Identifying and managing the risk of Musculoskeletal Discomfort (MSD) in train driving

Paul Thompson, Head of Risk and Safety Performance for Northern Rail, developed this case study during his 1st year Master of Science study in Occupational Health and Safety Management at Loughborough University, *"Identifying and managing the risk of MSD in train driving"*.

Northern Rail has worked with BUPA, Loughborough University, and RSSB to develop a tool for identifying and managing the risk of musculoskeletal discomfort in train driving. The initial work by Northern has been developed further and, following user testing by a group of passenger, freight and On Track Machine operators, an MSD assessment tool (MAT) for train driving cabs has been launched by RSSB primarily for use by Railway Group Members.

Introduction

The rail industry has long been aware of the problems of musculoskeletal discomfort, in both upper and lower limbs, in train drivers. Train cab design has been historically poor in the UK, with adjustability in seat ranges, space, reach and vision to controls being a particular problem.

The need for a practical method to assess musculoskeletal risks arising from driving trains has been brought into closer focus in recent years as a result of successful civil claims arising from failure of employers to conduct suitable and sufficient risk assessments to underpin adequate control.

Proposals by the European Commission for a new directive to provide increased protection against musculoskeletal disorders (including in train driving cabs) will strengthen the need for a robust risk assessment method for MSD risk.

Key findings from Northern's work on MSD risk in train driving

Northern's study identified potential musculoskeletal discomfort risks associated with:

A. Six key driving tasks
B. Four key risk factors
C. Eleven key anthropometric dimensions

A. The six key driving tasks

Figure 1

The six key driving tasks identified were:

1. Operating the brake controller *(Shown in step 3 'Full Service' position)*
2. Operating the warning Horn
3. Resetting the Automatic Warning System *(AWS)*
4. Operating the power controller *(7 step shown in 'zero' no power position)*
5. Operating the Driver Safety Device *(DSD)*
6. Observing internal and external information *(instrumentation and window)*

B. The four key risk factors

Awkward Posture

Awkward posture relates to the extent of deviation of the joint and/or upper limb (or part of the limb) from a neutral position. Awkward posture in train driving was not considered sufficient alone to give rise to musculoskeletal injury. Increased risk of fatigue, pain or injury from awkward postures is most likely when used repetitively or for prolonged periods (Buckle, 1987, Hagberg et al, 1995, HSE HSG 60, 2002). There is a proven association between awkward posture and the dimensions of workplace design. Key risk areas for awkward posture identified from the Northern study include:

i. Working with unsupported shoulders or raised shoulders due to no armrest; limited armrest adjustment; or fixed armrest independent of the seat pan. Inadequate horizontal adjustment of seat base, or length of upper thigh limiting forward seating position, due to insufficient distance from the front of the seat backrest to primary controls;
ii. Inadequate depth of the seat pan;
iii. Inadequate vertical adjustment of seat base. Where seat bases were independent of the seat backrest, as the seat moves down the backrest moves apart, reducing lower back support;
iv. Prolonged leaning forward and bending and/or rotation of the neck due to insufficient room for the legs and feet to allow the driver to get close enough to the controls; and clearance between underside of desk to footplate. Drivers with longer lower legs at vertical under desk likely to compromise space with pelvis twisting to accommodate.

Repetitive Movements

Repeated task movements can increase the degree of MSD risk; a high degree of repetition is generally accepted as one movement every 30 seconds. Northern reviewed the frequency of key driving tasks across a range of route types (Table 2) and found the brake movement task over the intensive route closest to the high repetitive task threshold; however no Northern depot is exposed to 100% of intensive routes

Operation of the controls was therefore not considered a highly repetitive task for Northern's operations. The study recognised that driving over very intensive routes or use of combined power and brake controller for example might increase risk from repetitive movements.

Table 2

Key Tasks	Frequency of activity									
	Route 1 Intensive			Route 2 Urban			Route 3 Rural			Av.
	Sample *t* 2 hrs	*6 hr shift	1 in X seconds	Sample *t* 3 hrs	*6 hr shift	1 in X seconds	Sample *t* 2 hrs	*6 hr shift	1 in X seconds	Av. 1 in X seconds
Brake Controller	236	707	30.5	233	466	46.4	192	576	37.5	38.1
Power Controller	145	435	49.7	299	598	36.1	134	402	53.7	46.5
AWS cancellations	36	108	200	31	62	348	13	13	554	367
Vigilance	N/A	-	-	72*	144	150	35	35	206	178
Warning horn	3	9		4	8		4	12		

** Vigilance 1hr and 30 recorded 36 events, rounded up.*

Duration of task

MSD risk is increased when the joints or muscles are overused and do not have adequate time to recover. Where tasks are held for longer than one minute or more than 50% of the duty cycle, duration is a high risk factor (McAtamney and Corlett 1993, Hignett and McAtamney 2000)

Northern's study concluded that the risk from task duration for upper limb discomfort was very low, as the duration of tasks is short for the brake controller, power controller, AWS and warning horn, at about 1 second (e.g. 2.6% duty cycle for brake controller) for each separate movement. .

