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Ergonomics Evaluation of Control Room Operators in Selected Oil and Gas Installations in Delta and Rivers States

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Abstract: **This study evaluated ergonomic hazards faced by control room workers in selected oil and gas establishments in Delta and Rivers states. The study focused on data collected from 110 operators in control rooms using a self- administered questionnaire. Data gathered from the study were analyzed with descriptive statistics. The results showed considerable work station ergonomic deficiencies which included lack of rest breaks, absence of display screen antiglare, lack of foot rest, uncomfortable cold control room temperature and poor workplace ergonomic practices. The study also showed that the ergonomics deficiencies had serious health implications on control room workers as there seems to be a prevalent health hazard called computer vision syndrome (CVS). The results from the study confirmed that poor work station ergonomics impacted negatively on the wellbeing of operators in the control room. The result of the study established prevalence of CVS among control room operators in the sampled area and identified substantial work station ergonomic lapses such as lack of intermitted work breaks, display screen glare, cold working environment, poor ergonomic practices as ergonomic risk factors for CVS. The study recommends some basic ergonomic modifications in the design of oil and gas control rooms, also operators of control rooms should engage in intermitted rest breaks to reduce work-related symptoms such as eye strain, back pain, headache, and physical discomfort. Lastly, operators of control room should be trained periodically on ergonomic awareness and supervised on compliance to ergonomic work practices.**

Keywords: **Ergonomics, Control Room, Operators, Oil Installation, Digital Control Station, Computer visual syndrome.**

I. INTRODUCTION

In recent years process control and monitoring in oil and gas installations worldwide, is shifting from the traditional control panel to a computer-based control rooms like Digital Control System (DCS) and Virtual Display Unit (VDU) [8]. In a control station, a hierarchy of control devices are connected by communication networks for control and monitoring. The Nigerian oil and gas industry has witnessed a significant increase in advanced control and automation, computerization of process control and monitoring in which the visual display units (VDUs) have partially or completely replaced the traditional control panels. The demand for better quality and accuracy in control room operation necessitated the advancement in automation processes, accelerated technological innovation, and computerization of process control, which requires less field operators and more computer-literate operators at control rooms, and by extension; improved ergonomic and human factors demand [11].

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[7] a control room may be defined as a physical structure where operators control, monitor and optimize operations. They are facilities that serve as operations centers to monitor and control system and data acquisition (SCADA) in power plants or industrial production plants such as the oil and gas industry. The control room serves as a safety critical barrier against major hazards.

Control room operation is a sedentary, computer-intensive office job that requires at least eight (8) hours of computing time and sitting on an office chair. Over the years within the control rooms in the oil and gas facilities under investigation, visual fatigue, low back pain and nasal congestion are common complaint among control room operators. Several studies [18] [16] [12] [4] been conducted on control room ergonomics in other industries, to the best of my knowledge, there is no research exploring how ergonomics affect control room operators in oil and gas industries. So, this study seeks to carry out a survey on oil and gas operators working in the control rooms of oil and gas installations, not on musculoskeletal disorders but on other ergonomic conditions.

With the introduction of computerized process control and monitoring, control room operators now spend more time in front of computer workstations. This has brought new forms of control devices and has created new ergonomic issues, such as; sitting posture, temperature (extreme cold condition), poor lighting system, glares from computer screens, prolonged job task (long working hours) resulting in CVS and work-related disorders [17] [1] [9].

Operators in the control room of these installations make very challenging and serious decision each working day, decisions that have a great impact on productivity, quality and safety. For managers of plant and control rooms, the main focus is how to maintain the well-being of operators at levels that ensure optimal performance. It is thus of vital importance that control stations and human machine interfaces should be designed according to ergonomic principles [18]. Ergonomics adapts work tools and equipment to suit man's natural ability and needs. Ergonomics increases productivity and workplace efficiency by redesigning employee's job and adapting work tasks to individual's intellectual compatibilities. This helps to reduce employee's exposure to injurious job processes and occupational hazards [10].

II. MATERIALS AND METHOD

A. STUDY AREA

This research was undertaken in selected oil and gas facilities in Delta and Rivers States. Delta State has boundaries with Imo, Edo, Bayelsa and Anambra States. Delta was formed in August 27th 1991, is an oil producing state situated in the Niger Delta that produces about 35% of Nigeria's crude and a reasonable quantity of natural gas respectively. A reason for selecting these states borders on the fact that they are the two highest oil and gas producing states in Nigeria.

