Appendix-I

Fabric Defects

Following are the additional fabric defects and their related theory.

- **Broken Ends**: This is a void in the warp direction due to yarn breakage. This defect is caused by bunch of broken ends woven in the fabric.

- **Broken pick**: This defect is due to discontinuity in the filling direction caused by a break or cut in the filling yarn. It causes sharp discontinuity in the weave pattern over the part of the pick length. Also it is due to the failure of the weaver to detect it and replace it in time. Controlling the weft breaks by improving the quality of yarn, looking into the factors responsible for weft breaks due to pirn and shuttle accessories and training the weaver are the remedies to reduce defects of this kind.

- **Broken Pattern**: It is the discontinuity of weave or design pattern.

- **Double end**: When two or more fiber ends unintentionally get woven as one, a double end type of defect is formed. This defect is characterized by the thick bar running parallel to the warp. Double end in the fabric are mostly caused due to sticky ends coming from sizing or miss drawing of ends. This can be reduced by training the weaver to correctly draw the ends.

- **Float (Jala)**: It is formed due to improper interlacement of the warp and weft yarn over certain area and is caused by an entanglement of adjoining ends. This kind of fault is most objectionable as the cloth has to be cut near this defect. This defect is caused due to warp breakages on loom arising out of incorrect shedding or bad sizing.

- **Gout**: It is the foreign matter usually lint or accidentally waste into the fabric. Hardened fluff as well as foreign matter such as pieces of feather accessories or wood chips, woven into the texture of the fabric is known as gout.

- **Hole**: Hole is formed due to accidental cutting or tear. Rough Mechanical parts of the looms can cause this.
Appendix-I

- **Lashing in**: It is the length of the yarn i.e. pulled inadvertently into the shed during weaving and this yarn is found touched in selvedge (widthwise edges) of the fabric. This defect is common in auto-loom. When the weft yarn is caught due to damaged picker or any rough surface in the box, this extra length of the weft gets loosely caught in the selvedge. Alternately improper functioning of shutter eye cutter on auto looms can cause this kind of defect.

- **Local Distortion**: It occurs when there is displacement of warp and/or weft threads from their normal position which occurs due to variation in tension of both yarns.

- **Missing end**: Absence of warp end at its proper place in a fabric is termed as a missing end. This defect appears in a fabric as a fine warp way crack till it is rectified by the weaver. This is most frequently occurring defect in Indian fabrics and constitutes 40 to 50 percent of the total defects in loom shed cloth. Number of missing ends may be more than one. Negligence of the weaver to draw the broken ends in place or improper functioning of the warp stop motion are the causes for this defect

- **Stain**: It is caused by lubricants and rust and oil, which is major problem in textile mills.

- **Oily or soiled ends**: It is oily or soiled warp threads.

- **Oily weft**: It is a dirty or oily weft appearing across the width of the fabric.

- **Reed Mark**: It is a pronounced mark caused due to damaged or defective reed. This produces grouping of warp ends in fabrics producing fine cracks. Higher warp tension resorting to late shedding and the use of coarser reed are the causes for this defect.

- **Bad selvedge**: The defect is characterized by the appearance of curls and folds in the fabric selvedge which become very prominent after wet processing.

- **Slough off**: This defect is due to a bunch of weft woven into the fabric. The removal of slough off during grey mending will form a hole in the
Appendix-I

fabric. The cause for this is softly wound pirns, improper weft package characteristics and poor humidity.

- **Smash**: This fault is characterized by the broken ends and floating picks. The defect is caused when many ends break consequent to the shuttle trap. Causes for this may be improper timing of shedding and picking motion, improper care to start the loop after rest.

- **Snarl**: It is a length of the weft yarn which has spontaneously doubled back on itself due to insufficient tension. If the portion of the weft yarn has over twisted zone it may snarl when it is loose. Another cause may be, if the weft in shuttle has inadequate tension then excess yarn released from the pirn turns around itself and forms a snarl.

- **Stitches**: More specifically it is a single thread float either warp or weft way. A place in the fabric where warp and weft yarns escape required interlacement. Main causes are entanglement of warp threads due to delay in repairing a broken end, knots with long tail ends, breakage of wire healds on running loom and unsatisfactory working of warp stop motion.

- **Loose thread**: This fault is due to any hanging thread on the face of the fabric.

