APPENDIX K – ELECTRICAL

K1. CABLE PULLING

Table K-1. Cable Puller (2-3" diameter, horizontal pull) RULA

Rapid Upper Limb Assessment (RULA)
Matamney and Corlett (1993)

Work Phase	Pull cable horizontal, below knee level		Hold cable below knee level, wait for signal		Rest		Pull cable horizontal, above knee level	
	Spec	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***
Shoulder Extension/ Flexion	mod flx	3	mod flx	3	neut	1	sl flx	2
Shoulder is Raised (+1)		0		0		0		0
Upper Arm Abducted (+1)		0		0		0		0
Arm supported, leaning (-1)		0		0		0		0
Elbow Extension/ Flexion	ext	1	ext	1	neut	2	ext	1
Shoulder Abduction/ Adduction	neut	0	neut	0	neut	0	mod abd	1
Shoulder Lateral/ Medial	neut	0	neut	0	neut	0	neut	0
Wrist Extension/ Flexion	ext	2	ext	2	neut	1	neut	1
Wrist Deviation	ulnar	1	ulnar	1	ulnar	1	ulnar	1
Wrist Bent from Midline (+1)		0		0		0		0
Wrist Twist (1) In mid range or (2) End of range		1		1		1		1
Arm and Wrist Muscle Use Score: lf posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0		0
Arm and Wrist Force/ Load Score: If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		1		0		1

Table K-1. Cable Puller (2-3" diameter, horizontal pull) RULA (continued)

Work Phase	Pull cable horizontal, below knee level		Hold cable below knee level, wait for signal		Rest		Pull cable horizontal, above knee level	
	Spec	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***
Neck Extension/ Flexion	ext	4	ext	4	neut	1	sl flx	2
Neck Twist (+1)		0		0		0		0
Neck Side-Bent (+1)		0		0		0		0
Trunk Extension/ Flexion	hyp flx	4	hyp flx	4	neut	1	sl flx	2
Trunk Twist (+1)		0		0		0		1
Trunk Side Bend (+1)		0		0		0		0
Legs: If legs and feet are supported and balanced: (+1); If not: (+2)		1		1		1		1
Neck, Trunk, and Leg Muscle Use Score: If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0		0
Neck, Trunk, and Leg Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		1		1		1
Total RULA Score	**7**		**6**		**2**		**4**	

1 or 2 = Acceptable
3 or 4 = Investigate Further
5 or 6 = Investigate Further and Change Soon
7 = Investigate and Change Immediately

Table K-2. Cable Puller (2-3" diameter, downward pull) RULA

Rapid Upper Limb Assessment (RULA)
Matamney and Corlett (1993)

Work Phase	Pull cable down		Rest		Hold cable, wait for signal	
	Specific	***RULA Score***	***Specific***	***RULA Score***	***Specific***	***RULA Score***
Shoulder Extension/ Flexion	hyp flx	4	neut	1	mod flx	3
Shoulder is Raised (+1)		1		0		0
Upper Arm Abducted (+1)		0		0		0
Arm supported, leaning (-1)		0		0		0
Elbow Extension/ Flexion	ext	1	neut	2	neut	2
Shoulder Abduction/ Adduction	neut	0	neut	0	neut	0
Shoulder Lateral/ Medial	neut	0	neut	0	neut	0
Wrist Extension/ Flexion	ext	2	neut	1	neut	1
Wrist Deviation	ulnar	1	neut	0	ulnar	1
Wrist Bent from Midline (+1)		0		0		0
Wrist Twist (1) In mid range or (2) End of range		1		1		1
Arm and Wrist Muscle Use Score If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0
Arm and Wrist Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		0		1

Table K-2. Cable puller (2-3" diameter, downward pull) RULA (continued)

Work Phase	Pull cable down		Rest		Hold cable, wait for signal	
	Spec	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***
Neck Extension/ Flexion	sl flx	2	sl flx	2	neut	1
Neck Twist (+1)		0		0		0
Neck Side-Bent (+1)		0		0		0
Trunk Extension/ Flexion	sl flx	2	neut	1	neut	1
Trunk Twist (+1)		0		0		0
Trunk Side Bend (+1)		0		0		0
Legs If legs and feet are supported and balanced: (+1); if not: (+2)		1		1		1
Neck, Trunk, and Leg Muscle Use Score If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		1		0
Neck, Trunk, and Leg Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		1		1
Total RULA Score	**7**		**3**		**4**	

1 or 2 = Acceptable
3 or 4 = Investigate Further
5 or 6 = Investigate Further and Change Soon
7 = Investigate and Change Immediately

Table K-3. Cable Puller (2-3" diameter, upward push) RULA

Rapid Upper Limb Assessment (RULA)
Matamney and Corlett (1993)

Work Phase	Feed/ push cable upwards		Rest		Hold cable, wait for signal	
	Specific	***RULA Score***	***Specific***	***RULA Score***	***Specific***	***RULA Score***
Shoulder Extension/ Flexion	mod flx	3	neut	1	mod flx	3
Shoulder is Raised (+1)		1		0		1
Upper Arm Abducted (+1)		0		0		0
Arm supported, leaning (-1)		0		0		0
Elbow Extension/ Flexion	neut	2	neut	2	neut	2
Shoulder Abduction/ Adduction	neut	0	neut	0	neut	0
Shoulder Lateral/ Medial	neut	0	neut	0	neut	0
Wrist Extension/ Flexion	flx	2	neut	1	neut	1
Wrist Deviation	ulnar	1	neut	0	neut	0
Wrist Bent from Midline (+1)		0		0		0
Wrist Twist (1) In mid range or (2) End of range		1		1		1
Arm and Wrist Muscle Use Score: If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0
Arm and Wrist Force/ Load Score: If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		0		1

Table K-3. Cable Puller (2-3" diameter, upward push) RULA (continued)

Work Phase	Feed/ push cable upwards		Rest		Hold cable, wait for signal	
	Specific	***RULA Score***	***Specific***	***RULA Score***	***Specific***	***RULA Score***
Neck Extension/ Flexion	ext	4	sl flx	2	neut	1
Neck Twist (+1)		0		0		0
Neck Side-Bent (+1)		0		0		0
Trunk Extension/ Flexion	sl flx	2	neut	1	neut	1
Trunk Twist (+1)		0		0		0
Trunk Side Bend (+1)		0		0		0
Legs: If legs and feet are supported and balanced: (+1); If not: (+2)		1		1		1
Neck, Trunk, and Leg Muscle Use Score: If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		1		0
Neck, Trunk, and Leg Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		1		1
Total RULA Score	**7**		**3**		**4**	

1 or 2 = Acceptable
3 or 4 = Investigate Further
5 or 6 = Investigate Further and Change Soon
7 = Investigate and Change Immediately

Table K-4. Cable Puller (1-2" diameter, overhead) RULA

Rapid Upper Limb Assessment (RULA)
Matamney and Corlett (1993)

Work Phase	Pull cable overhead		Rest, wait for signal		Hold cable overhead, wait for signal	
	Specific	***RULA Score***	***Specific***	***RULA Score***	***Specific***	***RULA Score***
Shoulder Extension/ Flexion	hyp flex	4	hyp flex	4	hyp flex	4
Shoulder is Raised (+1)		1		1		1
Upper Arm Abducted (+1)		0		0		0
Arm supported leaning(-1)		0		-1		0
Elbow Extension/ Flexion	ext	1	ext	1	ext	1
Shoulder Abduction/ Adduction	neut	0	neut	0	neut	0
Shoulder Lateral/ Medial	lat	1	neut	0	neut	0
Wrist Extension/ Flexion	ext	2	neut	1	ext	2
Wrist Deviation	ulnar	1	neut	0	ulnar	1
Wrist Bent from Midline (+1)		0		0		0
Wrist Twist (1) In mid range, or (2) End of range		1		1		1
Arm and Wrist Muscle Use Score If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0
Arm and Wrist Force/ load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		0		1

Table K-4. Cable Puller (1-2" diameter, overhead) RULA (continued)

Work Phase	Pull cable overhead		Rest, wait for signal		Hold cable overhead, wait for signal	
	Specific	*RULA Score*	*Specific*	*RULA Score*	*Specific*	*RULA Score*
Neck Extension/ Flexion	ext	4	ext	4	sl flx	2
Neck Twist (+1)		0		0		0
Neck Side-Bent (+1)		0		0		0
Trunk Extension/ Flexion	neut	1	neut	1	neut	1
Trunk Twist (+1)		0		0		0
Trunk Side Bend (+1)		0		0		0
Legs: If legs and feet are supported and balanced: (+1); If not: (+2)		1		1		1
Neck, Trunk, and Leg Muscle Use Score: If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0
Neck, Trunk, and Leg Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		1		0		1
Total RULA Score	**6**		**3**		**5**	

1 or 2 = Acceptable
3 or 4 = Investigate Further
5 or 6 = Investigate Further and Change Soon
7 = Investigate and Change Immediately

Table K-5. Cable Puller (1.5" diameter) RULA

Rapid Upper Limb Assessment (RULA)
Matamney and Corlett (1993)

Work Phase	Feed cable below feet, sitting		Feed cable below feet squatting		Change position		Arrange cable in conduit		Rest	
	Spec	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***
Shoulder Extension/ Flexion	sl flex	2	sl flex	2	sl flex	2	sl flex	2	sl flex	2
Shoulder is Raised (+1)		0		0		0		0		0
Upper Arm Abducted (+1)		0		0		0		0		0
Arm supported, leaning (-1)		0		0		0		0		0
Elbow Extension/ Flexion	ext	1	ext	1	ext	1	neut	2	ext	1
Shoulder Abduction/ Adduction	neut	0	neut	0	neut	0	neut	0	neut	0
Shoulder Lateral/ Medial	neut	0	neut	0	neut	0	lat	1	neut	0
Wrist Extension/ Flexion	ext	2	ext	2	neut	1	ext	2	neut	1
Wrist Deviation	ulnar	1	ulnar	1	neut	0	neut	0	neut	0
Wrist Bent from Midline (+1)		0		0		0		0		0
Wrist Twist (1) In mid range or (2) End of range		1		1		1		1		1
Arm and Wrist Muscle Use Score If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		0		0		0		0		0
Arm and Wrist Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		3		0		1		0

Table K-5. Cable Puller (1.5" diameter) RULA (continued)

Work Phase	Feed cable below feet, sitting		Feed cable below feet squatting		Change position		Arrange cable in conduit		Rest	
	Spec	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***
Neck Extension/ Flexion	sl flx	2	sl flx	2	neut	1	sl flx	2	sl flx	2
Neck Twist (+1)		1		1		0		1		0
Neck Side-Bent (+1)		0		0		0		0		0
Trunk Extension/ Flexion	sl flx	2	mod flx	3	sl flx	2	sl flx	2	neut	1
Trunk Twist (+1)		1		1		0		0		0
Trunk Side Bend (+1)		1		0		0		0		0
Legs: If legs and feet are supported and balanced: (+1); If not: (+2)		1		1		1		1		1
Neck, Trunk, and Leg Muscle Use Score If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		0		0		0		0		0
Neck, Trunk, and Leg Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		3		1		1		0
Total RULA Score	**7**		**7**		**2**		**4**		**2**	

1 or 2 = Acceptable
3 or 4 = Investigate Further
5 or 6 = Investigate Further and Change Soon
7 = Investigate and Change Immediately

Table K-6. Cable Puller (0.75” diameter) RULA

Rapid Upper Limb Assessment (RULA)
Matamney and Corlett (1993)