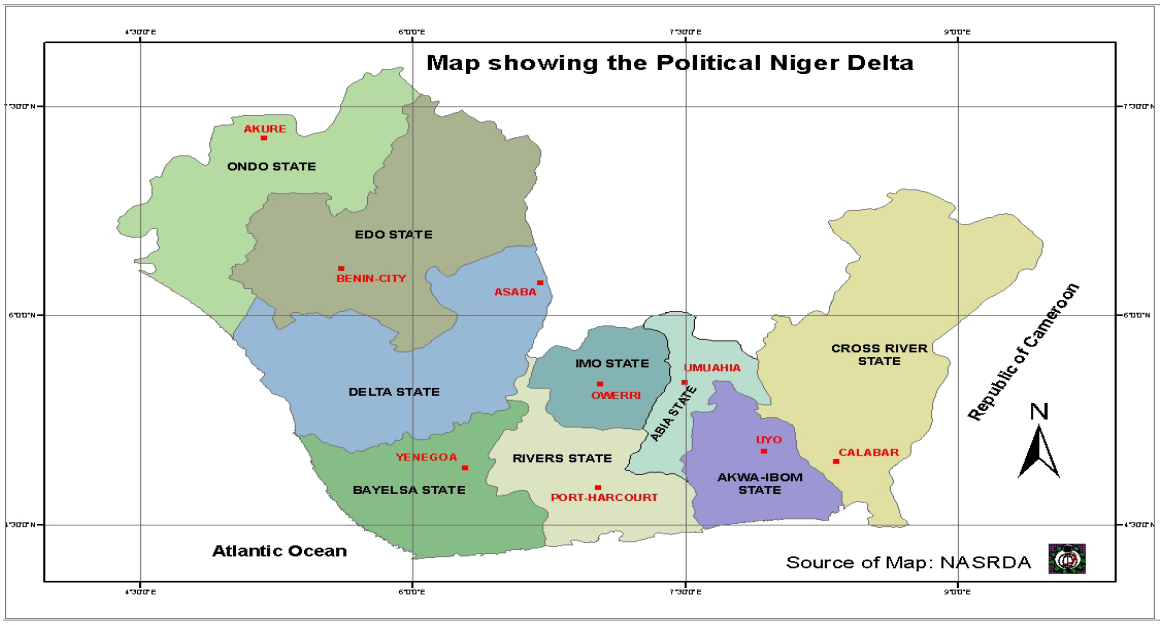

Fig. 1: Map of Niger Delta region Source: [6]

B. RESEARCH DESIGN

The research design adopted in the study was the cross-sectional research design. The cross-sectional research design was used because it allows the investigator to measure the outcome and the exposures in the study participants at the same time. To achieve this, the researcher employed a structured instrument which was administered to control room operators.

C. SAMPLING AND SAMPLING TECHNIQUE

i. STUDY POPULATION

[2] defines the study population as the group or the individuals to whom the survey applies. The study population for this study are operators in control rooms of selected oil and gas facilities in Delta and Rivers state.

ii. SAMPLE SIZE

The entire operators in control rooms who were on duty (day and night shift) during the duration of the field work were sampled for this study. This was done because the study population was relatively small and had a homogenous characteristic. Total population sampling affords researchers the chances of getting deep insights to the phenomenon being studied, and reduces the dangers of missing potentially significant findings. 130 respondents were covered and the questionnaires were distributed to 130 control room operators.

iii. SAMPLING TECHNIQUE

Copies of the research instrument were distributed to a total of 130 operators in control rooms which were drawn for the survey. The respondents were selected using purposive sampling technique, which examines the entire population.