- **Weft bar**: It is an unwanted bar running for full width of the fabric that differs in appearance from the adjacent normal fabric. The bar formation may be due to mix up of finer and coarser weft yarn with normal one running in the fabric, long term periodic variation in the yarn during spinning or faulty take up motion on the looms. Remedy could be to control the count of the yarn and attending to the mechanical condition of the loom.

- **Weft crack**: It is a open place causing a streak of variable length or width. This defect is introduced on woven fabric when an open space is formed across the piece due to absence of weft yarn. A stripe in the fabric where the pick is lower than the normal is called weft crack or jerky. This defect is caused due to mechanical fault on the loom such as incorrect setting of anti-crack motion, loose crank arm and loose fitting of reed.
Appendix-I

- **Broken Pick.** It is due to presence of two picks in the same shed for a part of the width of the fabric or it is due to partial pick inserted in the fabric because of weft break of weft exhaustion.

- **Warp streak:** Warp streaks are narrow, bare and dense stripes running along the warp direction of the fabric. These are due to the warp yarn that differ from the adjacent warp end in material, count, filament, twist, luster, tension, colour. When the dyed fabric is viewed in reflected light the dense regions reflect more light and appear lighter in shades and vice versa. Uneven spacing of the reed dents give a continuous type of warp streak. It can be reduced by using good quality reeds.

- **Coarse pick:** It is due to one or more picks of diameter larger than the normal filling yarn in the fabric.

- **Crammed picks:** A strip in the fabric where the pick density is more than the normal is called crammed picks (Patti). The defect is caused by the improper setting of the anti-crack motion and the release finger or because of releasing of excessive cloth at the time of restarting the loom.

- **Barre:** An unintentional repetitive visual pattern of continuous bars and stripes usually parallel to filling of woven fabric or to the courses of circular knit fabric results into this defect.

- **Temple Marks:** In this defect the yarns are distorted from their true paths and fine holes are caused near surfaces.

- **Thick place:** An unintentional change in the fabric appearance characterized by a small area of more closely spaced yarns or by congregation of thick yarns compared to the adjacent construction results into this kind of defect.

- **Thin place:** When the pick density at any place in the fabric decrease from the desired one a thin place is produced in the fabric. The causes for thick and thin places in the fabric are irregular setting of take-up, improper working of let off motion on the loom and insufficient care by the operator while adjusting the fell of the cloth at the time of float removal or repairing of smash.
Appendix-II

Defect Classification and Grading

Table A in Appendix-I shows the fabric defect classification as minor and major defect according to ISO 8402.98[B4-B6]. Also Appendix II describes about the standard fabric grading based on 4 point and 10 point systems.

TABLE A

<table>
<thead>
<tr>
<th>Minor and Major Defect Classification [5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of Defects</td>
</tr>
<tr>
<td>Missing Ends</td>
</tr>
<tr>
<td>Cracks</td>
</tr>
<tr>
<td>Thick Places</td>
</tr>
<tr>
<td>Broken Picks</td>
</tr>
<tr>
<td>Floats/stitches</td>
</tr>
<tr>
<td>Slubs</td>
</tr>
<tr>
<td>Filament rupture</td>
</tr>
<tr>
<td>Double picks</td>
</tr>
<tr>
<td>Lashing in</td>
</tr>
<tr>
<td>Hole</td>
</tr>
<tr>
<td>Local distortion</td>
</tr>
<tr>
<td>Oil stains</td>
</tr>
<tr>
<td>Slough off</td>
</tr>
<tr>
<td>Smash</td>
</tr>
<tr>
<td>Snarl</td>
</tr>
<tr>
<td>Stitches</td>
</tr>
<tr>
<td>Weft Bar</td>
</tr>
<tr>
<td>Weft crack</td>
</tr>
<tr>
<td>Chapa</td>
</tr>
</tbody>
</table>
Appendix-II

Grading Systems

There are two fabric grading systems viz. 4 point and 10-point system.

- **4-point system.**

  Four point system also called as American Approval manufacturers association [AAMA] a giant grading system for determining fabric quality is widely used by department of Defense in US and endorsed by AAMA and ASQ as in Table I. Total defect points per 100 square meters are calculated using the equation.

  \[ DPPHSY = \frac{TPSIR \times 3600}{F_w \times TYI} \] (II.1)

  Where, \( DPPHSY \) is Defect points per 100 square yards, \( TPSIR \) is total points scored in the roll and \( F_w \) is Fabric width and \( TYI \) is Total Yards Inspected.

