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Commissioner Edward McGaffigan, Jr.
United States Nuclear Regulatory Commission
Washington, DC 20555

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November 26, 2002

Dear Commissioner McGaffigan:

Wackenhut Nuclear Services' Lt. Todd Lynch from the Monticello Nuclear Generating Facility shared your letter of November 12th to him with me, as well as the letter he had written to you on the subject of 12-hour shifts. I appreciate your response to Lt. Lynch and concur with your observations on excessive overtime.

Approximately three months ago we engaged Peter-Paul Seidenschur, Ph.D, from EMAX, our EAP provider, to conduct a research summary on shifts and schedules. The purpose for this request was two-fold. First, we were concerned about the amount of ongoing overtime our officers were working versus adequate security force staffing. The second reason was to identify what the best type of schedule(s) we should be recommending our officers be on, with adequate staffing.

Dr. Seidenschur and his staff did extensive research on the matter and produced a white paper with their findings and recommendations. I have provided a number of our clients who are on the NEI Security Working Group with a copy of this report. I would also like to provide you with a copy, as it may assist you and the Commission as you continue to look into this issue.

Should you have any questions of Dr. Seidenschur or me, please do not hesitate to call me at the above number.

Sincerely,

Richard A. Michau, CPP
President
Wackenhut Nuclear Services

cc: A. Bernstein
P. Seidenschur

Attachment

B-3

**Exploring The Issue Of Effective Shift Length
For Nuclear Security Personnel**

A Review of the Literature

Commissioned by

Wackenhut Nuclear Services

Principal Investigator

Peter-Paul T Seidenschnur Ph.D.

Vice President

Bensinger, DuPont and Associates
Emax Division

November 2002

Introduction

The concept of shift work has undoubtedly been an issue ever since man felt insecure enough to post a member of the group, be that family, tribe, or community to stand guard while the others rested or slept. There can also be very little doubt that shift work even under those circumstances presented issues and problems. The concept of shift work began to receive more attention since the proliferation of the incandescent light bulb, because this made the possibility of maximizing industrial investment a functional reality. Consequent to the light bulb we could run manufacturing machinery 24 hours a day. This in a sense tripled production capacity.

As the manufacturing "day" grew so grew the demand for other services to grow into a 24-hour function as well. So we see the advent of 24-hour food services, and retail operation not to mention medical services and of course the need to protect these 24 hour operating entities on the same basis as day protection was a given. Over the decades management, human resources and social scientists became more enthralled and creative with the process of maximizing the three-shift system. Considerable thought went into the concept of length of shift, direction of rotation, frequency of rotation, and length of week.

In time a virtual science evolved around the scheduling process. At about the same time behavioral scientists, production experts and safety and health specialists began to study the impact and effectiveness of shift work from their respective fields of interest. Throughout this period there had been an almost hedonistic monotheistic preoccupation of investigating shift work from a perspective of maximizing productivity. This is almost self-explanatory when one remembers that much of the research was requested or commissioned by management or principal stakeholders in the respective industries. There was some discernable change in research focus and related outcomes when organized labor became interested in the welfare of its members and also began to attempt to document the impact shift work had on the health and well being of its members.

The debate over various key issues in relationship to shift work may have simmered on if it had not been for the recognition of several, now obvious concepts and the transpiration and consequential effect of 9.11.

Consequent to transpirations of 9.11 the total nature of America changed almost overnight. As a nation we became much more aware of our vulnerability and associated with that awareness came a higher expectation of our security service providers. This was perhaps nowhere more apparent than in the air transportation industry and in the nuclear generating industry, the latter being clearly recognized as an outstanding potential temptation for terroristic threat. As a consequence the security personnel were put on the highest alert and for all intensive purposes remained that way since.

The mandate on security personnel in the nuclear generating industry has expanded significantly. The expansion of security efforts are to assure not just the owners but the

entire nation that these facilities were indeed secure and safe with no danger of an outside or for that matter even a saboteur force to succeed in generating fear or endangering the safe operation of the facility. The security industry achieved this. In doing so, the industry avoided even the most speculative potential of causing mass hysterical reaction in the population at large.

This achievement came at no small cost, there has been, as stated earlier an exponential increase in demand of effort on the part of the security group. To meet this demand it was necessary to expand the man-hours spent on security enormously. In the initial phases of the post 9.11 response-staff was asked to simply provide more hours on the site to meet the needs. Much overtime and schedule disruption took place to respond to the immediate need. This was, no doubt, made possible by the heightened level of arousal experienced as an after effect of the threat recognized in the audacity of the 9.11 act.

A year after 9.11 the adrenaline has dissipated but the demand for services has not. We now find security as well as operating staff beginning to show signs of burnout, such as committing more errors, becoming more susceptible to illness, displaying increased signs of aberrant behavior, or becoming overly involved in alcohol/drug usage. With this clear indication that something needs to be changed we again look at the issue of shift work and how it might be structured to revitalize the work force and at the same time reduce the error rate and human cost. That brings us full circle to this study.

Purpose

The purpose of this study was to investigate the functional variability of the 12-hour versus the 8-hour work shift as it applies in the nuclear security industry.