D. VALIDITY AND RELIABILITY OF INSTRUMENT

The research instrument was subjected to face and content validation. This was necessitated by the need for the items on the instrument to appear valid and logically linked to the study objectives, while also covering the full range of the issues concerning ergonomic evaluation of control room operators

E. RESULTS AND DISCUSSION

i. RESULTS

A total of 130 questionnaires were distributed amongst the sample population out of which one hundred and ten (110) were returned, representing 85% response rate. Nine (9) of the returned questionnaires were voided. A total 101 valid questionnaire used for the analysis presented below.

ii. DEMOGRAPHIC DATA

Indicated in **Table 1** is the observed demographic distribution of the respondents.

iii. NATURE OF THE WORK CHAIR AND DESK

Presented in **Fig. 2** is the perception of the respondents on the nature of their work chair and desk. Eighty-one percent (81%, n=82) of the work desk had adequate leg room and nineteen percent (19%, n=21) did not have. Seventy-six percent (76%, n=77) of the work desk was free of obstruction and twenty-four (24%, n=34) was not. Seventy-two percent (72%, n=73) of the work desk was free from glare.

iv. NATURE OF WORK COMPUTER

Fig. 3 shows views of the respondents on the nature of their work computer. Eighty-four percent (84%, n=85) of the respondents judged the image of the display screen as stable and sixteen percent (16%, n=15) judged it as unstable. Thirty seven percent (37%, n=38) said the contrast and brightness can be adjusted and sixty three percent (63%, n=63) said it cannot be adjusted. Twenty-three percent (23%, n=24) of the computer had antiglare and seventy-seven (77%, n=77) had no antiglare. Forty-three percent (43%, n=44) said the height and position of the keyboard was appropriate and fifty-seven (57%, n=57) said it was inappropriate.

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v. WORK PATTERN

Fig. 4 shows the work pattern of the operators in control rooms of oil faculties in the study area. Seventy-four percent (74%) of the respondents did not take intermittent break during work hours. Fifty-seven percent (57%, n=58) of the respondents did not find their work pattern flexible and forty-three percent (43%, n=44) found it flexible. Most of the respondents (72%) took different body posture during work.

vi. WORK RELATED ILLNESS DUE TO ERGONOMIC CONDITIONS

Indicated in **Fig. 5** is the response of the operator's work-related illness due to ergonomic conditions. Seventy-six percent (76%, n=76) of the respondents had experienced back pain six months ago and forty-four (24%, n=25) percent had not. Seventy percent (70%, n=71) experienced eye strain and thirty percent (30%, n=30) did not experienced eye strain. Sixty-eight percent (68%, n=69) experienced headache and thirty-two percent (32%, n=32) had not experienced it. Sixty-five (65%) and fifty-three percent (53%) experienced visual and physical disorders respectively during or after using the display equipment.

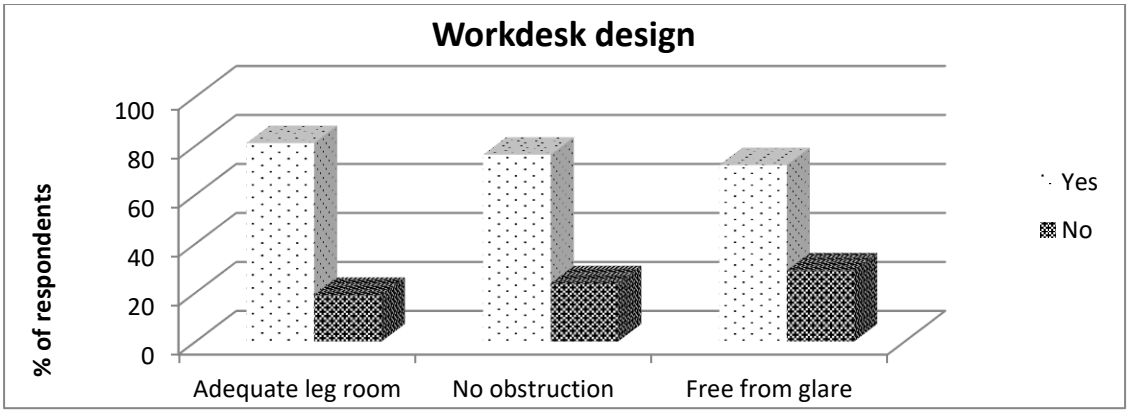
vii. WORK RELATED ILLNESS DUE TO ERGONOMICS AGAINST YEARS OF WORK EXPERIENCE

Fig. 6 is the graph depicting the connection between work related illness occurrence and the respondent's years of work experience. Respondents with 4years and less of work experience had more back pain (78%, n=79), more eye (73%, n=74) and visual discomfort (71%, n=72) when compared to their counterparts with 5 to 9 years (67%, n=68), (71%, n=72) and (48%, n=48) and 10 years and above (59%, n=-60), (67%, n=68), and (68%, n-69) for back pain, eye strain and visual discomfort respectively. This disparity could be attributed to conditioning or adaptation to the task, or personal work pattern modifications, usually exhibited by the experienced workers. However, operators with 10 years and above work experience suffered more physical comfort.