Work Phase	Pull cable		Feed cable		Change position		Adjusting cable		Tie cables		Rest	
	Spec	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***
Shoulder Extension/ Flexion	mod flex	3	hyp flex	4	mod flex	3	hyp flex	4	hyp flex	4	neut	1
Shoulder is Raised (+1)		0		1		0		1		1		0
Upper Arm Abducted (+1)		1		0		0		0		0		0
Arm supported, leaning (-1)		0		0		0		0		0		0
Elbow Extension/ Flexion	neut	2	ext	1	neut	2	ext	1	ext	1	ext	1
Shoulder Abduction/ Adduction	mod abd	1	neut	0	neut	0	neut	0	neut	0	neut	0
Shoulder Lateral/ Medial	lat	1	mod med	1	neut	0	neut	0	neut	0	neut	0
Wrist Extension/ Flexion	ext	2	neut	1	neut	1	ext	2	ext	2	neut	1
Wrist Deviation	ulnar	1	ulnar	1	neut	0	ulnar	1	ulnar	1	neut	0
Wrist Bent from Midline (+1)		0		0		0		0		0		0
Wrist Twist (1) In mid range or (2) End of range		1		1		1		1		1		1
Arm and Wrist Muscle Use Score If posture mainly static (ie. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		0		0		0		0		0		0
Arm and Wrist Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		3		2		1		1		1		0

Table K-6. Cable Puller (0.75" diameter) RULA (continued)

Work Phase	Pull cable		Feed cable		Change position		Adjusting cable		Tie cables		Rest	
	Spec	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***	***Spec***	***RULA Score***
Neck Extension/ Flexion	neut	1	ext	4	ext	4	ext	4	ext	4	sl flx	2
Neck Twist (+1)		1		1		1		0		0		0
Neck Side-Bent (+1)		0		0		0		0		0		0
Trunk Extension/ Flexion	neut	1	neut	1	neut	1	neut	1	neut	1	neut	1
Trunk Twist (+1)		1		1		1		0		0		0
Trunk Side Bend (+1)		0		0		0		0		0		0
Legs: If legs and feet are supported and balanced: (+1); If not: (+2)		1		1		1		1		1		1
Neck, Trunk, and Leg Muscle Use Score: If posture mainly static (i.e. held for longer than 10 minutes) or if action repeatedly occurs 4 times per minute or more: (+ 1)		0		0		0		0		0		0
Neck, Trunk, and Leg Force/ Load Score: If load less than 2 kg (intermittent): (+0). If 2kg to 10 kg (intermittent): (+1). If 2kg to 10 kg (static or repeated): (+2). If more than 10 kg load or repeated or shocks: (+3)		3		2		1		1		1		0
Total RULA Score	**7**		**7**		**3**		**5**		**5**		**1**	

1 or 2 = Acceptable
3 or 4 = Investigate Further
5 or 6 = Investigate Further and Change Soon
7 = Investigate and Change Immediately

Table K-7. Cable Puller (2-3" diameter, horizontal pull) Strain Index

Strain Index: Distal Upper Extremity Disorders Risk Assessment
Moore and Garg (1995)

1. Intensity of Exertion: An estimate of the strength required to perform the task one time. Mark the rating after using the guidelines below; then fill in the corresponding multiplier in the far right box.					
Rating Criterion	**% Maximal Strength**	**Borg Scale**	**Perceived Effort**	**Rating**	**Multiplier**
Light	< 10%	< or = 2	barely noticeable or relaxed effort	1	1.0
Somewhat Hard	10% - 29%	3	noticeable or definite effort	2	3.0
Hard	30% - 49%	4 –5	obvious effort; unchanged facial expression	3	6.0
Very Hard	50% - 79%	6 – 7	substantial effort; changes to facial expression	4	9.0
Near Maximal	> or = 80%	> 7	uses shoulder or trunk to generate force	5	13.0
Intensity of Exertion Multiplier					**9.0**

2. Duration of Exertion (% of cycle): Calculated by measuring the duration of all exertions during an observation period, and then dividing the measured duration of exertion by the total observation time and multiplying by 100. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: % Duration of Exertion = 100 x duration of all exertions (sec) / Total observation time (sec) = 100 x 164 (sec)/780 (sec) = 21%	**Rating Criterion**	**Rating**	**Multiplier**
	< 10%	1	0.5
	10% - 29%	2	1.0
	30% - 49%	3	1.5
	50% - 79%	4	2.0
	> or = 80%	5	3.0
Duration of Exertion Multiplier			**1.0**

3. Efforts per Minute: Measured by counting the number of exertions that occur during an observation period, and then dividing the number of exertions by the duration of the observation period, measured in minutes. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: Efforts per Minute = number of exertions / total observation time (min) = 82/13 = 6	**Rating Criterion**	**Rating**	**Multiplier**
	< 4	1	0.5
	4 – 8	2	1.0
	9 – 14	3	1.5
	15 – 19	4	2.0
	> or = 20	5	3.0
Efforts per Minute Multiplier			**1.0**

Table K-7. Cable Puller (2-3" diameter, horizontal pull) Strain Index (continued)

4. Hand/Wrist Posture: An estimate of the position of the hand or wrist relative to neutral position.						
Rating Criterion	**Wrist Extension**	**Wrist Flexion**	**Ulnar Deviation**	**Perceived Posture**	**Rating**	**Multiplier**
Very Good	0 – 10 degrees	0 – 5 degrees	0 – 10 degrees	perfectly neutral	1	1.0
Good	11 – 25 degrees	6 – 15 degrees	11 – 15 degrees	near neutral	2	1.0
Fair	26 – 40 degrees	16 – 30 degrees	16 – 20 degrees	non-neutral	3	1.5
Bad	41 – 55 degrees	31 – 50 degrees	21 – 25 degrees	marked deviation (*estimated, based on RULAs done)	4	2.0
Very Bad	> 60 degrees	> 50 degrees	> 25 degrees	near extreme	5	3.0
Hand/Wrist Posture Multiplier						**2.0**

5. Speed of Work: An estimate of how fast the worker is working.				
Rating Criterion	**Observed Pace/MTM Predicted Pace x 100%**	**Perceived Speed**	**Rating**	**Multiplier**
Very Slow	< or = 80%	extremely relaxed pace	1	1.0
Slow	81% – 90%	"taking one's own time"	2	1.0
Fair	91% - 100%	"normal" speed of motion	3	1.0
Fast	101% - 115%	rushed, but able to keep up	4	1.5
Very Fast	> 115%	rushed, barely or unable to keep up	5	2.0
Speed of Work Multiplier				**1.0**

6. Duration of Task per Day: Either measured of obtained from plant personnel			
Worksheet:	**Rating Criterion**	**Rating**	**Multiplier**
Duration of Task per Day (hrs)	< or = 1 hr	1	0.25
= duration of task (hrs) +	1 –2 hrs	2	0.50
duration of task (hrs) + …	2 – 4 hrs	3	0.75
	4 – 8 hrs	4	1.00
= (estimate ~ 4- 8 hrs)	> or = 8 hrs	5	1.50
Duration of Task per Day Multiplier			**1.00**

Table K-7. Cable Puller (2-3" diameter, horizontal pull) Strain Index (continued)

7. Calculate the Strain Index (SI) Score: Insert the multiplier values for each of the six task variables into the spaces below, then multiply them all together.							
Intensity of Exertion	**Duration of Exertion**	**Efforts per Minute**	**Hand/Wrist Posture**	**Speed of Work**	**Duration of Task**		**SI SCORE**
9.0 X	**1.0 X**	**1.0 X**	**2.0 X**	**1.0 X**	**1.00**	**=**	**18**

SI Scores are used to predict Incidence Rates of Distal Upper Extremity injuries per 100 FTE:
-- SI Score < 5 is correlated to an Incidence Rate of about 2 DUE injuries per 100 FTE;
-- SI Score of between 5 – 30 is correlated to an Incidence Rate of about 77 DUE injuries per 100 FTE;
-- SI Score of between 31 – 60 is correlated to an Incidence Rate of about 106 DUE injuries per 100 FTE; and
-- SI Score of > 60 is correlated to an Incidence Rate of about 130 DUE injuries per 100 FTE.

Table K-8. Cable Puller (2-3" diameter, downward pull) Strain Index

Strain Index: Distal Upper Extremity Disorders Risk Assessment
Moore and Garg (1995)

1. Intensity of Exertion: An estimate of the strength required to perform the task one time. Mark the rating after using the guidelines below; then fill in the corresponding multiplier in the far right box.					
Rating Criterion	**% Maximal Strength**	**Borg Scale**	**Perceived Effort**	**Rating**	**Multiplier**
Light	< 10%	< or = 2	barely noticeable or relaxed effort	1	1.0
Somewhat Hard	10% - 29%	3	noticeable or definite effort	2	3.0
Hard	30% - 49%	4 –5	obvious effort; unchanged facial expression	3	6.0
Very Hard	50% - 79%	6 – 7	substantial effort; changes to facial expression	4	9.0
Near Maximal	> or = 80%	> 7	uses shoulder or trunk to generate force	5	13.0
Intensity of Exertion Multiplier					**13.0**

2. Duration of Exertion (% of cycle): Calculated by measuring the duration of all exertions during an observation period, and then dividing the measured duration of exertion by the total observation time and multiplying by 100. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: % Duration of Exertion = 100 x duration of all exertions (sec) / Total observation time (sec) = 100 x 140 (sec)/644 (sec) = 22%	**Rating Criterion**	**Rating**	**Multiplier**
	< 10%	1	0.5
	10% - 29%	2	1.0
	30% - 49%	3	1.5
	50% - 79%	4	2.0
	> or = 80%	5	3.0
Duration of Exertion Multiplier			**1.0**

3. Efforts per Minute: Measured by counting the number of exertions that occur during an observation period, and then dividing the number of exertions by the duration of the observation period, measured in minutes. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: Efforts per Minute = number of exertions / total observation time (min) = 130/10.7 = 12	**Rating Criterion**	**Rating**	**Multiplier**
	< 4	1	0.5
	4 – 8	2	1.0
	9 – 14	3	1.5
	15 – 19	4	2.0
	> or = 20	5	3.0
Efforts per Minute Multiplier			**1.5**

Table K-8. Cable Puller (2-3" diameter, downward pull) Strain Index (continued)

4. Hand/Wrist Posture: An estimate of the position of the hand or wrist relative to neutral position.						
Rating Criterion	**Wrist Extension**	**Wrist Flexion**	**Ulnar Deviation**	**Perceived Posture**	**Rating**	**Multiplier**
Very Good	0 – 10 degrees	0 – 5 degrees	0 – 10 degrees	perfectly neutral	1	1.0
Good	11 – 25 degrees	6 – 15 degrees	11 – 15 degrees	near neutral	2	1.0
Fair	26 – 40 degrees	16 – 30 degrees	16 – 20 degrees	non-neutral	3	1.5
Bad	41 – 55 degrees	31 – 50 degrees	21 – 25 degrees	marked deviation (*estimated, based on RULAs done)	4	2.0
Very Bad	> 60 degrees	> 50 degrees	> 25 degrees	near extreme	5	3.0
Hand/Wrist Posture Multiplier						**2.0**

5. Speed of Work: An estimate of how fast the worker is working.				
Rating Criterion	**Observed Pace/MTM Predicted Pace x 100%**	**Perceived Speed**	**Rating**	**Multiplier**
Very Slow	< or = 80%	extremely relaxed pace	1	1.0
Slow	81% – 90%	"taking one's own time"	2	1.0
Fair	91% - 100%	"normal" speed of motion	3	1.0
Fast	101% - 115%	rushed, but able to keep up	4	1.5
Very Fast	> 115%	rushed, barely or unable to keep up	5	2.0
Speed of Work Multiplier				**1.5**

6. Duration of Task per Day: Either measured of obtained from plant personnel			
Worksheet:	**Rating Criterion**	**Rating**	**Multiplier**
Duration of Task per Day (hrs)	< or = 1 hr	1	0.25
= duration of task (hrs) +	1 –2 hrs	2	0.50
duration of task (hrs) + …	2 – 4 hrs	3	0.75
	4 – 8 hrs	4	1.00
= (estimate ~ 4- 8 hrs)	> or = 8 hrs	5	1.50
Duration of Task per Day Multiplier			**1.00**

Table K-8. Cable Puller (2-3" diameter, downward pull) Strain Index (continued)

7. Calculate the Strain Index (SI) Score: Insert the multiplier values for each of the six task variables into the spaces below, then multiply them all together.							
Intensity of Exertion	**Duration of Exertion**	**Efforts per Minute**	**Hand/Wrist Posture**	**Speed of Work**	**Duration of Task**		**SI SCORE**
13.0 X	**1.0 X**	**1.5 X**	**2.0 X**	**1.5 X**	**1.00**	**=**	**58.5**

SI Scores are used to predict Incidence Rates of Distal Upper Extremity injuries per 100 FTE:
-- SI Score < 5 is correlated to an Incidence Rate of about 2 DUE injuries per 100 FTE;
-- SI Score of between 5 – 30 is correlated to an Incidence Rate of about 77 DUE injuries per 100 FTE;
-- SI Score of between 31 – 60 is correlated to an Incidence Rate of about 106 DUE injuries per 100 FTE; and
-- SI Score of > 60 is correlated to an Incidence Rate of about 130 DUE injuries per 100 FTE.

