APPENDIX B – SHEAR OPERATIONS

B1. SHEAR OPERATOR

Table B-1. Shear Operator #1 UE CTD Checklist

Michigan Checklist for Upper Extremity Cumulative Trauma Disorders
Lifshitz and Armstrong (1986)

* "No" responses are indicative of conditions associated with the risk of CTD's

Risk Factors	**No**	**Yes**
1. Physical Stress		
1.1 Can the job be done without hand/ wrist contact with sharp edges	N	
1.2 Is the tool operating without vibration?		Y
1.3 Are the worker's hands exposed to temperature >21degrees C (70 degrees F)?	N	
1.4 Can the job be done without using gloves?	N	
2. Force		
2.1 Does the job require exerting less than 4.5 kg (10 lb) of force?	N	
2.2 Can the job be done without using finger pinch grip?		Y
3. Posture		
3.1 Can the job be done without flexion or extension of the wrist?	N	
3.2 Can the tool be used without flexion or extension of the wrist?	n/a	n/a
3.3 Can the job be done without deviating the wrist from side to side?		Y
3.4 Can the tool be used without deviating the wrist from side to side?		Y
3.5 Can the worker be seated while performing the job?	N	
3.6 Can the job be done without "clothes wringing" motion?		Y
4. Workstation Hardware		
4.1 Can the orientation of the work surface be adjusted?	N	
4.2 Can the height of the work surface be adjusted?	N	
4.3 Can the location of the tool be adjusted?	n/a	n/a
5. Repetitiveness		
5.1 Is the cycle time longer than 30 seconds?		Y
6. Tool Design		
6.1 Are the thumb and finger slightly overlapped in a closed grip?	n/a	n/a
6.2 Is the span of the tool's handle between 5 and 7 cm (2-2 3/4 inches)?	n/a	n/a
6.3 Is the handle of the tool made from material other than metal?	n/a	n/a
6.4 Is the weight of the tool below 4 kg (9 lb)?	n/a	n/a
6.5 Is the tool suspended?	n/a	n/a
TOTAL	**8 (57%)**	**6 (43%)**

Table B-2. Shear Operator #2 UE CTD Checklist

Michigan Checklist for Upper Extremity Cumulative Trauma Disorders
Lifshitz and Armstrong (1986)

* "No" responses are indicative of conditions associated with the risk of CTD's

Risk Factors	**No**	**Yes**
1**. Physical Stress**		
1.1 Can the job be done without hand/ wrist contact with sharp edges	N	
1.2 Is the tool operating without vibration?		Y
1.3 Are the worker's hands exposed to temperature >21 degrees C (70 degrees F)?		Y
1.4 Can the job be done without using gloves?	N	
2. Force		
2.1 Does the job require exerting less than 4.5 kg (10lbs) of force?	N	
2.2 Can the job be done without using finger pinch grip?		Y
3. Posture		
3.1 Can the job be done without flexion or extension of the wrist?	N	
3.2 Can the tool be used without flexion or extension of the wrist?	n/a	n/a
3.3 Can the job be done without deviating the wrist from side to side?		Y
3.4 Can the tool be used without deviating the wrist from side to side?		Y
3.5 Can the worker be seated while performing the job?	N	
3.6 Can the job be done without "clothes wringing" motion?		Y
4. Workstation Hardware		
4.1 Can the orientation of the work surface be adjusted?	N	
4.2 Can the height of the work surface be adjusted?	N	
4.3 Can the location of the tool be adjusted?	n/a	n/a
5. Repetitiveness		
5.1 Is the cycle time longer than 30 seconds?		Y
6. Tool Design		
6.1 Are the thumb and finger slightly overlapped in a closed grip?	n/a	n/a
6.2 Is the span of the tool's handle between 5 and 7 cm (2-2 3/4 inches)?	n/a	n/a
6.3 Is the handle of the tool made from material other than metal?	n/a	n/a
6.4 Is the weight of the tool below 4 kg (9lbs)?	n/a	n/a
6.5 Is the tool suspended?	n/a	n/a
TOTAL	7 (50 %)	7 (50 %)

Table B-3. Shear Operator #1 OWAS

OWAS: OVAKO Work Analysis System
Louhevaara and Suurnäkki (1992)

