

Assessing Musculoskeletal Injury Risk During Product Development



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*Goal: Provide information
that will help participants
understand how ergonomics
exposures are assessed at
USACHPPM*

Learning Objectives

At the completion of the presentation participants will be able to:

- ◆ understand the importance of identifying and mitigating ergonomic risks during product design
- ◆ be familiar with the current Army process for identifying and mitigating injury risks from ergonomic exposures

Learning Objectives

At the completion of the presentation participants will be able to:

- ◆ be familiar with the vision for improving risk assessment of ergonomic exposures

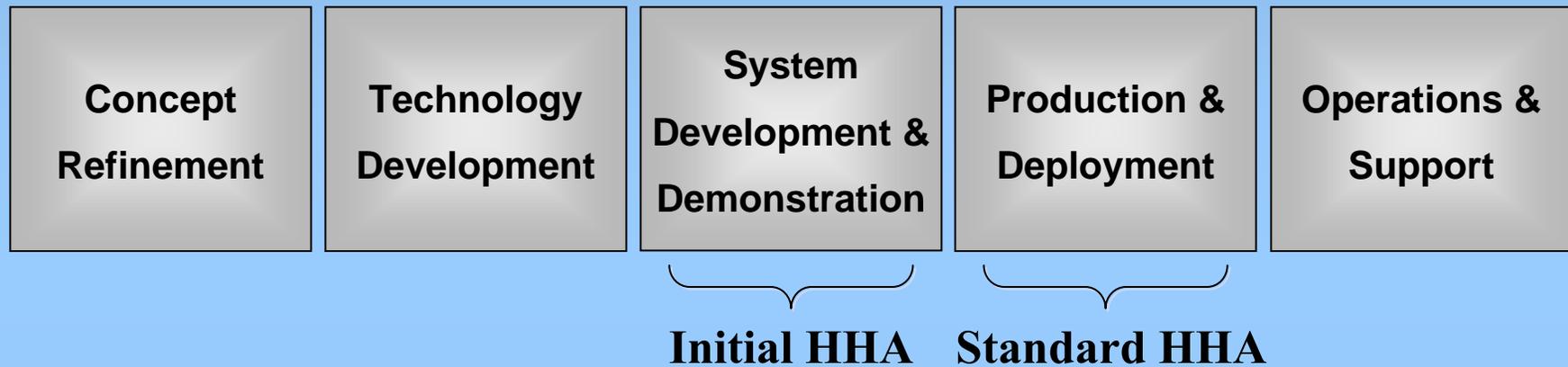
Army Regulation 40-10

Identify and assess health hazards

- ◆ Preserve and protect the health of individual Soldiers
- ◆ Design out health hazards to eliminate ... health hazard-based retrofits
- ◆ Reduce environmental and occupational health hazards

The DoD Acquisitions System

Phases of Product Development



Initial HHA done while product developed

**Standard HHA done after product developed
or when an existing product is modified**

The DoD Acquisitions System

Phases of Product Development



Human Systems Integration

**Though HHAs can help,
Culture is better!**

Types of Products

Identify & Assess Health Hazards

- ◆ Weapons platforms
- ◆ Munitions
- ◆ Equipment
- ◆ Clothing
- ◆ Training devices
- ◆ Other materiel systems

Types of Products Reviewed



Lifting/Carrying (Setting Up/Breaking Down Simulators)

Helicopter flight training simulator

Types of Products Reviewed



Lifting/Carrying (Launching/Retrieving UAVs)

Unmanned Aerial Vehicle (UAV)

Types of Products Reviewed



Pushing/Pulling (Setting Up/Breaking Down Bladders)

Many systems use bladders to contain liquids such as water and fuel

Types of Products Reviewed



Exertions & Non-Neutral Postures (Using Sprayer)

High Pressure Sprayers for Cleaning, Decontamination, Depainting & Special Applications

Types of Products Reviewed



Hand-Arm Vibration (Operating Powered Hand Tools)