Table K-9. Cable Puller (2-3" diameter, upward push) Strain Index

Strain Index: Distal Upper Extremity Disorders Risk Assessment
Moore and Garg (1995)

1. Intensity of Exertion: An estimate of the strength required to perform the task one time. Mark the rating after using the guidelines below; then fill in the corresponding multiplier in the far right box.					
Rating Criterion	**% Maximal Strength**	**Borg Scale**	**Perceived Effort**	**Rating**	**Multiplier**
Light	< 10%	< or = 2	barely noticeable or relaxed effort	1	1.0
Somewhat Hard	10% - 29%	3	noticeable or definite effort	2	3.0
Hard	30% - 49%	4 –5	obvious effort; unchanged facial expression	3	6.0
Very Hard	50% - 79%	6 – 7	substantial effort; changes to facial expression	4	9.0
Near Maximal	> or = 80%	> 7	uses shoulder or trunk to generate force	5	13.0
Intensity of Exertion Multiplier					**13.0**

2. Duration of Exertion (% of cycle): Calculated by measuring the duration of all exertions during an observation period, and then dividing the measured duration of exertion by the total observation time and multiplying by 100. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: % Duration of Exertion = 100 x duration of all exertions (sec) / Total observation time (sec) = 100 x 170 (sec)/817 (sec) = 21%	**Rating Criterion**	**Rating**	**Multiplier**
	< 10%	1	0.5
	10% - 29%	2	1.0
	30% - 49%	3	1.5
	50% - 79%	4	2.0
	> or = 80%	5	3.0
Duration of Exertion Multiplier			**1.0**

3. Efforts per Minute: Measured by counting the number of exertions that occur during an observation period, and then dividing the number of exertions by the duration of the observation period, measured in minutes. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: Efforts per Minute = number of exertions / total observation time (min) = 141/13.6 = 10.4	**Rating Criterion**	**Rating**	**Multiplier**
	< 4	1	0.5
	4 – 8	2	1.0
	9 – 14	3	1.5
	15 – 19	4	2.0
	> or = 20	5	3.0
Efforts per Minute Multiplier			**1.5**

Table K-9. Cable Puller (2-3" diameter, upward push) Strain Index (continued)

4. Hand/Wrist Posture: An estimate of the position of the hand or wrist relative to neutral position.						
Rating Criterion	**Wrist Extension**	**Wrist Flexion**	**Ulnar Deviation**	**Perceived Posture**	**Rating**	**Multiplier**
Very Good	0 – 10 degrees	0 – 5 degrees	0 – 10 degrees	perfectly neutral	1	1.0
Good	11 – 25 degrees	6 – 15 degrees	11 – 15 degrees	near neutral	2	1.0
Fair	26 – 40 degrees	16 – 30 degrees	16 – 20 degrees	non-neutral	3	1.5
Bad	41 – 55 degrees	31 – 50 degrees	21 – 25 degrees	marked deviation (*estimated, based on RULAs done)	4	2.0
Very Bad	> 60 degrees	> 50 degrees	> 25 degrees	near extreme	5	3.0
Hand/Wrist Posture Multiplier						**2.0**

5. Speed of Work: An estimate of how fast the worker is working.				
Rating Criterion	**Observed Pace/MTM Predicted Pace x 100%**	**Perceived Speed**	**Rating**	**Multiplier**
Very Slow	< or = 80%	extremely relaxed pace	1	1.0
Slow	81% – 90%	"taking one's own time"	2	1.0
Fair	91% - 100%	"normal" speed of motion	3	1.0
Fast	101% - 115%	rushed, but able to keep up	4	1.5
Very Fast	> 115%	rushed, barely or unable to keep up	5	2.0
Speed of Work Multiplier				**1.5**

6. Duration of Task per Day: Either measured of obtained from plant personnel			
Worksheet:	**Rating Criterion**	**Rating**	**Multiplier**
Duration of Task per Day (hrs)	< or = 1 hr	1	0.25
= duration of task (hrs) +	1 –2 hrs	2	0.50
duration of task (hrs) + …	2 – 4 hrs	3	0.75
	4 – 8 hrs	4	1.00
= (estimate ~ 4- 8 hrs)	> or = 8 hrs	5	1.50
Duration of Task per Day Multiplier			**1.00**

Table K-9. Cable Puller (2-3" diameter, upward push) Strain Index (continued)

7. Calculate the Strain Index (SI) Score: Insert the multiplier values for each of the six task variables into the spaces below, then multiply them all together.							
Intensity of Exertion	**Duration of Exertion**	**Efforts per Minute**	**Hand/Wrist Posture**	**Speed of Work**	**Duration of Task**		**SI SCORE**
13.0 X	**1.0 X**	**1.5 X**	**2.0 X**	**1.5 X**	**1.00**	**=**	**58.5**

SI Scores are used to predict Incidence Rates of Distal Upper Extremity injuries per 100 FTE:
-- SI Score < 5 is correlated to an Incidence Rate of about 2 DUE injuries per 100 FTE;
-- SI Score of between 5 – 30 is correlated to an Incidence Rate of about 77 DUE injuries per 100 FTE;
-- SI Score of between 31 – 60 is correlated to an Incidence Rate of about 106 DUE injuries per 100 FTE; and
-- SI Score of > 60 is correlated to an Incidence Rate of about 130 DUE injuries per 100 FTE.

Table K-10. Cable Puller (1-2" diameter, overhead) Strain Index

Strain Index: Distal Upper Extremity Disorders Risk Assessment
Moore and Garg (1995)

1. Intensity of Exertion: An estimate of the strength required to perform the task one time. Mark the rating after using the guidelines below; then fill in the corresponding multiplier in the far right box.					
Rating Criterion	**% Maximal Strength**	**Borg Scale**	**Perceived Effort**	**Rating**	**Multiplier**
Light	< 10%	< or = 2	barely noticeable or relaxed effort	1	1.0
Somewhat Hard	10% - 29%	3	noticeable or definite effort	2	3.0
Hard	30% - 49%	4 –5	obvious effort; unchanged facial expression	3	6.0
Very Hard	50% - 79%	6 – 7	substantial effort; changes to facial expression	4	9.0
Near Maximal	> or = 80%	> 7	uses shoulder or trunk to generate force	5	13.0
Intensity of Exertion Multiplier					**6.0**

2. Duration of Exertion (% of cycle): Calculated by measuring the duration of all exertions during an observation period, and then dividing the measured duration of exertion by the total observation time and multiplying by 100. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: % Duration of Exertion = 100 x duration of all exertions (sec) / Total observation time (sec) = 100 x 141 (sec)/465 (sec) = 30%	**Rating Criterion**	**Rating**	**Multiplier**
	< 10%	1	0.5
	10% - 29%	2	1.0
	30% - 49%	3	1.5
	50% - 79%	4	2.0
	> or = 80%	5	3.0
Duration of Exertion Multiplier			**1.5**

3. Efforts per Minute: Measured by counting the number of exertions that occur during an observation period, and then dividing the number of exertions by the duration of the observation period, measured in minutes. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: Efforts per Minute = number of exertions / total observation time (min) = 97/8 = 12.5	**Rating Criterion**	**Rating**	**Multiplier**
	< 4	1	0.5
	4 – 8	2	1.0
	9 – 14	3	1.5
	15 – 19	4	2.0
	> or = 20	5	3.0
Efforts per Minute Multiplier			**1.5**

Table K-10. Cable Puller (1-2" diameter, overhead pull) Strain Index (continued)

4. Hand/Wrist Posture: An estimate of the position of the hand or wrist relative to neutral position.						
Rating Criterion	**Wrist Extension**	**Wrist Flexion**	**Ulnar Deviation**	**Perceived Posture**	**Rating**	**Multiplier**
Very Good	0 – 10 degrees	0 – 5 degrees	0 – 10 degrees	perfectly neutral	1	1.0
Good	11 – 25 degrees	6 – 15 degrees	11 – 15 degrees	near neutral	2	1.0
Fair	26 – 40 degrees	16 – 30 degrees	16 – 20 degrees	non-neutral	3	1.5
Bad	41 – 55 degrees	31 – 50 degrees	21 – 25 degrees	marked deviation (*estimated, based on RULAs done)	4	2.0
Very Bad	> 60 degrees	> 50 degrees	> 25 degrees	near extreme	5	3.0
Hand/Wrist Posture Multiplier						**2.0**

5. Speed of Work: An estimate of how fast the worker is working.				
Rating Criterion	**Observed Pace/MTM Predicted Pace x 100%**	**Perceived Speed**	**Rating**	**Multiplier**
Very Slow	< or = 80%	extremely relaxed pace	1	1.0
Slow	81% – 90%	"taking one's own time"	2	1.0
Fair	91% - 100%	"normal" speed of motion	3	1.0
Fast	101% - 115%	rushed, but able to keep up	4	1.5
Very Fast	> 115%	rushed, barely or unable to keep up	5	2.0
Speed of Work Multiplier				**1.0**

6. Duration of Task per Day: Either measured of obtained from plant personnel			
Worksheet:	**Rating Criterion**	**Rating**	**Multiplier**
Duration of Task per Day (hrs)	< or = 1 hr	1	0.25
= duration of task (hrs) +	1 –2 hrs	2	0.50
duration of task (hrs) + …	2 – 4 hrs	3	0.75
	4 – 8 hrs	4	1.00
= (estimate ~ 4- 8 hrs)	> or = 8 hrs	5	1.50
Duration of Task per Day Multiplier			**1.00**

Table K-10. Cable Puller (1-2” diameter, overhead pull) Strain Index (continued)

7. Calculate the Strain Index (SI) Score: Insert the multiplier values for each of the six task variables into the spaces below, then multiply them all together.							
Intensity of Exertion	**Duration of Exertion**	**Efforts per Minute**	**Hand/Wrist Posture**	**Speed of Work**	**Duration of Task**		**SI SCORE**
6.0 X	**1.5 X**	**1.5 X**	**2.0 X**	**1.0 X**	**1.00**	=	**27**

SI Scores are used to predict Incidence Rates of Distal Upper Extremity injuries per 100 FTE:
-- SI Score < 5 is correlated to an Incidence Rate of about 2 DUE injuries per 100 FTE;
-- SI Score of between 5 – 30 is correlated to an Incidence Rate of about 77 DUE injuries per 100 FTE;
-- SI Score of between 31 – 60 is correlated to an Incidence Rate of about 106 DUE injuries per 100 FTE; and
-- SI Score of > 60 is correlated to an Incidence Rate of about 130 DUE injuries per 100 FTE.

