Abstract

Drivers of residential solid waste collection trucks are exposed to a wide variety of physical and health hazards. Automated robotic arm collection methods eliminated most physical and ergonomic hazards associated with manual waste collection. However, whole-body vibration (WBV) exposure is a hazard that may be significant and greater than found in semi-automated or manual methods. WBV was found in a pilot field study of automated waste collection trucks. Four trials were run under similar route conditions. Vibrations were measured at the seat-driver interface using a tri-axial accelerometer seat pad and portable vibration monitors and compared with WBV from prior published waste collection data. The average WBV exposure value, corresponding to 0.99 m/s², was below the limit value of 1.15 m/s² for frequency-weighted r.m.s. acceleration, which is the ISO 2631-1 action level zone present potential health risks.

Methods

A summary of the frequency weighted r.m.s. Aeq values in the X, Y, Z, and XYZ axes are presented in Table 1. The respective averages are presented at the bottom of the table. The four values for the XYZ-sum are within 0.99 m/s² ± 0.02 average. The individual X, Y, and Z axis values for the trucks ranged from 0.36–0.40, 0.35–0.46, and 0.56–0.65 respectively for the three axes; the widest distribution was noted in the X-axis data. XYZ-sum axes Vibration Dose Values (VDV) ranged 3.31 to 9.77 and the Crest Factors (CF) 2.84 to 8.04.

Table 2 presents data for WBV during three phases of the collection operation. The X and Y axes are highest in the collection mode due to the lateral movement of the robotic arm and very frequent start and stop motion of the vehicle.

The following visually depicts vibration in the individual three axes and combined throughout an 8-hour workday. Each mode of operation shows its own distinct vibration patterns (collection and drive).

Conclusions

This study found automated residential waste collection drivers are exposed to WBV levels associated with an increased health risk while working.

In the absence of a U.S. regulatory standard, a comparison of findings is made with European minimum requirements for the protection of workers from exposure to mechanical vibration. European Directive 2002/44/EC presents a daily exposure action value of 0.5 m/s² and a limit value of 1.15 m/s².

Table 3. Comparison of Findings with Prior Studies According to Axis, m/s²

<table>
<thead>
<tr>
<th>Waste Collection Type</th>
<th>Daily Exposure</th>
<th>Peak Exposure</th>
<th>Water Collection Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>Maximum</td>
<td></td>
<td>Average</td>
</tr>
<tr>
<td>Semi-</td>
<td>manual</td>
<td>semi-</td>
<td>automated</td>
</tr>
<tr>
<td>Manual</td>
<td>0.90</td>
<td>1.31</td>
<td>0.45</td>
</tr>
<tr>
<td>Automated</td>
<td>1.34</td>
<td>2.42</td>
<td>1.13</td>
</tr>
</tbody>
</table>

This study identified a need to improve operation mode detail from the operator or an assigned observer. Additional variables to consider for further research include the effects of operation route, collection route characteristics (terrain, road, home spacing), equipment type, and seat transmission (seat type, condition, adjustment).

References

2. European Parliament Directive 2002/44/EC presents a daily exposure action value of 0.5 m/s² and a limit value of 1.15 m/s² (2002/44/EC).
3. Whole body vibration exposure in residential solid waste collection. Helmut Paschold, Ph.D., CSP, CIH, PE & Jeremy Slaglay, Ph.D., CSP, CIH
4. Indiana University of Pennsylvania, Department of Safety Sciences

Whole body vibration exposure in residential solid waste collection

Helmut Paschold, Ph.D., CSP, CIH, PE & Jeremy Slaglay, Ph.D., CSP, CIH

Abstract

Drivers of residential solid waste collection trucks are exposed to a wide variety of physical and health hazards. Automated robotic arm collection methods eliminated most physical and ergonomic hazards associated with manual waste collection. However, whole-body vibration (WBV) exposure is a hazard that may be significant and greater than found in semi-automated or manual methods. WBV was found in a pilot field study of automated waste collection trucks. Four trials were run under similar route conditions. Vibrations were measured at the seat-driver interface using a tri-axial accelerometer seat pad and portable vibration monitors and compared with WBV from prior published waste collection data. The average WBV exposure value, corresponding to 0.99 m/s², was below the limit value of 1.15 m/s² for frequency-weighted r.m.s. acceleration, which is the ISO 2631-1 action level zone present potential health risks.

Methods

A summary of the frequency weighted r.m.s. Aeq values in the X, Y, Z, and XYZ axes are presented in Table 1. The respective averages are presented at the bottom of the table. The four values for the XYZ-sum are within 0.99 m/s² ± 0.02 average. The individual X, Y, and Z axis values for the trucks ranged from 0.36–0.40, 0.35–0.46, and 0.56–0.65 respectively for the three axes; the widest distribution was noted in the X-axis data. XYZ-sum axes Vibration Dose Values (VDV) ranged 3.31 to 9.77 and the Crest Factors (CF) 2.84 to 8.04.

