Threshold Limit Values for Physical Agents (TLV®-PA) Committee

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Updates for 2006

• RF&MW: Note on Ultra-wide bandwidth

• Sub-RF Magnetic Fields: Note on Contact Currents

• Sub-RF Static Fields: Note on Contact Currents

• Noise: Note on Ototoxicity

• Note on carcinogenicity
NICs for 2006

• Visible and Near Infrared Radiation

• Heat Stress and Strain
Visible and Near Infrared Radiation

Thermal Effects Hazard Function
Overestimated Risk

• The risk of thermal effects between 380 and 500 nm was higher than necessary.

• The hazard function \([R(\lambda)]\) in this range was reduced accordingly.
Graphically Speaking

![Graph showing hazard function with wave length in nm on the x-axis and hazard function on the y-axis. Two lines represent R(\lambda) - New and R(\lambda) - Old.]
Heat Stress and Strain

Major Changes
Action Limit

• Action Limit
  ✓ Replaces the Unacclimatized TLV®

• Work below the Action Limit is presumptively low stress for any healthy worker.
TLV® for Heat Stress

![Graph showing the relationship between Metabolic Rate (W) and WBGTeff (°C)].

- **TLV®**
- **Action Limit**
Accounting for Clothing

• Clothing makes an environmental condition seem worse. It reduces both evaporative and dry heat exchange.

• Intuitively, there should be a factor that adjusts the environmental measures to an equivalent condition in work clothes.
## Changed and Expanded for 2006

**Clothing Adjustment Factors [°C-WBGT]**

<table>
<thead>
<tr>
<th>Clothing Type</th>
<th>Previous</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Clothes (Baseline)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cloth Coveralls</td>
<td>3.5</td>
<td>0</td>
</tr>
<tr>
<td>Double Layer Cloth Clothing</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>SMS Coveralls</td>
<td>---</td>
<td>0.5</td>
</tr>
<tr>
<td>Polyolefin Coveralls</td>
<td>---</td>
<td>1</td>
</tr>
<tr>
<td>Limited-use Vapor-Barrier Coveralls</td>
<td>---</td>
<td>11</td>
</tr>
</tbody>
</table>
Environment Plus Clothing

Effective WBGT \( (WBGT_{\text{eff}}) \) =

\[ \text{Measured WBGT} + \text{Clothing Adjustment Factor (CAF)} \]
Heat Stress and Strain

TLV®

Process Flow

(See TLV® Decision Flow Chart)
Screening

1. Clothing Adjustment Factors Available?
   - NO
   - YES

2. Are Screening Criteria for Action Limit Exceeded?
   - NO
   - YES

3. Are Screening Criteria for TLV® Exceeded?
   - NO
   - YES

- NO: Continue Work
- YES: Implement General Controls

Low Risk
- Monitor Conditions

Continue Work
- Maintain Controls
- Monitor Conditions
Table Changes for 2006

• Assigned metabolic rate in each category has a lower value.
  ✓ Better reflects work physiology principles and other standards.
  ✓ Means higher WBGT values.

• Allocation of Work/Rest described as a range of % work in the cycle.
## Metabolic Rate by Category

### Reference Metabolic Rate [W]

<table>
<thead>
<tr>
<th>Category</th>
<th>Previous</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest (Baseline)</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>Light</td>
<td>230</td>
<td>180</td>
</tr>
<tr>
<td>Moderate</td>
<td>350</td>
<td>300</td>
</tr>
<tr>
<td>Heavy</td>
<td>465</td>
<td>415</td>
</tr>
<tr>
<td>Very Heavy</td>
<td>580</td>
<td>520</td>
</tr>
</tbody>
</table>
## Screening Action Limit

<table>
<thead>
<tr>
<th>%Work</th>
<th>L</th>
<th>M</th>
<th>H</th>
<th>VH</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 to 100</td>
<td>28.1</td>
<td>25.0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>50 to 75</td>
<td>28.7</td>
<td>26.0</td>
<td>24.2</td>
<td>--</td>
</tr>
<tr>
<td>25 to 50</td>
<td>29.3</td>
<td>27.2</td>
<td>25.7</td>
<td>24.6</td>
</tr>
<tr>
<td>0 to 25</td>
<td>30.0</td>
<td>28.8</td>
<td>27.8</td>
<td>27.0</td>
</tr>
</tbody>
</table>

Note: TLVs® and BEIs® Book rounds these numbers to the nearest 0.5 °C-WBGT
**Screening TLV®**

<table>
<thead>
<tr>
<th>%Work</th>
<th>L</th>
<th>M</th>
<th>H</th>
<th>VH</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 to 100</td>
<td>30.8</td>
<td>28.2</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>50 to 75</td>
<td>31.2</td>
<td>29.0</td>
<td>27.6</td>
<td>--</td>
</tr>
<tr>
<td>25 to 50</td>
<td>31.8</td>
<td>30.1</td>
<td>28.8</td>
<td>27.9</td>
</tr>
<tr>
<td>0 to 25</td>
<td>32.3</td>
<td>31.3</td>
<td>30.5</td>
<td>29.8</td>
</tr>
</tbody>
</table>

Note: TLVs® and BEIs® Book rounds these numbers to the nearest 0.5 ° C-WBGT
Detailed Analysis

Are Data Available for Detailed Analysis?