Table K-11. Cable Puller (1.5" diameter) Strain Index

Strain Index: Distal Upper Extremity Disorders Risk Assessment
Moore and Garg (1995)

1. Intensity of Exertion: An estimate of the strength required to perform the task one time. Mark the rating after using the guidelines below; then fill in the corresponding multiplier in the far right box.					
Rating Criterion	**% Maximal Strength**	**Borg Scale**	**Perceived Effort**	**Rating**	**Multiplier**
Light	< 10%	< or = 2	barely noticeable or relaxed effort	1	1.0
Somewhat Hard	10% - 29%	3	noticeable or definite effort	2	3.0
Hard	30% - 49%	4 –5	obvious effort; unchanged facial expression	3	6.0
Very Hard	50% - 79%	6 – 7	substantial effort; changes to facial expression	4	9.0
Near Maximal	> or = 80%	> 7	uses shoulder or trunk to generate force	5	13.0
Intensity of Exertion Multiplier					**6.0**

2. Duration of Exertion (% of cycle): Calculated by measuring the duration of all exertions during an observation period, and then dividing the measured duration of exertion by the total observation time and multiplying by 100. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: % Duration of Exertion = 100 x duration of all exertions (sec) / Total observation time (sec) = 100 x 91 (sec)/152 (sec) = 60%	**Rating Criterion**	**Rating**	**Multiplier**
	< 10%	1	0.5
	10% - 29%	2	1.0
	30% - 49%	3	1.5
	50% - 79%	4	2.0
	> or = 80%	5	3.0
Duration of Exertion Multiplier			**2.0**

3. Efforts per Minute: Measured by counting the number of exertions that occur during an observation period, and then dividing the number of exertions by the duration of the observation period, measured in minutes. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: Efforts per Minute = number of exertions / total observation time (min) = 6/2.5 = 2.4, but task somewhat static, set multiplier to 1.0	**Rating Criterion**	**Rating**	**Multiplier**
	< 4	1	0.5
	4 – 8	2	1.0
	9 – 14	3	1.5
	15 – 19	4	2.0
	> or = 20	5	3.0
Efforts per Minute Multiplier			**1.0**

Table K-11. Cable Puller (1.5" diameter) Strain Index (continued)

4. Hand/Wrist Posture: An estimate of the position of the hand or wrist relative to neutral position.						
Rating Criterion	**Wrist Extension**	**Wrist Flexion**	**Ulnar Deviation**	**Perceived Posture**	**Rating**	**Multiplier**
Very Good	0 – 10 degrees	0 – 5 degrees	0 – 10 degrees	perfectly neutral	1	1.0
Good	11 – 25 degrees	6 – 15 degrees	11 – 15 degrees	near neutral	2	1.0
Fair	26 – 40 degrees	16 – 30 degrees	16 – 20 degrees	non-neutral (*estimated, based on RULAs done)	3	1.5
Bad	41 – 55 degrees	31 – 50 degrees	21 – 25 degrees	marked deviation	4	2.0
Very Bad	> 60 degrees	> 50 degrees	> 25 degrees	near extreme	5	3.0
Hand/Wrist Posture Multiplier						**1.5**

5. Speed of Work: An estimate of how fast the worker is working.				
Rating Criterion	**Observed Pace/MTM Predicted Pace x 100%**	**Perceived Speed**	**Rating**	**Multiplier**
Very Slow	< or = 80%	extremely relaxed pace	1	1.0
Slow	81% – 90%	"taking one's own time"	2	1.0
Fair	91% - 100%	"normal" speed of motion	3	1.0
Fast	101% - 115%	rushed, but able to keep up	4	1.5
Very Fast	> 115%	rushed, barely or unable to keep up	5	2.0
Speed of Work Multiplier				**1.0**

6. Duration of Task per Day: Either measured of obtained from plant personnel			
Worksheet:	**Rating Criterion**	**Rating**	**Multiplier**
Duration of Task per Day (hrs)	< or = 1 hr	1	0.25
= duration of task (hrs) +	1 –2 hrs	2	0.50
duration of task (hrs) + …	2 – 4 hrs	3	0.75
	4 – 8 hrs	4	1.00
= (estimate ~ 4- 8 hrs)	> or = 8 hrs	5	1.50
Duration of Task per Day Multiplier			**1.00**

Table K-11. Cable Puller (1.5” diameter) Strain Index (continued)

7. Calculate the Strain Index (SI) Score: Insert the multiplier values for each of the six task variables into the spaces below, then multiply them all together.							
Intensity of Exertion	**Duration of Exertion**	**Efforts per Minute**	**Hand/Wrist Posture**	**Speed of Work**	**Duration of Task**		**SI SCORE**
6.0 X	**2.0 X**	**1.0 X**	**1.5 X**	**1.0 X**	**1.00**	**=**	**18**

SI Scores are used to predict Incidence Rates of Distal Upper Extremity injuries per 100 FTE:
-- SI Score < 5 is correlated to an Incidence Rate of about 2 DUE injuries per 100 FTE;
-- SI Score of between 5 – 30 is correlated to an Incidence Rate of about 77 DUE injuries per 100 FTE;
-- SI Score of between 31 – 60 is correlated to an Incidence Rate of about 106 DUE injuries per 100 FTE; and
-- SI Score of > 60 is correlated to an Incidence Rate of about 130 DUE injuries per 100 FTE.

Table K-12. Cable Puller (0.75" diameter) Strain Index

Strain Index: Distal Upper Extremity Disorders Risk Assessment
Moore and Garg (1995)

1. Intensity of Exertion: An estimate of the strength required to perform the task one time. Mark the rating after using the guidelines below; then fill in the corresponding multiplier in the far right box.					
Rating Criterion	**% Maximal Strength**	**Borg Scale**	**Perceived Effort**	**Rating**	**Multiplier**
Light	< 10%	< or = 2	barely noticeable or relaxed effort	1	1.0
Somewhat Hard	10% - 29%	3	noticeable or definite effort	2	3.0
Hard	30% - 49%	4 –5	obvious effort; unchanged facial expression	3	6.0
Very Hard	50% - 79%	6 – 7	substantial effort; changes to facial expression	4	9.0
Near Maximal	> or = 80%	> 7	uses shoulder or trunk to generate force	5	13.0
Intensity of Exertion Mutliplier					**6.0**

2. Duration of Exertion (% of cycle): Calculated by measuring the duration of all exertions during an observation period, and then dividing the measured duration of exertion by the total observation time and multiplying by 100. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: % Duration of Exertion = 100 x duration of all exertions (sec) / Total observation time (sec) = 100 x 330 (sec)/745 (sec) = 44%	**Rating Criterion**	**Rating**	**Multiplier**
	< 10%	1	0.5
	10% - 29%	2	1.0
	30% - 49%	3	1.5
	50% - 79%	4	2.0
	> or = 80%	5	3.0
Duration of Exertion Multiplier			**1.5**

3. Efforts per Minute: Measured by counting the number of exertions that occur during an observation period, and then dividing the number of exertions by the duration of the observation period, measured in minutes. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: Efforts per Minute = number of exertions / total observation time (min) = 20/12.45 = 1.6	**Rating Criterion**	**Rating**	**Multiplier**
	< 4	1	0.5
	4 – 8	2	1.0
	9 – 14	3	1.5
	15 – 19	4	2.0
	> or = 20	5	3.0
Efforts per Minute Multiplier			**0.5**

Table K-12. Cable Puller (0.75" diameter) Strain Index (continued)

4. Hand/Wrist Posture: An estimate of the position of the hand or wrist relative to neutral position.						
Rating Criterion	**Wrist Extension**	**Wrist Flexion**	**Ulnar Deviation**	**Perceived Posture**	**Rating**	**Multiplier**
Very Good	0 – 10 degrees	0 – 5 degrees	0 – 10 degrees	perfectly neutral	1	1.0
Good	11 – 25 degrees	6 – 15 degrees	11 – 15 degrees	near neutral	2	1.0
Fair	26 – 40 degrees	16 – 30 degrees	16 – 20 degrees	non-neutral	3	1.5
Bad	41 – 55 degrees	31 – 50 degrees	21 – 25 degrees	marked deviation (*estimated, based on RULAs done)	4	2.0
Very Bad	> 60 degrees	> 50 degrees	> 25 degrees	near extreme	5	3.0
Hand/Wrist Posture Multiplier						**1.5**

5. Speed of Work: An estimate of how fast the worker is working.				
Rating Criterion	**Observed Pace/MTM Predicted Pace x 100%**	**Perceived Speed**	**Rating**	**Multiplier**
Very Slow	< or = 80%	extremely relaxed pace	1	1.0
Slow	81% – 90%	"taking one's own time"	2	1.0
Fair	91% - 100%	"normal" speed of motion	3	1.0
Fast	101% - 115%	rushed, but able to keep up	4	1.5
Very Fast	> 115%	rushed, barely or unable to keep up	5	2.0
Speed of Work Multiplier				**1.0**

6. Duration of Task per Day: Either measured of obtained from plant personnel			
Worksheet:	**Rating Criterion**	**Rating**	**Multiplier**
Duration of Task per Day (hrs)	< or = 1 hr	1	0.25
= duration of task (hrs) +	1 –2 hrs	2	0.50
duration of task (hrs) + …	2 – 4 hrs	3	0.75
	4 – 8 hrs	4	1.00
= (estimate ~ 4- 8 hrs)	> or = 8 hrs	5	1.50
Duration of Task per Day Multiplier			**1.00**

Table K-12. Cable Pullers (0.75” diameter) Strain Index (continued)

7. Calculate the Strain Index (SI) Score: Insert the multiplier values for each of the six task variables into the spaces below, then multiply them all together.							
Intensity of Exertion	**Duration of Exertion**	**Efforts per Minute**	**Hand/Wrist Posture**	**Speed of Work**	**Duration of Task**		**SI SCORE**
6.0 X	**1.5 X**	**0.5 X**	**1.5 X**	**1.0 X**	**1.00**	**=**	**6.8**

SI Scores are used to predict Incidence Rates of Distal Upper Extremity injuries per 100 FTE:
-- SI Score < 5 is correlated to an Incidence Rate of about 2 DUE injuries per 100 FTE;
-- SI Score of between 5 – 30 is correlated to an Incidence Rate of about 77 DUE injuries per 100 FTE;
-- SI Score of between 31 – 60 is correlated to an Incidence Rate of about 106 DUE injuries per 100 FTE; and
-- SI Score of > 60 is correlated to an Incidence Rate of about 130 DUE injuries per 100 FTE.

