

AN ERGONOMIC EVALUATION

Ankh Morpork Postal Service

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Topic Outline

1 Introduction to Ankh
Morpork Postal Service

2 Tasks & Key Ergonomic
Concerns

3 Analysis

4 Recommendations



Ankh Morpork Postal Service (AMPS)

Introduction

- mail delivery service of envelopes and packages
 - maximum weight for packages: 30 kg
 - maximum size packages: 100cmx50cmx50xcm
- each mail carrier is assigned a geographical area
 - shifts are 8 hours in length
 - deliveries proceed “rain or shine”

However:

The postal service had an increase in reported musculoskeletal disorders once incorporating packages into their deliveries.



Purpose

This case study will focus on engaging an ergonomics consultant to comprehensively evaluate the operations of the Ankh Morpork Postal Service and to identify areas of risk.



Ergonomic Concerns

TASKS & KEY CONCERNs

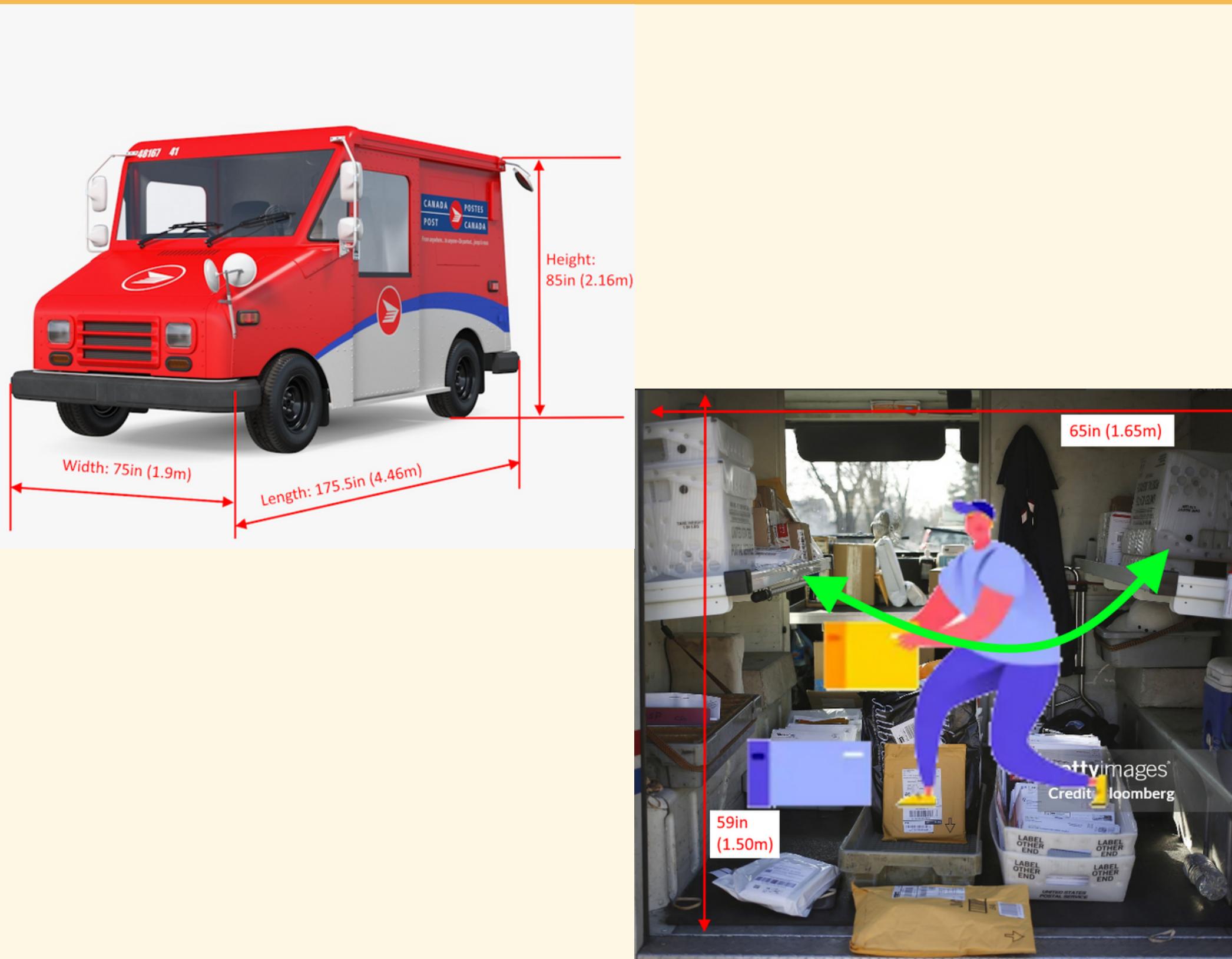
- Rearranging truck and lifting and carrying packages
 - Musculoskeletal Disorders
- Slips Trips and Falls (ex. due to weather)
- Heat and Cold Stress
- Vibration from driving in the truck





Analysis

Reorganizing of Mail Tray/Package



NIOSH Method – Lifting, Lowering,
Twisting

Liberty Mutual (LM-MMH) Method
– Lifting, Lowering

UTAH estimation – Lifting Force

Rapid Upper Limb Assessment

REORGANIZING OF MAIL TRAY/PACKAGE

NIOSH Method - Lifting, Lowering, Twisting

NIOSH Method	
Lifting Indicator (Mail Tray - 5kg)	0.885 \leqslant 1
Lifting Indicator(Package - 30kg)	5.31 \geqslant 1

Liberty Mutual (LM-MMH) Method - Lifting, Lowering

Liberty Mutual (LM-MMH) Method	
Male Case for Mail Tray - 5kg (3/min)	Lift: 28.8kg Lower: 31.0kg
Male Case for Package - 30kg (2/min)	Lift: 31.7kg Lower: 33.7kg
Female Case for Mail Tray - 5kg (3/min)	Lift: 12.3kg Lower: 12.5kg
Female Case for Package - 30kg (2/min)	Lift: 13.0kg Lower: 13.3kg

UTAH estimation - Lifting Force

Activity	Force (N)
Mail Tray (5kg) for Male	2945
Mail Tray (5kg) for Female	2527
Package (30kg) for Male	7720
Package (30kg) for Female	7302
Reference	3100