Table 1: Demographic distribution of respondents

VARIABLES	OPTIONS	FREQUENCY	PERCENTAGE
GENDER	Male	83	82
	Female	18	28
AGE	<30 Years	57	57
	31 - 40 Years	18	18
	41 - 50 Years	15	15
	>50 Years	11	11
WORK EXPERIENCE	0 - 4 Years	37	36
	5 - 9 Years	40	40
	>10 Years	24	24

Source: Authors field work



Source: Authors field work

Fig. 2 Response of respondents on work desk design in control rooms.

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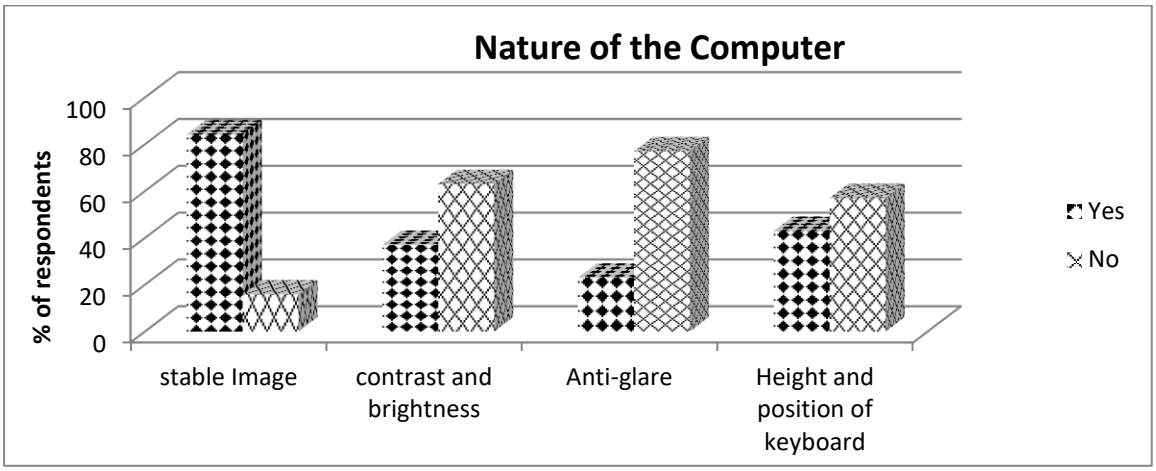
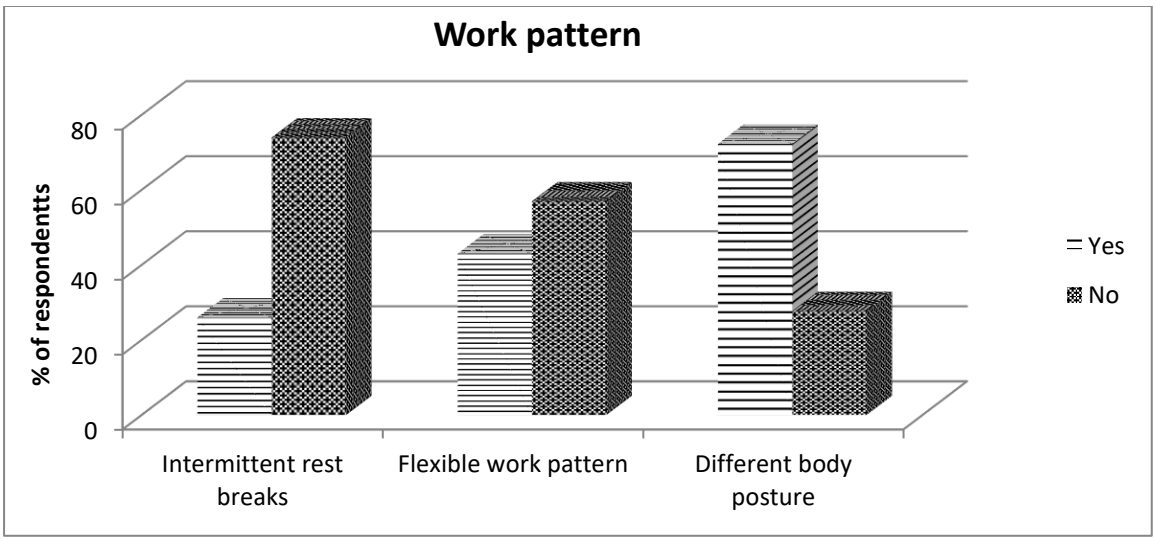