Table K-13. Cable Puller (2-3" diameter, pull horizontal) 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)?		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/a	n/a
3.2 Can the tool be used without flexion or extension of the wrist?	N	
3.3 Can the job be done without deviating the wrist from side to side?	N	
3.4 Can the tool be used without deviating the wrist from side to side?	n/a	n/a
3.5 Can the worker be seated while performing the job?	N	Y
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?	N	
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	**9 (64%)**	**5 (36%)**

Table K-14. Cable Puller (2-3" diameter, downward pull) 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		Y
1.2 Is the tool operating without vibration?		Y
1.3 Are the worker's hands exposed to temperature >21degrees 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?	N	
3.4 Can the tool be used without deviating the wrist from side to side?	n/a	n/a
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	
5. Repetitiveness		
5.1 Is the cycle time longer than 30 seconds?	n/a	n/a
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	**8 (57%)**	**5 (43%)**

Table K-15. Cable Puller (2-3" diameter, upward push) 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		Y
1.2 Is the tool operating without vibration?		Y
1.3 Are the worker's hands exposed to temperature >21degrees 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?	N	
3.4 Can the tool be used without deviating the wrist from side to side?	n/a	n/a
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?	N	
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	**8 (57%)**	**5 (43%)**

Table K-16. Cable Puller (1-2" diameter, overhead) 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)?		Y
1.4 Can the job be done without using gloves?		Y
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?	N	
3.4 Can the tool be used without deviating the wrist from side to side?	n/a	n/a
3.5 Can the worker be seated while performing the job?		Y
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?	N	
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 (54%)**	**6 (46%)**

Table K-17. Cable Puller (1.5" diameter) 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		Y
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	Y
1.4 Can the job be done without using gloves?		Y
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	
3.3 Can the job be done without deviating the wrist from side to side?	N	
3.4 Can the tool be used without deviating the wrist from side to side?	N	
3.5 Can the worker be seated while performing the job?		Y
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	
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	**9 (53%)**	**8 (47%)**

Table K-18. Cable Puller (0.75" diameter) 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		Y
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	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?	N	
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	
3.3 Can the job be done without deviating the wrist from side to side?	N	
3.4 Can the tool be used without deviating the wrist from side to side?	N	
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	
5. Repetitiveness		
5.1 Is the cycle time longer than 30 seconds?	N	
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	**14 (74%)**	**5 (26%)**

Table K-19. Cable Puller (2-3" diameter, horizontal pull) OWAS

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

Work Phase	Pull cable horizontally, below knee level	Hold cable below knee level, wait for signal	Rest	Pull cable horizontal, above knee level
TOTAL Combination Posture Score	**2**	**2**	**1**	**2**
Common Posture Combinations (collapsed across work phases)				
Back	2	1		
Arms	1	1		
Legs	4	2		
Posture Repetition (% of working time)	28	73		
Back % of Working Time Score	1	1		
Arms % of Working Time Score	1	1		
Legs % of Working Time Score	2	1		
ACTION CATEGORIES: 1 = no corrective measures 2 = corrective measures in the near future 3 = corrective measures as soon as possible 4 = corrective measures immediately				

Table K-19. Cable Puller (2-3" diameter, horizontal pull) OWAS (continued)

Work Phase	Pull cable horizontally, below knee level	Hold cable below knee level, wait for signal	Rest	Pull cable horizontal, above knee level
Posture				
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	2	2	1	2
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	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	4	4	2	4
Load/ Use of Force				
1 = weight or force needed is = or <10 kg (<22lbs) 2 = weight or force > 10 but < 20kg (>22lbs < 44 lbs) 3 = weight or force > 20 kg (>44 lbs)	2	1	1	1
Phase Repetition				
% of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	21	4	73	3

Table K-20. Cable Puller (2-3" diameter, downward pull) OWAS

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

Work Phase	Pull cable down	Rest	Hold cable, wait for signal
TOTAL Combination Posture Score	**3**	**1**	**1**
Common Posture Combinations (collapsed across work phases)			
Back	2	1	1
Arms	2	1	2
Legs	4	2	2
Posture Repetition (% of working time)	22	63	15
Back % of Working Time Score	1	1	1
Arms % of Working Time Score	1	1	1
Legs % of Working Time Score	2	1	1
ACTION CATEGORIES: 1 = no corrective measures 2 = corrective measures in the near future 3 = corrective measures as soon as possible 4 = corrective measures immediately			

Table K-20. Cable Puller (2-3" diameter, downward pull) OWAS (continued)

Work Phase	Pull cable down	Rest	wait for signal
Posture			
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	2	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	2	1	2
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	4	2	2
Load/ Use of Force			
1 = weight or force needed is = or <10 kg (<22lbs) 2 = weight or force > 10 but < 20kg (>22lbs < 44 lbs) 3 = weight or force > 20 kg (>44 lbs)	3	1	1
Phase Repetition			
% of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	22	63	15

Table K-21. Cable Puller (2-3" diameter, upward push) OWAS

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

Work Phase	Feed/ push cable upwards	Rest	Hold cable, wait for signal
TOTAL Combination Posture Score	**3**	**1**	**1**
Common Posture Combinations (collapsed across work phases)			
Back	2	1	1
Arms	1	1	2
Legs	4	2	2
Posture Repetition (% of working time)	21	58	21
Back % of Working Time Score	1	1	1
Arms % of Working Time Score	1	1	1
Legs % of Working Time Score	2	1	1
ACTION CATEGORIES: 1 = no corrective measures 2 = corrective measures in the near future 3 = corrective measures as soon as possible 4 = corrective measures immediately			

Table K-21. Cable Puller (2-3" diameter, upward push) OWAS (continued)

Work Phase	Feed/ push cable upwards	Rest	Hold cable, wait for signal
Posture			
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	2	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	1	1	2
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	4	2	2
Load/ Use of Force			
1 = weight or force needed is = or <10 kg (<22lbs) 2 = weight or force > 10 but < 20kg (>22lbs < 44 lbs) 3 = weight or force > 20 kg (>44 lbs)	3	1	1
Phase Repetition			
% of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	21	58	21

Table K-22. Cable Puller (1-2" diameter, overhead) OWAS

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

Work Phase	Pull cable overhead	Rest, wait for signal	Hold cable overhead, wait for signal
TOTAL Combination Posture Score	**1**	**1**	**1**
Common Posture Combinations (collapsed across work phases)			
Back	1	1	1
Arms	2	2	1
Legs	1	1	1
Posture Repetition (% of working time)	22	50	6
Back % of Working Time Score	1	1	1
Arms % of Working Time Score	1	1	1
Legs % of Working Time Score	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 K-22. Cable Puller (1-2" diameter, overhead) OWAS (continued)

Work Phase	Pull cable overhead	Rest, wait for signal	Hold cable overhead, wait for signal
Posture			
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	1	1	1
Arms 1 = both arms are below shoulder level 2 = one arm s at or above shoulder level 3 = both arms are at or above shoulder level	3	2	3
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	1	1	1
Load/ Use of Force			
1 = weight or force needed is = or <10 kg (<22lbs) 2 = weight or force > 10 but < 20kg (>22lbs < 44 lbs) 3 = weight or force > 20 kg (>44 lbs)	2	1	1
Phase Repetition			
% of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	16	50	6

Table K-23. Cable Puller (1.5” diameter) OWAS

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

Work Phase	Feed cable below feet, sitting	Feed cable below feet squatting	Change position	Arrange cable in conduit	Rest
TOTAL Combination Posture Score	**3**	**2**	**2**	**2**	**1**
Common Posture Combinations (collapsed across work phases)					
Back	4	2	2	2	1
Arms	1	1	1	1	1
Legs	1	4	7	1	1
Posture Repetition (% of working time)	16	26	7	11	3
Back % of Working Time Score	2	1	1	1	1
Arms % of Working Time Score	1	1	1	1	1
Legs % of Working Time Score	1	2	1	1	1
ACTION CATEGORIES: 1 = no corrective measures 2 = corrective measures in the near future 3 = corrective measures as soon as possible 4 = corrective measures immediately					

Table K-23. Cable Puller (1.5" diameter) OWAS (continued)

Work Phase	Feed cable below feet, sitting	Feed cable below feet squatting	Change position	Arrange cable in conduit	Rest
Posture					
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	4	2	2	2	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	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	1	4	7	1	1
Load/ Use of Force					
1 = weight or force needed is = or <10 kg (<22lbs) 2 = weight or force > 10 but < 20kg (>22lbs < 44 lbs) 3 = weight or force > 20 kg (>44 lbs)	2	2	1	1	1
Phase Repetition					
% of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	16	26	7	11	3

Table K-24. Cable Puller (0.75" diameter) OWAS

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

Work Phase	Pull cable	Feed cable	Change position	Adjust cable	Tie cables	Rest
TOTAL Combination Posture Score	**1**	**1**	**1**	**1**	**2**	**1**
Common Posture Combinations (collapsed across work phases)						
Back	1	1	1	2		
Arms	1	2	3	3		
Legs	2	2	2	2		
Posture Repetition (% of working time)	12	24	9	5		
Back % of Working Time Score	1	1	1	1		
Arms % of Working Time Score	1	1	1	1		
Legs % of Working Time Score	1	1	1	1		
ACTION CATEGORIES: 1 = no corrective measures 2 = corrective measures in the near future 3 = corrective measures as soon as possible 4 = corrective measures immediately						

Table K-24. Cable Puller (0.75" diameter) OWAS (continued)

Work Phase	Pull cable	Feed cable	Change position	Adjust cable	Tie cables	Rest
Posture						
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	1	1	1	1	2	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	1	2	2	3	3	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	2	2	2	2
Load/ Use of Force						
1 = weight or force needed is = or <10 kg (<22lbs) 2 = weight or force > 10 but < 20kg (>22lbs < 44 lbs) 3 = weight or force > 20 kg (>44 lbs)	2	2	1	1	1	1
Phase Repetition						
% of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	4	16	8	9	5	8

Table K-25. Cable Pullers (2-3" diameter, horizontal pull) 3DSSPP Table

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

Work Phase:	**Disc Compression (lbs) @ L5/S1 (Note: NIOSH Recommended Compression Limit (RCL) is 770 lbs)**
Cable Puller Pull 2-3" Cable Horizontally  Estimated Load ~ 40 lbs per hand	133 pounds

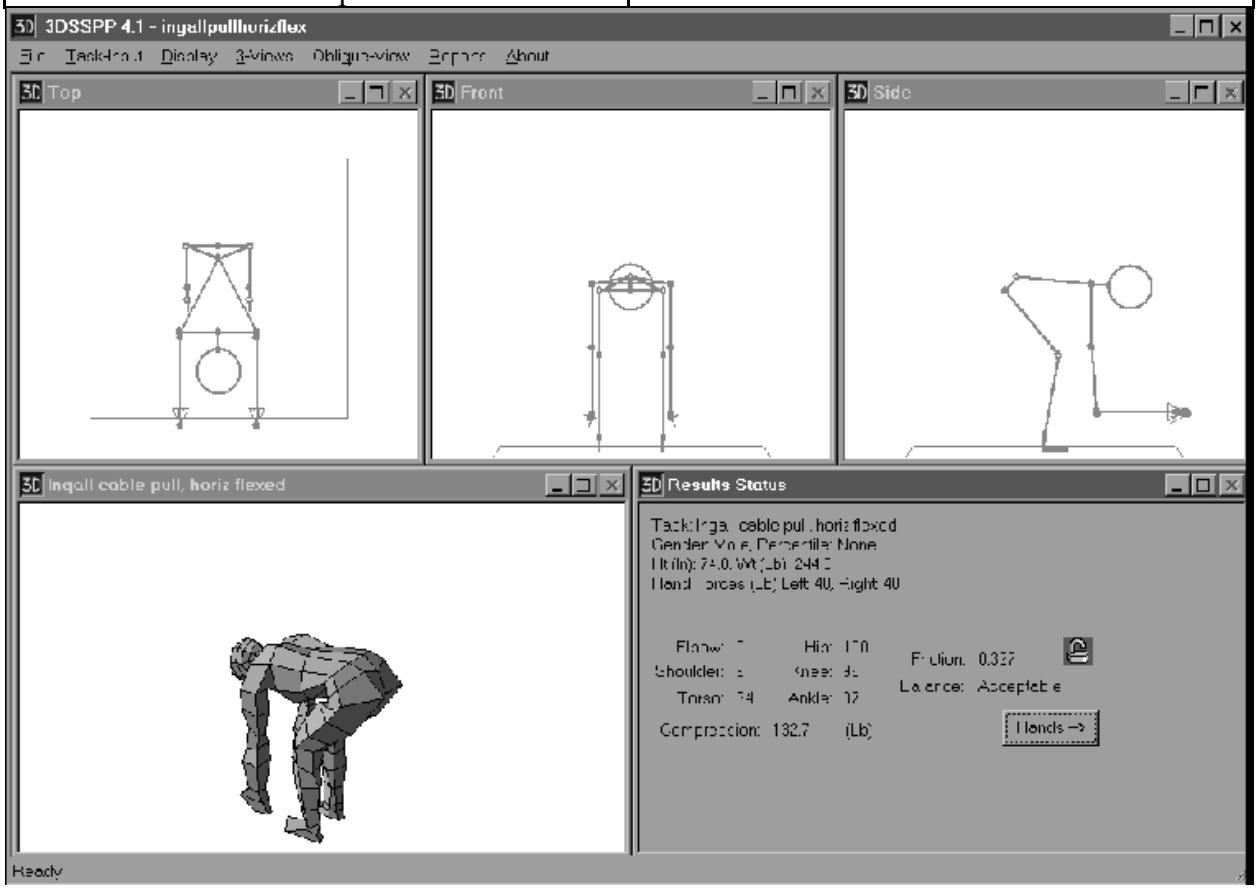


Table K-26. Cable Puller (2-3" diameter, downward pull) 3DSSP

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

Work Phase:	**Disc Compression (lbs) @ L5/S1 (Note: NIOSH Recommended Compression Limit (RCL) is 770 lbs)**
 Cable Puller Pull 2-3" Cable Down Estimated Load ~ 50 lbs per hand	215 pounds

