



Ergonomic Case Study of an Industrial Pipefitter

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Introduction

Industrial Nuclear Power Plant professionals risking life and limb every day to keep the lights on at night. The complex tasks these workers must complete day after day put increased strain on their bodies and overtime can result in Work-Related Musculoskeletal Disorders (WMSD).

Purpose:

- Analyze crucial Pipefitter tasks and postures with ergonomic assessment tools
- Determine if key tasks led to diagnosed Musculoskeletal Disorders over time
- Propose ergonomic suggestions and solutions for mitigating potential risk of injury

Participant

- 52-year-old Caucasian Male
- 6 feet 1 inch, 213 pounds
- 30+ years plumbing/pipefitting



Figure 1: Pipefitter using a pipe wrench to undo nuts on a pipe flange

Research Methods

- Interviews regarding tasks performed and discomfort survey
- Task Analysis
- Ergonomic Assessment tools
 - Moore-Garg Strain Index
 - Hand TLV

Strain Index		2	
Moore-Garg Strain Index			
Task: Tightening Large Bolts/Flange		Analyst: Dylan DuPre	
Job: Nuclear Pipefitter		Date: 11/29/20	
Strain Index	Find rating for each risk factor and multiply them together.	SI < 3: Safe	SI between 3 and 5: Uncertain
Risk Factor	Rating	SI between 5 and 7: Some Risk	SI > 7: Hazardous
Intensity of Exertion (Borg Scale values in brackets)	Rating	Left	Right
Duration of Exertion (% of Cycle)	Rating	1.5	1.5
Efforts Per Minute	Rating	1.0	1.0
Hand/Wrist Posture	Rating	1.5	1.5
Speed of Work	Rating	1.0	1.0
Duration of Task Per Day (hours)	Rating	.50	.50
$9 \times (1.5) \times 1 \times (1.5) \times 1 \times (.50) = 10.13$			

Figure 2: Moore-Garg Strain Index for tightening large bolts on pipe flange

Hand Activity TLV		1	
ACGIH TLVs for Hand Activity			
Job: Pipe Grinding	Analyst: Dylan DuPre	Date: 11-29-20	
Hand Activity Level (HAL) (See table below)	Left: 4	Right: 4	
Normalized Peak Force (NPF) (See table below)	6	6	
Ratio = NPF / (10-HAL)	$\frac{6}{(10-4)} = 1.1$	$\frac{6}{(10-4)} = 1.1$	
Determine Result	TLV = 0.78 AL = 0.56	<input checked="" type="checkbox"/> I > TLV <input type="checkbox"/> AL to TLV <input type="checkbox"/> < AL	
Hand Activity Level Rating			
0: Hands idle most of the time; no regular exertion 2: Consistent motion/exc. no frequent pauses 4: Slow steady motion/exc. infrequent pauses 6: Steady motion/exc. no regular pauses 8: Rapid steady motion/exc. no regular pauses 10: Rapid steady motion/exc. difficulty keeping up or continuous exertion			
Estimation of Normalized Peak Force for Hand Forces			
%MVC	Score	Verbal Anchor	Moore-Garg Observer Scale (Alternative Method)
0	0	Nothing at all	0
5	0.5	Extremely Weak (Just Noticeable)	0.5
10	1	Very Weak	1
20	2	Weak (Light)	2
30	3	Moderate	3
40	4	Obvious Effort, But Unchanged Facial Expression	4
50	5	Strong (Heavy)	5
60	6	Substantial Effort with Changed Facial Expression	6
70	7	Very Strong	7
80	8	Uses Shoulder or Trunk for Force	8
90	9		9
100	10	Extremely Strong (almost maximum)	10

