Sign Service Life

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Current Sign Service Life

NCDOT Routine Maintenance Improvement Plan (RMIP) sign service life: 10 years

– There is no study to support this number
– Previous studies indicated that 10 years is an underestimated sign service life
1. Literature Review: DOT’s Practices

<table>
<thead>
<tr>
<th>Sign Service Life</th>
<th>Location</th>
<th>Number of DOTs to Adopt</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 years</td>
<td>Arkansas, Maine</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Mississippi *, North Carolina,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and South Carolina</td>
<td></td>
</tr>
<tr>
<td>12 years</td>
<td>Minnesota, Mississippi *,</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>New York *, South Dakota,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wisconsin, and Wyoming</td>
<td></td>
</tr>
<tr>
<td>15 years</td>
<td>Michigan, New York *, Ohio,</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Oklahoma, and Vermont</td>
<td></td>
</tr>
<tr>
<td>18 years</td>
<td>Indiana</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

* Indicates a range for that state

- Most DOTs use a sign life > 10 years
1. Literature Review: Studies Recommendations

<table>
<thead>
<tr>
<th>Authors</th>
<th>Location</th>
<th>Sign Service Life-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dumont et al. (2013)</td>
<td>Minnesota</td>
<td>Minimum: 15 years</td>
</tr>
</tbody>
</table>
| Immaneni et al. (2009)   | North Carolina   | 20 to 30 years for white  
                       |                  | 24 years for yellow and red  
                       |                  | 37 years for green  |
| Clevenger et al. (2012)  | Pennsylvania     | Minimum: 15 years  |
| Pulver et al. (2018)     | South Carolina   | 10 years           |
| Kipp and Fitch (2009)    | Vermont          | 15 years for red  
                       |                  | 15 to 20 years for white, yellow, and green  |
| Pike and Carlson (2014)  | Wyoming          | Recommendation: 15 years |

• Most literature studies recommend a sign life $\geq$ 15 years
White Type III Sheeting

Retroreflectivity (cd/lx/m²)

Sign Age (Years)

Min (white on red) = 35
Min (black on white) = 50
Min (white on green) = 120

Black et al.  Bischoff and Bullock  Rasdorf et al.  Kipp and Fitch
Immaneni et al.  Re et al.  Clevenger et al.  Huang et al.
Pike and Carlson  Preston et al.  Min: White on Red  Min: White on Green

Min: Black on White
Yellow Type III Sheeting

<table>
<thead>
<tr>
<th>Study</th>
<th>Min (signs &lt; 48&quot;)</th>
<th>Min (signs ≥ 48&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black et al.</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>Bischoff and Bullock</td>
<td></td>
<td></td>
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<tr>
<td>Rasdorff et al.</td>
<td></td>
<td></td>
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<tr>
<td>Immaneni et al.</td>
<td></td>
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<tr>
<td>Re et al.</td>
<td></td>
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<tr>
<td>Clevenger et al.</td>
<td></td>
<td></td>
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<tr>
<td>Pike and Carlson</td>
<td></td>
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</tbody>
</table>

Retroreflectivity (cd/lx/m²) vs. Sign Age (years)
Red Type III Sheeting

Retroreflectivity (cd/lx/m²) vs. Sign Age (years)

- Black et al.
- Bischoff and Bullock
- Kipp and Fitch
- Immaneni et al.
- Re et al.
- Clevenger et al.
- Preston et al.
- Min

Min = 7
Green Type III Sheeting

Retroreflectivity (cd/lx/m²)

Sign Age (years)

Min = 15

Black et al.
Kipp and Fitch
Immaneni et al.
Clevenger et al.
Huang et al.
Pike and Carlson
Preston et al.
Min
2. Simulation

- Considered only spot replacement (there is no nighttime inspection nor blanket replacement)