Rapid Upper Limb Assessment

Activity	RULA Score
Mail Tray (5kg) Lifting	7
Mail Tray (5kg) Lowering	4
Package (30kg) Lifting	7
Package (30kg) Lowering	7

Lifting, Carrying and Lowering of Packages from Truck to Residences



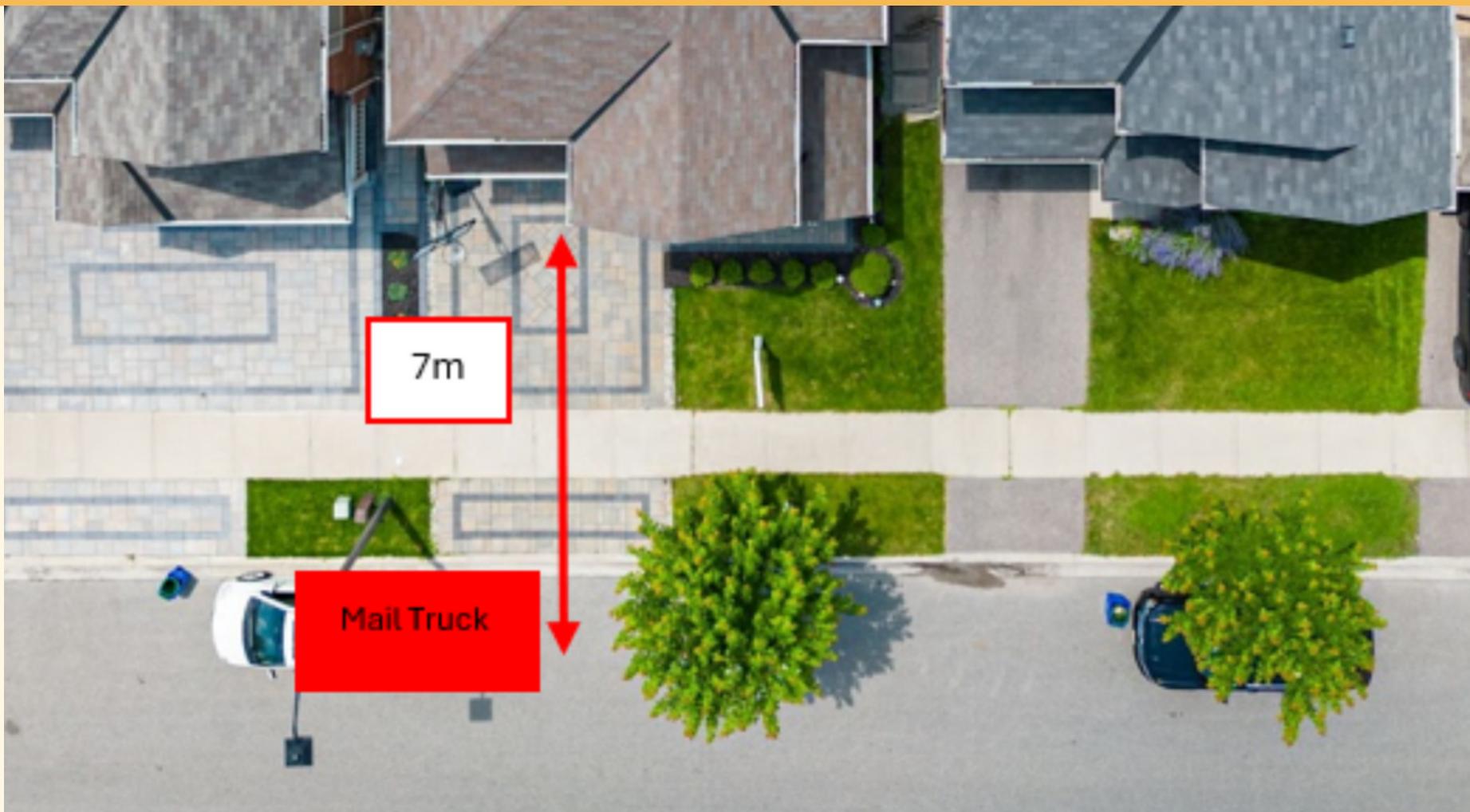
The main purpose of the job of a delivery person is delivering packages and mail to hundreds of houses per day.

The role is very demanding due to the high frequent rate of lifting, carrying and lowering of those packages.

The job comes with a high risk of many musculoskeletal disorders (MSDs), specifically to lower back.



Lifting, Carrying and Lowering of Packages from Truck to Residences



Lifting, Carrying and Lowering of Packages from Truck to Residences

NIOSH Method

NIOSH Equation for Lifting Outputs		Value-Package 30Kg	Value - Mail 2Kg
Recommended Weight Limit (RWL)	$LC \times HM \times VM \times DM \times FM \times AM \times CM$	M:10.5 F: 10.7	M:20.2 F: 20.7
Lifting Indicator (LI) for Package	Load Weight (Package) 30 kg / RWL(Av) 10.6	2.83 Acceptable but should attempt redesign	
Lifting Indicator (LI) for Mail	Load Weight (Mail) 2kg/ RWL(Av) 20.45		0.098 Objective for task design



Liberty Mutual (LM-MMH) Method



Lift/ Lower	Items	Sex	Freq. times/min	Max Allowed Lift (kg)/%Capable	Max Allowed Lower (kg)/%Capable	Safety Concern & Comments
	Mail (2kg)	M	0.32	45.5 kg/100%	47.2 kg/99.9%	Acceptable
		F		19.4 kg/100.0%	19.7 kg/99.9%	Acceptable
Carry	Package (30kg)	M	0.16	35.3 kg/86.8%	36.7 kg/87.5%	Acceptable
		F		13.9 kg/0.1%	14.1 kg/1.3%	Not Acceptable
Carry	Items	Sex	Freq. times/min	Max Allowed Carried (kg)/%Capable		
	Mail (2kg)	M	0.32	23 kg / 100%		
		F		15.0 kg/100%		
	Package (30kg)	M	0.16	25.6 kg/56.6%		
		F		15.9 kg/0.5%		

Slips, Trips & Falls

Slips, trips and falls are a very common reason for injuries in various occupational settings. The biggest potential for accidents are:

