	ManTRA	OCRA	OWAS	QEC	REBA
Title	Manual Tasks Risk Assessment Tool V2.0	Concise Exposure Index	Ovako Working Posture Analysis System	Quick Exposure Checklist	Rapid Entire Body Assessment
Overview	Manual task assessment tool. Intervention information included.	Upper limb assessment tool. Intervention information included.	Entire body assessment tool.	Upper limb assessment checklist tool. Useful for comparison before and after an intervention.	Entire body assessment checklist tool. Intervention information included.
Type	Risk Assessment	Risk Assessment	Risk Assessment	Checklist	Risk Assessment
Stated Purpose	• To assess exposure to musculoskeletal risk factors associated with manual tasks in workplace. • To prioritize tasks that must be changed due to a high risk.	• The purpose of this index is to classify diverse occupational scenarios according to their exposure to WMSDs.	• A practical method for identifying and evaluating poor working posture.	• User-friendly tool designed to assess worker exposure to risks for work-related musculoskeletal disorders of the upper limbs. • Useful for comparison before and after an intervention.	• REBA was specifically designed to assess various unpredictable working postures found in health care and other service industries. The Rapid Entire Body Assessment (REBA) is similar to RULA, but it has been modified to be more useful for working postures found in the health care and other service industries. • A postural analysis system that is sensitive to musculoskeletal risks in a variety of tasks. • "Front line" assessment as part of a broader ergonomic assessment.
	• Incorporates assessment of manual task risk levels, related safety activity, organizational environment. **Straker et al. Ergonomics 2004.**				
	• To assist inspectors in auditing workplaces across all industries for compliance with the Queensland Manual Tasks Advisory Standard. **ManTRA, V2.0 Cornell University Ergonomics Web.**	• The purpose of this index is to quantify worker exposure to tasks involving repetitive movements of the upper limbs. **Grieco, Ergonomics, 1998.**	• To determine the loads caused by the most common postures of the back, arms and legs in different jobs. • Useful for directing improvements in the working methods. **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447-459.**		

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Body Parts Assessed		*Arm/wrist/hand*, lower limbs, back, neck/shoulder	*Elbows, wrists, hands*	Back, *arms*, legs	Back, *shoulder/arm, wrist/hand*	*Wrists, forearms, elbows, shoulders*, neck, trunk, back, legs and knees
Measurement of Risk Factors	Force	• Determine the maximum force exerted within each region during the task relative to the maximal force which can be exerted.	• Force required is considered by determining the perceived effort of maintaining a posture using the Borg scale.	• The load or use of force is characterized by the mass involved.	• The measurement of force considers the maximum weight handled in the task. This ranges from a light load of 5kg to a very heavy load of 20kg or more. • The measurement of hand force exertion ranges from low values of less than 1kg to high values of more than 4kg.	• Force measurement is divided into different categories. The different categories range from loads less than 5kg to loads greater than 10kg. The risk associated with shock or a rapid build up of force are also considered.
	Posture	• Posture is measured by considering deviations from the mid range. • Postures combinations such as twisting and bending are also considered.	• The posture of each part of the body is assessed by considering the angle of flexion/extension of each segment.	• Back posture is identified by a number indicating whether the back is straight, bent or bent and twisted. • Arm posture is identified by a number indicating whether one or both arms are at or below shoulder level. • Leg posture is identified by a number indicating that the worker is sitting, standing on one or two legs, squatting on one or two bent legs, kneeling or walking.	• Back posture is considered by determining if it is neutral, moderately or excessively flexed or twisted. • Shoulder/arm posture is considered by determining movement frequency. This assessment should be done when the shoulder/arm is most heavily loaded, not necessarily at the same time the back is assessed. • Wrist/hand posture is considered at the most awkward point of a task. Movement is regarded as almost straight if it is limited within a small angular range (eg. <15ºC). Otherwise, it is deviated or bent. • Neck posture is considered by determining the angle of bending and twisting.	• The posture is evaluated by measuring joint angle are wrist, lower arm, upper arm, leg, neck and trunk posture.
	Time	• Total time for which a person performs the task in a typical day (exposure). • Total cycle time for each region of the body is measured. • The typical time which the task is performed without break is measured	• The duration of the task is considered as well as the number of recommended actions and the total number of actions for repetitive tasks. The recovery time is also considered as well as the number of tasks per minute.	• Observations are made at time intervals of 30 or 60 seconds during field work. Using video tape, smaller intervals of 40 seconds are possible.	• The number of times a task is performed is considered. • The duration of a task is measured. It is rated depending on repetition time.	• Repetition – e.g., repeating same motions every few seconds for 2 hours at a time, or using a device (such as a keyboard and/or mouse) steadily for more than 4 hours daily.