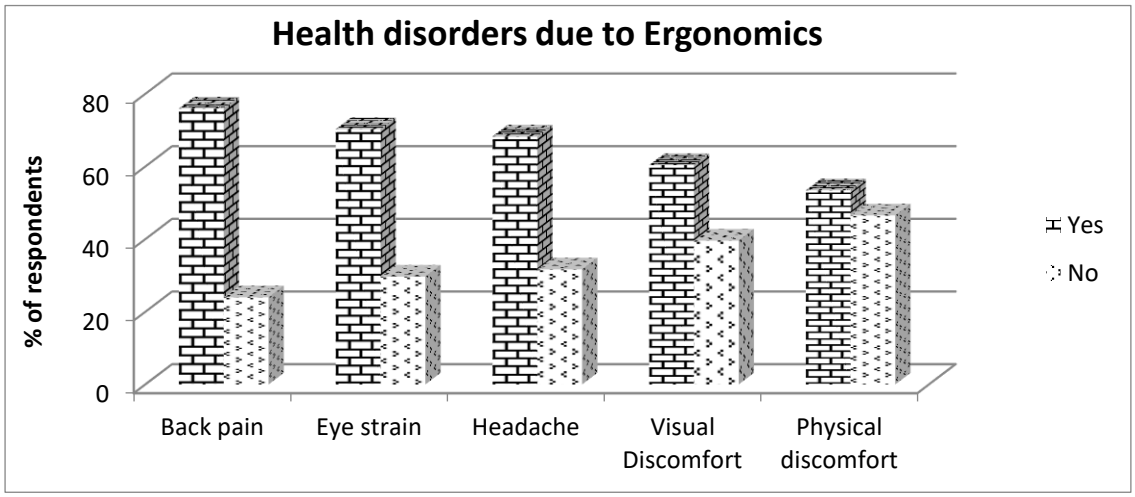
Source: Authors field work.

Fig. 3 Nature of control room work computer.



Source: Authors field work.

Fig.4 Work pattern of control room operators.



Source: Authors field work.

Fig. 5 Health disorders among respondent due to ergonomics.

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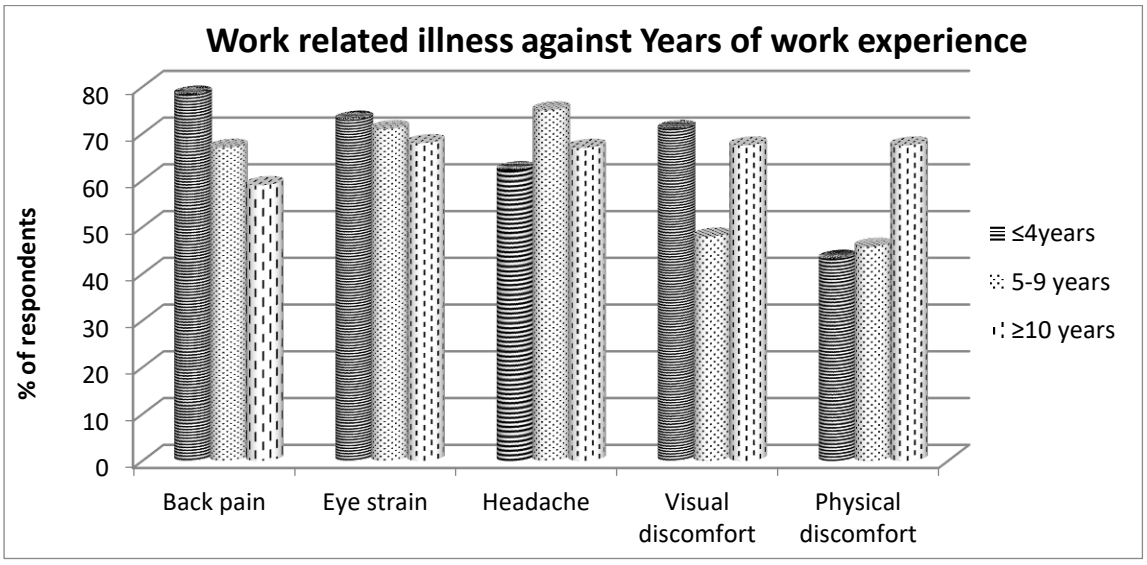

Source: Authors field work.