Commercial Off-the-Shelf Items Included in Equipment Sets

Types of Products Reviewed



Whole Body Vibration & Jolt (Operating Equipment)

Driving Army heavy vehicles and commercial vehicles on various road surfaces

Types of Products Reviewed



Biomechanical Stress from Head Supported Mass

Helmets & Special Optic such as Night Vision Goggles

*Assessing Injury Risk
From Lifting/Lowering
Activities*

Risk Assessment Code Matrix

RAC Matrix

	A	B	C	D	E
I	1	1	1	2	3
II	1	1	2	3	4
III	2	3	3	4	5
IV	3	5	5	5	5



Hazard Probability

A = Frequent

B = Probable

C = Occasional

D = Remote

E = Improbable



Hazard Severity

I = Catastrophic

II = Critical

III = Marginal

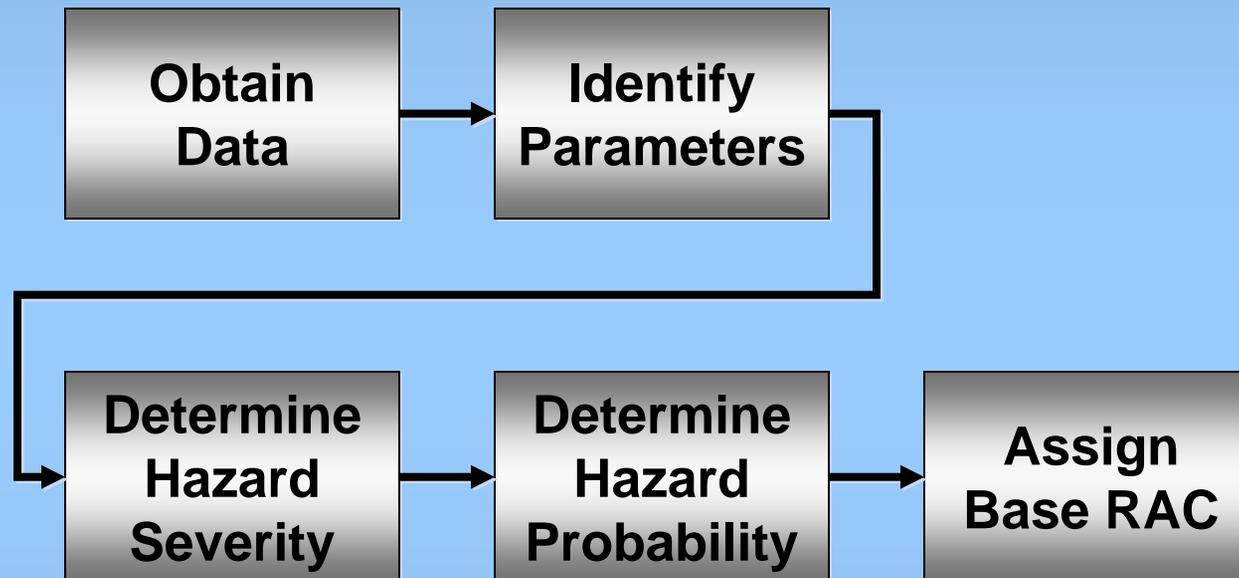
IV = Negligible

Syntax:

RAC 2 (HS II, HP C)

Determining Injury Risk

Steps in the Risk Assessment Process



Determining Injury Risk

Review Data

- ◆ Obtain data from system developer
 - Weapon Developer
 - Equipment Developer

Determining Injury Risk

Review Data

- ◆ Identify Parameters
 - Mission Scenario
 - Description of MMH Team
 - Object Characteristics
 - Description of Handling Activities

Determining Injury Risk

Review Data

◆ Identify Parameters

Scenario: Male & female occupational specialty

Only one person will be available to lift

Lifter will likely to be female

Frequency will be once

Trajectory will be obstacle-free

Terrain will be uneven

Item: 46 pound box (20" x 20" x 20")

