

Fatigue Management Among Mining Department Shift Workers At Newmont Ghana Gold Limited Ahafo Mine, Kenyase, Brong Ahafo Region, Ghana.

Desmond Asare, Godfred Etsey Sebiawu, Napoleon Jackson Mensah

Abstract: Fatigue is a growing problem in modern society. The incidences of insufficient sleep and circadian disruptions have become all too common in today's fast-paced world and these problems are increasingly taking their toll both in the workplace and in everyday life. Fatigue management is critical to shift workers as its effective management promotes an occupational health and wellbeing among workers including mining Shift workers. The case of this study was done at Newmont Ghana Gold Limited (NGGL) Ahafo mine. The conditions under which some of the segments of the company work make them very much susceptible to fatigue. The study revealed that the mining shift work is male dominated and made up of the youth and; that the causes of fatigue was as a result of travelling long distances to work on daily basis under strict national speed limits of Ghana. Quality of sleep among respondents was insufficient and disturbances due to extra responsibilities as family heads. Lack of fatigue management training, noise from hauling activities and the monotonous nature of their jobs constitute the causes of fatigue among this shift workers investigated. The study recommended that more females should be given the necessary training and education for them to become employable at the mines, Newmont as a mining company should create residences for workers in neighbouring communities and also offer more training and education programmes on how fatigue should be managed by mine shift workers in the mining industry.

Key Terms: Newmont Ghana Gold Limited, Newmont Mining Corporation, Personal Protective Equipment and circadian disruptions.

1 INTRODUCTION

Newmont Ghana Gold Limited (NGGL), is fully owned by Newmont Mining Corporation (NMC), one of the largest gold producers in the world with assets in the United States, Australia, Peru, Indonesia, Ghana, Canada, New Zealand, and Mexico with headquarters in Denver, Colorado. It has approximately 31,000 employees worldwide. Newmont Ghana's operations are significant to Newmont, in that its gold reserves are estimated to comprise almost 20% of NMC's worldwide assets. In 2009, NGGL produced 531,470 ounces of gold (about 15 tonnes), equivalent to 17.0% of Ghana's total production. Corresponding revenues were USD \$528 million or 20.7% of Ghana's gold exports. The company had 1,731 direct employees on its payroll (Kapstein et al. 2011). Mining can be highly demanding and exhausting. It requires intense focus and physical exertion, the use of heavy mobile equipment and repetitive work tasks, and is performed either on the surface of the earth or underground.

These tasks frequently involve manual handling associated with repetitive lifting, shoveling, operating heavy machinery, and handling awkward objects such as cabling and ventilation materials. Mining job demands various underground tasks. The workers' roles at a mine site are extremely varied and may involve a significant amount of physical work with tasks involving strength, mobility and muscular endurance. The work intensity is generally intermittent. This raises concern with respect to musculoskeletal injury since many may be unprepared for high intensity loading which may exceed their physical capacity. This emphasises the need for a level of functional fitness consistent with the demands of the position, as might occur when selecting an elite athlete for a particular position in a team sport. These factors all contribute to the relatively high injury rate in the mining sector. The intermittent nature of underground mining with peaks of very high intensity work causes a dramatic rise in heart rate. This individual record may under-represent the actual situation (Abt, et al 1999). Fatigue presents a number of problems and challenges to the individual and the organization at large. In relation to work performance, fatigue can cause tremendous reduction in safe work behaviour, productivity, teamwork and morale (Goldenhar, et al 2002). In the same regard, it increases the risk of accidents at the work place. Goldenhar, et al also observed that injury frequency and severity increases during extended period of work, Fatigue can also lead to micro sleeps which can cause so many accidents. Micro sleeps come in the form of four to five second naps. In relation to the health of the individual, fatigue may cause adverse effect such as gastrointestinal disorders (Holmes, 2001), which would have a negative effects on the health of shift workers in the mines, a fact that may be explained by poorer patterns of their nutritional behaviour relative to their daytime counterparts (Knutsson, 2000), higher levels of hypertension and obesity (Bofinger & Ham, 2002, & Dembe, et al 2005), increase in musculoskeletal injuries (Parker

