Supplementary Material for Challenges in predicting the filtration performance of a novel sewn mask: scale-up from filter holder to mannequin measurements

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Appendix A1. Challenge particle distributions

Before the start of filtration tests, the size distribution of the undiluted challenge aerosol was measured with a scanning mobility particle sizer (SMPS) (Table A1).

Table A1. Summary statistics of undiluted, unclassified NaCl aerosol generated by Collison nebulizer

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometric Standard</td>
<td>2.25</td>
<td>2.26</td>
<td>2.13</td>
<td>2.31</td>
<td>0.04</td>
</tr>
<tr>
<td>Geo Mean (nm)</td>
<td>55</td>
<td>54</td>
<td>50</td>
<td>65</td>
<td>3</td>
</tr>
<tr>
<td>Mean (nm)</td>
<td>80</td>
<td>79</td>
<td>74</td>
<td>90</td>
<td>4</td>
</tr>
<tr>
<td>Median (nm)</td>
<td>49</td>
<td>48</td>
<td>45</td>
<td>58</td>
<td>3</td>
</tr>
<tr>
<td>Mode (nm)</td>
<td>39</td>
<td>39</td>
<td>31</td>
<td>51</td>
<td>4</td>
</tr>
<tr>
<td>Total Concentration (# cm$^{-3}$)</td>
<td>$2.21 \times 10^6$</td>
<td>$2.16 \times 10^6$</td>
<td>$1.69 \times 10^6$</td>
<td>$3.64 \times 10^6$</td>
<td>$3.82 \times 10^5$</td>
</tr>
</tbody>
</table>

As described in the methods section, the transfer function was wider (1 : 3.44 aerosol-to-sheath flowrate ratio). The transfer function $\Omega$ for each diameter setpoint is shown in Figure A1, and the singly and doubly charged size distributions for each setpoint are shown in Figure A2.
Figure A1. DMA transfer functions for 1 : 3.44 aerosol-to-sheath flowrate ratio with respect to singly charged diameter
Figure A2. Size distributions of singly and doubly charged particles which are selected from the undiluted aerosol (geometric mean of 54 nm, geometric standard deviation of 2.26) by the DMA with a 1 : 3.44 aerosol-to-sheath flowrate ratio (prior to the second neutralizer). The ratio of the number concentration of doubly and singly charged particles is 20, 19, 15, and 11% for increasing DMA setpoint diameters of 136, 200, 300, and 466 nm respectively.
Appendix A2. Methods of calculation

Particle filtration efficiency for a single punch at a given diameter was calculated from the unfiltered (bypass) and filtered particle concentrations ($C_{\text{Bypass}}$ and $C_{\text{Filtered}}$ respectively). $C_{\text{Bypass}}$ was also corrected for particle penetration through the empty filter holder (or sampling with a mannequin that did not have a mask) relative to the bypass concentration (Figure A3):

$$\text{Filtration Efficiency} = 1 - \frac{C_{\text{Filtered}}}{C_{\text{Bypass}}C_{\text{Filtered,Blank}}/C_{\text{Bypass,Blank}}} \quad (1)$$

$C_{\text{Unfiltered}}$ and $C_{\text{Filtered}}$ (and the corresponding blank measurements) were calculated as the mean of replicate measurements through the bypass line and filter respectively for the same punch:

$$C = \frac{1}{J} \sum_{j=1}^{J} \bar{x}_j \quad (2)$$

where $\bar{x}_j$ is the $j^{th}$ replicate measurement (of a total of $J$) for a given condition (filtered or unfiltered) and is calculated from the mean concentration (#/cc) recorded by the condensation particle counter (CPC) (for at least 30 s at 1 s time resolution):

$$\bar{x}_j = \frac{1}{n_{\text{CPC}}} \sum_{i=1}^{n_{\text{CPC}}} x_i \quad (3)$$

where $x_i$ is the $i^{th}$ raw concentration datum (of a total of $n_{\text{CPC}}$ data) recorded by the CPC.