Work Phase	Activate shear	Position plate in front of shear, measure piece	Guide overhead jib crane to back of shear to move plate	Attach crane clamp to plate	Lift, move plate from back of shear to front with crane	Manual pick up piece from shear slope	Manual carry plate from shear back to front	Undefined	Walk back, forth from shear front, back (no load)
Total Combination Posture Score	1	2	1	1	2	2,4	1	1	1
Common Posture Combinations (collapsed across work phases)									
Back	1	2	1	2	2	4	1		
Arms	3	1	1	1	1	1	1		
Legs	2	2	7	7	4	4	2		
Posture Repetition (% of working time)	5	20	5	4	< 1	< 1	66		
Back % of Working Time Score	1	1	1	1	1	1	1		
Arms % of Working Time Score	1	1	1	1	1	1	1		
Legs % of Working Time Score	1	1	1	1	1	1	1		
ACTION CATEGORIES: 1 = No corrective measures 2 = Corrective measures in near future 3 = Corrective measures as soon as possible 4 = Corrective measures immediately									

Table B-3. Shear Operator #1 OWAS (continued)

Work Phase	Activate shear	Position plate in front of shear, measure piece	Guide overhead jib crane to back of shear to move plate	Attach crane clamp to plate	Lift, move plate from back of shear to front with crane	Manual pick up piece from shear slope	Manual carry piece from shear back to front	Undefined	Walk back, forth from shear front, back (no load)
Posture									
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	1	2	1	1	2	2,4	1	1	1
Arms 1 = both arms are below shoulder level 2 = one arm is at or above shoulder level 3 = both arms are at or above shoulder level	3	1	1	1	1	1	1	1	1
Legs 1 = sitting 2 = standing with both legs straight 3 = standing with the weight on one straight leg 4 = standing or squatting with both knees bent 5 = standing or squatting with one knee bent 6 = kneeling on one or both knees 7 = walking or moving	2	2,4	7	7	7	4	7	2	7
Load/Use of Force 1 = weight or force needed is = or < 10 kg (< 22 lb) 2 = weight or force > 10 kg but < 20 kg (> 22 lb, < 44 lb) 3 = weight or force > 20 kg (> 44 lb)	1	1	1	1	1	1	1	1	1
Phase Repetition % of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	5	20	1	< 1	4	< 1	2	66	< 1

Table B-4. Shear Operator #1 NIOSH Manual Materials Handling Checklist

NIOSH Hazard Evaluation Checklist for Lifting, Carrying, Pushing, or Pulling
Waters and Putz-Anderson (1996)

* "YES" responses are indicative of conditions that pose a risk of developing low back pain; the larger the percentage of "YES" responses, the greater the risk.

RISK FACTORS	YES	NO
General		
1.1 Does the load handled exceed 50 lb?		N
1.2 Is the object difficult to bring close to the body because of its size, bulk, or shape?	Y	
1.3 Is the load hard to handle because it lacks handles or cutouts for handles, or does it have slippery surfaces or sharp edges?	Y	
1.4 Is the footing unsafe? For example, are the floors slippery, inclined, or uneven?		N
1.5 Does the task require fast movement, such as throwing, swinging, or rapid walking?		N
1.6 Does the task require stressful body postures, such as stooping to the floor, twisting, reaching overhead, or excessive lateral bending?	Y (extreme lumbar flexion)	
1.7 Is most of the load handled by only one hand, arm, or shoulder?		N
1.8 Does the task require working in environmental hazards, such as extreme temperatures, noise, vibration, lighting, or airborne contamination?		N
1.9 Does the task require working in a confined area?		N
Specific		
2.1 Does the lifting frequency exceed 5 lifts per minute (LPM)?		N (LPM = 0.12 over total observed time of 25 minutes)
2.2 Does the vertical lifting distance exceed 3 feet?	Y	
2.3 Do carries last longer than 1 minute?		N
2.4 Do tasks which require large sustained pushing or pulling forces exceed 30 seconds duration?		N
2.5 Do extended reach static holding tasks exceed 1 minute?		N
TOTAL	**4 (29%)**	**10(71%)**

Table B-5. Shear Operator #2 NIOSH Manual Materials Handling Checklist

NIOSH Hazard Evaluation Checklist for Lifting, Carrying, Pushing, or Pulling
Waters and Putz-Anderson (1996)

* "YES" responses are indicative of conditions that pose a risk of developing low back pain; the larger the percentage of "YES" responses, the greater the risk.