- Desmond Asare is a Safety Officer at Wade Walker Electrical and Instrumentation Contractors, A Murray & Robert Company. E-mail: despa2003@yahoo.co.uk
- Godfred Etsey Sebiawu is a lecturer at the Department of Dispensing Technology, Wa Polytechnic, Wa, Ghana. E-mail: etseygodfred@yahoo.com
- Napoleon Jackson Mensah is a lecturer at the Department of Science Laboratory Technology, Wa Polytechnic, Wa, Ghana. E-mail: jacksonnapoleon@yahoo.com

2002, Spark, et al 1997), insomnia (Taris, et al 2006), psychological distress, neuro-psychic, breast cancer, diabetes (Harm,2006) and pregnancy complications among others. Some of these adverse effects are observed among some of the staff which gives a cause for alarm. The cause of industrial accidents is exceedingly complex but the link between increased fatigue with lowered performance and subsequent high rates of accidents would seem logical. Recent estimates of percentage injuries and fatalities caused primarily by sleepiness or fatigue diverge considerably, varying from 2% to 45% (Schutte, 2005). A great proportion of human error today is fatigue-related and this state of impairment is a natural consequence of human biological systems. In the simple equation underlying business, loss has a direct negative effect on the finance of an organization with its ripples affecting the growth and sustainability of the organization. It is therefore necessary to investigate the effect of shift work and sleep-related fatigue on sleep patterns and, subsequently, on health and safety which inevitably would help save lives, and reduce damage to properties.

1.1 Employee Fatigue in Mining

Fatigue is a growing problem in modern society. The incidences of insufficient sleep and circadian disruptions have become all too common in today's fast-paced world and these problems are increasingly taking their toll both in the workplace and in everyday life (Caldwell, et al 2008). Employee fatigue is a critical safety issue that affects many mines in the South African mining industry (Schutte and Maldonado, 2003). Fatigue has become pervasive because many employees work non-standard schedules, and they often fail to obtain sufficient sleep. From a health and safety standpoint, employee fatigue is a significant concern. Over the last number of years, increasing attention has been paid to fatigue management in the industry because of the recognition that sleepiness and fatigue are becoming endemic in the mining population, contributing to human error, and consequently to many (sometimes catastrophic) accidents. Fatigue is a serious threat to quality of life and severely compromises work performance when it becomes chronic or excessive (Piper, 1989; Okogbaa, Shell & Filipusic, 1994). Unfortunately, its complex and dynamic nature makes fatigue difficult to define, observe and measure.

1.2 The Study Area

The case of this study was done at Newmont Ghana Gold Limited (NGGL) Ahafo mine, Kenyase in the Brong Ahafo Region of Ghana. The conditions under which some of the segments of the company work make them very much susceptible to fatigue. Some of the incidence that has been recorded in the company gives an indication of fatigue especially among the mining department shift workers. From observation and informants, there have been reports of several accidents and incidents occurring among mine shift workers. Most of the workers in these segments of the operations of NGGL work under extreme difficult conditions and without an effective and adequate management of fatigue among them there is a high possibility of health risks and hazards. This can directly or indirectly affect the health of the workers and the operations of the company. As a mining company, NGGL finds itself in a position that makes

some of its workers very much susceptible to fatigue. As a company that is bent on ensuring excellence in its operations, preventing fatigue among its staff is not an issue that will be out of place. A cursory consideration of the various studies that have been performed over the years in terms of health and environment reveals that not much has been done in regards to stress and fatigue. Most of these studies have concentrated on the effect of some of the chemicals of the company's operations on the lives of people and the environment, and issues in work related stress and fatigue. This study seeks to be one that is directed solely on the mine shift workers in relation to fatigue. NGGL has in place some safety guidelines in place to protect the health and safety of workers but the impact of this has not been adequately measured. This study will bring out empirical evidence to portray the issues related to health and safety that are associated with fatigue in the mine shift department. This will assist stakeholders to put in place various policies and programs to enhance occupational health and safety in the organization.

