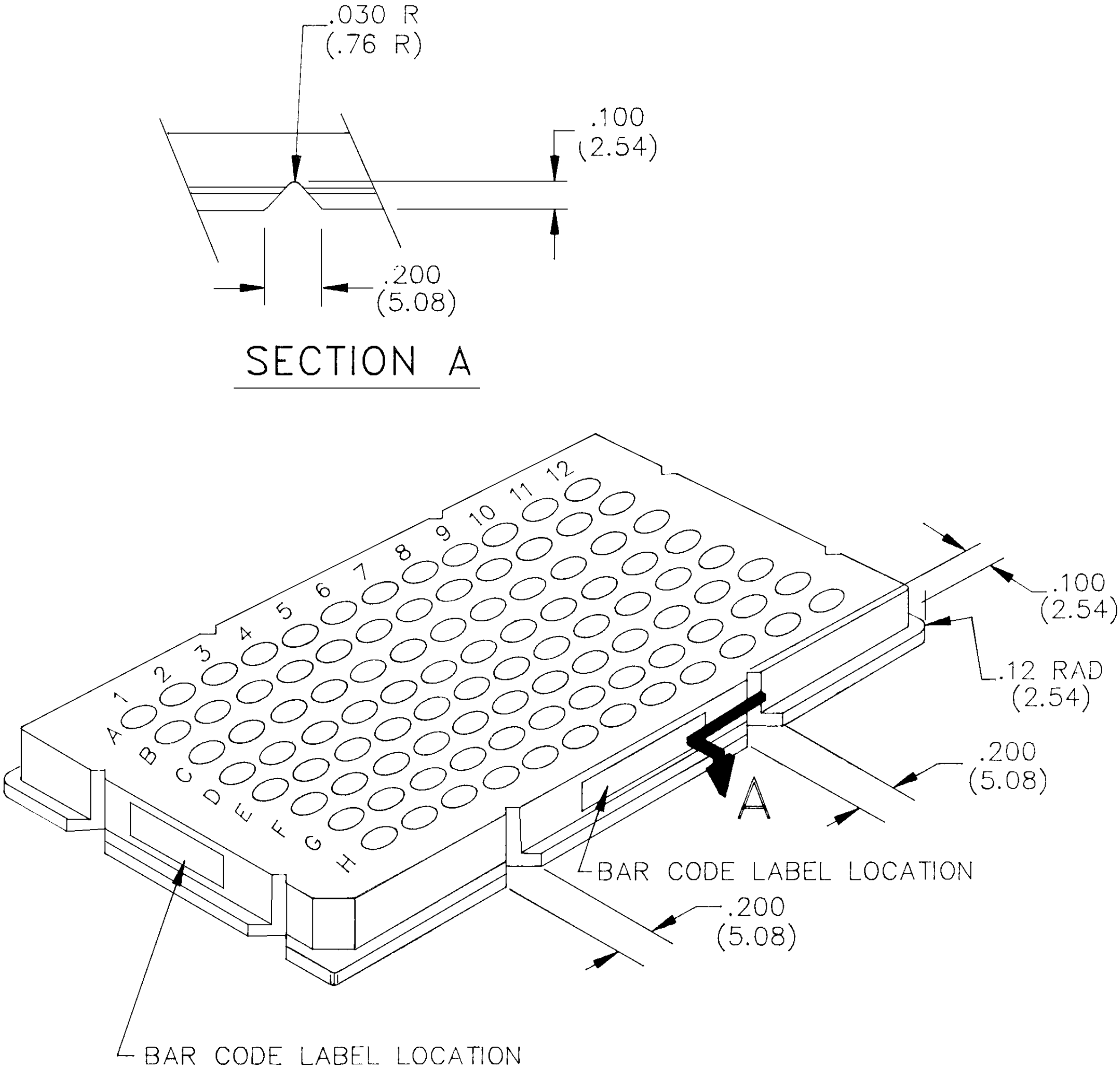

Figure 4. *Robotic finger locators. Dimension in inches and (mm).*

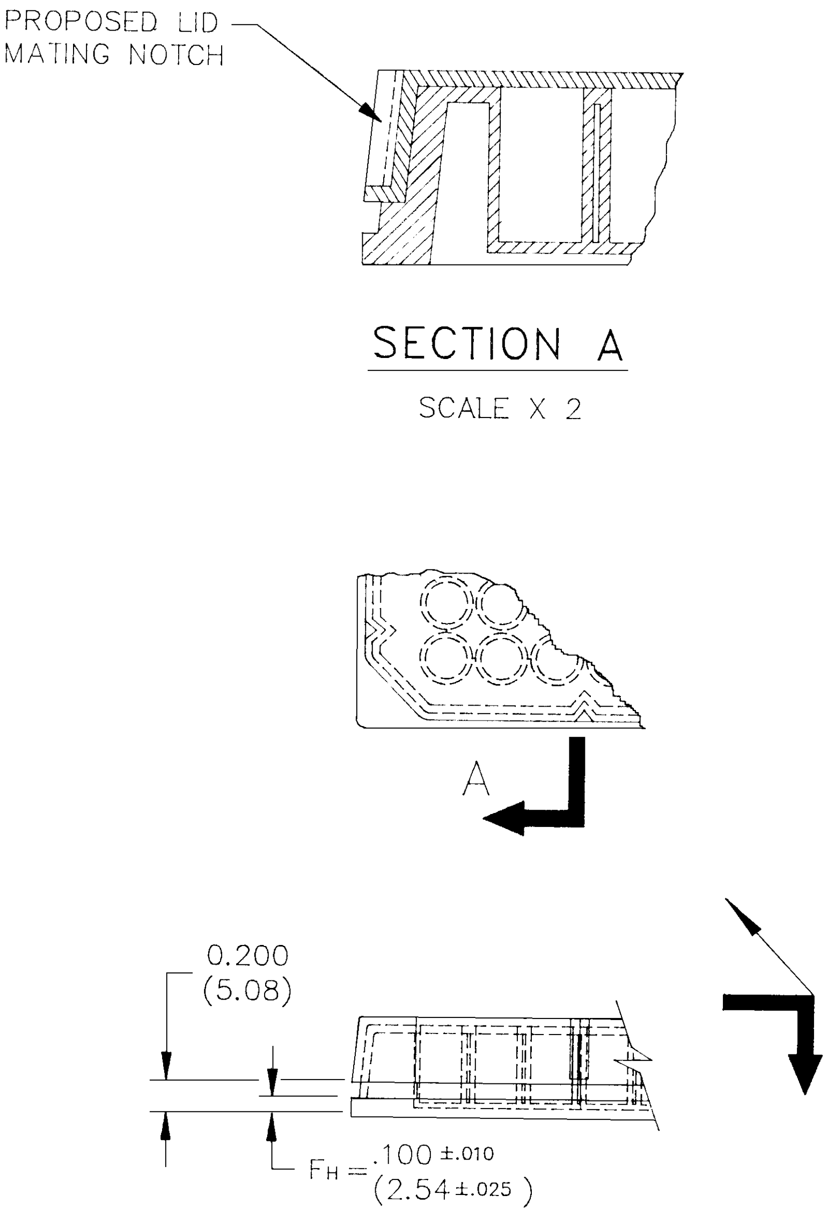

Figure 5. *Lid design. Dimension in inches and (mm).*

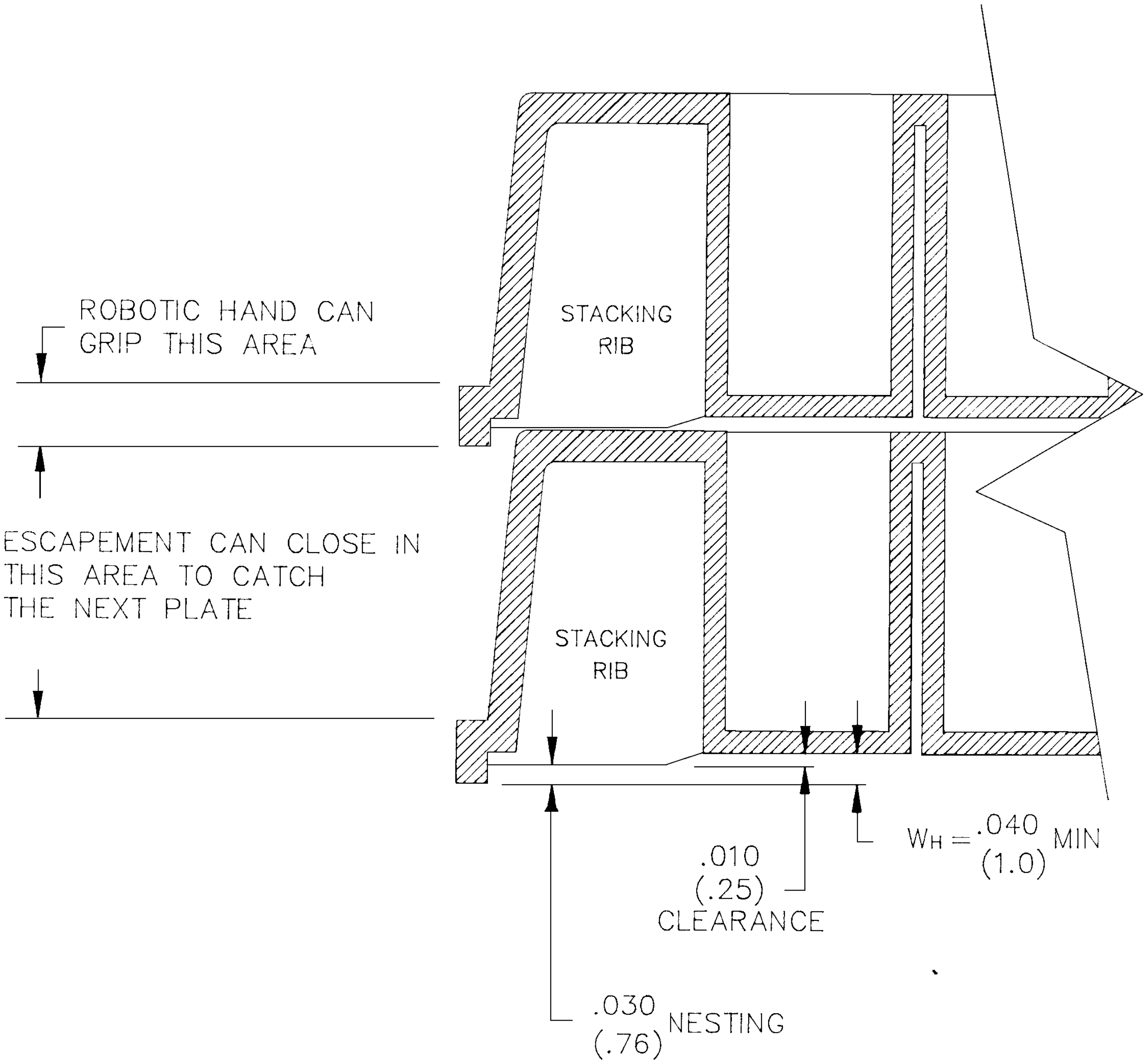

Figure 6. *Plate stacking. Dimension in inches and (mm).*

5. Corner Radius

5.1. The four outside corners of the plate footprint shall have a corner radius to the outside of 0.12 inch (3.2 mm).

6. Bottom Outside Flange

6.1. The bottom outside flange, defined as dimension F_H in Fig. 2, shall be 0.100 inch ± 0.010 (2.54 mm ± 0.25 mm).

6.2. The bottom flange width measured at the top of the flange, defined as dimension F_W in Fig. 2, shall be 0.060 inch ± 0.004 (1.5 mm ± 0.1 mm).

7. External Clearance to the Plate Bottom

7.1. The plane of the bottom external surface of the wells, defined by the perimeter of the outside perimeter wells, shall be 0.040 inch ±0.010 (1.0 mm ± 0.25 mm) above the resting plane. This is shown as W_H in Fig. 2.