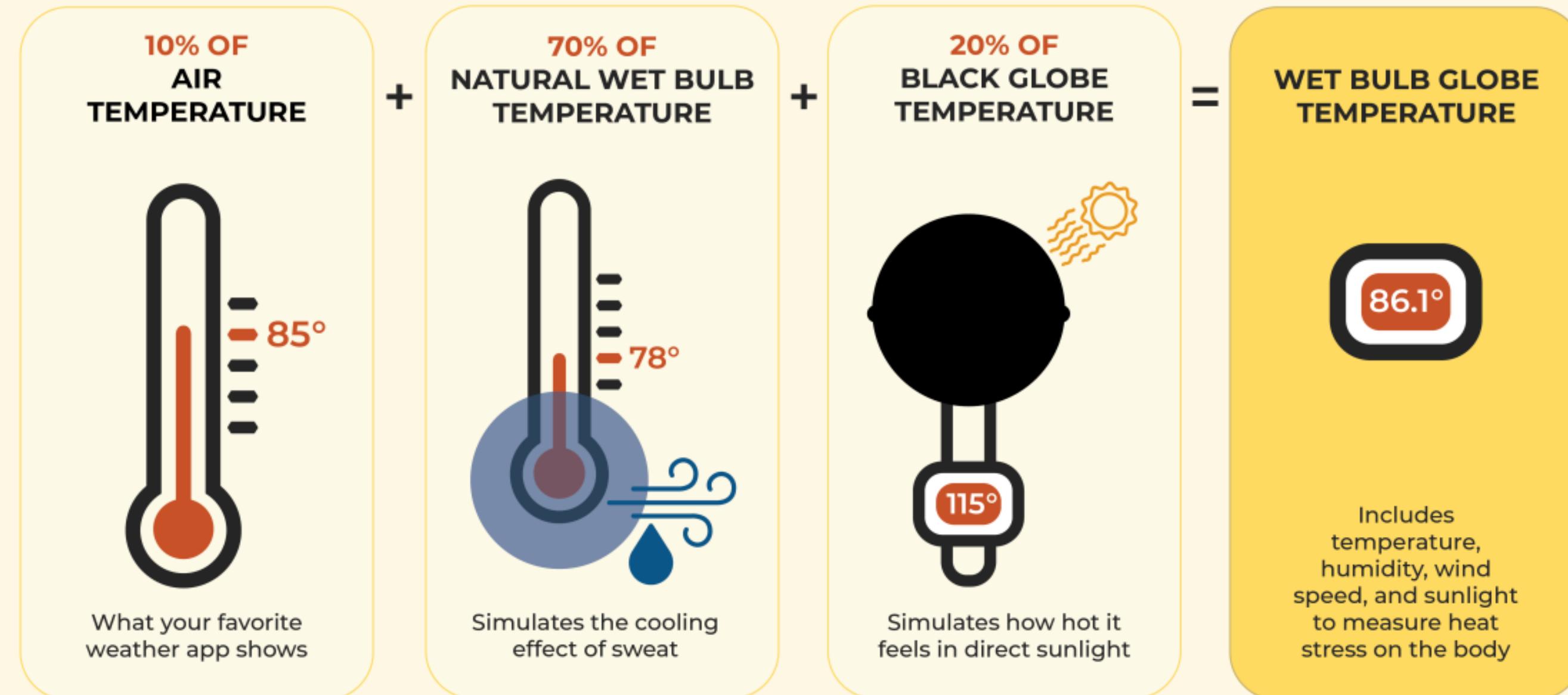
- Uneven sidewalks/pavement/flooring,
- Wet surfaces
- Cluttered pathways
- Tripping hazards including cords, rugs, stairs and steps.

However, icy conditions are much more dangerous, 70% of all falls are due to icy, wet or snowy surfaces.

In Ontario, about 20,000 emergency department visits and 2,000 hospitalizations are due to falls on ice.



Heat Stress



Heat Stress

	September 4, 2023
Air Temperature	91°F/32.9 °C
Cloud Cover	Clear (solar irradiance of 990 w/m ²)
Wind Speed	16 mph
Relative Humidity	46%
Barometric Pressure	29.26 inHg
Clothing Adjustment Factor	0 - work clothes

WBGT is 29°C

WBGT Effective = WBGT Outside + Clothing Adjustment Factor (CAF) (Celsius)

WBGT_{eff} = 29°C

METS for mail carrier = 2.3

Female = 66.80kg

Female Metabolic Rate = 187.44 Watts

Male = 84.60kg

Male Metabolic Rate = 237.39 Watts

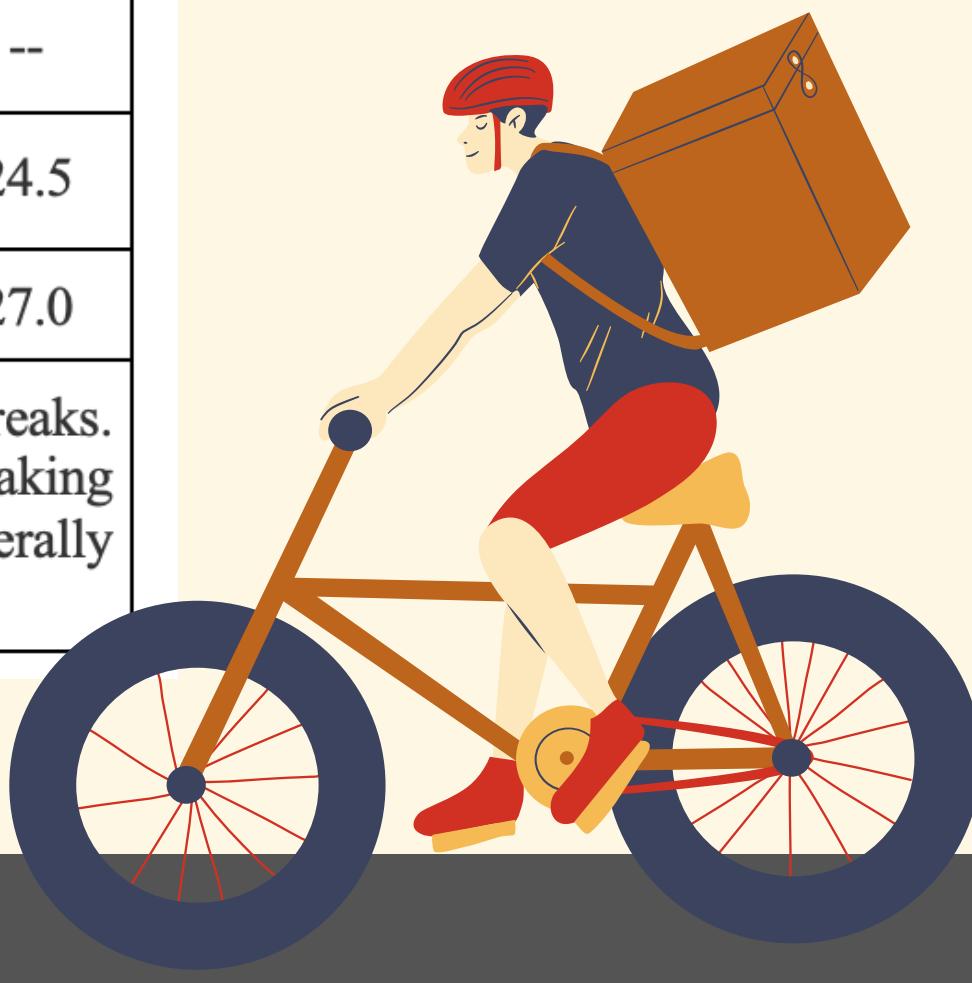
Work Category = Light (180-300 Watts)