  Acceptance criteria are 18/24 points per 100 square meters for shirting /suiting material. If one meter of cloth is having more than 10 points is not acceptable [2]. Disadvantages of 4 point system: It does not have provision for the probability of minor defects causing the fabric to be classified as seconds or minor defects falling out of cutting table during garmenting. There is no standard viewing condition for inspecting the fabric. Manual method has limitation of human error.

- **Ten-Point system**

  In 1955, the Ten-Point System for piece goods evaluation was approved and adopted by the Textile Distributor's Institute and National Federation of Textiles. This system assigns penalty points to each defect, depending on its length. The Ten-Point System is somewhat complicated because points-per-length vary for warp and filling defects. Table II.b shows a breakdown of the points: Under the Ten-Point System, a piece is graded a "first" if the total penalty points do not exceed the total yardage of the piece. A piece is graded a "second" if the total penalty points exceed the total yardage of the piece.
### Appendix-II

#### Table II.B:  
**Four-Point System**

<table>
<thead>
<tr>
<th>Length of defect in fabrics</th>
<th>Points Allotted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 7.5 cms</td>
<td>1</td>
</tr>
<tr>
<td>Over 7.5 cms up to 15 cms</td>
<td>2</td>
</tr>
<tr>
<td>Over 15 cms up to 22.5 cms</td>
<td>3</td>
</tr>
<tr>
<td>Over 22.5 cms</td>
<td>4</td>
</tr>
<tr>
<td>Holes &amp; opening (largest dimension)</td>
<td></td>
</tr>
<tr>
<td>2.5 cms or less</td>
<td>2</td>
</tr>
<tr>
<td>Over 2.5 cms</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Table II.C:  
**Ten-Point System**

<table>
<thead>
<tr>
<th>Length of defect</th>
<th>Points allotted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warp defects</td>
<td></td>
</tr>
<tr>
<td>Up to 2.5 cms</td>
<td>1</td>
</tr>
<tr>
<td>2.5 to 12.5 cms</td>
<td>3</td>
</tr>
<tr>
<td>12.5 cms to 25 cms</td>
<td>5</td>
</tr>
<tr>
<td>26 cms to 90 cms</td>
<td>10</td>
</tr>
<tr>
<td>Filing defect (weft defect)</td>
<td></td>
</tr>
<tr>
<td>Up to 2.5 cms</td>
<td>1</td>
</tr>
<tr>
<td>2.5 cms to 12.5 cms</td>
<td>3</td>
</tr>
<tr>
<td>12.5 inch to half-width</td>
<td>5</td>
</tr>
<tr>
<td>Larger than half-width</td>
<td>10</td>
</tr>
</tbody>
</table>

#### Table II.D:  
**Value Loss Expected from different Types of Looms**

<table>
<thead>
<tr>
<th>Type of Loom</th>
<th>Expected Maximum value loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Automatic Looms</td>
<td>8-10%</td>
</tr>
<tr>
<td>Conventional Automatic Looms</td>
<td>7-8%</td>
</tr>
<tr>
<td>Automatic Looms</td>
<td>5-6%</td>
</tr>
<tr>
<td>Shuttleless weaving Machine</td>
<td>2-3%</td>
</tr>
</tbody>
</table>
Appendix III

Feature Tables showing the abbreviations and long forms of various texture features

Table III.A: Short Forms of Various IP Techniques

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Image Processing Method</th>
<th>Short form</th>
<th>Image Processing Algorithm</th>
<th>Short form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fractal Dimension</td>
<td>FD</td>
<td>Fourier Transform</td>
<td>FT</td>
</tr>
<tr>
<td>2</td>
<td>Bi-Level Transform</td>
<td>BLT</td>
<td>Correlation Approach</td>
<td>CA</td>
</tr>
<tr>
<td>3</td>
<td>Gray Level Statistics</td>
<td>GLS</td>
<td>Gabor Transform</td>
<td>GA</td>
</tr>
<tr>
<td>4</td>
<td>Morphological Operation</td>
<td>MO</td>
<td>Wavelet Transform</td>
<td>WT</td>
</tr>
<tr>
<td>5</td>
<td>Co-occurrence Matrix</td>
<td>COCM</td>
<td>Fourier Power Spectrum</td>
<td>FPS</td>
</tr>
</tbody>
</table>