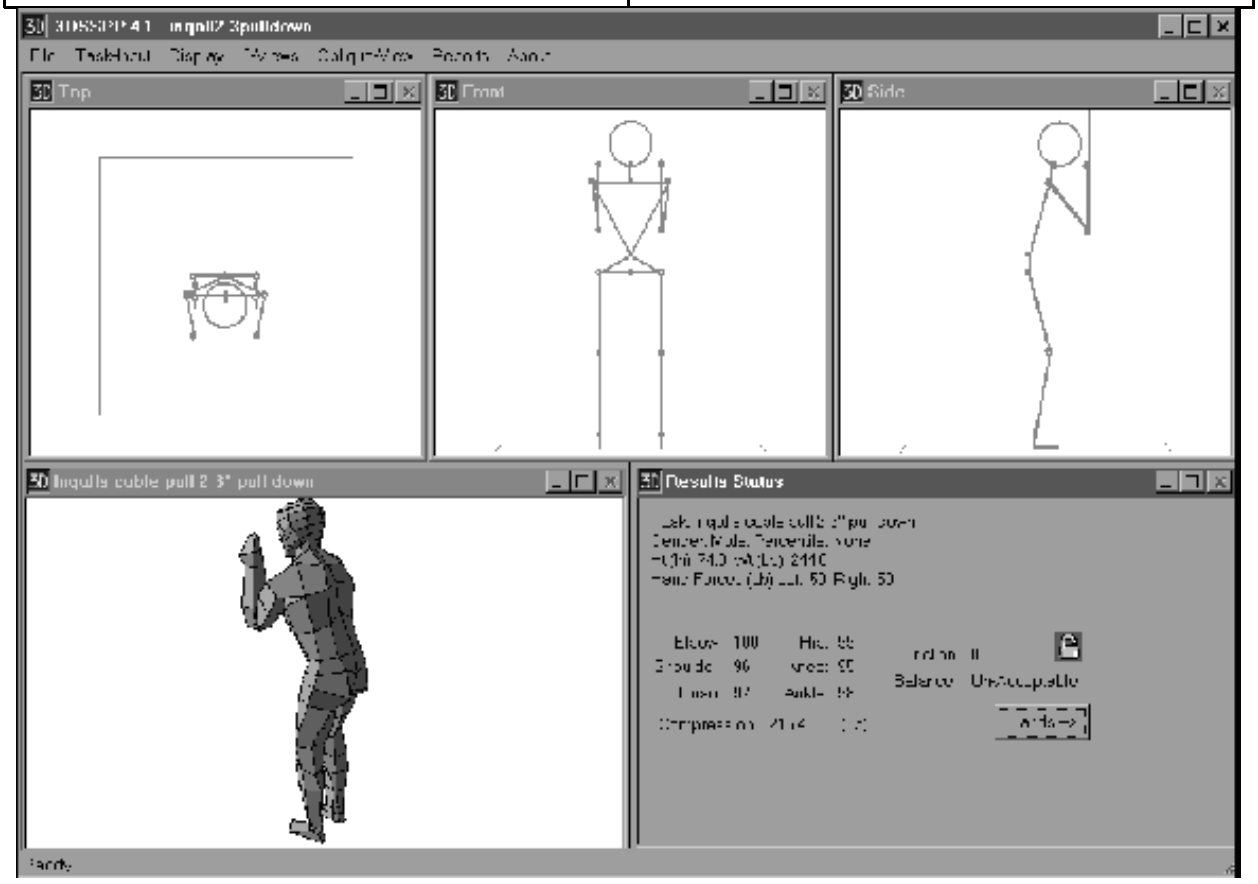


Table K-27. Cable Puller (2-3" diameter, upward push) 3DSSP Table

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

Work Phase:	**Disc Compression (lbs) @ L5/S1 (Note: NIOSH Recommended Compression Limit (RCL) is 770 lbs)**
 Cable Puller Push 2-3" Cable Upwards Estimated Load ~ 50 lbs per hand	**813 pounds**

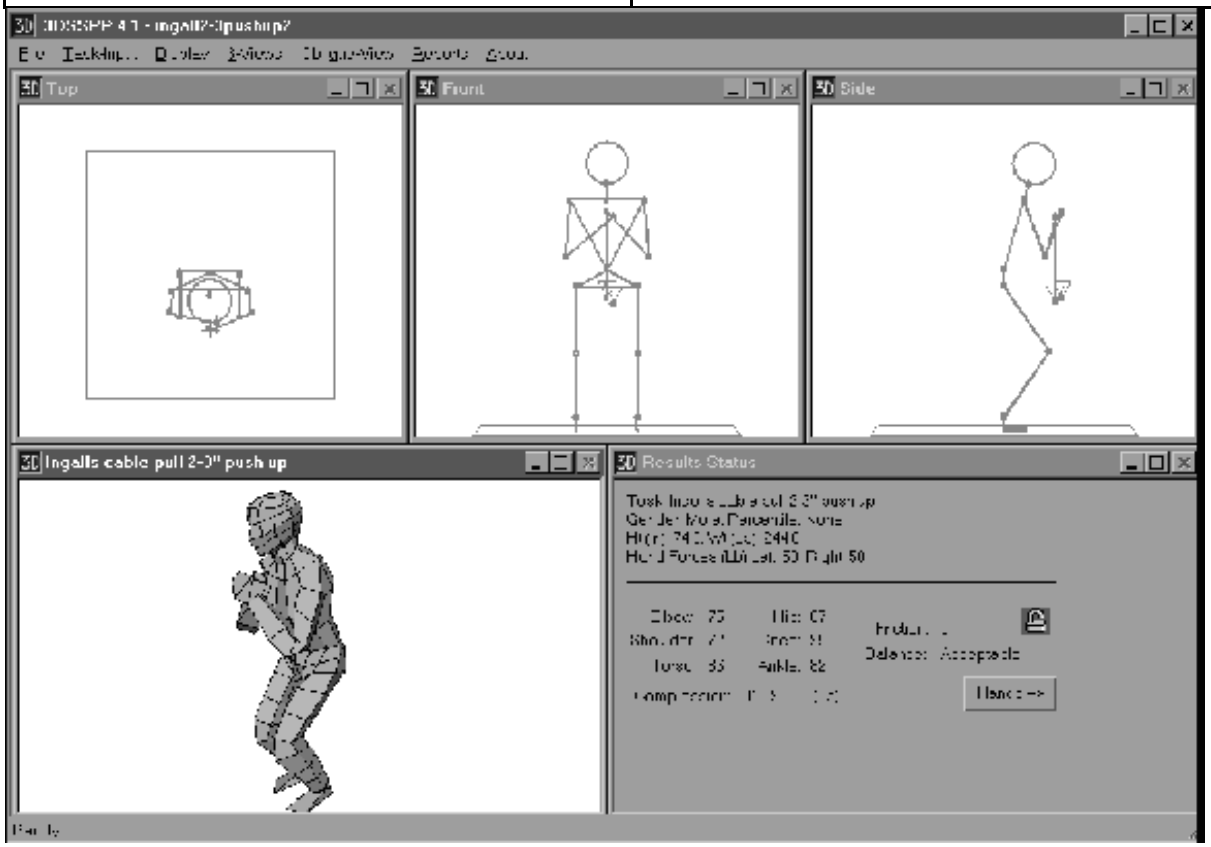
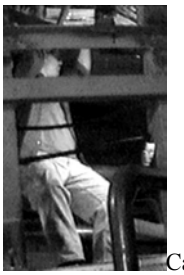


Table K-28. Cable Puller (1-2" diameter, overhead) 3DSSP

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

Work Phase:	**Disc Compression (lbs) @ L5/S1 (Note: NIOSH Recommended Compression Limit (RCL) is 770 lbs)**
 Cable Puller Pull 1-2" Cable Overhead Estimated Load ~ 20 lbs per hand	636 pounds