Object weight evenly distributed

Determining Injury Risk

Determine Hazard Severity (HS)

- ◆ Use MIL-STD-1472F para 5.9.11.3
 - Calculate Maximum Design Weight Limit (MDWL)

Notes:

- Assumes young, healthy population
- Assumes two-handed lift
- MDWLs are not TLVs for injury

Determining Injury Risk

Determine Hazard Severity (HS)

- ◆ Use MIL-STD-1472F para 5.9.11.3
 - Calculate Maximum Design Weight Limit (MDWL)

MDWL = 37 lbs

Determining Injury Risk

Determine Hazard Severity (HS)

- ◆ Calculate Lifting Index (Task Demand/MDWL)

Determining Injury Risk

Determine Hazard Severity (HS)

- ◆ Calculate Lifting Index (Task Demand/MDWL)

$$\begin{aligned}\text{Lifting Index} &= 46 \text{ lb} / 37 \text{ lb} \\ &= 1.24\end{aligned}$$

Determining Injury Risk

Determine Hazard Severity (HS)

- ◆ Determine HS – Magnitude of Index

Lifting Index	HS
N/A	I
> 1.88	II
> 1.50	III
> 1.00	IV
≤ 1.00	N/A

Note:

- Ranges not validated

Determining Injury Risk

Determine Hazard Severity (HS)

- ◆ Determine HS – Magnitude of Index

Lifting Index	HS
N/A	I
> 1.88	II
> 1.50	III
> 1.00	IV
≤ 1.00	N/A

← LI = 1.24
HS = III

Determining Injury Risk

Determine Hazard Probability (HP)

- ◆ Award points based upon presence of factors in lifting scenario

Note:

- Factors and point values decided by USACHPPM Ergonomics Program

Determining Injury Risk

Determine Hazard Probability (HP)

- ◆ Award points based upon presence of factors in lifting scenario

Factor	Points
Team Size	0 = 1-2, 1 = 3-4, 2 > 4 lifters
Grasp	0 = 2 handed, 1 = 1 handed
Footing	0 = Fair to Good, 1 = Poor
Load Symmetry	0 = Uniform, 1 = Unequal
Extra Point	Optional 1 Point Levy

Determining Injury Risk

Determine Hazard Probability (HP)

- ◆ Award points based upon presence of factors in lifting scenario

Factor	Points	
Team Size	0 = 1-2, 1 = 3-4, 2 > 4 lifters	0
Grasp	0 = 2 handed, 1 = 1 handed	0
Footing	0 = Fair to Good, 1 = Poor	1
Load Symmetry	0 = Uniform, 1 = Unequal	0
Extra Point	Optional 1 Point Levy	0

Determining Injury Risk

Determine Hazard Probability (HP)

- ◆ Convert points to Hazard Probability

Points	HP
0	E
1	D
2	C
3	B
≥ 4	A

Determining Injury Risk

Determine Hazard Probability (HP)

- ◆ Convert points to Hazard Probability

Points	HP
0	E
1	D
2	C
3	B
≥ 4	A

← 1 Point
HP = D

Determining Injury Risk

Assign Base RAC

- ◆ Look up in RAC Table Matrix

HP
↓

	A	B	C	D	E
I	1	1	1	2	3
II	1	1	2	3	4
III	2	3	3	4	5
IV	3	5	5	5	5

HS →

RAC 4
(HS III, HP D)

Lessons Learned

Learned About System Developers

- ◆ Conduct poor ergonomics reviews
- ◆ Fail to understand chronic exposures
- ◆ Misapply MIL-STD-1472F

Lessons Learned

Learned About Process

- ◆ Increases reliability
- ◆ Required additional assumptions
- ◆ Needs continued development

Future Developments

Current Effort

Contained in Excel

- ◆ Considers more variables
- ◆ Excel constrains individual flexibility

Future Plans

Create a software application

- ◆ Interface will increase visibility
- ◆ Platform will structure assessment
- ◆ Platform will allow more flexibility