Table III.B: First Order Histogram Features (Hf)

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Feature Name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mean</td>
<td>H1f1</td>
</tr>
<tr>
<td>2.</td>
<td>Standard deviation</td>
<td>H1f2</td>
</tr>
<tr>
<td>3.</td>
<td>Variance</td>
<td>H1f3</td>
</tr>
<tr>
<td>4.</td>
<td>Skewness</td>
<td>H1f4</td>
</tr>
<tr>
<td>5.</td>
<td>Kurtosis</td>
<td>H1f5</td>
</tr>
<tr>
<td>6.</td>
<td>Energy</td>
<td>H1f6</td>
</tr>
<tr>
<td>7.</td>
<td>Entropy</td>
<td>H1f7</td>
</tr>
</tbody>
</table>

Table III.C: Second Order Histogram Features (H2f)

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Feature Name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Autocorrelation</td>
<td>H2f1</td>
</tr>
<tr>
<td>2.</td>
<td>Covariance</td>
<td>H2f2</td>
</tr>
<tr>
<td>3.</td>
<td>Inertia</td>
<td>H2f3</td>
</tr>
<tr>
<td>4.</td>
<td>Absolute value</td>
<td>H2f4</td>
</tr>
<tr>
<td>5.</td>
<td>Inverse difference</td>
<td>H2f5</td>
</tr>
<tr>
<td>6.</td>
<td>Energy</td>
<td>Hf6</td>
</tr>
<tr>
<td>7.</td>
<td>Entropy</td>
<td>Hf7</td>
</tr>
</tbody>
</table>
Table III. D
Co-occurrence Matrix Features (CMF)

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Feature Name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CM features obtained in four directions viz. 0°, 135°, 90° and 45°</td>
<td>CMf</td>
</tr>
<tr>
<td>2</td>
<td>Angular 2nd moment</td>
<td>CMf1</td>
</tr>
<tr>
<td>3</td>
<td>Contrast (Energy)</td>
<td>CMf2</td>
</tr>
<tr>
<td>4</td>
<td>Correlation</td>
<td>CMf3</td>
</tr>
<tr>
<td>5</td>
<td>Variance</td>
<td>CMf4</td>
</tr>
<tr>
<td>6</td>
<td>Inverse difference moment</td>
<td>CMf5</td>
</tr>
<tr>
<td>7</td>
<td>Sum average</td>
<td>CMf6</td>
</tr>
<tr>
<td>8</td>
<td>Sum Variance</td>
<td>CMf7</td>
</tr>
<tr>
<td>9</td>
<td>Sum Entropy</td>
<td>CMf8</td>
</tr>
<tr>
<td>10</td>
<td>Entropy</td>
<td>CMf9</td>
</tr>
<tr>
<td>11</td>
<td>Difference variance</td>
<td>CMf10</td>
</tr>
<tr>
<td>12</td>
<td>Difference entropy</td>
<td>CMf11</td>
</tr>
<tr>
<td>13</td>
<td>Information measure of correlation</td>
<td>CMf12, CMf13</td>
</tr>
<tr>
<td>14</td>
<td>Maximal Correlation Coefficient</td>
<td>CMf4</td>
</tr>
<tr>
<td>15</td>
<td>Homogeneity</td>
<td>CMf6</td>
</tr>
<tr>
<td>16</td>
<td>Mean</td>
<td>Cmf7</td>
</tr>
<tr>
<td>17</td>
<td>Standard Deviation</td>
<td>Cmf8</td>
</tr>
</tbody>
</table>

Table III. E
Fourier Spectrum Features (FSF)

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Feature Name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Peak Intensity (0,0)( central intensity of spectrum)</td>
<td>FSf1</td>
</tr>
<tr>
<td>2</td>
<td>The intensity subtracts F(0,0) from the 5x5 sample of F(0,0) center</td>
<td>FSf2</td>
</tr>
<tr>
<td>3</td>
<td>Peak intensity at F(1,0)(intensity on u-axis)</td>
<td>FSf3</td>
</tr>
<tr>
<td>4</td>
<td>Peak intensity at F(0,1) (intensity on v-axis)</td>
<td>FSf4</td>
</tr>
<tr>
<td>5</td>
<td>Average intensity between F(0,0) and F(1,0)</td>
<td>FSf5</td>
</tr>
<tr>
<td>6</td>
<td>Average intensity between F(0,0) and F(0,1)</td>
<td>FSf6</td>
</tr>
<tr>
<td>7</td>
<td>Intensity ratio of F(0,0) to F(1,0)</td>
<td>FSf7</td>
</tr>
<tr>
<td>8</td>
<td>Intensity ratio of F(0,0) to F(0,1)</td>
<td>FSf8</td>
</tr>
<tr>
<td>9</td>
<td>Intensity ratio of F(1,0) to F(1,0)</td>
<td>FSf9</td>
</tr>
</tbody>
</table>
### Table III. F