The uncertainty in filtration efficiency is the combined uncertainty of the four concentrations in (1):

$$S_{\text{Efficiency}} = (1 - \text{Filtration Efficiency}) \times \sqrt{\frac{S_{\text{Bypass}}}{C_{\text{Bypass}}}^2 + \frac{S_{\text{Filtered}}}{C_{\text{Filtered}}}^2 + \frac{S_{\text{Bypass,Blank}}}{C_{\text{Bypass,Blank}}}^2 + \frac{S_{\text{Filtered,Blank}}}{C_{\text{Filtered,Blank}}}^2} \quad (4)$$

The uncertainties ($S_{\text{Bypass}}, S_{\text{Filtered}}, S_{\text{Bypass,Blank}}, S_{\text{Filtered,Blank}}$) for each concentration in (1) were calculated as the combined error from the maximum relative CPC variability ($S_{\text{CPC}}$) observed for that condition and punch, the variability between replicate measurements of the filtered or unfiltered particle concentrations ($S_{\text{Punch}}$), and the uncertainty $S_{\text{Infiltration}}$ from infiltration of particles through leaks in the system or by penetration of the HEPA filter (described in more detail below):
\[ S = \sqrt{S_{\text{CPC}}^2 + S_{\text{Punch}}^2 + S_{\text{Infiltration}}^2} \]  

\( S_{\text{CPC}} \) describes the uncertainty from the variability in the CPC measurement over time for a single concentration measured. The maximum relative uncertainty of repeated measurements (for a given diameter and punch) was used in (5):

\[ S_{\text{CPC}} = \text{max} \left( \frac{s_{\text{CPC},j}}{\bar{x}_j/n_{\text{CPC}}} \right) \times C \]  

where \( n_{\text{CPC}} \) is the number of CPC measurements and \( s_{\text{CPC},j} \) is the standard deviation of the raw CPC data:

\[ s_{\text{CPC},j} = \sqrt{\sum_{i=1}^{n_{\text{CPC}}}(x_{i,j} - \bar{x}_j)^2 / n_{\text{CPC}} - 1} \]  

\( S_{\text{Punch}} \) describes the variability between repeated measurements of the same condition (bypass or filtered), punch, and particle diameter and was calculated as the standard error of the mean of these replicate measurements:

\[ S_{\text{Punch}} = \sqrt{\frac{\sum(y_j - \bar{y})^2}{n_{\text{condition}} - 1}} \]  

where \( n_{\text{condition}} \) is the number of replicate measurements for a punch and condition (bypass or filtered).

Finally, any particles infiltrating through leaks in the system (i.e. imperfect barrel seal) (or by incomplete removal by the HEPA filter) represent an uncertainty in the particle concentration of the size distribution selected by the DMA. This uncertainty \( S_{\text{Infiltration}} \) was quantified by closing the aerosol ball valve after testing each full mask to measure the contribution of these particles. (We used the average value from these tests (1.1 \# cm\(^{-3}\)) to estimate this source of uncertainty for the initial two trials, which occurred before this step was added to the test protocol.) The range of \( S_{\text{Infiltration}} \) was 0.7 to 1.5 \#/cm\(^3\). For context, leaks in tubing from the diluter up to and including the barrel were evaluated as a function of pressure (by measuring the rise in barrel pressure over time when at the same pressures (~7.6 kPa below room pressure) typical of the mask tests), from this test, we estimate that the leak into the system was on the order of 0.28 L min\(^{-1}\) (0.3% of total flow).
The filtration efficiency data presented neglect the contribution of material “shedding”, which was smaller than the uncertainty contributed by infiltration. The aerosol flow was capped off to measure filter holder and bypass concentrations with HEPA-filtered air (Table A2 on next page). The H600 material was cut from Glidden masks to evaluate a worst-case scenario where material wear from the sewing process might lead to shedding. At two face velocities and for all three material combinations, the bypass concentration was higher than the filter holder concentration, indicating that the filter material is not a net source of particles. In addition, the concentration of particles from the HEPA filtered air was small (<0.5 # cm$^{-3}$) in comparison to that generated from the Collison nebulizer (on the order of 100-1000 # cm$^{-3}$ (dependent on diameter) when diluted for a 60 cm s$^{-1}$ filter holder test).