Future Plans

Lifting Injury Risk Estimator

Step 1: Enter System Information

System Name:

Item Name:

Step 2: Select Population of Lifter(s)

Population:

Step 3: Personal Space Allocated To Each Lifter

Lifter personal space is the amount of room each lifter needs to perform the lift without interfering with other lifters. This value is used to estimate the maximum number of lifters that can be physically accommodated around the perimeter of the object being lifted. Since MIL-STD-1472F assumes a two-handed lift, a default value of 36 inches is used. This value can be changed for different lifting conditions.

PersSpace: in

Step 4: Enter Object Information

Weight: lb

Length: in

Width: in

Height: in

in (perimeter)

1 lifter:

Step 5: Enter Task Information

Vertical Range:	<input type="text" value="Ground to < 5 ft high"/>	
Lift Freq:	<input type="text"/> lifts per hr	x 1
Object Depth:	MIL-STD-1472F multiplies base MAW by 1 for an object with a in. width Designating 1 lifter(s) makes this rule: <input type="text" value="Inactive"/>	x 1
Obstacles:	<input type="text" value="No"/>	x 1
Base 1-person max lifting limit: =		

Step 6: Compare Lifters Required by Object Size & Mass

#LiftersObjSize:

#LiftersObjMass:

Step 7: Designate Minimum Number of Lifters

The "Recommended Minimum # Lifters" is generated by the computer program. By default, the program sets the "Designated Minimum # Lifters" to this same value. However, you may override the default and place another number in the "Designated Minimum # Lifters" field.

Recommended Minimum # Lifters =

Designated Minimum # Lifters =

Step 8: Note Lift Index

The lift index is ratio of the weight of the object and the maximum allowable weight that the lifting team can handle based upon MIL-STD-1472F.

$$\text{Lift Index} = \frac{\text{Actual Object Weight}}{\text{MAW for 1 Lifters}} = \frac{\text{---}}{\text{---}} = \text{---}$$

1	2	3	4	5	6	7	8	9	10
<input type="text"/>									
11	12	13	14	15	16	17	18	19	20
<input type="text"/>									
21	22	23	24	25	26	27	28	29	30
<input type="text"/>									

Future Plans

Lifting Injury Risk Estimator

Step 9: Select Lifting Conditions

Team Size:

Grasp Type:

Footing:

Load Symmetry:

Above Shoulder:

Other Factor:

Total HP Points =

Hazard Severity Sets

LI > = HS(II)

<= LI < HS(III)

<= LI < HS(IV)

LI < HS(0)

Hazard Probability Sets

> HP(A)

HP(B)

HP(C)

HP(D)

HP(E)

Step 10: Estimate RAC

RAC : HS() HP()

Lifting Index (Largest) =

HS Scoring Thresholds*		
LI >= 1.50	HS(II)	Severe injury
1.33 <= LI < 1.50	HS(III)	Minor injury
1.00 <= LI < 1.33	HS(IV)	< minor injury
LI < 1.00	HS(0)	Below HS

* Assumes IVD rupture most severe injury

Total HP Points =

HP Scoring Thresholds				A	B	C	D	E
> 3 pts	HP(A)	Frequent	I	1	1	1	2	3
3 pts	HP(B)	Probable	II	1	1	2	3	4
2 pts	HP(C)	Occasional	III	2	3	3	4	5
1 pts	HP(D)	Remote	IV	3	5	5	5	5
0 pts	HP(E)	Improbable						

Future Plans

Lifting Injury Risk Estimator

Step 11: Create Report for Current Risk Estimate

Labeling Suggestions (uncheck to exclude from report):

- 1.
- 2.
- 3.
- 4.
- 5.
- 6. Enter custom label text here.

Rules Invoked:

<input type="text"/>

Create Current Report

Copy Current Report to Clipboard

Open Another Report

Save
Report

Print Report

< 3

Questions