Heat Stress

Allocation of Work in a Work/Rest Cycle	Acclimatized				Action Limit (Unacclimatized)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75-100%	31.0	28.0	--	--	28.0	25.0	--	--
50-75%	31.0	29.0	27.5	--	28.5	26.0	24.0	--
25-50%	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0-25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

Notes: Assumes 8-hour workdays in a 5-day workweek with conventional breaks. TLVs assume that workers exposed to these conditions are adequately hydrated, are not taking medication, are wearing lightweight clothing (long-sleeve shirts and pants) and are in generally good health.



Cold Stress



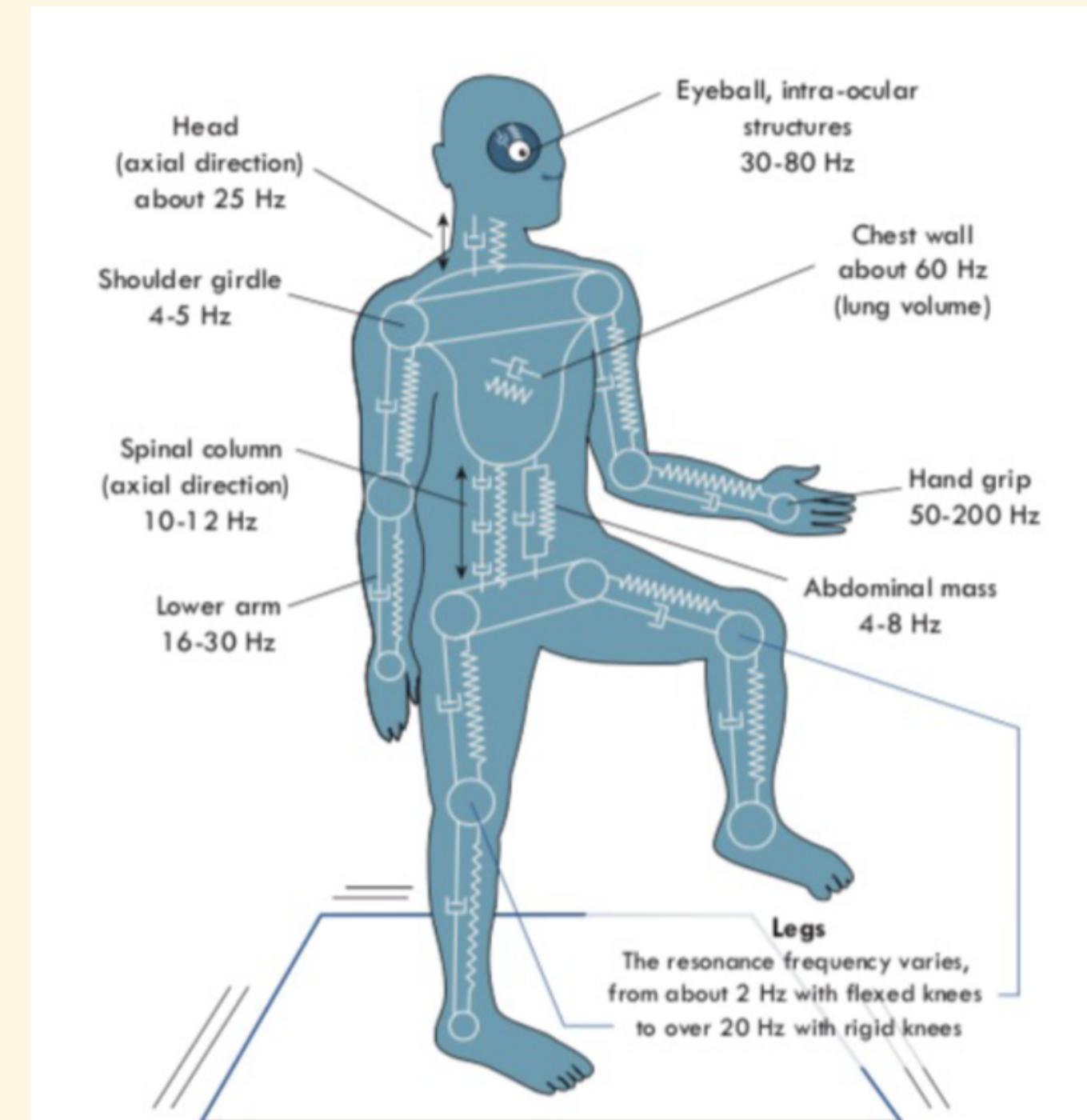
	February 3 2023
Air Temperature	-2°F/-18.9 °C
Wind Speed	41 mph