8. Sidewall V Locators

8.1. There shall be V-shaped indentations on the ends of the plates between rows A-B and Rows G-H. The same indentations shall be located between column 3–4 and column 9–10 on both sides (See Fig. 4).

8.2. The V shaped indentation shall measure 0.200 inch (5.0 mm) at the outside opening of the bottom flange. The depth of the V shall be 0.100 inch (2.5 mm) (See Fig. 3).

8.3. The Apex of the V shall be located 1.063 inches ± 0.003 (27.0 mm ± 0.08) from the horizontal and vertical direction (See Fig. 3).

8.4. The Apex of the V may have an internal radius of 0.030 inch (0.76 mm) maximum.

9. Lid Design

9.1. The corner of the plate at the H1 well location, shall be cut off at an angle, as shown in Fig. 1.

9.2. The side flanges of the lid, when placed on the resting plate, will have a minimum clearance of 0.200 inch (5.08 mm) between the bottom of the lid flange and the resting plane of the plate (Fig. 5).

10. Plate Designation

10.1. A microplate meeting all of the dimensional requirements of this standard may be designated as MP96-1.

10.2. A microplate meeting all of the dimensional requirements of this standard, except Sect. 8 (Sidewall V Locators) may be designated as MP96-2.

10.3. A microplate meeting the dimensions defined in Sects. 1, 2 and 3 may be designated as MP96-3.

Any questions concerning this Microplate Standardization effort may be directed to the author at the address shown.

References and Notes

1. Tom Astle served as Chairman for a committee organized under the auspices of the Society for Biomolecular Screening to facilitate the creation of a dimensional standard for 96-well microplates.
2. This final version was submitted to the SBS October 12, 1996