Miscellaneous Features (MF)

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Feature Name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gray level mean</td>
<td>Mf1</td>
</tr>
<tr>
<td>2</td>
<td>Gray level standard deviation</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Spatial frequency</td>
<td>Mf1</td>
</tr>
<tr>
<td>4</td>
<td>Spatial frequency measure</td>
<td>Mf2</td>
</tr>
<tr>
<td>5</td>
<td>Mf2 – RMS row frequency</td>
<td>Mf2-1</td>
</tr>
<tr>
<td>6</td>
<td>Mf2 – RMS row frequency</td>
<td>Mf2-2</td>
</tr>
<tr>
<td>7</td>
<td>Cluster shade</td>
<td>Mf3</td>
</tr>
<tr>
<td>8</td>
<td>Cluster prominence</td>
<td>Mf4</td>
</tr>
<tr>
<td>9</td>
<td>Local Binary Pattern</td>
<td>Mf5</td>
</tr>
<tr>
<td>10</td>
<td>Markov random field matrix</td>
<td>Mf6</td>
</tr>
<tr>
<td>11</td>
<td>Multi resolution spatial</td>
<td>Mf7</td>
</tr>
</tbody>
</table>
Appendix- IV

Neural Net Theory

A classical feed forward neural network theory is presented as, it is used by us for classification of defects. The input propagates till the output layer. The error is calculated and it is propagated back to update the weights until the weights are optimized. The network keeps training all the patterns repeatedly until the total error falls to some pre-determined low target value and then it stops. The adjusted weights after training are used in testing phase.

Fig III.11 Configuration of three layer NN

A classical NN has three layers namely input layer with L nodes, hidden layer with M nodes and output layer with K nodes as shown in Fig III.11. Classification by NN consists of two phases viz. learning phase and second testing phase. Training is equivalent to finding the proper weights for all the connection nodes, so that the desired output is obtained. For training present, the input vector $X_p = (X_{p1}, X_{p2}, X_{p3}, \ldots, X_{pN})$ for each node and
Appendix - IV

desired output for each node in the output layer. The steps involved for NN training and various related equations are as mentioned further.

1. Initialise all the connection weights \( W_{ij} \) between node \( j \) in the hidden layer and node \( i \) in the input layer.

2. Present the input for each node and desired output for each node in the output layer. Input vector is denoted by,

\[
X_p = X_{p1}, X_{p2}, \ldots, X_{pN}.
\]  

(1)

3. Calculate the net input to each node in the hidden layer using

\[
net_{pj}^h = \sum_{i=1}^{N} W_{ij}^h + X_{pi} + \theta_j^h
\]  

(2)

\( \theta_j \) = bias value for hidden layer nodes.

4. Calculate the output of the hidden nodes using,

\[
i_{pj} = f_j^h (net_{pj}^h)
\]  

(3)

\[
f_j^h = \frac{1}{1 + e^{-net_j}}
\]  

(4)

\( f \) – non linear function called sigmoid function.

5. Move to the output layer. Calculate the net input values to each unit using

\[
net_{pk}^o = \sum_{j=1}^{L} W_{kj}^o i_{pj} + \theta_j^o
\]  

(5)

6. Calculate the outputs of all the nodes.

\[
O_{pk} = f_k^o (net_k^o)
\]  

(6)
Appendix- IV

where \( f_k^o = \frac{1}{(1 + e_k^{net,o})} \) \hspace{1cm} (7) is a sigmoid function.

7. Calculate the error term for each output node.

\[ \delta_k^o = (Y_{pk} - O_{pk})O_{pk}(1 - O_{pk}) \] \hspace{1cm} (8)

\( Y_{pk} \) and \( O_{pk} \) stand for actual and desired values for an output node.