Table 2 presents data for WBV during three phases of the collection operation. The X and Y axes are highest in the collection mode due to the lateral movement of the robotic arm and very frequent start and stop motion of the vehicle.

The following visually depicts vibration in the individual three axes and combined throughout an 8-hour workday. Each mode of operation shows its own distinct vibration patterns (collection and drive).

Conclusions

This study found automated residential waste collection drivers are exposed to WBV levels associated with an increased health risk while working.

In the absence of a U.S. regulatory standard, a comparison of findings is made with European minimum requirements for the protection of workers from exposure to mechanical vibration. European Directive 2002/44/EC presents a daily exposure action value of 0.5 m/s² and a limit value of 1.15 m/s². All four measurements showed exposure to be above the action value and below the limit value. According to ISO 2631-1:1997(E), values in the action level zone present potential health risks requiring attention. Precise assessment of risk within the action level zone is currently not feasible, however, it should be noted that the average XYZ-sum value, 0.99 m/s², was only 15% below the limit value that suggests health risks are likely.

The automated system had higher vibration levels than those found for semi-automated collection methods as reported by prior researchers monitoring WBV in refuse collection [9, 10, 11].

References

2. European Parliament Directive 2002/44/EC presents a daily exposure action value of 0.5 m/s² and a limit value of 1.15 m/s² (2002/44/EC).
3. Whole body vibration exposure in residential solid waste collection. Helmut Paschold, Ph.D., CSP, CIH, PE & Jeremy Slaglay, Ph.D., CSP, CIH
4. Indiana University of Pennsylvania, Department of Safety Sciences

Whole body vibration exposure in residential solid waste collection

Helmut Paschold, Ph.D., CSP, CIH, PE & Jeremy Slaglay, Ph.D., CSP, CIH

Abstract

Drivers of residential solid waste collection trucks are exposed to a wide variety of physical and health hazards. Automated robotic arm collection methods eliminated most physical and ergonomic hazards associated with manual waste collection. However, whole-body vibration (WBV) exposure is a hazard that may be significant and greater than found in semi-automated or manual methods. WBV was found in a pilot field study of automated waste collection trucks. Four trials were run under similar route conditions. Vibrations were measured at the seat-driver interface using a tri-axial accelerometer seat pad and portable vibration monitors and compared with WBV from prior published waste collection data. The average WBV exposure value, corresponding to 0.99 m/s², was below the limit value of 1.15 m/s² for frequency-weighted r.m.s. acceleration, which is the ISO 2631-1 action level zone present potential health risks.

Methods

A summary of the frequency weighted r.m.s. Aeq values in the X, Y, Z, and XYZ axes are presented in Table 1. The respective averages are presented at the bottom of the table. The four values for the XYZ-sum are within 0.99 m/s² ± 0.02 average. The individual X, Y, and Z axis values for the trucks ranged from 0.36–0.40, 0.35–0.46, and 0.56–0.65 respectively for the three axes; the widest distribution was noted in the X-axis data. XYZ-sum axes Vibration Dose Values (VDV) ranged 3.31 to 9.77 and the Crest Factors (CF) 2.84 to 8.04.

Table 2 presents data for WBV during three phases of the collection operation. The X and Y axes are highest in the collection mode due to the lateral movement of the robotic arm and very frequent start and stop motion of the vehicle.

The following visually depicts vibration in the individual three axes and combined throughout an 8-hour workday. Each mode of operation shows its own distinct vibration patterns (collection and drive).

Conclusions

This study found automated residential waste collection drivers are exposed to WBV levels associated with an increased health risk while working.

In the absence of a U.S. regulatory standard, a comparison of findings is made with European minimum requirements for the protection of workers from exposure to mechanical vibration. European Directive 2002/44/EC presents a daily exposure action value of 0.5 m/s² and a limit value of 1.15 m/s². All four measurements showed exposure to be above the action value and below the limit value. According to ISO 2631-1:1997(E), values in the action level zone present potential health risks requiring attention. Precise assessment of risk within the action level zone is currently not feasible, however, it should be noted that the average XYZ-sum value, 0.99 m/s², was only 15% below the limit value that suggests health risks are likely.

The automated system had higher vibration levels than those found for semi-automated collection methods as reported by prior researchers monitoring WBV in refuse collection [9, 10, 11].

References

2. European Parliament Directive 2002/44/EC presents a daily exposure action value of 0.5 m/s² and a limit value of 1.15 m/s² (2002/44/EC).
3. Whole body vibration exposure in residential solid waste collection. Helmut Paschold, Ph.D., CSP, CIH, PE & Jeremy Slaglay, Ph.D., CSP, CIH
4. Indiana University of Pennsylvania, Department of Safety Sciences