FROSTBITE GUIDE						
Increasing risk of frostbite for most people in 10 to 30 minutes of exposure						
High risk for most people in 5 to 10 minutes of exposure						
High risk for most people in 2 to 5 minutes of exposure						
High risk for most people in 2 minutes of exposure or less						

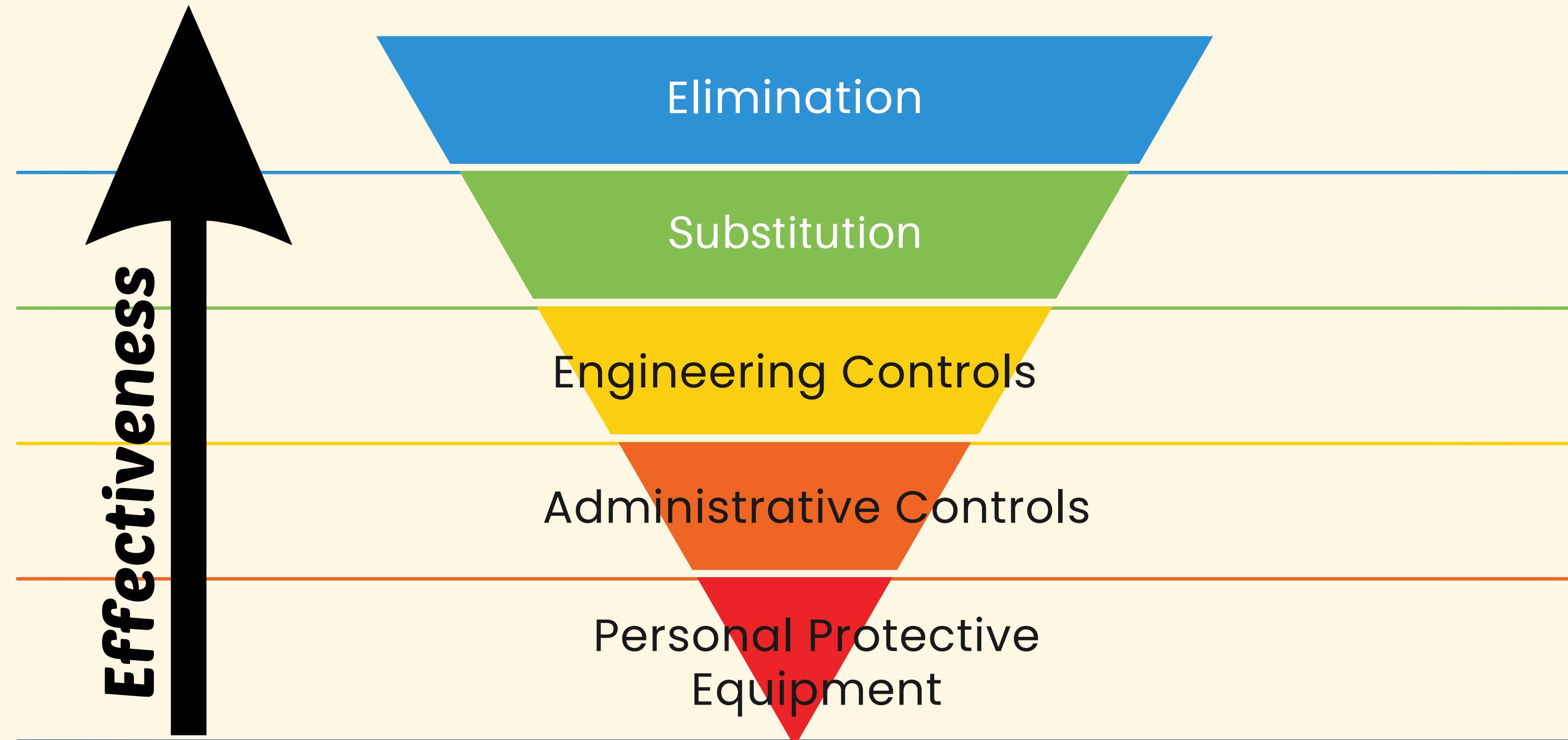
WIND CHILL TEMPERATURE INDEX Frostbite Times are for Exposed Facial Skin												
Air Temperature (°C)												
Wind Speed (km/h)	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	-58
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57	-63
15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	-60	-66
20	1	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62	-68
25	1	-6	-12	-19	-25	-32	-38	-44	-51	-57	-64	-70
30	0	-6	-13	-20	-26	-33	-39	-46	-52	-59	-65	-72
35	0	-7	-14	-20	-27	-33	-40	-47	-53	-60	-66	-73
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68	-74
45	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62	-69	-75
50	-1	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69	-76
55	-2	-8	-15	-22	-29	-36	-43	-50	-57	-63	-70	-77

Whole Body Vibration

- Whole body vibration can be a result of driving
- Each part of the body has different resonant frequencies where levels of strain and tissue damage are highest
- Other health effects associated with whole body vibration are spine disorders, MSDs, neck pain, gastrointestinal issues, etc.
- Ankh Morpork's mail truck produced safe resonant frequencies upon vibration analysis