8. Calculate the error term for each hidden node.

\[ \delta_i^h = O_{pi}(1 - O_{pi}) \sum_{k=1}^{1} W_{ki}^o \delta_k^o \] \hspace{1cm} (9)

Note: Error terms for hidden units are calculated before the connection weights to the layer have been updated.

9. Update weights of output layer.

\[ W_{ji}^h(t + 1) = (W_{ji}^h(t) + \eta \delta_i^h X_i) + \gamma(W_{ji}^h(t) - W_{ji}^h(t - 1)) \] \hspace{1cm} (10)

10. Update weights of hidden layer.

\[ W_{ji}^h(t + 1) = (W_{ji}^h(t) + \eta \delta_i^h X_i) + \gamma(W_{ji}^h(t) - W_{ji}^h(t - 1)) \] \hspace{1cm} (11)

\( \eta \)-learning rate and \( \gamma \)-momentum factor, its value is a constant between 0 and 1.

11. Return to step 2 to present another new input for each node until all the training sets have been stabilized.
Appendix- IV

Table IV-A: Result of DSA for Normal Twill Sample

<table>
<thead>
<tr>
<th>Samples Numbers</th>
<th>Logic ‘0’- True Normal Sample, Logic ‘1’=Incorrectly Detected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1-12</td>
<td>0</td>
</tr>
<tr>
<td>13-24</td>
<td>0</td>
</tr>
<tr>
<td>25-36</td>
<td>0</td>
</tr>
<tr>
<td>37-48</td>
<td>0</td>
</tr>
<tr>
<td>49-60</td>
<td>0</td>
</tr>
<tr>
<td>61-72</td>
<td>0</td>
</tr>
<tr>
<td>73-84</td>
<td>0</td>
</tr>
<tr>
<td>85-96</td>
<td>0</td>
</tr>
<tr>
<td>97-108</td>
<td>0</td>
</tr>
<tr>
<td>109-115</td>
<td>0</td>
</tr>
</tbody>
</table>

Table IV-B: Result of DSA for Faulty Twill Samples

<table>
<thead>
<tr>
<th>Samples Numbers</th>
<th>Logic ‘1’- True Defect Sample, Logic ‘0’=Incorrectly Detected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1-12</td>
<td>1</td>
</tr>
<tr>
<td>13-24</td>
<td>1</td>
</tr>
<tr>
<td>25-36</td>
<td>1</td>
</tr>
<tr>
<td>37-48</td>
<td>1</td>
</tr>
<tr>
<td>49-60</td>
<td>1</td>
</tr>
<tr>
<td>61-72</td>
<td>1</td>
</tr>
<tr>
<td>73-85</td>
<td>0</td>
</tr>
</tbody>
</table>

IV-C Countercheck Algorithm for Verification of ANN Classification

1. Mix the samples randomly and keep this information as known classification reference. i.e. Group samples/sample type (normal/defect) into different groups $G_1$, $G_2$, $G_3$......... $G_n$ with known ID range.
2. Let the random sample ID be classified by NN into a group, $N_g$.
3. Take $N_g$ and check if $N_g$ falls in the known reference group $G_1$, $G_2$, $G_3$......... $G_n$ identified by us.
4. If yes then NN classification is correct otherwise declare the sample as misclassified.
Table IV-D: Computation of Degree of Periodicity $\alpha$ to SNR for Defect Free Samples S2 class