**Fig. A3.** Particle loss in an empty filter holder (at three flowrates) and a mannequin without a mask (at 85 L/min)
Table A2. Bypass and filter holder particle concentrations for HEPA-filtered air

<table>
<thead>
<tr>
<th>Material</th>
<th>Face Velocity (cm s⁻¹)</th>
<th>( C_{\text{Bypass}} ) (# cm⁻³)</th>
<th>( C_{\text{Filter Holder}} ) (# cm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H600 Double Layer</td>
<td>7.49</td>
<td>0.020 +/- 0.011</td>
<td>0.014 +/- 0.004</td>
</tr>
<tr>
<td></td>
<td>10.6</td>
<td>0.013 +/- 0.002</td>
<td>0.013 +/- 0.002</td>
</tr>
<tr>
<td></td>
<td>60.25</td>
<td>0.348 +/- 0.062</td>
<td>0.173 +/- 0.003</td>
</tr>
<tr>
<td>H600-Filti-H600</td>
<td>7.54</td>
<td>0.016 +/- 0.007</td>
<td>0.009 +/- 0.001</td>
</tr>
<tr>
<td></td>
<td>60.4</td>
<td>0.438 +/- 0.017</td>
<td>0.074 +/- 0.004</td>
</tr>
<tr>
<td>Vflex N95</td>
<td>7.2</td>
<td>0.021 +/- 0.009</td>
<td>0.010 +/- 0.000</td>
</tr>
<tr>
<td></td>
<td>60.4</td>
<td>0.467 +/- 0.029</td>
<td>0.187 +/- 0.065</td>
</tr>
</tbody>
</table>

Appendix A3. Fitting filter holder filtration as a function of face velocity

To fit filter holder filtration efficiency as a function of face velocity for interpolation, we required a simplified functional form with a limited number of fitting parameters. We simplified the classical filtration model, which can be found in Hinds (1999):

\[
E = 1 - \exp \left[ \frac{-4E \Sigma \alpha}{\pi d_f (1-\alpha)} \right] \tag{9}
\]

where \( E \) is filtration efficiency, \( E_{\Sigma} \) is the single fiber filtration efficiency, \( t \) is the filter thickness, \( \alpha \) is the packing density of the filter, and \( d_f \) describes the effective fiber diameter. We note that only \( E_{\Sigma} \) among these variables changes as a function of face velocity \( (U_0) \) for cases where pressure drop and \( U_0 \) are proportional and where \( d_f \) follows Davies’ Law (Hinds, 1999).

To achieve a functional form for fitting data for a single particle distribution with only two fitting parameters, we included only diffusion and interception terms, knowing full well that other mechanisms (particularly electrostatic capture) contribute:

\[
E_{\Sigma} = E_D + E_R + E_{DR} + E_I + E_q \approx E_D + E_R = 2 \cdot \left( \frac{U_0 d_f}{D} \right)^{-2/3} + \frac{(1-\alpha)R^2}{Ku(1+R)} \tag{10}
\]

where each efficiency term \( E \) describes the relative contribution of diffusion, interception, an interaction term for the interception of diffusing particles, impaction, and electrostatic capture, \( D \) is particle diameter, \( R \) is the ratio of particle diameter and fiber diameter, and \( Ku \) is the
Kuwubara factor (which depends only on $\alpha$) (Hinds, 1999). Least squares regression (weighted by the inverse of the measurement uncertainties) was used to separately fit the parameters $a$ and $b$ for each material and each particle distribution:

$$E = 1 - \exp\left[-\frac{4\left(2\frac{U_0}{U_0}\right)^{-2/3} + \frac{(1-\alpha)R^2}{KuR(1+R)}\alpha}{\pi d_f (1-\alpha)}\right] = 1 - \exp\left[-\left(a \cdot (U_0)^{-2/3} + b\right)\right]$$

Data for the 60 cm s$^{-1}$ face velocity were excluded from the regressions for the VFlex and double-layered H600 materials, since including this data greatly decreased the quality of the regression, indicating a substantial shift in filtration mechanisms at higher face velocities that could not be described with this simplified form.
Appendix A4. Mannequin test replicates

Table A3. Filtration efficiency and pressure drop measurements for mannequin test replicates