RISK FACTORS	YES	NO
General		
1.1 Does the load handled exceed 50 lbs?		N
1.2 Is the object difficult to bring close to the body because of it's size, bulk, or shape?	Y	
1.3 Is the load hard to handle because it lacks handles or cutouts for handles, or does it have slippery surfaces or sharp edges?	Y	
1.4 Is the footing unsafe? For example, are the floors slippery, inclined, or uneven?	Y (ridges at shear press back)	
1.5 Does the task require fast movement, such as throwing, swinging, or rapid walking?		N
1.6 Does the task require stressful body postures such as stooping to the floor, twisting, reaching overhead, or excessive lateral bending?	Y (extreme lumbar flexion)	
1.7 Is most of the load handled by only one hand, arm, or shoulder?		N
1.8 Does the task require working in environmental hazards, such as extreme temperatures, noise, vibration, lighting, or airborne contamination?		N
1.9 Does the task require working in a confined area?		N
Specific		
2.1 Does the lifting frequency exceed 5 lifts per minute (LPM)?		N (LPM = 0.10 over total observed time of 10 minutes)
2.2 Does the vertical lifting distance exceed 3 feet?	Y	
2.3 Do carries last longer than 1 minute?		N
2.4 Do tasks which require large sustained pushing or pulling forces exceed 30 seconds duration?		N
2.5 Do extended reach static holding tasks exceed 1 minute?		N
TOTAL	**5 (36 %)**	**9 (64 %)**

Table B-6. Shear Operator #1 NIOSH Lifting Equation Analysis

NIOSH Lifting Equation
Waters, Putz-Anderson, Garg, and Fine (1993)

Duration: 1 hour	**Average Object Weight: 20 pounds**	**Maximum Object Weight: 51 pounds**
ORIGIN VARIABLE	**ORIGIN VALUE**	**ORIGIN MULTIPLIER**
Horizontal Location, H	24 inches	0.42
Vertical Location, V	5 inches	0.81
Travel Distance, D	31 inches	0.88
Asymmetric Angle, A	0 degrees	1.00
Frequency, F	0.16 lifts/minute	1.00
Hand to Object Coupling, C	Poor	0.90
DESTINATION VARIABLE	**DESTINATION VALUE**	**DESTINATION MULTIPLIER**
Horizontal Location, H	12 inches	0.83
Vertical Location, V	36 inches	0.96
Travel Distance, D	31 inches	0.88
Asymmetric Angle, A	0 degrees	1.00
Frequency, F	0.16 lifts/minute	1.00
Hand to Object Coupling, C	Poor	0.90
RESULTS	**ORIGIN**	**DESTINATION**
Recommended Weight Limit (RWL)	13.7 pounds	32.2 pounds
Lifting Index, LI (RWL/Load)	1.46	
Population Capable	Male = 95 % Capable Female = 49 % Capable	

Table B-7. Shear Operator #2 NIOSH Lifting Equation Analysis

NIOSH Lifting Equation
Waters, Putz-Anderson, Garg, and Fine (1993)

Duration: 1 hour	**Average Object Weight: 20 pounds**	**Maximum Object Weight: 51 pounds**
ORIGIN VARIABLE	***ORIGIN VALUE***	***ORIGIN MULTIPLIER***
Horizontal Location, H	24 inches	0.42
Vertical Location, V	7 inches	0.83
Travel Distance, D	29 inches	0.89
Asymmetric Angle, A	40 degrees	0.87
Frequency, F	0.16 lifts/minute	1.00
Hand to Object Coupling, C	Poor	0.90
DESTINATION VARIABLE	***DESTINATION VALUE***	***DESTINATION MULTIPLIER***
Horizontal Location, H	10 inches	1.00
Vertical Location, V	31 inches	0.99
Travel Distance, D	29 inches	0.89
Asymmetric Angle, A	40 degrees	0.87
Frequency, F	0.16 lifts/minute	1.00
Hand to Object Coupling, C	Poor	0.90
RESULTS	***ORIGIN***	***DESTINATION***
Recommended Weight Limit (RWL)	12.4 pounds	35.2 pounds
Lifting Index, LI (RWL/Load)	1.61	
Population Capable	Male = 92 % Capable Female = 41 % Capable	