2 THE MINING ENVIRONMENT AT NGGL AHAFO MINE

Working arrangements in the mining sector differ from those in the rest of the industry: working hours are longer; the workforce live and work away from their abode for longer periods. The periods are divided into shifts comprising consecutive days followed by consecutive nights and sometimes the day shift alternates with the night shift. Shifts at NGGL are 12hours long periods of 4 days in a week with overtime. The shift patterns are all nights, all days or split shift. Longer periods of working for the miners adversely affect amount of time available for sleep and social activities. The increased competition between sleep and other activities results in sleep of a limited quality and length. The miners accumulates a sleep debt which results in fatigue that ultimately affect their health, performance and increase the risk of an accident. The 12hours system generates a compressed working week, which has been defined as "any system of fixed working hours more than eight hours in duration which results in a working week of less than five full days"(Tepas, 1985, p.148)

2.1 NGGL Ahafo Mine Work Setting

Participants worked a regular rotating 12 hour shift schedule consisting of 4 days shifts (D:0600h-1800h) with overtime and two days off, or 4 nights shifts with overtime and two days off, or two days shifts and two nights shifts with overtime and two days off. This type of shift has been in place since the inception of the mine in 2006. The types of work carried out at the mine are basically classified as adding hauling of ore, control room operations, field maintenance of heavy equipment, general plant work, manual handling, operating machinery and driving forklifts. Most of these workers are constantly exposed to loud noise from machines, high temperatures, dust and hazardous chemicals. All jobs types at the pit required workers to wear minimum personal protective equipment (PPE), consisting of full overalls, hardhats, goggles, gloves and footwear. Sometimes additional PPE such as respirators is required due to excessive dust. The main focus of this research is to investigate the influence of psychosocial factors on fatigue,

illness, injury, and factors that causes and influence fatigue among mine shift workers at the Newmont Ahafo Mine.

3 METHODS

Total sample size of 200 workers at the Mine Department were chosen comprising of the following: haul truck operators, loaders, drillers, mine dispatchers, and mine Maintenance mechanics at Newmont Ghana Gold Limited Ahafo Mine. The study used purposive and convenience sampling techniques for the selection of the sample size. Supervisors in mine operations and engineering were selected purposely to know strategies that currently exist in managing fatigue among their operational crew. The researcher chose the non-probability sampling techniques and the sample size based on the nature of the work of the workers in the mine shift. There is a lot of activity that goes on in their operations a reason for which the workers will not readily be available for the study especially when it comes to data collection. The reason to use this sampling technique was based on the availability and the quickness with which data was gathered. The primary source included: questionnaire administered personally and interviews conducted. Hand distribution questionnaires and face to face interviews/ interview guide were adopted to collect information from the respondent. Another set of questionnaire was also administered to the supervisors about the current fatigue management strategies being practiced at Newmont. Desk top information was surfed from the Internet and research on similar articles reviewed as a secondary source of data collection.

3.1 Data Analysis

The data obtained were imputed and coded using Statistical Package for the Social Scientist (SPSS) version 20 for windows, employing both descriptive (such as frequencies, means, percentages and proportions) and inferential statistical tools. The results are presented in tables, bar charts and pie chart with Microsoft Excel 2007.

3.2 Analysis of Findings

This section clarified demographic features of the respondents such as gender, age, educational level and the type of work one does at the mine as shown in Table 1 & 2 below.