<table>
<thead>
<tr>
<th></th>
<th>Filtration Efficiency (%)*</th>
<th>Pressure Drop (Pa)*</th>
<th>Number of Replicates (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial N95 FFR (VFlex)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>98.5% (98.0% - 99.0%)</td>
<td>99.0% (98.4% - 99.7%)</td>
</tr>
<tr>
<td>Glidden Mask in a Double Layer of Halyard H600 Sterilization Wrap</td>
<td>Mean</td>
<td>85% (84% - 86%)</td>
<td>87% (85% - 88%)</td>
</tr>
<tr>
<td></td>
<td>Mean - Stitched Seams Sealed with Silicone</td>
<td>86% (84% - 88%)</td>
<td>88% (87% - 89%)</td>
</tr>
<tr>
<td>Glidden Mask in a Triple Layered Combination: H600-Filti-H600</td>
<td>Mean</td>
<td>90% (89% - 91%)</td>
<td>91% (89% - 92%)</td>
</tr>
<tr>
<td></td>
<td>Mean - Stitched Seams Sealed with Silicone</td>
<td>92% (91% - 93%)</td>
<td>93% (92% - 94%)</td>
</tr>
</tbody>
</table>

*95% confidence intervals in parentheses
Appendix A5. Quantitative fit testing

**Table A4.** Quantitative fit testing fit factor results for the Glidden mask design

<table>
<thead>
<tr>
<th>Material</th>
<th>H600-Filti-H600</th>
<th>H600-MERV-H600</th>
<th>H600-Swiffer-H600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mask Size</td>
<td>Regular</td>
<td>Small*</td>
<td>Regular</td>
</tr>
<tr>
<td>Mask Size of Volunteer</td>
<td>Regular</td>
<td>Small</td>
<td>Regular</td>
</tr>
<tr>
<td>Test Result</td>
<td>Pass</td>
<td>Fail (20)</td>
<td>Pass</td>
</tr>
<tr>
<td>Overall Fit Factor</td>
<td>182</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>Normal Breathing</td>
<td>184</td>
<td>24</td>
<td>200</td>
</tr>
<tr>
<td>Deep Breathing</td>
<td>192</td>
<td>30</td>
<td>200</td>
</tr>
<tr>
<td>Head Side-to-Side</td>
<td>200</td>
<td>30</td>
<td>200</td>
</tr>
<tr>
<td>Head Up-and-Down</td>
<td>200</td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>Talking</td>
<td>132</td>
<td>30</td>
<td>200</td>
</tr>
<tr>
<td>Bending Over</td>
<td>188</td>
<td>11</td>
<td>200</td>
</tr>
<tr>
<td>Volunteer ID</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Notes</td>
<td>Worked well - stays still with breathing. No complaints. Straps just need some careful adjustment when donning.</td>
<td>The mask appears too large (the edges overlap onto the ears).</td>
<td>Mask is obviously too large.</td>
</tr>
</tbody>
</table>

* Small mask size was a modified version with 1.3 cm decrease in raw material rectangle dimensions (from 22.9 by 25.4 cm rectangle to 21.6 cm by 24.1 cm).
Appendix A6. Glidden mask pattern with detailed instructions

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Glidden100 mask pattern using H600 with chin casing for enhanced fit

**Cut along center line** to expand pattern 1/2" between nose & chin pleats - pattern dimensions should be **9" x 10"** (size medium/regular)

1/2" Nose piece casing (adjust dimensions to fit metal)

1/2" from top of fabric edge

Line B measures 1 1/2"

Nose pleat FOLD Line A

2" from top fabric edge

Line A measures 2 3/4"

Chin pleat FOLD Line C

1 1/4" from bottom fabric edge

Line D measures 1 1/4"

Chin pleat FOLD Line D

3/4" from fabric edge

1/4" from fabric edge

1/2" casing for spandex strip

Calibration scale

Line E measures 3 1/2"

Chin pleat FOLD Line E

2 1/2" from bottom fabric edge

Line F measures 2 1/2"

To chin pleat Line F

2" from bottom fabric edge

Line C measures 2"

To chin pleat Line C

1/2" from bottom fabric edge

1/4" from bottom fabric edge

1/4" seam from fabric edge

3/4" seam from fabric edge

Revised 4/9/20
Glidden100 Mask Pattern and Directions
For use with H600 Sterilization Wrap fabric

Select **ACTUAL SIZE** when printing PDF. Check 2" scale on the pattern design for calibration.