Table B-8. Shear Operator #1 3D Static Strength Prediction Program

3D Static Strength Prediction Program
University of Michigan (1997)

Work Phase: **Manual Placement of Angle Iron Rake Frame Components**	**Disc Compression (lb) @ L5/S1** **(Note: NIOSH Recommended Compression Limit (RCL) is 770 lb)**
Shear press operator picks up material from the back of the shear, approximate weight 20 pounds	553 pounds
Shear press operator lifts plate out of bin at side of shear, approximate weight 20 pounds	628 pounds

Table B-9. Shear Operator #2 3D Static Strength Prediction Program

3D Static Strength Prediction Program
University of Michigan (1997)

Work Phase: **Shear Operation**	**Disc Compression (lbs) @ L5/S1** **(Note: NIOSH Recommended Compression Limit (RCL) is 770 lbs)**
One-handed pick-up of plate from back of shear. Plate weighs 20 lbs; lifts plate off shelf at back of tray, then drops plate into bin; 20 lbs in right hand	673 lbs. (middle of lift)

Table B-10. Shear Operator #1 PLIBEL

PLIBEL Checklist
(Kemmlert, 1995)

Section I: Musculoskeletal Risk Factors Methods of Application: 1) Find the injured body region, answer yes or no to corresponding questions. 2) Answer questions, score potential body regions for injury risk.					
Musculoskeletal Risk Factor Questions	**Body Regions**				
	Neck, Shoulder, Upper Back	Elbows, Forearm, and Hands	Feet	Knees and Hips	Low Back
1: Is the walking surface uneven, sloping, slippery or nonresilient?			N	N	N
2: Is the space too limited for work movements or work materials?	N	N	N	N	N
3: Are tools and equipment unsuitably designed for the worker or the task?	N	N	N	N	N
4: Is the working height incorrectly adjusted?	Y				Y
5: Is the working chair poorly designed or incorrectly adjusted?	Y				Y
6: If work performed standing, is there no possibility to sit and rest?			Y	Y	Y
7: Is fatiguing foot pedal work performed?			N	N	
8: Is fatiguing leg work performed? e.g. ...					
a) repeated stepping up on stool, step, etc.			N	N	N
b) repeated jumps, prolonged squatting or kneeling?			N	N	N
c) one leg being used more often in supporting the body?			Y	Y	Y
9: Is repeated or sustained work performed when the back is:					
a) mildly flexed forward?	Y				Y
b) severely flexed forward?	N				N
c) bent sideways or mildly twisted?	N				N
d) severely twisted?	N				N

Table B-6. Shear Operator #1 PLIBEL (continued)

10: Is repeated/sustained work performed with neck:					
a) flexed forward?	Y				
b) bent sideways or mildly twisted?	Y				
c) severely twisted?	N				
d) extended backwards?	N				
11: Are loads lifted manually? Note important factors:					
a) periods of repetitive lifting	N				N
b) weight of load	Y				Y
c) awkward grasping of load	Y				Y
d) awkward location of load at onset or end of lifting	Y				Y
e) handling beyond forearm length	Y				y
f) handling below knee length	Y				Y
g) handling above shoulder height	N				N
12: Is repeated, sustained or uncomfortable carrying, pushing or pulling of loads performed?	N	N			N
13: Is sustained work performed when one arm reaches forward or to the side without support?	N				
14: Is there a repetition of:					
a) similar work movements?	Y	Y			
b) similar work movements beyond comfortable reaching distance?	N	N			
15: Is repeated or sustained manual work performed? Notice factors of importance as:					
a) weight of working materials or tools	Y	Y			
b) awkward grasping of working materials or tools	Y	Y			
16: Are there high demands on visual capacity?	N				
17: Is repeated work with forearm and hand performed with:					
a) twisting movements?		N			
b) forceful movements?		N			
c) uncomfortable hand positions?		N			
d) switches or keyboards?		N			