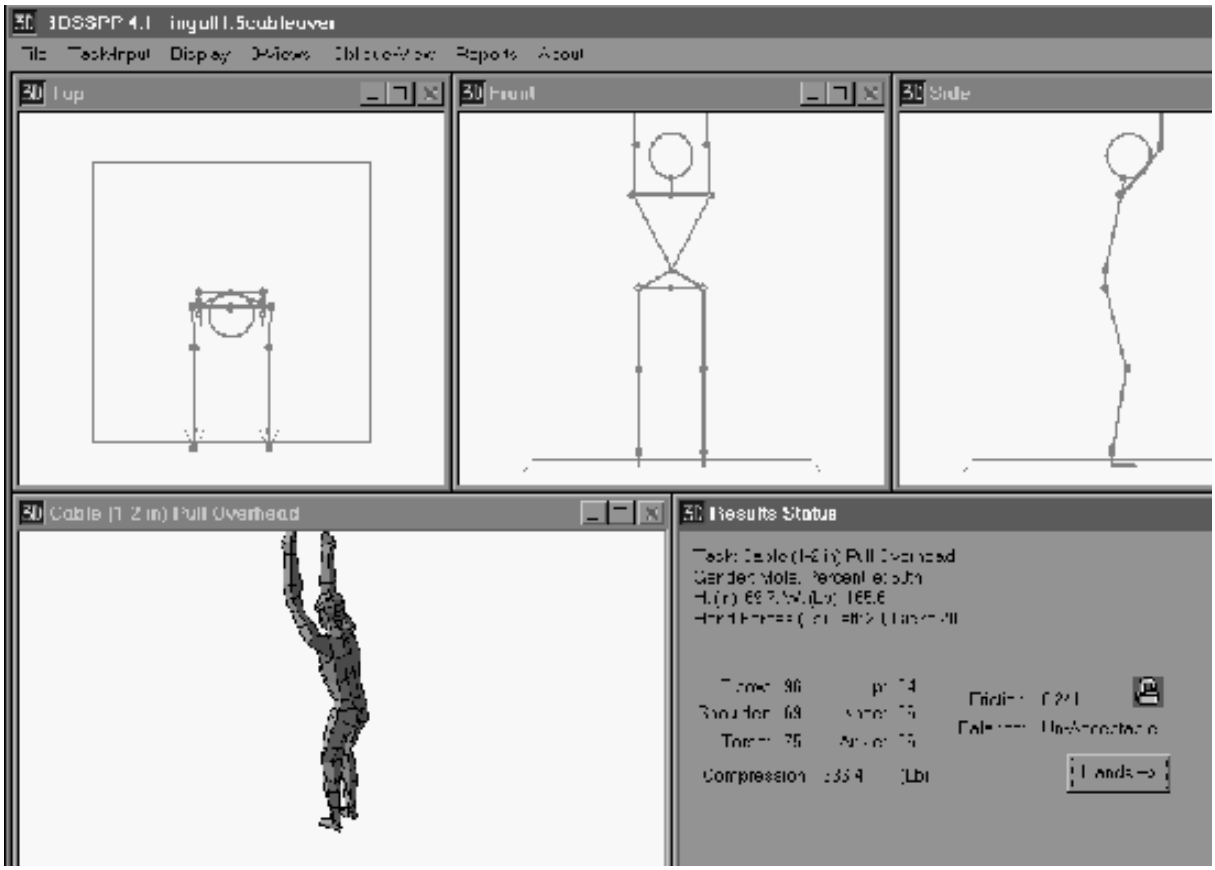


Table K-29. Cable Puller (2-3" diameter, pull horizontal) PLIBEL

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, and Upper Back	Elbows, Forearms, and Hands	Feet	Knees and Hips	Low Back
1: Is the walking surface uneven, sloping, slippery or nonresilient?			Y	Y	Y
2: Is the space too limited for work movements or work materials?	Y	Y	Y	Y	Y
3: Are tools and equipment unsuitably designed for the worker or the task?	Y	Y	Y	Y	Y
4: Is the working height incorrectly adjusted?	Y				Y
5: Is the working chair poorly designed or incorrectly adjusted?	n/a				n/a
6: If work performed standing, is there no possibility to sit and rest?			N	N	N
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?			Y	Y	Y
c) one leg being used more often in supporting the body?			N	N	N
9: Is repeated or sustained work performed when back is:					
a) mildly flexed forward?	Y				Y
b) severely flexed forward?	Y				Y
c) bent sideways or mildly twisted?	N				N
d) severely twisted?	N				N

Table K-29. Cable Puller (2-3" diameter, pull horizontal) PLIBEL (continued)

10: Is repeated/sustained work performed with neck:					
a) flexed forward?	Y				
b) bent sideways or mildly twisted?	N				
c) severely twisted?	N				
d) extended backwards?	Y				
11: Are loads lifted manually? Note important factors:					
a) periods of repetitive lifting	N				N
b) weight of load	N				N
c) awkward grasping of load	Y				Y
d) awkward location of load at onset or end of lifting	N				N
e) handling beyond forearm length	N				N
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?	Y	Y			Y
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?		Y			
b) forceful movements?		Y			
c) uncomfortable hand positions?		Y			
d) switches or keyboards?		N			

Table K-29. Cable Puller (2-3" diameter, pull horizontal) PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, and Upper Back	Elbows, Forearms, and Hands	Feet	Knees and Hips	Low Back
SUM	13	9	4	4	10
PERCENTAGE	50	81.8	50	50	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?	Y				
20: Is the job performed under time demands or psychological stress?	N				
21:Can the work have unusual or expected situations?	N				
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				

Table K-30. Cable Puller (2-3" diameter, downward pull) PLIBEL

PLIBEL Checklist
Kemmlert (1995)

Section I: Musculoskeletal Risk Factors

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, and Upper Back	Elbows, Forearms, 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?	Y	Y	Y	Y	Y
3: Are tools and equipment unsuitably designed for the worker or the task?	Y	Y	Y	Y	Y
4: Is the working height incorrectly adjusted?	Y				Y
5: Is the working chair poorly designed or incorrectly adjusted?	n/a				n/a
6: If work performed standing, is there no possibility to sit and rest?			N	N	N
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 K-30. Cable Puller (2-3" diameter, downward pull) PLIBEL (continued)

10: Is repeated/sustained work performed with neck:					
a) flexed forward?	Y				
b) bent sideways or mildly twisted?	N				
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	N				N
c) awkward grasping of load	Y				Y
d) awkward location of load at onset or end of lifting	N				N
e) handling beyond forearm length	N				N
f) handling below knee length	N				N
g) handling above shoulder height	Y				Y
12: Is repeated, sustained or uncomfortable carrying, pushing or pulling of loads performed?	Y	Y			Y
13: Is sustained work performed when one arm reaches forward or to the side without support?	Y				
14: Is there a repetition of:					
a) similar work movements?	Y	Y			
b) similar work movements beyond comfortable reaching distance?	Y	Y			
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?		Y			
c) uncomfortable hand positions?		Y			
d) switches or keyboards?		N			

Table K-30. Cable Puller (2-3" diameter, downward pull) PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, and Upper Back	Elbows, Forearms, and Hands	Feet	Knees and Hips	Low Back
SUM	11	7	1	1	6
PERCENTAGE	42.3	63.6	12.5	12.5	28.6

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?	Y
20: Is the job performed under time demands or psychological stress?	N
21: Can the work have unusual or expected situations?	N
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

Table K-31. Cable Puller (2-3" diameter, upward push) PLIBEL

PLIBEL Checklist
Kemmlert (1995)

Section I: Musculoskeletal Risk Factors

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, and Upper Back	Elbows, Forearms, 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?	Y	Y	Y	Y	Y
3: Are tools and equipment unsuitably designed for the worker or the task?	Y	Y	Y	Y	Y
4: Is the working height incorrectly adjusted?	Y				Y
5: Is the working chair poorly designed or incorrectly adjusted?	n/a				n/a
6: If work performed standing, is there no possibility to sit and rest?			N	N	N
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?			Y	Y	Y
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 K-31. Cable Puller (2-3" diameter, upward push) PLIBEL (continued)

10: Is repeated/sustained work performed with neck:					
a) flexed forward?	N				
b) bent sideways or mildly twisted?	N				
c) severely twisted?	N				
d) extended backwards?	Y				
11: Are loads lifted manually? Note important factors:					
a) periods of repetitive lifting	Y				Y
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	N				N
f) handling below knee length	N				N
g) handling above shoulder height	Y				Y
12: Is repeated, sustained or uncomfortable carrying, pushing or pulling of loads performed?	Y	Y			Y
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?	Y	Y			
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?		Y			
c) uncomfortable hand positions?		Y			
d) switches or keyboards?		N			

Table K-31. Cable Puller (2-3" diameter, upward push) PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, and Upper Back	Elbows, Forearms, and Hands	Feet	Knees and Hips	Low Back
SUM	13	7	3	3	11
PERCENTAGE	50	63.6	37.5	37.5	52.4
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?	Y				
20: Is the job performed under time demands or psychological stress?	N				
21:Can the work have unusual or expected situations?	N				
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				

Table K-32. Cable Puller (1-2" diameter, overhead) PLIBEL

PLIBEL Checklist
Kemmlert (1995)

Section I: Musculoskeletal Risk Factors

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, and Upper Back	Elbows, Forearms, 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?	Y	Y	Y	Y	Y
3: Are tools and equipment unsuitably designed for the worker or the task?	Y	Y	Y	Y	Y
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?			N	N	N
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?	N				N
b) severely flexed forward?	N				N
c) bent sideways or mildly twisted?	N				N
d) severely twisted?	N				N

Table K-32. Cable Puller (1-2" diameter, overhead) PLIBEL (continued)

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

Table K-32. Cable Puller (1-2" diameter, overhead) PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, and Upper Back	Elbows, Forearms, and Hands	Feet	Knees and Hips	Low Back
SUM	13	10	2	2	7
PERCENTAGE	50	90.9	25	25	33.3
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?	Y				
20: Is the job performed under time demands or psychological stress?	N				
21:Can the work have unusual or expected situations?	N				
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				

Table K-33. Cable Puller (1.5” diameter) PLIBEL

PLIBEL Checklist
Kemmlert (1995)

Section I: Musculoskeletal Risk Factors

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, Hands	Feet	Knees and Hips	Low Back
1: Is the walking surface uneven, sloping, slippery or nonresilient?			Y	Y	Y
2: Is the space too limited for work movements or work materials?	Y	Y	Y	Y	Y
3: Are tools and equipment unsuitably designed for the worker or the task?	Y	Y	Y	Y	Y
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?			N	N	N
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?			Y	Y	Y
c) one leg being used more often in supporting the body?			N	N	N
9: Is repeated or sustained work performed when back is:					
a) mildly flexed forward?	Y				Y
b) severely flexed forward?	Y				Y
c) bent sideways or mildly twisted?	Y				Y
d) severely twisted?	N				N

Table K-33. Cable Puller (1.5” diameter) PLIBEL (continued)

10: Is repeated/sustained work performed with neck:					
a) flexed forward?	Y				
b) bent sideways or mildly twisted?	N				
c) severely twisted?	N				
d) extended backwards?	N				
11: Are loads lifted manually? Note important factors:					
a) periods of repetitive lifting	Y				Y
b) weight of load	Y				Y
c) awkward grasping of load	Y				Y
d) awkward location of load at onset or end of lifting	N				N
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?	Y	Y			Y
13: Is sustained work performed when one arm reaches forward or to the side without support?	Y				
14: Is there a repetition of:					
a) similar work movements?	Y	Y			
b) similar work movements beyond comfortable reaching distance?	Y	Y			
15: Is repeated or sustained manual work performed?					
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?		Y			
c) uncomfortable hand positions?		Y			
d) switches or keyboards?		N			

Table K-33. Cable Puller (1.5” diameter) PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, Upper Back	Elbows, Forearm, Hands	Feet	Knees and Hips	Low Back
SUM	19	9	4	4	15
PERCENTAGE	73.1	81.8	50	50	71.4
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?	N				
22: Are the following present?					
a) cold	Y				
b) heat	Y				
c) draft	Y				
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 K-34. Cable Puller (0.75" diameter) 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, and Upper Back	Elbows, Forearms, and Hands	Feet	Knees and Hips	Low Back
1: Is the walking surface uneven, sloping, slippery or nonresilient?			Y	Y	Y
2: Is the space too limited for work movements or work materials?	Y	Y	Y	Y	Y
3: Are tools and equipment unsuitably designed for the worker or the task?	Y	Y	Y	Y	Y
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?			N	N	N
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..			Y	Y	Y
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? **backwards in this case	Y				Y
b) severely flexed forward?	N				N
c) bent sideways or mildly twisted?	N				N
d) severely twisted?	N				N

Table K-34. Cable Puller (0.75” diameter) PLIBEL (continued)

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

Table K-34. Cable Puller (0.75” diameter) PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, and Upper Back	Elbows, Forearms, and Hands	Feet	Knees and Hips	Low Back
SUM	15	9	4	4	11
PERCENTAGE	57.7	81.8	50	50	52.4
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?	N				
22: Are the following present?					
a) cold	Y				
b) heat	Y				
c) draft	Y				
d) noise	Y				
e) troublesome visual conditions	N				
f) jerks, shakes, or vibration	N				
Environmental / Organizational Risk Factors Score					
SUM	4				
PERCENTAGE	40.0				

A2. CABLE CONNECTOR

Table K-35. Cable Connector RULA

Rapid Upper Limb Assessment (RULA)
Matamney and Corlett (1993)