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			• The length of time that a risky posture is maintained is considered. **Grieco, Ergonomics, 1998.**			
	Other	• Vibration is measured.	• Vibration, recovery time, exposure to low temperatures, use of gloves, effect of high precision work, intensity of exertion are considered. **Grieco, Ergonomics, 1998.**		• Other task components are characterized. They include, vibration, visual demand of the work, the difficulty a worker has keeping up with the work, and the workers opinion of how stressful they find their job. • The assessment is completed by an observer regarding posture and repetition of movements. The worker completes the assessment regarding the weight lifted, the time spend doing this task, the vibration experienced, the visual demand, the difficulty keeping up with a task and the stress of the work. **Li et al. Proceedings of the Human Factors and Ergonomics Society, 1998.**	• Hand hold on a tool or handle is rated. • Activity level is rated including the size of the action and whether it affects a small part of the body or causes a large posture change.
Evaluation of Single Risk Factors	Force	• Maximum force score corresponds to the maximum force possible. Scoring scale ranges from minimal to maximal force.	• Reference lifting score = 1. This is largely acceptable conditions for the majority of healthy adult working population. As this values changes, exposure is more dangerous, different interventions can be identified. Strong propensity towards preventative actions. • Required force is evaluated by rating the perceived effort using the Borg scale and the percent effort required with respect to the MVC. These values are combined in a multiplying factor. **Grieco, Ergonomics, 1998.**	• A value of 1 is given to tasks involving less than 10kg, a value of 2 is given to tasks involving from 10 to 20 kg and a value of 3 is given to tasks involving more than 20kg.	• Force/load handled by the body and hands is rated.	• Assessment done by observer and by worker. • Also rated is the force due to a load, the coupling of a hand and object and the activity level.

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	Posture	• Awkwardness rating is low for postures close to neutral, and greater for tasks near the end of the range of motion in more than one direction. • Higher risk occurs when the deviation of the upper limb occur in combinations. For example, wrist extension combined with ulnar deviation.	• The amount of time that each segment spends in a risky posture is determined. The riskiest posture maintained for the longest time is used to determine a postural involvement index score that corresponds to a multiplying factor. **Grieco, Ergonomics, 1998.**	• Postures are classified based on a risk assessment of musculoskeletal disorders and physical load. • Each classified posture is recognized by a 4-digit code that indicates the back, arm and leg posture and the load or use of force. • A fifth digit is used to indicate the work phase or task that the worker is working on. • Back posture and movement score determined.	• Shoulder/arm posture and movement are rated. • Wrist/hand posture and movement are rated. • The neck posture is rated according to the degree of bending and twisting.	• The posture of the trunk, neck, legs, upper arm, lower arm and wrist are given a score.
	Time	• Cycle time (exposure), time that a person typically performs the task during an entire day. • Cycle duration, typical time that task is performed without a break. • Task speed was assessed. Slow to moderate movements have the least risk. Static application of force to a particular region has greater risk. Tasks with fast movement, quick accelerations and decelerations have the greatest risk.	• The frequency of task repetition is evaluated as well as the duration of repetitive tasks and recovery time. **Grieco, Ergonomics, 1998.**	• Multiply the reference frequency (30 actions/min) by number of repetitions actually done (after altering this value to take into account the force, posture, recovery time etc.)		
	Other	• Vibration rating ranges from a low value for no vibration to a higher value for severe amplitudes.	• Vibration, recovery time, exposure to low temperatures, use of gloves, and the effect of high precision work was also considered. Depending on the amount of time spend working in such conditions, a corresponding multiplier is assigned. • The preexisting disorders that workers were affected by (Carpal Tunnel Syndrome, epicondylitis etc,) are also considered in a concise damage index. **Grieco, Ergonomics, 1998.**		• Vibration, visual demand, task duration, vibration, difficulty keeping up, stress level. • Back movement is rated by determining how often person bends or twists within one task cycle. • Shoulder/arm movement determined by how often the motion of a task is repeated. • Wrist/hand movement does not include movement of the fingers. One motion is counted each time the same or similar motion or pattern is repeated over a set period of time.	