The pattern will be a PDF diagram of basic stitch and fold lines. Pattern can be made with or without the bottom casing but the use of a strip of spandex through the bottom casing gives a tighter fit under the chin.

**Materials needed:**
- **Halyard H600 Sterilization Wrap** - medical grade "fabric" - medical facility to provide or sourced online.
- **Nose piece insert** - tin strip used for coffee bags - typically measures 5 ¼"
- **Pinch-style clips. DO NOT USE PINS** Use office supply binder clips, sewing/quilt clips or clothespins
- **Fabric bias tape**, 3/8" to 1/4" wide 2 yards per mask. If possible - use two different sets colors in matching order on each side. Either 50/50 Poly/Cotton or 100% Cotton is fine.
- **Medium Weight Spandex** or similar stretchy fabric. The stretchy tie that goes through the chin casing is optional for general use but essential for healthcare providers and at risk individuals because it greatly improves the fit of the mask. Use spandex (very stretchy) fabric cut in 36" x 1" strips. Fold lengthwise and use wide/long zigzag stitches down the length of the spandex tie.
- **Cotton wrapped polyester thread**
- **SHARP, narrow sewing machine sharp needles** - 80/12 or size 90/14. A Microtex/Sharp needle works very well and a universal needle is a good second option. Note: Sew slowly through the thick layers of the folds to avoid needle breakage.

**IMPORTANT NOTES:**
- **DO NOT USE PINS** in this fabric because the puncture hole will allow infiltration through the mask. Instead use large office supply binder clips, clothes pins or sewing/quilting clips to hold pleats in place.

- For those working with the H600 fabric that is 36" x 36" please see diagram below for cutting suggestions to maximize fabric usage. The cutting plan allows for 9" x 10" rectangles for making the masks.

![Cutting Plan for 36" x 36" H600 Fabric](image)

- The H600 fabric is double-layered - the outer (right) sides are a shinier, slightly darker shade of blue. Make sure original layers STAY together. The duller, lighter inner sides remain facing each other while sewing.

Revised 4/9/20
CONSTRUCTION - step by step directions:

1. **Cut fabric:** This mask pattern is made using a 9”x10” size piece of layered H600 fabric. See diagram above for suggestions for cutting the 36” x 36” into 12 masks.

2. **Nose piece preparation:**
   a. Use strip from coffee bags.

3. **To prepare a paper pattern:** select "Actual Size" Landscape when printing PDF. The pattern will print on an 8.5” x 11” page which needs to be trimmed ½” along the cut lines indicated at the ends of the page to give the 10” width. **Next, cut the page in half along center cut line and expand by adding ½" between the pleats to make the required pattern dimensions of 9” x 10”**. Place a blank page behind the two halves and tape the pattern to make it the correct size. **NOTE:** Experienced sewers and quilters may prefer to lightly mark the pattern fold and stitch lines with chalk or a fabric pen on fabric at this point.

4. **Place pattern** on the H600 double-sided fabric and cut along the dark outer lines, **DO NOT USE PINS**. Keep the darker, shiny layer - the right sides of the fabric - facing out in both directions. Use a weight on the paper to cut or use clips to hold fabric pieces and pattern together in place.

5. **Casings:** There is no need to fold over the fabric for a casing since the fabric is already 2 layers. Stitch the two layers together to create the casings for the nose piece and the spandex or elastic. The casing under the chin is optional for general use but essential for a better fit for healthcare workers. The ¼" seam across the bottom of the fabric is necessary even if you do not use the elastic casing.

   ![Nose piece casing - at top of pattern](image1)

   ![Spandex casing at bottom of pattern](image2)

   a. Sew narrow seams ¼” from the edges top and bottom as indicated to create outer edge of casing.
   b. Adjust the dimensions of the ¾"seams to fit your specific nose piece and spandex size. Most work well with a ¾" seam from edge.
   c. To close the ends of the nose piece casing use a felt tip marker to draw two lines measuring 2" from each end of the casing or adjust measurement to fit your nose piece.
   d. Sew across one end of the nose piece casing to close that side before inserting metal nose piece.
   e. Insert nose piece into casing.
   f. After inserting the wire into the casing - sew the other small seam at the other end of the casing to keep it in place.
   g. Do not insert spandex strip through bottom casing until final step.
6. **Mark Pleats**: Align the pattern with the nose piece casing. With clips holding the pattern in place, use sharp point scissors to cut each V as indicated by the triangle shapes along the sides of the pattern - the point of the V marks each fold line and the line it matches up with. The diagonals of the V should line up when pleats are properly in place. You can also mark the lines based on measurements noted on pattern using chalk or fabric marker. (Helpful hint- after you fold a line, place a clip in the center to hold the fold while you line up the V notches along the side. Leave center clips in place as long as needed.)