Table 1. Respondent distribution by gender

Gender	Frequency	Percentage (%)	Cumulative Frequency (%)
Female	20	10.0	10.00
Male	180	90.0	100.00

Source: Field Data, 2013

Table 2. Respondent distribution by age

Age (Years)	Frequency	Percentage (%)	Cumulative Frequency (%)
20-29	72	36.0	36.0
30-39	104	52.0	88.0
40-49	16	8.0	96.0
50-59	8	4.0	100.0

Source: Field Data, 2013

In relation to marital status of the respondents, 80% were married, 10% single and 10% were divorced. For how long the respondents have being working with NGGL, 29% indicated less than six (6) months, 30% between a year and two (2) years, 60% above two years and 8% of the respondents indicated outside what has already being indicated. The study identified 93% of the respondents as permanent workers of NGGL and the rest of 7% being on contract and table 3:also shows the type of work.

Table 3. Types of work

Types of work	Frequency	Percentage (%)	Percentage Cumulative (%)
Mining Engineers	10	5.0	5.0
Drillers	4	2.0	7.0
Operators	166	88.0	95.0
Mechanics/Electricians	10	5.0	100.0

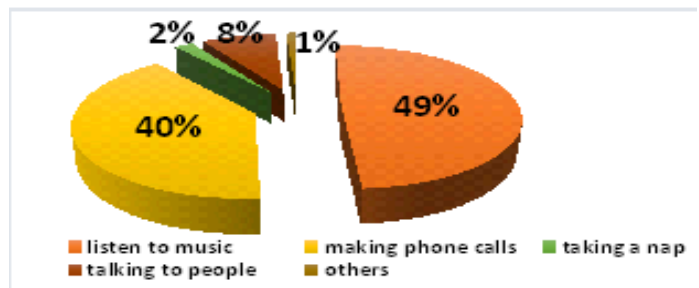
Source: Field Data, 2013

3.4 Causes and Effect of Fatigue at Work Site

Table 4. Time it takes to get to work

Time it takes to get to work in (min)	Frequency	Percentage (%)	Percentage Cumulative (%)
Less than 20	20	10.0	10.0
Between 20-30	60	30.0	40.0
Between 30-50	64	32.0	72.0
Above 50	56	28.0	100.0

Source: Field Data, 2013



Source: Field Data, 2013

Fig.1. Activities to Respond to Fatigue

In describing their quality of sleep, 30% said undisturbed, 68% disturbed, and 2% said others. In indicating the number of hours respondents work on shifts, 2% said 8 hours, 1% said 9 hours, 95% said 12 hours and 2% indicated others.

Table 5. Shift Days

Days of Shift	Percentage (%)	Cumulative Percentage (%)
3 days	3.0	3.0
More than 3 days	40.0	43.0
1 week	49.0	92.0
More than 1 week	8.0	100.0

Source: Field Data, 2013

For 49% of the respondents, they are involved in 1 week of shifts, 40% said more than 3 days, 3% said 3 days and 8% said more than a week. In relation to regular training on fatigue management, 40% said Yes while 60% said No. Asked whether there are enough time for adequate sleep, 70% of the respondents said Yes and 30% No. In terms of job being repetitive or monotonous 98% said yes while 2% said no. Talking about time pressure as a result of heavy workload, 95% said Yes and 5% said No. In relation to irregular and unplanned schedules as a result of call outs, 80% said yes, while 20% said no. For 70% of the respondents, complex physical tasks are undertaken on night shift but 30% thought otherwise.