Hierarchy of Controls



Elimination/Substitution



Recommendations

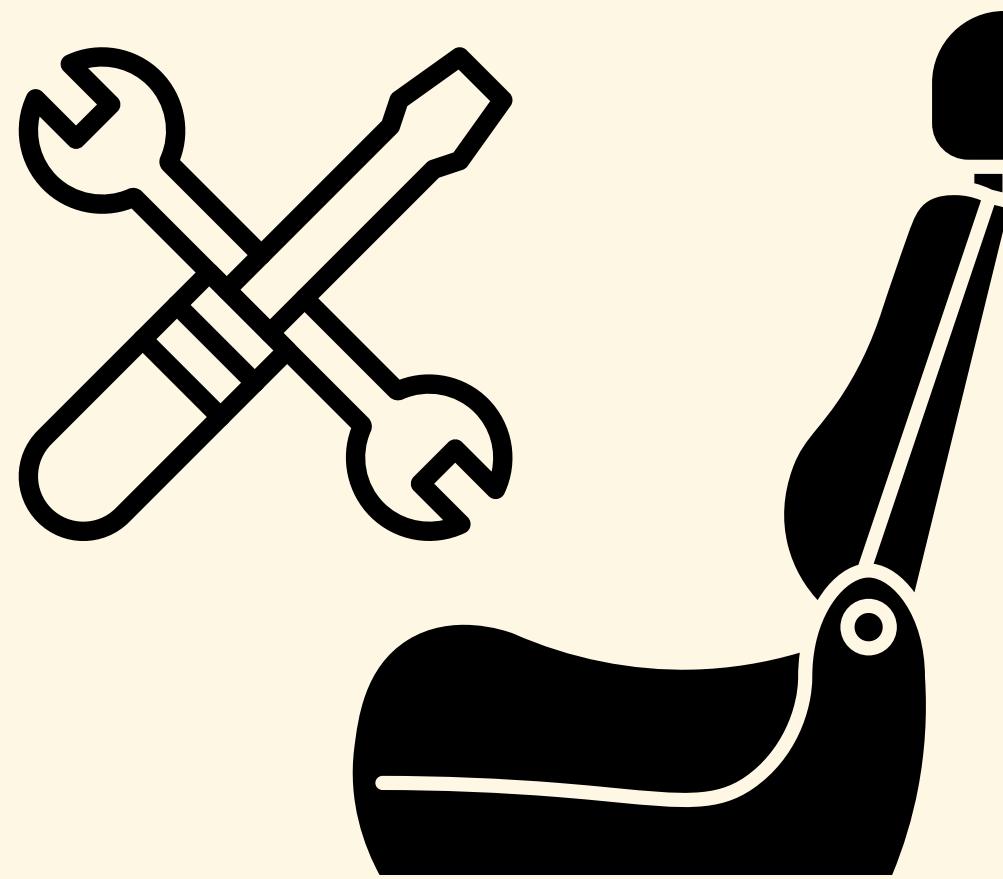
Truck Re-organization and Package Delivery

- Reduce package weights
- Redesign
- Stretch!
- Maximize the use of assistive devices
- Hire a second delivery personnel to divide work