![3D diagram of pleats](image)

7. **Nose pleat** - with nose piece casing at the top edge, fold pleats as shown in diagram above. As indicated on the pattern, fold Line A to meet Line B. The pleat nearest the nose piece should be facing toward the casing. Use binder clips or sewing clips at center and on both sides to hold pleat in place.

8. **Chin pleats** go in opposite direction from the nose piece casing. Fold bottom pleat FIRST - bring Line C downward (away from nose piece) to meet Line D above elastic casing (if not using elastic casing then fold to 1" from fabric edge). Fold Line E to meet Line F. The upper chin pleat should be slightly (but not completely) overlapping the bottom pleat. Secure with binder clips or sewing clips along side.

9. **Stitch sides along pleats**. Carefully stitch a narrow ⅛" seam along both sides to secure the ends of the pleats. Begin stitching at top of nose piece casing but end at the bottom chin pleat. STOP at casing - DO NOT stitch through the bottom casing for the spandex.

10. **Fold the mask** almost in half (as shown below). Line up the front top corners (above nose piece casing) just below the elastic/spandex casing behind it. Use large clips to hold the sides together.

![Fold Mask and draw angled seam](image)

11. **Draw lines** but do NOT sew yet. Using a fine felt tip marker, ball point pen, chalk or fabric marker (do NOT use a pencil or anything sharp that might scratch or puncture the surface of the fabric) lightly draw a line for stitching at an angle from the upper corner of the nose piece to a point 2 ¾" from the outside edge along the centerfold (as shown in diagram above).
12. **Prepare and place bias strips:** Cut 4 bias strips to 18" each (it is helpful to use two different colors of bias strips on each side to make it easy to tie each oppositional strip). If not already done, stitch down the entire length of the bias strip so it no longer unfolds. Use pinch clips to secure the bias strip in place as shown below with the bias strips arranged at 90° angles. If using two different colors of bias strips line them up with similar colors going the same direction. Example: blue strips both going horizontal and reds strips going vertical.

![Bias Strip Placement Diagram](image)

13. **Stitch seams** as drawn, back stitching across each end to completely secure closure at the centerfold and across the bias strip. Stitching should be fully across the edge before back stitching. **Do NOT go back and forth repeatedly.** NOTE: Stitch slowly to avoid needle breakage.

14. **Cut** away the excess fabric on the outside of the angled seam, ¼" from the stitch line. Be careful not to cut bias strips!

15. **Insert spandex** strip through casing. The strips measure 36" x 1" and are folded in half lengthwise then stitched with a wide zigzag down the entire length. Once inserted, center the strip so both ends are equal in length then stitch a vertical seam near center of the casing to prevent the spandex from being accidentally pulled out.

![Spandex Insertion Diagram](image)

Take care … be safe … stay well. We can do this!
Appendix A7. Step-by-step instructions (including photos) for making Glidden mask

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HALYARD H600 Sterilization wrap

H600 is double layered fabric cut into 9" x 10" rectangles

DO NOT USE PINS! Use clips instead
Insert nose piece - we used a piece of tin that measured 5.5" x 3/8" that was malleable and durable for repeated use.

Place the sheet of filter material between layers of H600 over the nose piece.
Then stitch around the nose piece to keep it in place.

Stitch casing for chin elastic
Line up pattern that indicates the location of pleats

Cut then pinch the pleats to match up the notches
Hold pleats with side clips

Diagram for folding the mask in half (nose pleats on top)
Line up edges so the Nose pleat matches up just under the chin casing - see below
Measure angle for side seams of mask (double seams close together)

Before sewing the seams place the ties along the seam to attach them in place.
Stitch across the ends of both bias strip ties then carefully cut away excess corner fabric.

Insert elastic or spandex strip through chin casing to create snug fit under chin.