Table B-6. Shear Operator #1 PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, Upper Back	Elbows, Forearm, and Hands	Feet	Knees and Hips	Low Back
SUM	13	3	2	2	10
PERCENTAGE	50.0	27.3	25.0	25.0	47.6
Section II: Environmental / Organizational Risk Factors (Modifying)					
18: Is there no possibility to take breaks and pauses?	N				
19: Is there no possibility to choose order and type of work tasks or pace of work?	N				
20: Is the job performed under time demands or psychological stress?	Y				
21:Can the work have unusual or expected situations?	Y				
22: Are the following present?					
a) cold	N				
b) heat	Y				
c) draft	N				
d) noise	Y				
e) troublesome visual conditions	N				
f) jerks, shakes, or vibration	N				
Environmental / Organizational Risk Factors Score					
SUM	4				
PERCENTAGE	40.0				

Table B-11. Shear Operator #2 PLIBEL

PLIBEL Checklist
Kemmlert (1995)

Section I: Musculoskeletal Risk Factors Methods of Application: 1) Find the injured body region, answer yes or no to corresponding questions (Preferred Method) 2) Answer questions, score potential body regions for injury risk					
Musculoskeletal Risk Factor Questions	**Body Regions**				
	Neck, Shoulder, Upper Back	Elbows, Forearms, Hands	Feet	Knees and Hips	Low Back
1: Is the walking surface uneven, sloping, slippery or nonresilient?			N	N	N
2: Is the space too limited for work movements or work materials?	N	N	N	N	N
3: Are tools and equipment unsuitably designed for the worker or the task?	N	N	N	N	N
4: Is the working height incorrectly adjusted?	Y				Y
5: Is the working chair poorly designed or incorrectly adjusted?	Y				Y
6: If work performed standing, is there no possibility to sit and rest?			Y	Y	Y
7: Is fatiguing foot pedal work performed?			N	N	
8: Is fatiguing leg work performed? e.g. ...					
a) repeated stepping up on stool, step etc..			N	N	N
b) repeated jumps, prolonged squatting or kneeling?			N	N	N
c) one leg being used more often in supporting the body?			N	N	N
9: Is repeated or sustained work performed when the back is:					
a) mildly flexed forward?	Y				Y
b) severely flexed forward?	N				N
c) bent sideways or mildly twisted?	N				N
d) severely twisted?	N				N

Table B-11. Shear Operator #2 PLIBEL (continued)

10: Is repeated or sustained work performed when the neck is:					
a) flexed forward?	Y				
b) bent sideways or mildly twisted?	N				
c) severely twisted?	N				
d) extended backwards?	N				
11: Are loads lifted manually? Notice factors of importance as:					
a) periods of repetitive lifting	N				N
b) weight of load	Y				Y
c) awkward grasping of load	Y				Y
d) awkward location of load at onset or end of lifting	Y				Y
e) handling beyond forearm length	Y				Y
f) handling below knee length	Y				Y
g) handling above shoulder height	N				N
12: Is repeated, sustained or uncomfortable carrying, pushing or pulling of loads performed?	N	N			N
13: Is sustained work performed when one arm reaches forward or to the side without support?	N				
14: Is there a repetition of:					
a) similar work movements?	Y	Y			
b) similar work movements beyond comfortable reaching distance?	N	N			
15: Is repeated or sustained manual work performed? Notice factors of importance as:					
a) weight of working materials or tools	Y	Y			
b) awkward grasping of working materials or tools	Y	Y			
16: Are there high demands on visual capacity?	N				
17: Is repeated work, with forearm and hand, performed with:					
a) twisting movements?		N			
b) forceful movements?		N			
c) uncomfortable hand positions?		N			
d) switches or keyboards?		N			

Table B-11. Shear Operator #2 PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, Upper Back	Elbows, Forearms, Hands	Feet	Knees and Hips	Low Back
SUM	12	3	1	1	9
PERCENTAGE	46.2	27.3	12.5	12.5	42.9
Section II: Environmental / Organizational Risk Factors (Modifying)					
18: Is there no possibility to take breaks and pauses?	N				
19: Is there no possibility to choose order and type of work tasks or pace of work	N				
20: Is the job performed under time demands or psychological stress	N				
21:Can the work have unusual or expected situations?	Y				
22: Are the following present?					
a) cold	N				
b) heat	Y				
c) draft	N				
d) noise	Y				
e) troublesome visual conditions	N				
f) jerks, shakes, or vibration	N				
Environmental / Organizational Risk Factors Score					
SUM	3				
PERCENTAGE	30.0				