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Evaluation of Combined Risk Factors	• Assess cycle time and task duration independently then give a combined score for the repetition risk factor. • The force and speed scores are independently assessed and combined to generate an exertion risk factor. • Cumulative risk score combines the scores of each individual part. Yields values between 5 and 25. • Further action is required no matter what the combined risk score is the exertion factor is greater than 5, the sum of exertion and awkwardness is greater than 8 and the cumulative risk score is 15 or greater.	• Combined the value determined by the exposure index (OCRA) and the damage index to determine degree of association. **Grieco, Ergonomics, 1998.** • Each task is classified based on exposure to WMSDs related. This is translated into a rating by comparing the number daily number of actions performed by the upper limbs during repetitive tasks and the number of recommended actions.	• Postural data is combined with the proportion of time that a worker spends in a particular position. This is used to determine the class of the job. Based on this class, action may or may not be required. • A similar analysis is done for the amount of time that each body part spends in a particular position. The results of this determination are also used to determine the class of the job. This class may or may not require action depending on the value. **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447-459.**	• The assessment performed by the observer and the worker are combined with the exposure scores to come up with an exposure score for the back, shoulder/arm, wrist/hand and neck.	• Upper, lower arm, wrist and wrist twist posture are combined into one score and muscle use and force are added to this. Neck, Trunk and Leg posture scores are combined into one posture based added to muscle use and force scores. • Individual scores are combined to determine the overall REBA score.
Validity		• Simple linear regression model provided a 'satisfactory predictive performance' of the risk of WMSDs based on index. • Preliminary validation of the degree of association of the index (OCRA) and the WMSDs detected. **Grieco, Ergonomics, 1998.**	• Based on the study by Burdorf, the OWAS system predicts back pain based on the amount of time spent working in a harmful posture. **Burdorf et al Ergonomics, 1991.**	• Assessment validity was moderate due to a low level of agreement on back posture classifications. • The relationship between exposure and work-related musculoskeletal disorders was not made. • Improvements to aid with assessing frequent body movements is required. **Li et al. Proceedings of the Human Factors and Ergonomics Society, 1998.**	
Limit or Guideline Level Proposed?	• Suggested thresholds help to make judgments about the safety of the task. • Action is recommended if : o The exertion score was 5 or greater for any body region o The sum of exertion	• The score is calculated and classified as red, green or amber. Green indicates and acceptable frequency of motion. Amber indicates an area of uncertainty, close monitoring is required. Red indicates a high risk of injury, the task must be improved.	• Posture combinations and the proportion of time spent in that posture are classified into 4 action categories indicating the urgency and priority for corrective measures. • An action class of 1 indicates that no action in required, 4	• Risk factor values are combined to give overall exposure scores. These scores are used to compare tasks before and after an intervention to determine the change in risk.	• The final REBA score provides an action level with an indication of urgency of intervention. • Scores range from 1-15 and are grouped into 5 action categories. These categories range from 'no action