Table 6. Adverse Working Conditions

Working Condition	Percentage (%)	Cumulative Percentage (%)
Noise	40	40.0
Heat	30	70.0
Cold	5	75.0
Dust	25	100.0

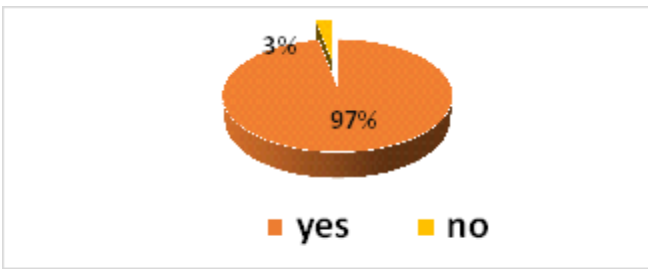
Source: Field Data, 2013

Table 7. Evidence of Problems Associated with Fatigue

Evidence of problem	Percentage (%)	Cumulative Percentage (%)
Family commitment	7	7.0
Insufficient quality sleep	80	87.0
Psychological issues	3	90.0
Hazardous substances	1	91.0
Alcohol and Drugs	9	100.0

Source: Field Data, 2013

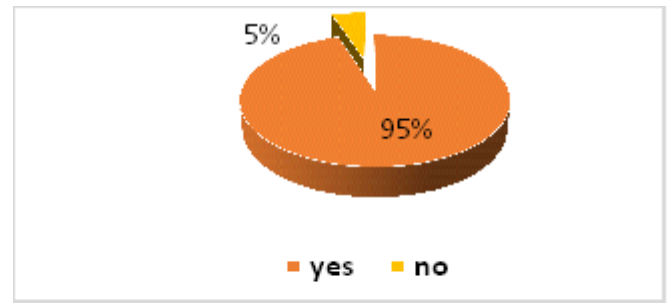
3.5 Institutional Framework for Fatigue Management



Source: Field Data, 2013

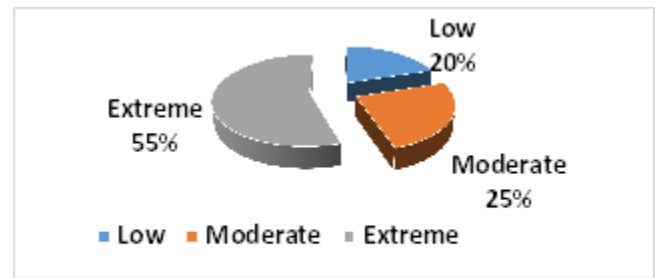
Fig.2. Sufficient Notices of Roster Changes

Most of the authorities, 97% indicated that there are sufficient notices on roster changes while 3% indicated otherwise as shown in Fig 2.



Source: Field Data, 2013

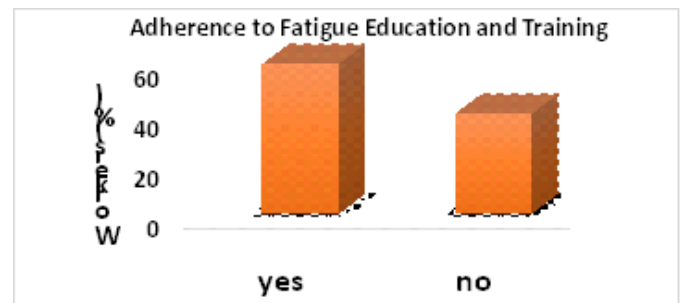
Fig.3. Whether Fatigue Management is taken into Account
In relation to whether fatigue management is taken into account in the activities of management, 95% said yes while 5% indicated otherwise as shown in Fig 3.



Source: Field Data, 2013

Fig.4. Levels of Fatigue in Working Environment

In terms of the levels of stress / fatigue in the working environments, 55% said it was extreme, 25% said moderate and 30% said low as shown in Fig 4.



Source: Field Data, 2013

Fig.5. Adherence to Fatigue Education and Training

4 DISCUSSION OF RESULTS

The gender distribution of the respondents clearly indicated that males continue to dominate employment levels in the mining industry. Most of them were males with few females who made up only 10% of the respondents. If being youth can be ascribed to all those below the ages of 40 years, then most of the respondents can be said to be in their youthful ages. This is normally the time that most people have the energy and strength to do extra work. Coupled with their work, most of the respondents have to combine work and family responsibilities since most of them were

noted to be married. This is a source of extra burden that may influence the idea of fatigue that is under study. One of the factors that is a major influencing factor for fatigue is the duration of exposure to the fatigue causing agents. For most of the respondents, 2 years have been the time they have spent with the institution and most of these were on permanent basis with very few of them on contract.