<table>
<thead>
<tr>
<th>Sample</th>
<th>%DOP</th>
<th>Sample</th>
<th>%DOP</th>
<th>Sample</th>
<th>%DOP</th>
<th>Sample</th>
<th>%DOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_1</td>
<td>10.66</td>
<td>N_{11}</td>
<td>9.18</td>
<td>N_{21}</td>
<td>11.15</td>
<td>N_{31}</td>
<td>11.16</td>
</tr>
<tr>
<td>N_2</td>
<td>10.09</td>
<td>N_{12}</td>
<td>13.49</td>
<td>N_{22}</td>
<td>10.12</td>
<td>N_{32}</td>
<td>11.50</td>
</tr>
<tr>
<td>N_3</td>
<td>9.57</td>
<td>N_{13}</td>
<td>9.23</td>
<td>N_{23}</td>
<td>9.54</td>
<td>N_{33}</td>
<td>11.01</td>
</tr>
<tr>
<td>N_4</td>
<td>9.59</td>
<td>N_{14}</td>
<td>9.50</td>
<td>N_{24}</td>
<td>10.82</td>
<td>N_{34}</td>
<td>10.19</td>
</tr>
<tr>
<td>N_5</td>
<td>9.71</td>
<td>N_{15}</td>
<td>8.87</td>
<td>N_{25}</td>
<td>10.82</td>
<td>N_{35}</td>
<td>9.87</td>
</tr>
<tr>
<td>N_6</td>
<td>9.84</td>
<td>N_{16}</td>
<td>10.32</td>
<td>N_{26}</td>
<td>10.32</td>
<td>N_{36}</td>
<td>8.40</td>
</tr>
<tr>
<td>N_7</td>
<td>9.524</td>
<td>N_{17}</td>
<td>7.93</td>
<td>N_{27}</td>
<td>11.26</td>
<td>N_{37}</td>
<td>9.78</td>
</tr>
<tr>
<td>N_8</td>
<td>10.692</td>
<td>N_{18}</td>
<td>12.04</td>
<td>N_{28}</td>
<td>12.86</td>
<td>N_{38}</td>
<td>9.78</td>
</tr>
<tr>
<td>N_9</td>
<td>11.38</td>
<td>N_{19}</td>
<td>11.79</td>
<td>N_{29}</td>
<td>11.24</td>
<td>N_{39}</td>
<td>11.55</td>
</tr>
<tr>
<td>N_{10}</td>
<td>11.89</td>
<td>N_{20}</td>
<td>12.03</td>
<td>N_{30}</td>
<td>9.86</td>
<td>N_{40}</td>
<td>9.54</td>
</tr>
</tbody>
</table>

Table IV-E: Computation of Degree of Periodicity $\alpha$ to SNR for Loose weft Defect Samples of S2 class

<table>
<thead>
<tr>
<th>Sample</th>
<th>%DOP</th>
<th>Sample</th>
<th>%DOP</th>
<th>Sample</th>
<th>%DOP</th>
<th>Sample</th>
<th>%DOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>F_1</td>
<td>10.21</td>
<td>F_{11}</td>
<td>8.17</td>
<td>F_{21}</td>
<td>7.69</td>
<td>F_{31}</td>
<td>9.56</td>
</tr>
<tr>
<td>F_2</td>
<td>7.10</td>
<td>F_{12}</td>
<td>9.71</td>
<td>F_{22}</td>
<td>7.69</td>
<td>F_{32}</td>
<td>8.85</td>
</tr>
<tr>
<td>F_3</td>
<td>8.53</td>
<td>F_{13}</td>
<td>9.68</td>
<td>F_{23}</td>
<td>7.08</td>
<td>F_{33}</td>
<td>10.15</td>
</tr>
<tr>
<td>F_4</td>
<td>10.35</td>
<td>F_{14}</td>
<td>8.52</td>
<td>F_{24}</td>
<td>8.60</td>
<td>F_{34}</td>
<td>8.57</td>
</tr>
<tr>
<td>F_5</td>
<td>9.85</td>
<td>F_{15}</td>
<td>7.63</td>
<td>F_{25}</td>
<td>9.77</td>
<td>F_{35}</td>
<td>8.46</td>
</tr>
<tr>
<td>F_6</td>
<td>6.44</td>
<td>F_{16}</td>
<td>8.35</td>
<td>F_{26}</td>
<td>10.40</td>
<td>F_{36}</td>
<td>7.61</td>
</tr>
<tr>
<td>F_7</td>
<td>8.02</td>
<td>F_{17}</td>
<td>12.81</td>
<td>F_{27}</td>
<td>10.45</td>
<td>F_{37}</td>
<td>9.45</td>
</tr>
<tr>
<td>F_8</td>
<td>8.49</td>
<td>F_{18}</td>
<td>6.12</td>
<td>F_{28}</td>
<td>8.54</td>
<td>F_{38}</td>
<td>7.40</td>
</tr>
<tr>
<td>F_9</td>
<td>9.02</td>
<td>F_{19}</td>
<td>6.54</td>
<td>F_{29}</td>
<td>7.20</td>
<td>F_{39}</td>
<td>9.67</td>
</tr>
<tr>
<td>F_{10}</td>
<td>9.33</td>
<td>F_{20}</td>
<td>8.95</td>
<td>F_{30}</td>
<td>9.19</td>
<td>F_{40}</td>
<td>6.58</td>
</tr>
</tbody>
</table>