

DRILLING DOWN INTO ERGONOMICS

ERGONOMIC ASPECTS OF OIL AND GAS DRILLING INDUSTRY USING DRILL PIPE SLIPS



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Those who work on oil and gas drilling rigs are largely exposed to ergonomic related injuries and associated risks. Repeated bending, lifting heavy items, pushing and pulling loads and working in awkward body postures are common practices on drilling rigs.

Compared with those in other industries, drilling crews are exposed to higher risk levels due to other risk factors such as psychological stressors, long working hours, time pressure, standing for long periods of time, heat and cold stress, isolation and high hazards working environment.

Musculoskeletal disorders impose major operating costs on employers in the drilling industry, but from an ergonomic aspect, very little research has been done on drilling rig equipment and associated methods. Since these injuries develop over a long period of the time, it is difficult to determine how often such injuries occur. Even though drilling equipment manufacturers have made

many efforts to introduce hands-free drilling operations and automating processes, this industry is still lagging behind when compared to other industries, and the development of technology is not widespread around the world.

One of the most strenuous tasks for the floorman is the handling of drill pipe slips. Drill pipe slips aid in drilling by gripping onto the drill string, which in turn is used to reach the wellbore's bottom. Due to awkward body postures during their handling, the number of slips being handled, and the speed of operation, the risks of developing musculoskeletal disorders are increased relatively. The main physiological factors that affect this task are high repetition, using considerable muscle force, long working hours, and local muscle fatigue. Different types of drill pipe slips have various weights, but a typical drill pipe slips is between 96 kg to 114 kg.

Due to associated risks, the setting and lifting of slips should be performed according to operational procedures ▶



with the use of three floorman. However, due to operational circumstances and a shortage of personnel on the rig floor, often it has been observed that slips had been handled by two persons only. A review of a recent incident found that serious disc injury to a worker while lifting slips occurred and employer was liable to pay 700,000 USD compensation, as the employer was negligent and allowed only two workers to lift drill pipe slips for prolonged periods.

Stooping, bending and twisting the back is prevalent during handling of drill pipe slips. Based on research conducted by health and safety consultancy services, the number of stooping, bending at the waist and twisting the back occurrences during a five-minute period for two and three people handling slips was

recorded and compared with automated slips, where the such awkward postures has been eliminated. Table 1 demonstrates this comparison.

Statistics

Statistics and incident trends published by drilling professional bodies don't demonstrate work related diseases lagging indicators. OSHA estimates that work-related musculoskeletal disorders in the United States account for over 600,000 injuries and illnesses (34 percent of all lost workdays reported to the Bureau of Labor Statistics). Based on statistics extracted from Norway Offshore Petroleum industry for the period 1992 to 2003, about 47% of work related diseases were attributed to musculoskeletal disorders. According

to the UK's Health and Safety Executive (HSE), Musculoskeletal Disorders (MSD) are a significant contributor to the incidence of occupational diseases offshore, accounting for over 20% of the injuries reported to the HSE, while the majority of back injuries are not reported.

The biology bit

Musculoskeletal Disorders can affect muscles, joints and tendons in all parts of the body, since the body's bones act as the support structure for human movement and are linked together by joints. In addition to this, human muscles are linked to bones via tendons. Due to nature of the task, a range of muscles and joints are being used during handling of drill pipe slips. Lower back,

abdominal, tricep, deltoid, and gamellus are the main muscles being used during handling of drill pipe slips, while vertebra, knee, wrist, hip and shoulder, and facet joints are the main joints being used during such operation. Due to awkward body postures, nerves can be compressed and tendons could be irritated during repeated handling.

Risk identification and selection of posture

To address MSDs, prevention strategies often concentrate on major risk factors such as force, posture and repetition. In order to perform risk estimation and identify the main risk factors that play when handling drill pipe slips, postural analysis has been performed. For this purpose the "Running in the Hole" operation was observed and the most awkward body postures selected. Using two persons instead of three persons and while lifting slips from a master bushing insert where the elevator is at its lowest level was the snapshot for posture examination. This posture occurs most frequently and involves ▶

Table 1. Exposure per minute based on a five-minute operation Source: Auto Slips¹

	Manual Slips	Manual Slips	Automated Slips
Number of Men at connection point	3	2	0
Stooping Occurrences	1	1.6	0
Bending at the Waist Occurrences	3.2	3.4	0
Twisting of the Back Occurrences	3	5.25	0

¹ Exposure per Minute Based on a five-minute operation cited in "Well Site Fishing & Rental Services", 2016



A. Neck, Trunk and Leg Analysis

REBA Assessment Worksheet

Table A: 8 (Trunk 5, Load/Force 3) + Table B: 6 (Upper Arm 4, Coupling 1) = 14 (REBA Score)