4.1 Causes and Effects of Fatigue at Work Site

Traveling from their places of residence to the work place sometimes does offer some form of tiredness. Most of the respondents take about half an hour to one hour for them to get to their work places. Most of them do reside in the regional capital and commute to the work place with buses that are under strict speed limits. This has the potential of making the workers even tired before they get to the work place. At the individual level, the respondents fancied listening to music and making phone calls as the means of taking care of their fatigue. Listening to music gives the individual that relaxing atmosphere so to speak, being in contact with others not physically but on the phone is considered as the next best option with dealing with stress. The study noted that the respondents were deeply aware of the fact that their work involved a lot of stress. Most of them indicated that in their daily work at the mine site they face stress. This confirms the work of Theron and van Heerden (2012) that fatigue is part and parcel of the work of people working in the mining industry. The quality of sleep is of vital importance to the overall issue of fatigue. The quality of sleep among the respondents can be noted to be poor since most of them indicated that their sleeps is disturbed. This can be linked to their marital status which gives them extra responsibilities as the heads of their families. After the hard day's work they need to busy themselves with other responsibilities that might be a source of hindrance to their sleep. The shifts for most of the respondents last for more than three (3) days. The research identified that there is a provision of training on fatigue management but this was not efficiently organized. From the responses of the respondents it can either be that the programme is not executed properly for the workers to appreciate it or the programme is not achieving the objectives for which it was instituted or intended for. The study noted a little bit of a controversy when it came to the sleep factor among the respondents. As indicated earlier, most of the respondents were of the view that their sleep was disturbed. It was surprising to note however, that most of them did indicate that there is enough time for adequate sleep. The work of the respondents itself presented some form of challenges when it comes to fatigue. There seem to be no dynamism when it comes to the actual work of the respondents. It was mostly found out to be monotonous. The monotonous nature of their jobs was characterised by much time pressure as a result of heavy workload. Their work is also characterised by much irregular and unplanned schedules as a result of call outs. For the night shifts, the respondents noted that work during this shift is characterised by complex physical task. This presents a unique situation that needs to be looked at if the workers at the night shift are to be prevented from being fatigued. Noise seems to be a major factor that causes fatigue among the respondents. This was followed by heat and dust in that order. For the respondents to know whether they are fatigued, a bench mark is their

ability to sleep. Most of them felt fatigued from their inability to sleep. It was interesting to note also that for some of them, their alcohol intake indicated their condition of stress.

4.2 Institutional Framework for Fatigue Management

In managing the fatigue among shift workers, one of the major factors to be considered is the changes that are associated with the roster. From the perspective of the management, the workers are given sufficient notices with the changes that occur on the roster. This in one way or the other may contradict the assertion by the workers that there are a lot of irregularities associated with the rosters for their shifts. As noted earlier by this study, NGGL seems to have a fatigue management programme in place in the institution and this was confirmed by almost all the management members that formed part of the study. However this programme seems not to be achieving its set objectives because the workers may be said not to be aware of it or the benefits they are to derive from it. In the face of all the factors in place to address the issue of stress, it must be noted that most members of the management team agreed with the assertions of the workers that the stress in the working environments were very much in the extreme. Although the workers did not give any positive response about the fatigue education and training programme in place at the company, the management were mostly of the view that the workers do positively respond to this programme.