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	and awkwardness was eight or greater for any region of the body o The cumulative risk score (total of time, exertion, awkwardness, vibration and repetition) was 15 or greater.	• An exposure index (OCRA) of 4 or more predicts a high occurrence of disorders. An exposure index of 0.8 to 4 is an intermediate value that does not necessarily mean a disorder will occur but does not completely rule out the possibility. **Grieco, Ergonomics, 1998.**	indicates that corrective measures are needed immediately. • A second classification is based on the amount of time each body part spends in each posture. The relative proportion of time spent in a position determines the action class (same as above). **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447-459.**		necessary' to 'action necessary now'.
Study Base/ Generalizability Used in: Developed in:	• 48 workplaces with 30-100 employees in the food, construction and health industries **Straker et al. Ergonomics 2004**	• 462 workers exposed to WMSDs and 749 workers not exposed to any specific occupational risk were examined. Total of 8 different tasks in eight manufacturing industries. Finishing ceramic ornaments, auto body sanding, door and window sanding, supermarket check out, vegetable packing, meat processing, etc.	• Developed for Finnish steel industry. • 680 jobs in the steel mill were studied to define the various postures. These jobs were representative of all steel mill jobs at the time. **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447-459.**	• Participatory approach involving 150 practitioners. • Manual laborers, laboratory workers, office workers, warehouse workers, supermarket workers.	• Reliability tested using 600 examples of postures from electricity, health care, manufacturing industries and 14 experts to perform the assessment/. • Inter-rater reliability of 62-85%.
		• Reference group of workers who were not exposed to the repetitive tasks. **Grieco, Ergonomics, 1998.**	• 120 workers from a factory that makes prefabricated concrete elements. **Burdorf et al, Ergonomics, 1991.**		
Equipment Required	• No equipment required beyond the assessment sheet.	• Stopwatch	• Video tape is useful to replay the task and increases the frequency of postural observations that can be made. Computer aided applications increase the ease of assessment.	• Stopwatch	• Camera, weight scale, stopwatch useful but not necessary
Measurement Characteristics			• Inter-observer reliability has been tested in many different job industries. The reported inter-observer reliability is high, averaging over 90%. Back posture is most difficult to distinguish. **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447-459.**	• Inter-observer reliability: Most agreement between observers for wrist/hand posture, wrist/hand movement, back posture, shoulder/arm posture, shoulder/arm movement. Least agreement between back movement. • Increased reliability when assessment done by practitioners with work experience.	

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			• Procedures are randomly observed and recorded for a few seconds. This results in a summary description of the job. **Li and Buckle, Ergonomics, 1999.**	• Intra-observer reliability: Assessment repeated by same practitioner after 3 weeks. High reliability in assessing back posture, back movement, shoulder/arm movement, wrist/hand posture. Lower reliability for wrist/hand movement, neck posture, shoulder/arm postures. Reliability did not change when assessments done by practitioners with more experience.	
Information for Intervention?	• Action is recommended if : o The exertion score was 5 or greater for any body region o The sum of exertion and awkwardness was eight or greater for any region of the body o The cumulative risk score (total of time, exertion, awkwardness, vibration and repetition) was 15 or greater.	• If the number of actions in a day performed by the upper limbs exceeds the calculated recommended limit, intervention is required.	• Two classes of action are determined based on postural data. The class of action determined will indicate whether an intervention is required or not. An action class of 1 indicates that no intervention is required. An action class of 4 indicates corrective action is needed immediately. **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447-459.**		• The calculated REBA score corresponds to an action level. The recommended action may include 'action necessary now'.
Limitations		• Does not propose threshold value as a standard. • Meant to identify jobs that require different levels of action	• This method does not consider the proportion of time spent using force or handling a load. **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447-459.**	• The hand force exertion value is somewhat difficult to determine. • No limit or guideline is proposed and there are no intervention instructions. This method is generally used to compare before and after.	• Heavy focus on posture. • No emphasis on the effect of frequency and cumulative loading. • Forces evaluator to use professional judgment to choose a representative 'snapshot' of the job
			• It also does not consider movement frequency or duration, recovery time or vibration. **David, Occupational Medicine, 2005.**	• The 'score system' has not been validated through epidemiological studies. **Li and Buckle, Ergonomics, 1999.**	• This method does not consider the duration of activity, the recovery period or vibration. **David et al. Occupational Medicine, 2005.**
			• Posture categories are too broad to accurately describe all postures **Li and Buckle, Ergonomics, 1999.**		