Work Phase	Arrange/tie cables		Change/ fix tools		Trim cable ties		Rest/ Inspect	
		RULA Score	***Specific***	***RULA Score***		***RULA Score***	***Specific***	***RULA Score***
Shoulder Extension/ Flexion	sl flex	2	sl flex	2	sl flex	2	neut	1
Shoulder is Raised (+1)		0		0		1		0
Upper Arm Abducted (+1)		0		0		0		0
Arm supported, leaning (-1)		-1		-1		-1		0
Elbow Extension/ Flexion	neut	2	neut	2	flx	2	neut	2
Shoulder Abduction/ Adduction	neut	0	neut	0	neut	0	neut	0
Shoulder Lateral/ Medial	mod med	1	mod med	1	mod med	1	neut	0
Wrist Extension/ Flexion	ext	2	neut	1	ext	2	neut	1
Wrist Deviation	rad	1	neut	0	ulnar	1	neut	0
Wrist Bent from Midline (+1)		0		0		0		0
Wrist Twist (1) In mid range or (2) End of range		1		1		1		1
Arm and Wrist Muscle Use Score: If posture mainly static (i.e. held for longer than 10 minutes) or; if action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0		0
Arm and Wrist Force/ load Score: If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		2		0		1		0

Table K-35. Cable Connector RULA (continued)

Work Phase	Arrange/tie cables				Trim cable ties		Rest/ Inspect	
	Specific	*RULA Score*	*Specific*	*RULA Score*		*RULA Score*	*Specific*	*RULA Score*
Neck Extension/ Flexion		1		1		1		1
Neck Twist (+1)		1		1		1		0
Neck Side-Bent (+1)		1		1		1		0
Trunk Extension/ Flexion	neut	1	neut	1	neut	1	neut	1
Trunk Twist (+1)		1		1		1		0
Trunk Side Bend (+1)		0		0		0		0
Legs: If legs and feet are supported and balanced: (+1); If not: (+2)		1		1		1		1
Neck, Trunk, and Leg Muscle Use Score: If posture mainly static (i.e. held for longer than 10 minutes) or; If action repeatedly occurs 4 times per minute or more: (+ 1)		1		0		0		0
Neck, Trunk, and Leg Force/ Load Score If load less than 2 kg (intermittent): (+0) If 2kg to 10 kg (intermittent): (+1) If 2kg to 10 kg (static or repeated): (+2) If more than 10 kg load or repeated or shocks: (+3)		1		0		1		0
Total RULA Score	**6**		**2**				**2**	

1 or 2 = Acceptable
3 or 4 = Investigate Further
5 or 6 = Investigate Further and Change Soon
7 = Investigate and Change Immediately

Table K-36. Cable Connector Strain Index

Strain Index: Distal Upper Extremity Disorders Risk Assessment
Moore and Garg (1995)

1. Intensity of Exertion: An estimate of the strength required to perform the task one time. Mark the rating after using the guidelines below; then fill in the corresponding multiplier in the far right box.					
Rating Criterion	**% Maximal Strength**	**Borg Scale**	**Perceived Effort**	**Rating**	**Multiplier**
Light	< 10%	< or = 2	barely noticeable or relaxed effort	1	1.0
Somewhat Hard		3	noticeable or definite effort	2	3.0
Hard	30% - 49%	4 –5	obvious effort; unchanged facial expression	3	6.0
Very Hard	50% - 79%	6 – 7	substantial effort; changes to facial expression	4	9.0
Near Maximal	> or = 80%	> 7	uses shoulder or trunk to generate force	5	13.0
Intensity of Exertion Multiplier					**3.0**

2. Duration of Exertion (% of cycle): Calculated by measuring the duration of all exertions during an observation period, and then dividing the measured duration of exertion by the total observation time and multiplying by 100. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: % Duration of Exertion = 100 x duration of all exertions (sec) / Total observation time (sec) = 100 x 889 (sec)/1075 (sec) = 83%	**Rating Criterion**	**Rating**	**Multiplier**
	< 10%	1	0.5
	10% - 29%	2	1.0
	30% - 49%	3	1.5
	50% - 79%	4	2.0
	> or = 80%	5	3.0
Duration of Exertion Multiplier			**3.0**

3. Efforts per Minute: Measured by counting the number of exertions that occur during an observation period, and then dividing the number of exertions by the duration of the observation period, measured in minutes. NOTE: If duration of exertion is 100% (as with some static tasks), then efforts/minute multiplier should be set to 3.0			
Worksheet: Efforts per Minute = number of exertions / total observation time (min) = task nearly static, set multiplier to 3.0	**Rating Criterion**	**Rating**	**Multiplier**
	< 4	1	0.5
	4 – 8	2	1.0
	9 – 14	3	1.5
	15 – 19	4	2.0
	> or = 20	5	3.0
Efforts per Minute Multiplier			**3.0**

Table K-36. Cable Connector Strain Index (continued)

4. Hand/Wrist Posture: An estimate of the position of the hand or wrist relative to neutral position.						
Rating Criterion	**Wrist Extension**	**Wrist Flexion**	**Ulnar Deviation**	**Perceived Posture**	**Rating**	**Multiplier**
Very Good	0 – 10 degrees	0 – 5 degrees	0 – 10 degrees	perfectly neutral	1	1.0
Good	11 – 25 degrees	6 – 15 degrees	11 – 15 degrees	near neutral	2	1.0
Fair	26 – 40 degrees	16 – 30 degrees	16 – 20 degrees	non-neutral (*estimated, based on RULAs done)	3	1.5
Bad	41 – 55 degrees	31 – 50 degrees	21 – 25 degrees	marked deviation	4	2.0
Very Bad	> 60 degrees	> 50 degrees	> 25 degrees	near extreme	5	3.0
Hand/Wrist Posture Multiplier						**1.5**

5. Speed of Work: An estimate of how fast the worker is working.				
Rating Criterion	**Observed Pace/MTM Predicted Pace x 100%**	**Perceived Speed**	**Rating**	**Multiplier**
Very Slow	< or = 80%	extremely relaxed pace	1	1.0
Slow	81% – 90%	"taking one's own time"	2	1.0
Fair	91% - 100%	"normal" speed of motion	3	1.0
Fast	101% - 115%	rushed, but able to keep up	4	1.5
Very Fast	> 115%	rushed, barely or unable to keep up	5	2.0
Speed of Work Multiplier				**1.0**

6. Duration of Task per Day: Either measured of obtained from plant personnel			
Worksheet:	**Rating Criterion**	**Rating**	**Multiplier**
Duration of Task per Day (hrs)	< or = 1 hr	1	0.25
= duration of task (hrs) +	1 –2 hrs	2	0.50
duration of task (hrs) + …	2 – 4 hrs	3	0.75
	4 – 8 hrs	4	1.00
= (estimate ~ 4- 8 hrs)	> or = 8 hrs	5	1.50
Duration of Task per Day Multiplier			**1.00**

Table K-36. Cable Connector Strain Index (continued)

7. Calculate the Strain Index (SI) Score: Insert the multiplier values for each of the six task variables into the spaces below, then multiply them all together.							
Intensity of Exertion	**Duration of Exertion**	**Efforts per Minute**	**Hand/Wrist Posture**	**Speed of Work**	**Duration of Task**		**SI SCORE**
3.0 X	**3.0 X**	**3.0 X**	**1.5 X**	**1.0 X**	**1.00**	**=**	**40.5**

SI Scores are used to predict Incidence Rates of Distal Upper Extremity injuries per 100 FTE:
-- SI Score < 5 is correlated to an Incidence Rate of about 2 DUE injuries per 100 FTE;
-- SI Score of between 5 – 30 is correlated to an Incidence Rate of about 77 DUE injuries per 100 FTE;
-- SI Score of between 31 – 60 is correlated to an Incidence Rate of about 106 DUE injuries per 100 FTE; and
-- SI Score of > 60 is correlated to an Incidence Rate of about 130 DUE injuries per 100 FTE.

Table K-37. Cable Connector 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		**Yes**
1. Physical Stress		
1.1 Can the job be done without hand/ wrist contact with sharp edges		Y
1.2 Is the tool operating without vibration?		Y
1.3 Are the worker's hands exposed to temperature >21degrees C (70 degrees F)?		Y
1.4 Can the job be done without using gloves?		Y
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?	N	
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	
3.3 Can the job be done without deviating the wrist from side to side?	N	
3.4 Can the tool be used without deviating the wrist from side to side?	N	
3.5 Can the worker be seated while performing the job?		Y
3.6 Can the job be done without "clothes wringing" motion?	N	
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	
5. Repetitiveness		
5.1 Is the cycle time longer than 30 seconds?	N	
6. Tool Design		
6.1 Are the thumb and finger slightly overlapped in a closed grip?		Y
6.2 Is the span of the tool's handle between 5 and 7 cm (2-2 3/4 inches)?		Y (cutter)
6.3 Is the handle of the tool made from material other than metal?		Y
6.4 Is the weight of the tool below 4 kg (9lbs)?		Y
6.5 Is the tool suspended?	N	
TOTAL	**12 (57%)**	

Table K-38. Cable Connector OWAS

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

Work Phase	tie cables	Change/ fix tools	Trim cable ties	Rest/ Inspect
TOTAL Combination Posture Score	**1**	**1**	**1**	**1**
Common Posture Combinations (collapsed across work phases)				
Back	3	1		
Arms	1	1		
Legs	1	1		
Posture Repetition (% of working time)	83	5		
Back % of Working Time Score	3	1		
Arms % of Working Time Score	1	1		
Legs % of Working Time Score	1	1		
ACTION CATEGORIES: 1 = no corrective measures 2 = corrective measures in the near future 3 = corrective measures as soon as possible 4 = corrective measures immediately				

Table K-38. Cable Connector OWAS (continued)

Work Phase	Arrange/ tie cables	Change/ fix tools	Trim cable ties	Rest/ Inspect
Posture				
Back 1 = straight 2 = bent forward, backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	3	3	3	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	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	1	1	1	1
Load/ Use of Force				
1 = weight or force needed is = or <10 kg (<22lbs) 2 = weight or force > 10 but < 20kg (>22lbs < 44 lbs) 3 = weight or force > 20 kg (>44 lbs)	2	1	1	1
Phase Repetition				
% of working time (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100)	77	4	2	5

Table K-39. Cable Connector PLIBEL

PLIBEL Checklist
Kemmlert (1995)

Section I: Musculoskeletal Risk Factors 1) Find the injured body region, answer yes or no to corresponding questions					
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?	Y	Y	Y	Y	Y
3: Are tools and equipment unsuitably designed for the worker or the task?	Y	Y	Y	Y	Y
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?			N	N	N
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 back is:					
a) mildly flexed forward?	N				N
b) severely flexed forward?	N				N
c) bent sideways or mildly twisted?	Y				Y
d) severely twisted?	N				N

Table K-39. Cable Connector PLIBEL (continued)

10: Is repeated/sustained work performed with neck:					
a) flexed forward?	N				
b) bent sideways or mildly twisted?	Y				
c) severely twisted?	N				
d) extended backwards?	Y				
11: Are loads lifted manually? Note important factors:					
a) periods of repetitive lifting	N				N
b) weight of load	N				N
c) awkward grasping of load	N				N
d) awkward location of load at onset or end of lifting	N				N
e) handling beyond forearm length	N				N
f) handling below knee length	N				N
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?	Y	Y			
15: Is repeated or sustained manual work performed?					
a) weight of working materials or tools	N	N			
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?		Y			
b) forceful movements?		Y			
c) uncomfortable hand positions?		Y			
d) switches or keyboards?		N			

Table K-39. Cable Connectors PLIBEL (continued)

Musculoskeletal Risk Factors Scores					
	Neck, Shoulder, Upper Back	Elbows, Forearm, Hands	Feet	Knees and Hips	Low Back
SUM	10	8	2	2	5
PERCENTAGE	38.5	72.7	25	25	23.8
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?	N				
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	2				
PERCENTAGE	20.0				