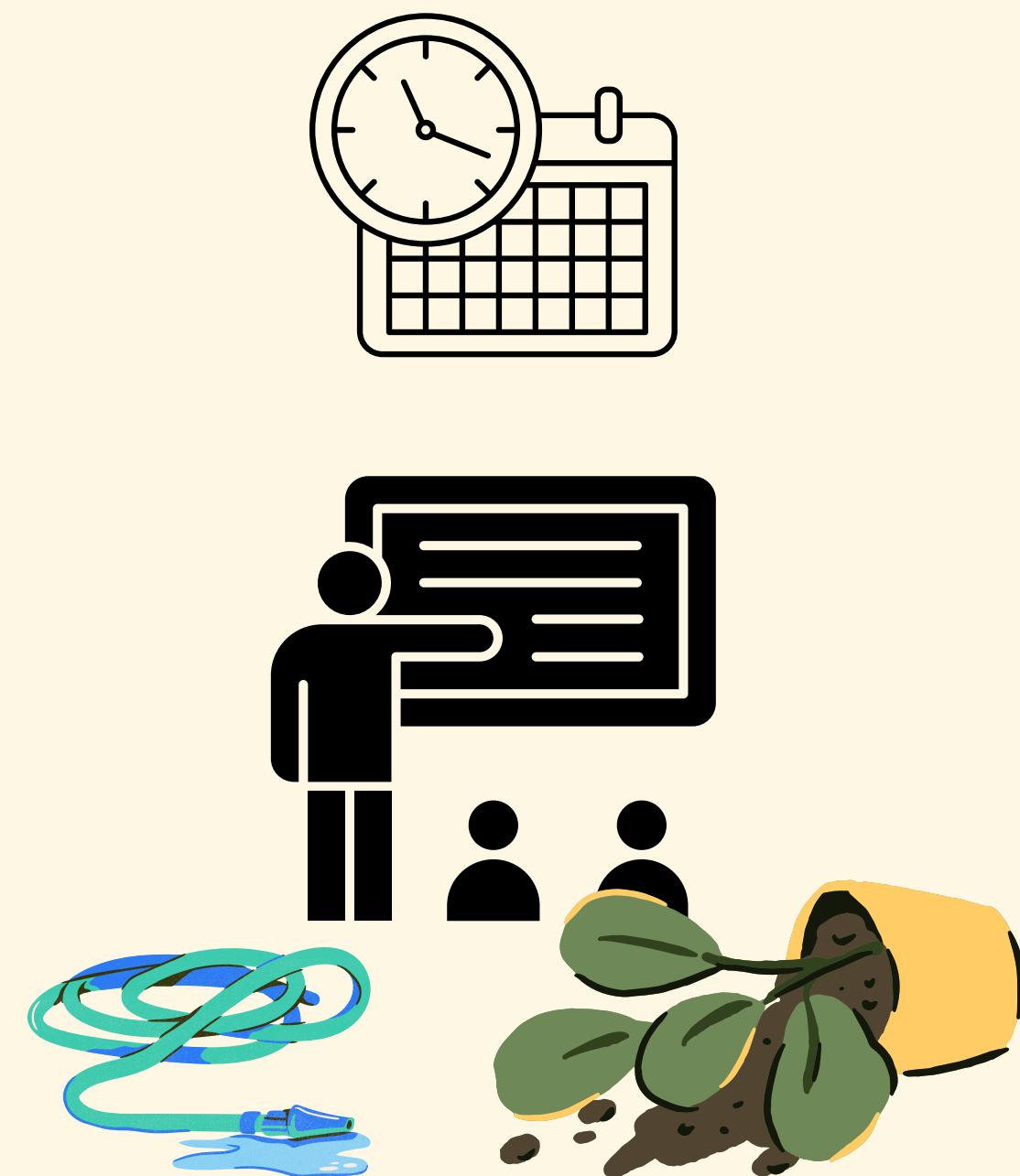


Slips, Trips, Falls and Vibration Controls

Engineering



Administrative

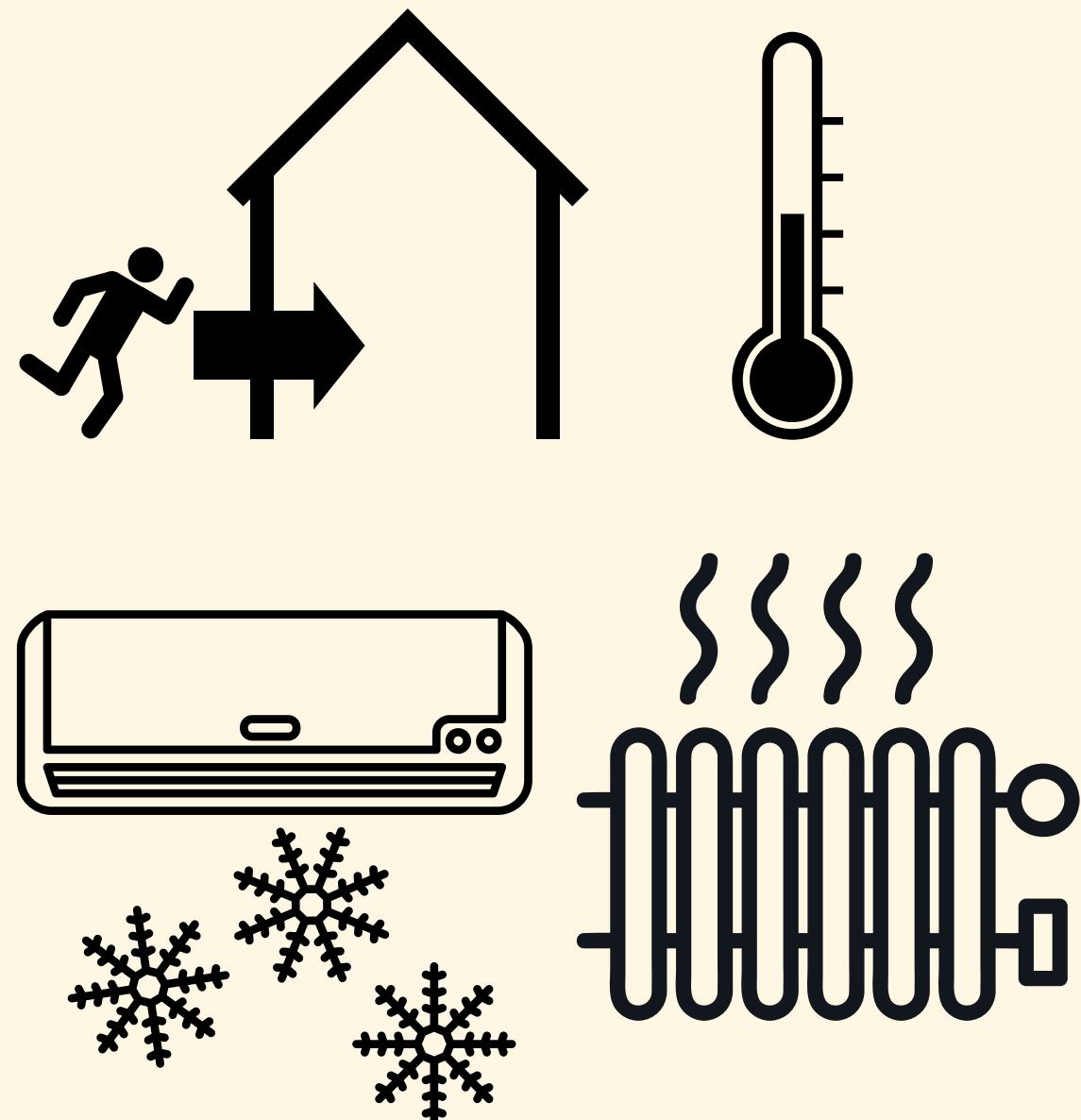


PPE



Heat and Cold Stress Controls

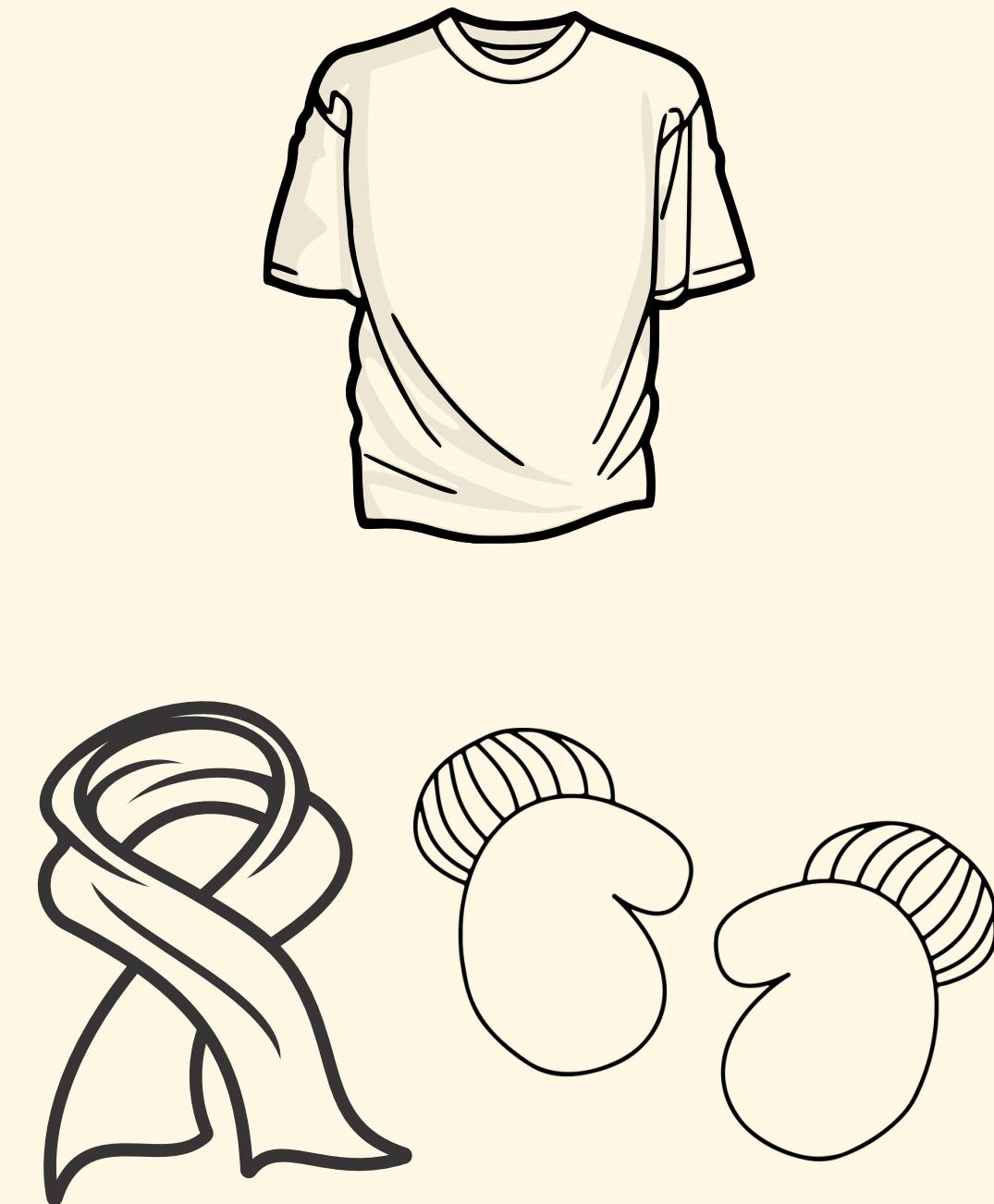
Engineering



Administrative



PPE



Thank you for listening!

Questions?



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Notes:

1. The TLV curve coincides with the upper boundary of the Health Guidance Caution Zones defined in ISO 2631-1.^{1,2} The TLVs refer to the maximum vector sum of the overall weighted RMS accelerations for a given expected daily exposure duration to which it is believed a majority of operators and occupants of land, air, and water vehicles may be exposed within a 24-hour period with a low probability of health risks. Exposures falling above the TLV or upper ISO boundary are associated with likely health

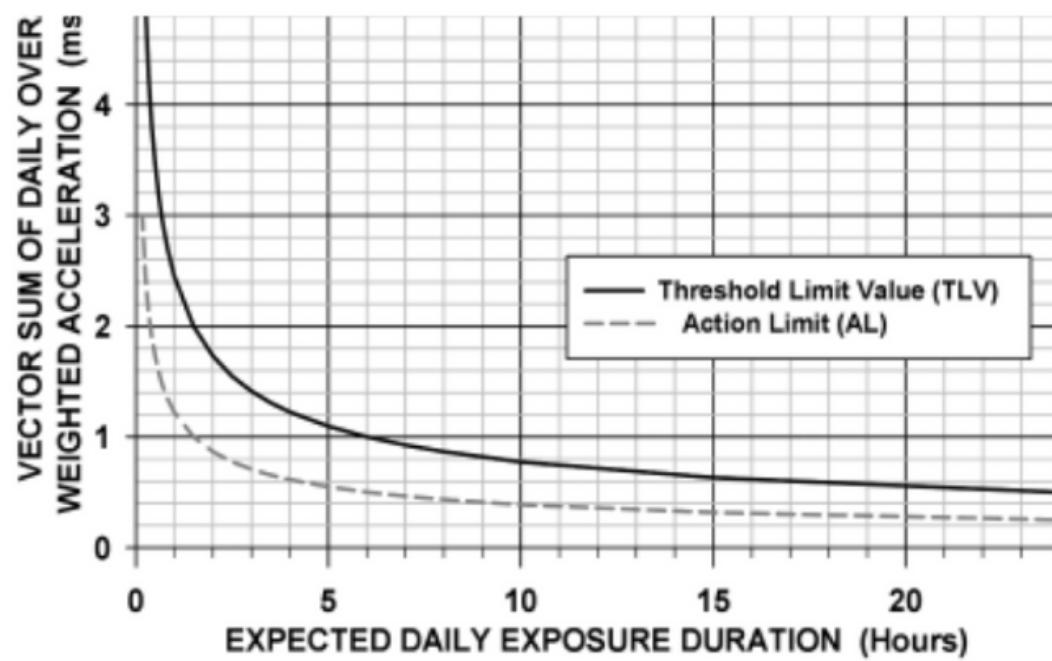


FIGURE 1. Threshold Limit Values (TLVs) and Action Limits (ALs) associated with the upper boundary and lower boundary of the ISO 2631-1 Health Guidance Caution Zones, respectively.^{1,2} **Note:** Values are constant for exposures at and below 10 minutes (0.17 h).

Estimated benefits for solution options

Option 1 Delivery Robot

Reduction in claims:	70%
Reduction in workers' comp costs:	\$ 186,671
Reduction in indirect costs:	\$ 205,338