Table C: 12 (Neck 2, Lower Arm 2) + Activity 2 = 14 (REBA Score)

Wrist: 2

Legs: 3

REBA Score | **Risk Level** | **Action**

1	Negligable	None necessary
2 - 3	Low	May be necessary
4 - 7	Medium	Necessary
8 - 10	High	Necessary soon
11 - 15	Very High	Necessary now

Subject: Posture Analysis
 Task: Lifting Drill Pipe Slips by Two Floorman
 Scorer: James
 Date: 22/01/2018

methodology is sensitive to musculoskeletal risk assessment in a variety of tasks and is more reliable and results could be validated, such methodology has been used.

As demonstrated on the REBA assessment worksheet, with scoring the body parts engaged in lifting drill pipe slips, and including some parameters such as weight of the load, methods of grips of the load, the total REBA score reached 14 based on action level table, such a score defined the posture as a very high risk level, for which immediate action is necessary.

Main findings

- All parts of the body, such as hands, fingers, shoulders, back, neck, legs, and wrists that could be affected by musculoskeletal disorders are engaged during lifting slips
- Occurrences of exerting excessive force, stooping, bending the waist and twisting the back were observed during handling of slips. Many manual handling injuries in such tasks are cumulative and result from repeatedly performing the same activities with poor posture
- Motion and acceleration of speed of operation – especially during bending and twisting – can increase the amount of force exerted on the body ▶

larger forces and muscular activity, causing more discomfort for workers. All parts of the body including hands, fingers, shoulders, back, neck, legs, and wrists that could be affected by musculoskeletal disorders are engaged in this task.

Posture analysis

Posture analysis methods are screening tools and they give risk estimation for practitioners to identify main risk factors

and prioritise remedial actions. Even though for selecting appropriate postural analysis, the usual parameters such as time for observation and analysis, required details, frequency of the task, associated costs, event driven and type of occupations have been considered, but for a dynamic task and when all body parts are moving, selection between Owaco Working Analysis System (OWAS) or Rapid Entire Body Assessment (REBA) is recommended. Considering the fact that REBA

“due to the nature of the drilling industry, addressing ergonomics and human factors in an organisation should have a multi-disciplinary approach”



- The use of Rapid Entire Body Assessment (REBA) indicated lifting, setting, and carrying of slips has been considered as a very high risk task, which needs urgent action taken by management
- Performing this task between just two people, rather than three, will increase the risk of injury and undue stress to the workers and may cause permanent disability
- Environmental factors such as slippery surfaces, greasy handles, and cold and hot temperatures contribute to awkward postures
- Communication between workers – prior to lifting slips – in such team handling tasks is crucial

Suggestions

Due to the nature of the drilling industry, addressing ergonomics and human factors in an organisation should have a multi-disciplinary approach. Dealing with technology, human factors and organisation in a well-structured approach to address ergonomic issues will be more effective. From a risk management perspective, the priority should be elimination of handling of slips by workers and accentuating the concept of ergonomics science, which is fitting the task to the individual rather than fitting individual to the task.

Organisation

Developing policies and procedures – including banning handling of slips by just two workers – and having leadership and commitment from top

management is a first step in the organisation; this should be embedded in each and every organisation's occupational health and safety management. Allocating responsibilities and sufficient resources to implement ergonomic programmes to address ergonomic and human factor issues in organisations' risk assessments and future rig design and procurement procedures is a second step. Organisational cultural shift is critical and encouragement of employees to report musculoskeletal disorders and particularly back injuries is fundamental for improvement.

Human factors

Involving competent ergonomics and human factors consultants and providing suitable training on such topics as recognising musculoskeletal risk factors and risk control strategies is essential; however, due to the nature of the operation, effectiveness of some training courses such as manual handling is limited. Involvement of an organisation's management in training is essential otherwise they have no sense of what sort of control measures are required to minimise the risks. Employee rotations to reduce the risk exposure level and pre-medical health checks are highly recommended to ensure people are physically fit for this type of demanding task.

Technology

With consideration of associated health and safety risks during handling of slips, the use of automated slips is highly recommended. Various slip lifting ▶



devices produce pneumatic or hydraulic configurations. These pieces of equipment not only reduce the work loads and make the job safer, they also enhance the efficiency of operations.

Conclusion

Handling of drill pipe slips by rig crew is a strenuous task and force, posture and repetition are three main risk factors in this operation. Company management should have a multi-disciplinary approach to minimising the risks and should consider the hierarchy of controls, while eliminating the handling of drill pipe slips should be in high priority. ■

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