- Input data
  - Deterioration models obtained from Immaneni et al. (2009) study
  - Sign color distribution obtained from Palmquist and Rasdorff (2001) study
  - 10,000 signs simulated for a period of 30 years
  - Annual damage rate of 4.04% (Rasdorf et al., 2006)
  - Annual spot replacement rate of 41.09% of damaged signs (Rasdorf and Machado, 2018)
Simulation Results (10,000 signs)

Damage rate 4.04% of signs. Spot replacement 41.09% of damaged signs.
Deterioration curves from Immaneni et al. (2009)

Note: White signs remain within compliance through 30 years
## 2. Simulation Results

<table>
<thead>
<tr>
<th>Years</th>
<th>Unsatisfactory Signs (Damaged + Non Compliant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5</td>
<td>2% to 5%</td>
</tr>
<tr>
<td>6 to 19</td>
<td>5%</td>
</tr>
<tr>
<td>20 to 22</td>
<td>10%</td>
</tr>
<tr>
<td>23 to 28</td>
<td>26%</td>
</tr>
<tr>
<td>29 and 30</td>
<td>28%</td>
</tr>
</tbody>
</table>
### 3. Glass Beaded Versus Prismatic Sheetung

<table>
<thead>
<tr>
<th>Color</th>
<th>Encapsulated Glass Bead Type III</th>
<th>Microprismatic Type III (High Intensity Prismatic)</th>
<th>Improvement From Glass-Bead to Microprismatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>250</td>
<td>560</td>
<td>310 (124%)</td>
</tr>
<tr>
<td>Yellow</td>
<td>170</td>
<td>420</td>
<td>250 (147%)</td>
</tr>
<tr>
<td>Red</td>
<td>45</td>
<td>84</td>
<td>39 (87%)</td>
</tr>
<tr>
<td>Green</td>
<td>45</td>
<td>56</td>
<td>11 (24%)</td>
</tr>
</tbody>
</table>

- Most, if not all, previous studies were done on glass beaded signs
- Microprismatic sheeting is superior to previous results
Warranty for White Type III Sheeting

- Min White: White on Green = 120
- Min White: Black on White
- Min White: White on Red = 35

Linear estimate of aggregate degradation
JKL Estimate

Retroreflectivity (cd/lx/m²)

Sign Age (years)
Warranty for Yellow Type III Sheeting

Retroreflectivity (cd/lx/m²) vs. Sign Age (years)

Linear estimate of aggregate degradation JKL Estimate

Min Yellow: signs ≥ 48" = 50
Min Yellow: signs < 48" = 75

Warranted Yellow
Warranty for Red Type III Sheeting

Linear estimate of aggregate degradation
JKL Estimate

Min = 7
Warranty for Green Type III Sheeting

- **Linear estimate of aggregate degradation**
- **JKL Estimate**
- **Min = 15**

- **Min Green**
- **Warranted Green**
4. Budget Impacts

Increasing the service sign life from 10 to 20 years

– Reduce annual cost by 50%
– Reduce need for night time inspections
– Double existing length of life
– Better utilization of public funds
– Documented vs. Subjective Decisions
– Create opportunity for budget savings to be utilized to replace outdated over head signs and large ground mounted signs.
5. Recommendations

Considered a Sign life expectancy of 20 years with a 8 year grace period for all signs expect red signs (1 year).

- Recommended practice based on field data collected, conversations with staff and retro reflective data from industry.

- 1 year grace period for Red signs (Division can track signs to be used for damaged in areas where sign life will not exceed 20 years)

- 8 year grace period for all other signs. (under sign replacement strategy – if sign is < 8 years stays until next cycle if > 8 recycle

- Signs greater than 8 years can be utilized for replacement of damage signs and missing, but will require tracking. **Do not reuse in areas where it will exceed the life by 20 years. This may be more effort than the benefit.

- Complete interim sign inspections as part of routine maintenance
6. Next Steps

– Integrate recommendation into RMIP

– Reanalyze the study again in 15 years with field measurements to confirm data.
Questions? Comments?