Increase in productivity:	10.0%
Productivity value:	\$ 34,000
Other estimated savings:	<input type="text"/>
Total estimated annual savings:	\$ 426,009
Total estimated savings over 3 years:	\$ 1,278,028
Total estimated savings over 5 years:	\$ 2,130,046

Option 2 Dolly

Reduction in claims:	15%
Reduction in workers' comp costs:	\$ 53,335
Reduction in indirect costs:	\$ 58,668
Increase in productivity:	5.0%
Productivity value:	\$ 17,000
Other estimated savings:	<input type="text"/>
Total estimated annual savings:	\$ 129,003
Total estimated savings over 3 years:	\$ 387,008
Total estimated savings over 5 years:	\$ 645,013

Option 3 Slip Resistant Boots

Reduction in claims:	10%
Reduction in workers' comp costs:	\$ 26,667
Reduction in indirect costs:	\$ 29,334
Increase in productivity:	0.0%
Productivity value:	\$ -
Other estimated savings:	<input type="text"/>
Total estimated annual savings:	\$ 56,001
Total estimated savings over 3 years:	\$ 168,004
Total estimated savings over 5 years:	\$ 280,006

Option 1 Thermometer

Reduction in claims:	10%
Reduction in workers' comp costs:	\$ 26,667
Reduction in indirect costs:	\$ 29,334
Increase in productivity:	0.0%
Productivity value:	\$ -
Other estimated savings:	<input type="text"/>
Total estimated annual savings:	\$ 56,001
Total estimated savings over 3 years:	\$ 168,004
Total estimated savings over 5 years:	\$ 280,006