Duration was considered a risk factor for lower limbs from DSD operation for those who have an awkward posture. DSD operation requires a constant load on the pedal with average journey times around 40 minutes, making an average duration of 20mins for each leg and 50% exertion (duty cycle) if each leg equally shares the task throughout the shift.

Forceful movements

Northern measured the forces applied to key driving controls (brake controller, power controller, AWS, DSD, and warning horn) and assessed them against an established reference standard for low, medium, and high push and pull forces using a pinch grip *(*Guangyan and Buckle, 1999).

Use of a pinch grip in the reference standard was likely to give pessimistic results when compared with Northern's results, as in reality loads will be distributed for brake controller, power controller, AWS and warning horn not only through the wrist (10%), but also through the elbow (60%) and shoulder (30%).

Table 3 shows the train driving forces produced by Northern using a digital force gauge in accordance with the manufacturer's instructions (ISOTEST® IST-300D Series). Green indicates low forces; amber medium; and red high.

The brake controller force movement results were obtained from each step taken through "step 0" to "Emergency" & vice versa. The pushing average of 1.12kg (11n) is marginally over the reference standard threshold, making it a medium risk, although the pulling average of 0.968kg (9.5n) is marginally under the threshold, making it a low movement force. The pushing average in emergency is a high force movement by design, to avoid inadvertent emergency brake applications, although such brake applications are a rare event.

Table 3

	Push Forces (Av.)		Pull Forces (Av.)	
	Newton	KG	Newton	KG
Brake Controller (1-3)	11n	1.12kg	9.5n	0.968kg
Brake Controller (Em)	43.1n	4.39kg	41.2n	4.2kg
Power controller	23.7n	2.416kg	13.9n	1.417kg
AWS	31.5n	3.212kg	-	-
DSD	83.3n	8.494kg	-	-
Warning horn	16.6n	1.692kg	11.5n	1.172kg

The power controller force movement results were obtained from each step taken separately through notch "zero" to "step 7" & vice versa. The pushing and pulling force averages measured for power controller and warning horn movement were medium risks. There are no force parameters available for AWS and DSD to judge whether the forces measured are in the low, medium or high force categories. Using the pinch grip parameters in the reference standard, the AWS would have a medium force risk.

The forces measured for the operation of power, brake, warning horn and AWS tasks were judged unlikely to present a significant foreseeable risk of injury.

Ergonomic Cab Anthropometric Assessment Tool (ECAAT)

Northern Rail, in conjunction with RSSB, developed an Ergonomic Cab Anthropometric Assessment Tool (ECAAT) designed to be used by its occupational health provider team to assess awkward postures relating to key driver and cab dimensions. ECAAT compares 11 driver body dimensions with related cab dimensions using licensed UK anthropometric data to determine spatial constraints across 10 classes of train. It is primarily used for driver recruitment screening, and tracking improvement for existing drivers who report discomfort, although, it can also be used for determining improvements in cab design. The assessment is designed to meet GM/RT2162 Industry requirements for Northern Rail.

All individuals identified as being Northern cab ‘users’ either new in post, or who report musculoskeletal pain which they attribute to cab use, are offered appropriate cab driver ergonomic risk assessment. If following the risk assessment the employee is at 10% or greater risk of exposure to musculoskeletal discomfort, i.e. body dimensions are not an anthropometric fit and exposure to the cab is over 10%, a site assessment is arranged. This will enable the assessor to identify any specific factors, work place or work patterns that may have increased the risk of musculoskeletal discomfort and where further efforts to reduce those risks are reasonably practicable. The ergonomic risk assessment, together with results of medical examinations and advice on fitness criteria, are key elements in supporting Northern’s decisions on management of MSD risk. The Northern Rail Cab Improvement Working Group considers any engineering improvements that are proposed. The professional Heads of Engineering and Operations may consider the feasibility, technical and operating specification in any design improvements.

Conclusion

The rail industry has long been aware of the problems of musculoskeletal discomfort, and train cab design has been historically poor with adjustability in seat ranges, space, reach and vision to controls being a particular problem. Identifying the cause of MSDs can be complex, with individual variation and non-work related causes a particular challenge.

Through use of their ECAAT risk assessment tool for train cabs, Northern assessed the risk associated with upper body forceful movements and repetitive tasks in train driving as low. Awkward postures adopted by drivers were judged to present an increased risk in these areas, which may contribute to cumulative discomfort over time. This is likely to be a significant problem with those who are at the extreme ends of the anthropometric range.

As well as supporting their own MSD risk management, Northern Rail’s work in this area has prompted further cross industry collaboration to produce an evidence based risk assessment tool for MSD risk in driving train cabs, available for use across mainline operators.