Figure 3: TLV for Hand activity on pipe grinding using large angle grinder

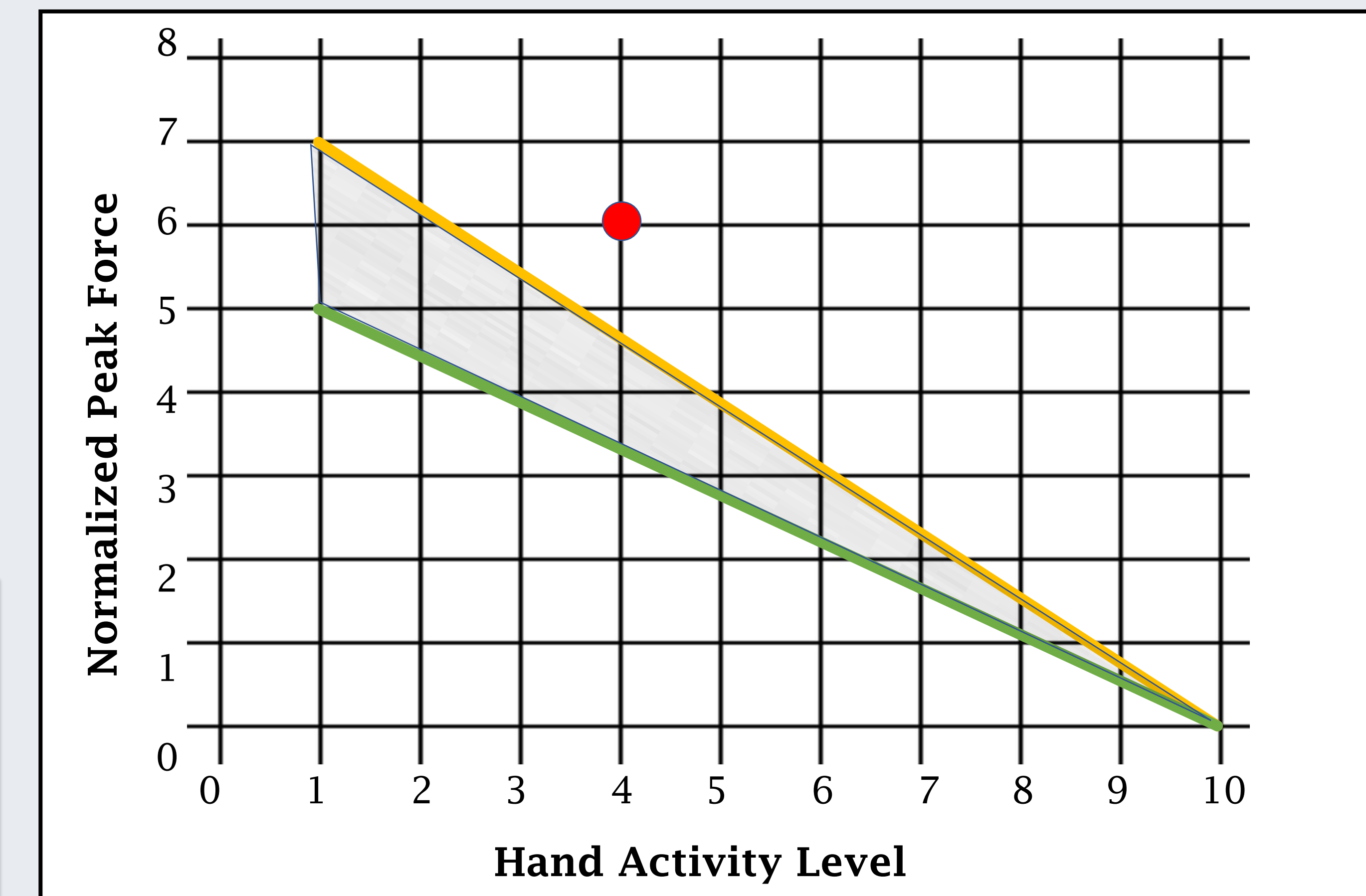


Figure 4: Graph showing the point, which resulted from the Hand TLV analysis, well above the area of normal work. Where ORANGE is the TLV, and GREEN is the Action Limit

Conclusion

- Ergonomic assessments issued, yielded results that explain potential risks associated with key pipefitting tasks.
- WMSD's are directly related with the tasks performed due to the high potential risks
- 30+ years of exposure to those risks have taken a toll on the participants physiology and mentality

Discussion

Primary Areas of Concern:

- Pain in Lower Back, near lumbar, upper shoulder, and wrists
 - SI shows a significant potential for risk when using a pipe wrench
 - Most likely attributes to upper shoulder pain
 - Hand TLV shows a value that is above the 'safe zone' resulting in potential risk when Pipe Grinding using an angle grinder
 - Most likely attributes to wrist and lower back pain

Solutions

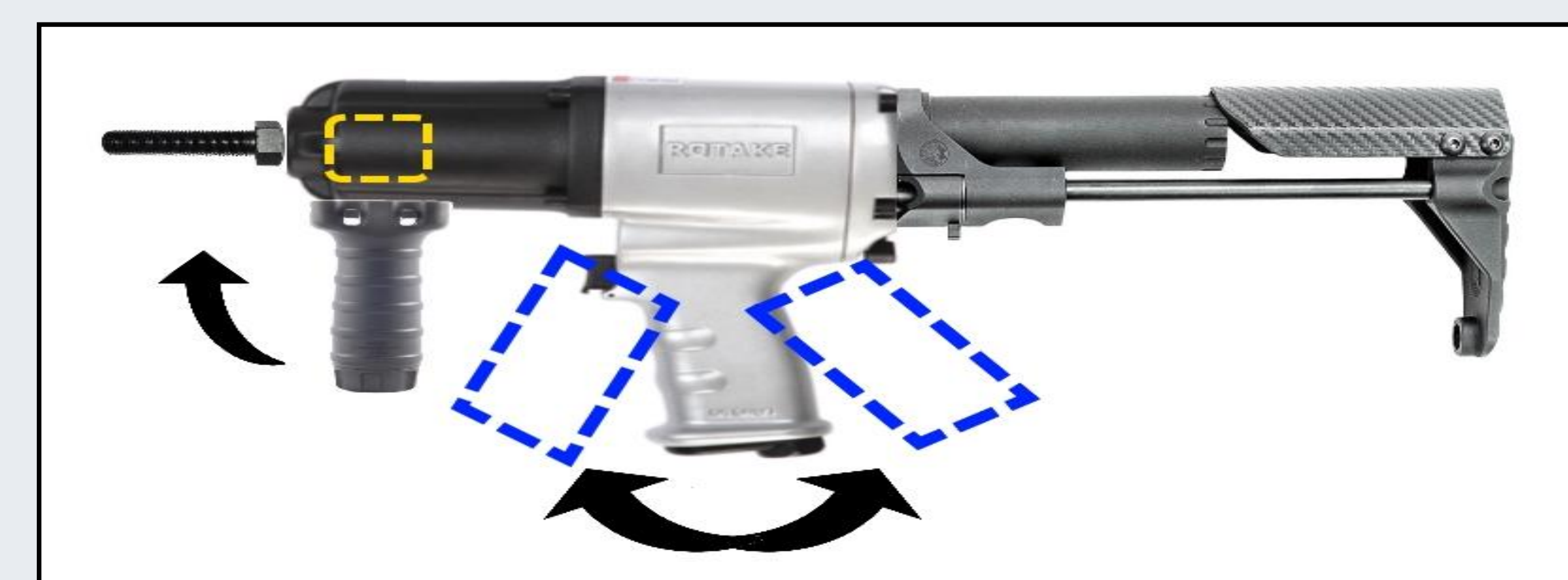


Figure 5: Redesign recommendation for an ergonomic pipe wrench alternative.