5 CONCLUSION

As is the case with most mining companies, male dominance in the industry was also noted in this study. The respondents were in their youthful ages with most of them married. Most of the respondents have worked with the company for more than 2 years and they mostly work on permanent basis. Transportation from the residence of the respondents to the mining site was noted to be a cause of fatigue among the respondents with most of them spending between half of an hour and one hour drive to and fro for work. Listening to music and making phone calls were the major means of dealing with fatigue among the respondents. Fatigue was noted by most of the respondents to be associated with their work which confirms that the respondents were deeply aware of the fact that their work involved a lot of stress this confirms earlier studies that fatigue is part and parcel of the work of people working in the mining industry. Quality of sleep among the respondents can be noted to be poor since most of them indicated that their sleep was disturbed. It was however controversial to note that most of them did indicate that there is enough time for sleep. The shifts for most of the respondents last for more than three (3) days. This can be interpreted either mean that the programme is not executed properly for the workers to appreciate it or the programme is not achieving the objectives for which it was instituted. The work of the respondents itself presented some form of challenges when it comes to fatigue. There seem to be no dynamism when it comes to the actual work of the respondents. It was mostly found out to be monotonous and night shifts were characterised by complex physical task which presents a unique situation worth considering for fatigue management. The major factors that cause fatigue among the respondents were noise, heat and dust in that

order. Most of them showed fatigue through their inability to sleep and for some through alcohol intake. Management indicated that workers are given sufficient notices with the changes on the roster but this contradicted the assertion by the workers that there are a lot of irregularities associated with the rosters for their shifts. NGGL seems to have a fatigue management programme in place in the institution and this was confirmed by almost all the management members that formed part of the study. However this programme seems not to be achieving its set objectives because the workers may be said not to be aware of it or the benefits they are to derive from it.

6 RECOMMENDATIONS

In order to ensure balance in employment, this study would recommend that more females should be given adequate training and education to make them employable in the industries that seem to be very much male dominated. The company can institute a means of creating residence for most of the workers onsite or in neighbouring communities since the transportation of workers from their residence seem to be causing fatigue. Alternative means of relaxing or dealing with fatigue should be made available to workers since over-reliance on listening to music and talking on phone can increase stress levels which in turn can influence fatigue levels. More adequate and sufficient avenues of sleep should be given the workers. This should include measures aimed at ensuring that workers' sleeps are not disturbed. The training and education programme on fatigue should be looked at. The study calls for a reconsideration of the whole programme in place since it seems not to be achieving the objective for which it was instituted. The management can introduce refresher programmes for workers in order to break the monotonous feature that is associated with their work. Of particular attention is the work that is executed during night shifts that was noted to be complex. Mechanisms need to be put in place to minimise noise, heat and dust in the institution since they were noted to be the main cause of stress and ultimately fatigue among the respondents. .2005 Prompt and accurate notices should be given to workers in matters that pertain to their roster so that they in turn can sufficiently prepare for them in the course of their study. Further studies are recommended into the training and education programme in place at NGGL and how this being executed. The study recognized some gaps in the design and implementation of the programme.

ACKNOWLEDGMENT

The authors would like to thank all the shift workers of mining department and their management of Newmont Ghana Gold Limited of Ahafo, Kenyase Brong Ahafo Region of Ghana.