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Core Reference	**Burgess-Limerich, L., Straker, L., Pollock, C., Egeskov, R. 2004. Manual Risk Assessment Tool (ManTRA) V2.0. *School of Human Movement Studies, The University of Queensland, Australia*. Accessed May 2006. http://ergonomics.uq.edu.au/download/mantra2.pdf**	**Occipinti, E. 1998. OCRA: a concise index for the assessment of exposure to repetitive movements of the upper limbs. *Ergonomics*. 41(9): pp 1290-1311**	**Karhu, O., Kansi, P., Kuorinka, I. 1977. Correcting working postures in industry: A practical method for analysis. *Applied Ergonomics*. 8(4): pp 199 to 201.**	**Guangyan, L., Buckle, P., 1999. Evaluating change in exposure to risk for musculoskeletal disorders ~ a practical tool. *Prepared by the Robens Centre for Health Ergonomics, University of Surrey, for the Health and Safety Executive*.** **QEC – Quick Exposure Check on risks for work-related musculoskeletal disorders. Maintained by G. Li in association with Human Engineering Inc., Bristol, UK Accessed May 3, 2006. http://www.sunderland.ac.uk/~ts0gli/QEC.html**	**Hignett S, and McAtamney L. 2000. Rapid Entire Body Assessment (REBA). *Applied Ergonomics*. 31(1): 201-205.**

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Other References	**Manual Task Risk Assessment Tool (ManTRA) V2.0. *Cornell University Ergonomics Web*. Accessed May 3, 2006. http://ergo.human.cornell.edu/cumantra2.htm** **Straker, L., Burgess-Limerick, R., et al 2004. A randomized and controlled trial of a participative ergonomics intervention to reduce injuries associated with manual tasks: physical risk and legislative compliance. *Ergonomics*. 47(2). pp 166-188.**	**Grieco, A. 1998. Application of the concise exposure index (OCRA) to tasks involving repetitive movements of the upper limbs in a variety of manufacturing industries: preliminary validations, *Ergonomics*, 41(9): pp 1347-1356.**	**Burdorf, A., Govaert, G., Elders, L. 1991. Postural load and back pain of workers in the manufacturing of prefabricated concrete elements. *Ergonomics*. 34(7): 909 to 918.** **David, G. 2005. Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational Medicine*. 55: pp 190 to 199.** **Karhu, O. et al. 1981. Observing working postures in industry: Examples of OWAS application. *Applied Ergonomics*. 12(1): pp 13 to 17.** **Hassanzadeh, M., et al. 2003. Evaluation of Musculoskeletal Disorders risk factors among the crew of the ports and shipping organization's vessels. *IEA Ergonomics in the Digital Age*, Seoul Korea.** **Karwowski, W., and Marras, W. 1999. OWAS Methods in *The Occupational Ergonomics Handbook*. pp 447 to 459.** **Kivi, P., Mattilal, M. 1991. Analysis and improvement of work postures in the building industry: application of the computerized OWAS method. *Applied Ergonomics*. 22(1): pp 43 to 48.** **Li, G., Buckle, P. 1999. Current techniques for assessing physical exposure to work-related musculoskeletal risks, with emphasis on posture-based methods. Ergonomics, 42(5): pp 674 to 695.**	**Li, G. and Buckle, P., 1998, A practical method for the assessment of work-related musculoskeletal risks - Quick Exposure Check (QEC). In the Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting, October 5-9, Chicago, Human *Factors and Ergonomics Society*: 1351-1355.** **Li, G., Buckle, P. 1999. Current techniques for assessing physical exposure to work-related musculoskeletal risks, with emphasis on posture-based methods. *Ergonomics*, 42(5): pp 674 to 695.**	**David, G. 2005. Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational Medicine*. 55: pp 190-199.**

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Example Worksheet	Worksheet **ManTRA, V2.0 Cornell University Ergonomics Web.**	Worksheet **Occipinti, Ergonomics, 1998.**	Worksheet and Computer Program **David, Occupational Medicine, 2005.**	Worksheet **QEC – Quick Exposure Check on risks for work-related musculoskeletal disorders. 2006**	Worksheet **Hignett et al. Applied Ergonomics, 2000.**
Comments					