Fig. 6 Work related illness against years of work experience.

viii. DISCUSSION

The study validates the widely accepted assumption that CVS is a work-related disorder among people working with visual display units [15] [19] [13]. The research discovered higher prevalence of CVS amongst operators in control rooms. Going by the study, Seventy-six percent (76%) of the respondents had experienced back pain six months ago, seventy-two percent (72%) had experience eye strain, sixty-eight percent (68%) had experience headache and sixty (60%) and fifty-three (53%) experience visual and physical disorders respectively during or after using the display equipment. these symptoms characterized computer vision syndrome [3].

[15] posited that these symptoms are usually temporary and disappear at the close of work. But most workers may experience persistence of symptoms after work and if no medical intervention, a visual disorder can result.

Temperature is one of the essential principles of workstations ergonomics. Majority (79%) of the operators in control rooms do not find the temperature of their workstation comfortable for their work and health. According to [14] temperature below or above the optimum temperature range of 17 centigrade and 23 centigrade have a significantly detrimental effects on health and productivity of workers. The data retrieved from this research established that most of the respondents (79%) had work-related nausea and cold. A plausible explanation for this finding could be that the temperature of the control rooms in the study area are below or above the optimum temperature range of 17 centigrade and 23 centigrade.

This research revealed that majority (74%) of operators in control rooms in the study population do not observe intermittent rest breaks during work hours. Figure 3.3 shows the relationship between intermittent rest breaks and back pain. Comparable results were found in the study done by [5], in which self-reported insufficiency of rest breaks was connected with work-related symptoms such as back pain, visual discomfort and headaches. Unfortunately, no multivariate analysis was performed, since individuals in these workplaces were exposed to so many ergonomic problems.

Poor computer ergonomics has a relationship with CVS and ergonomic training has generally been recommended as a preventive measure. The training-only group did not significantly differ from the control group. In this research, 82% and 87% of the respondents had adjustable chair and ergonomics awareness. However, computer vision syndromes were significantly associated with the respondents. An explanation for this finding could be that even though, the operators of control rooms in the study are ergonomically aware, they don't conform to ergonomic work practices.

III. CONCLUSION

Ergonomics work station design is a widely acceptable way of providing a conducive environment and practices that improves workers' health, safety, job satisfaction and overall productivity. This study has evaluated the impact of work station ergonomics on the health and safety of control room operators in selected oil and gas installations in Delta and Rivers

States. The results from the study confirmed that poor work station ergonomics impacted negatively on the health and safety of control room operators. Also, the study established prevalence of computer vision syndrome among control room operators in the study area and identified substantial work station ergonomic lapses such as lack of intermitted work breaks, display screen glare, cold working environment, poor ergonomic practices as ergonomic risk factors for computer vision syndrome. Common CVS work-related symptoms reported by the respondents included eye strain, back pain and headache. Working for long periods of time at computer stations without breaks, display screen glare, working in cold environment and poor ergonomic culture, were considered to be the major ergonomic risk factors. The research identified that even though the control rooms have adjustable work chair and operators have adequate knowledge of ergonomics, they have manifested computer vision syndromes, which can be attribute to non-compliance to ergonomic work practices.

The study recommends some basic ergonomic modifications in the design of oil and gas control rooms. The ergonomic changes should include economically adjustable chairs, foot rest and computers with antiglare devices. Also, operators in control room should engage in intermitted rest breaks to reduce work-related symptoms such as eye strain, back pain, headache, and physical discomfort. Control room operators who are working in extreme cold conditions should be provided with sweat shirts, coffee breaks and shift arrangement and lastly, control room operators should be made to undergo routine ergonomics awareness training and supervised on compliance to ergonomic work practices. This will help to reduce the prevalence of computer vision syndrome and other work-related disorders among control room operators.

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