Yes

Action Limit Exceeded?

No

Low Risk

Continue Work
Monitor Conditions

Yes

TLV® Exceeded?

No

Implement General Controls

Yes

Continue Work
Maintain Controls
Monitor Conditions
Task Analysis

• Breakdown by Location

• Breakdown by Homogeneous Activities

• Time Assigned for Each Location/Activity
Metabolic Rate Categories

• Light
  ✓ 180 W
  ✓ sitting, standing, light hand/arm work

• Moderate
  ✓ 300 W
  ✓ walking, moderate lifting

• Heavy
  ✓ 415 W
  ✓ heavy materials handling

• Very Heavy
  ✓ 520 W
  ✓ pick and shovel work

Potential Error
  • Broad Range
  • Over-Estimation
ISO Estimation Method

Earlier Methods in NIOSH Criteria Document

Components of Metabolic Rate

✓ Basal (Base) Metabolism (B)
✓ Posture (P)
✓ Type of Work (W)
✓ Walking (D)
✓ Climbing (C)

Total Metabolic Rate \( (M) = B + P + W + D + C \)
Clothing Adjustments to WBGT

\[ WBGT_{\text{measured}} + \text{Clothing Adjustment} = WBGT_{\text{eff}} \]
Time-Weighted Average

\[
\text{TWA-WBGT}_{\text{eff}} = \frac{\text{WBGT}_{\text{eff1}} \times t_1 + \cdots + \text{WBGT}_{\text{effn}} \times t_n}{t_1 + \cdots + t_n}
\]

\[
\text{TWA-M} = \frac{M_1 \times t_1 + \cdots + M_n \times t_n}{t_1 + \cdots + t_n}
\]

Over one to two hour time period.
Where is the job?

![Graph showing WBGTeff (°C) vs. Metabolic Rate [W]. The graph includes a solid line labeled "TLV®" and a dashed line labeled "Action Limit." The x-axis represents Metabolic Rate in watts, ranging from 100 to 600. The y-axis represents WBGTeff in °C, ranging from 20 to 36.]
Job Risk Factors

• Traditional
  ✓ Environment
  ✓ Work Demands
  ✓ Clothing Requirements

• Plus Time
Empirical Time Limits

US Navy PHEL Charts

![Graph showing WBGT vs. Exposure Time for different power levels (260 W, 200 W, 155 W).]
Rational Time Limits


- PHS: Predicted Heat Strain
Heat Strain Monitoring

When working above the TLV® or under conditions when a detailed analysis cannot be performed.
Heat Strain Monitoring

TLV® Exceeded?

Perform Heat Strain (Physiological) Monitoring

Excessive Heat Strain Based on Monitoring?

Continue Work
Maintain Controls
Monitor Conditions

Implement General Controls

YES

NO

Implement Job-Specific Controls

YES

NO
Body Core Temperature

• Acceptable Limit
  ✓ Acclimatized, Healthy, Experienced: 38.5 °C
  ✓ Unacclimatized and Unselected: 38 °C

• Oral Temperature
  ✓ No recent drinks/food, mouth closed
  ✓ Core is Oral plus 0.5 °C
Heart Rate

• Sustained heart rate greater than (180 - Age)

• Recovery heart rate greater than 120 bpm at one minute
Symptoms

• Sudden or severe fatigue, nausea, dizziness, or lightheadedness.

MEDICAL EMERGENCY

• Disorientation, irritability, malaise, chills, unconscious.
Patterns of Strain

• No pattern of excessive strain

• Pattern of excessive strain
Under Study*

• Ergonomics
  ✓ Hand-Arm Vibration
  ✓ Localized Fatigue

• Lasers

• Nonionizing Radiation
  ✓ Light and Near Infrared
  ✓ Radiofrequency and microwave radiation
  ✓ Static Magnetic Fields
  ✓ Ultraviolet Radiation

• Cold Stress

*Refer to the ACGIH® website for the up-to-date list. This list is evergreen and can change during the year.
Thank You

Thanks to
the Committee members