REFERENCES

- [1]. J.A., Caldwell, J.L. Caldwell and Schmidt, R.M. "Alertness management strategies for operational contexts," *Sleep Medicine Reviews*.vol.12, pp. 257-273, 2008.
- [2]. K. Sparks, C. Cooper, Y. Fried."The effects of hours of work on health: A meta-analytic review". *Journal of Occupational and Organizational Psychology*, Vol. 70, pp 391-408, 1997.
- [3]. T. Taris, D. Beckers, A. Dahlgren,"Overtime work and well-being: Prevalence, conceptualization and effects of working overtime". In S. McIntyre & J. Houdmont (Eds.), *Occupational health psychology: European perspectives on research, education and practice* (Vol. 2). Maia, Portugal: ISMAI. 2007.
- [4]. Ethan Kapstein, René Kim, "The Socio-Economic Impact of Newmont Ghana Gold Limited".2011.
- [5]. J.P. Harrington, "Health effects of shift work and extended hours of work". *Occupational and Environmental Medicine*.Vol.58:68-72. 2001.
- [6]. Nordqvist, Christian."What is Fatigue? What causes Fatigue?" *Medical News Today*. 2012.
- [7]. Isobel Boylan. "Fatigue management in the workplace".2011.
- [8]. R. Matthew, Hallowell. "Worker fatigue,managing concerns in rapid renewal highway construction projects". 2010
- [9]. P.C Schutte."Ergonomics in the South African mining industry". *Volume 105*; 369-372.2005.
- [10]. P.C Schutte. "Fatigue risk management; charting a path to a safer workplace".2009.
- [11]. Safe Work Australia. "Draft code of practice, Preventing and managing fatigue".2011.
- [12]. P.C Schutte, C.C. Maldonado, "Factors affecting driver alertness during the operation of haul trucks in the South African mining industry". *Safety in Mines Research Advisory Committee Project Report SIM 02 05 02*. Mine Health and Safety Council. 2003.
- [13]. E. Steven, Lerman, J. David, Flower, C. Eugenia, George, Benjamin Gerson, Natalie Hartenbaum, R. Steven, Hursh, Martin Moore-Ede, "Fatigue Risk Management in the Workplace". 2012.
- [14]. W.J.Theron and G.M.J. van Heerden."Fatigue knowledge-a new lever in safety management". *Volume 111*; 1-10. 2011.
- [15]. Work Safe."Fatigue Prevention in the workplace".2008.
- [16]. WSH Council "Workplace Safety & Health Guidelines, Fatigue management".2010.

- [17]. B. Piper, (1989). "Fatigue: Current bases for practice". In S. Funk, E. Tomquist, M. Champagne, et al. (Eds.), *Key aspects of comfort (pp. 187-189)*. 1989.
- [18]. G. Abt, & M. Tranter, "Assessment of Heart Rate and Metabolic Rate in an Australian Underground Coal Mine". *Journal of Occupational and Health Safety*. 1999.
- [19]. O.G. Okogbaa, R.L. Shell, & D. Filipusic. "On the investigation of the neurophysiological correlates of knowledge worker mental fatigue using the EEG signal". *Applied Ergonomics*, 25 (6), 355-365. 1994.
- [20]. A.L. Holmes, "Daytime cardiac autonomic activity during one week of continuous night shift". *Journal of Human Ergology*, 30:223-228. 2001.
- [21]. A. Knutsson, "Shift work and cardiovascular disease: review of disease mechanisms". *Rev Environ Health*, 15:359-72. 2000.
- [22]. C. Bofinger, & B. Ham, "Hearts Health and Coal Mining". *Conference Proceedings - Queensland Mining Industry Health and Safety Conference*, Townsville, Australia, 2002.
- [23]. A.W Parker, "The Aging Workforce: Perspectives and Implications". *Conference Proceedings - Queensland Mining Industry Health and Safety Conference*, Townsville, Australia, 2002
- [24]. A. Dembe, J. Erickson, R. Delbos, R., "The impact of overtime and long work hours on occupational injuries and illnesses: New evidence from the United States". *Occupational and Environmental Medicine*, 62 (9), 588-597. 2005
- [25]. M. Harma, "Work hours in relation to work stress, recovery and health". *Scandinavian Journal of Work, Environment and Health*, 32 (6), 502-514. 2006
- [26]. K. Sparks, C. Cooper, Y. Fried, "The effects of hours of work on health: A meta-analytic review". *Journal of Occupational and Organizational Psychology*, 70, 391-408. 1997.
- [27]. T. Taris, D. Beckers, A. Dahlgren, "Overtime work and wellbeing: Prevalence, conceptualization and effects of working overtime". In S. McIntyre & J. Houdmont (Eds.), *Occupational health psychology: European perspectives on research, education and practice (Vol. 2)*. 2007.