Rather than attempting any further research in this area it was decided to approach answering the question by means of a comprehensive analytical review of the existing literature. This decision was predicated on the fact that no such compendium of research literature seems to have been conducted recently. Industry or regulatory agency archives have very little definitive research on this subject. Indeed as the search progressed it seemed as though there has been a relative paucity of research activity on this subject in the USA. There has however been considerable effort both in the European Union, Australia and Scandinavia.

This review as stated is comprehensive and analytical, but does not purport to be exhaustive.

Findings

First and foremost there seems to be a pluralistic consensus that shift work in general does indeed have some deleterious effect on general health function, psychological,

social and organizational well being. Indications of this are found in research efforts as Tenkanen, Harma, Sjoblom, Alikoski (1996) and Tenkanen, Sjoblom, and Harma (1998) where they found sleep disturbance as associated with shift work (commonly 8-hour shift) tends to be an important factor in the occupational gradient of coronary heart disease. It must be noted that this research indicated only relationship, not causation.

In attempting to deal with this issue of shift work impact it appeared appropriate to consider impact to mean the consequent or dependent variable, while shift work was the dynamic or independent variable. As is not too uncommon in efforts of this type it becomes rapidly apparent that possibly the largest problem in reviewing research in this area is the problem of definition of terms. Before it becomes possible to comprehend the differences of impact of 12 versus 8-hour shift it is imperative to evaluate and draw consensus on the definition of terms used in the research efforts. The next major effort in this review was to sort research efforts into appropriate categories. The major categories, which seemed to evolve in the research efforts, could be defined as follows.

- Research focusing on Circadian rhythm function and the impact shift work, specifically rotating shift work had on it.
- Research focusing on the impact rotating shift work had on the work related elements of the subject's job such as safety, productivity, reliability, and accuracy.
- Research focusing on shift work impact on the physical/health and well being of the workers.
- Research focusing on shift work impact on the psychosocial condition of the employee.
- Research focusing on fatigue resulting from various shift schedule configurations.

In further approaching the research that has been reported it becomes clear that indeed there are conflicting findings reported. This, upon close examination, is readily explained by research design, instrumentation, sample selection, and, as mentioned earlier, by variable definition of terms.

Let us focus on the terms first.

The most controversial definition is the term "fatigue". Several researchers have functionally avoided the definition dilemma by using "self report" assessment of "fatigue". While this practice is expeditious from the design point of view and while it may keep the researcher politically correct, it clouds the issue of the meaning of fatigue even further in that the ambiguity is spread over the entire experimental population with no guidance as to what each responded may mean by their response.

Some more progressive researchers took the trouble to conduct factor analytic or analysis of variance efforts to come to a meaningful understanding of "fatigue". One of the more arduous efforts was undertaken in Sweden. The effort considered physical, psychological, cognitive/attention, and performance measures as factors of fatigue. The resultant findings clearly support previous research using the concept of "sleepiness" as the most

operationally functional definition. However the expansion of the concept of "fatigue" using some of the additional parameters offered an excellent possibility of a multi variant model, which would add more useful dimension function to the term.

A more simplistic definition of fatigue is based on cognitive response potential, which measures the response to cognitive perception and consequent response formulation efficiency based on controlled difficulty of tasks. Essentially this measures the mental adroitness of the respondent as a function of "fatigue". The logic being based in the concept that if perception, cognition are impaired the response capacity will also be impaired leading to increased consequential error potential.

There are a number of additional definitions of fatigue, which tend to be permutations of the ones mentioned.

The next major term conflict is "shift work". Superficially this would seem to be easily defined as the number of the hours worked and the time of day at which the work hours start. This definition has been considered sufficient by some researchers, but it comes to be misleadingly inadequate. This short coming is one of the explanations for the variability in findings which plagues the literature and causes some to come to the conclusion that there is conflicting evidence, when in fact the conflict arises in the inadequacy of "shift" definition. However when the definitional constructs of "shift" are fully accounted for then the findings could become more harmonious and consistent. Significant factors that must be added to the concept of shift besides number of hours and start time are frequency of work periods, speed of rotation, direction of rotation and length of rest periods between work cycles.

Impact is the next definitional issue.

There seems to be common consensus on such measures of consequential impact as the number of accidents being a means of impact assessment. Other commonly excepted measures of outcome such as sick time, number of illness claims and error rates, job satisfaction find acceptability if controlled for such extraneous or intervening variables as age, length of time on the job, position, training and education. Additional variables such as work climate, organizational stress and perceived commissioner of research have also been found to be variables capable of distorting findings and confounding the data, thereby leading researchers to spurious conclusions.

Before addressing the issue of the functional feasibility of 12-hour versus 8-hour shift it must be acknowledged that any shift other than day shift constitutes a higher level of stress (Folkard and Monk, 1979; Singer, 1982; Rutenfranz et al., 1985; Colligan and Tepas, 1986; Bohle and Tilley, 1989; Akerstedt, 1990; Glazner, 1991; Melamed, Oksenberg, 2002; Siebenaler and Tepas, 1994; Siebenaler and McGovern, 1991; Aguirre and Foret, 1994; Paley and Tepas 1994). This is commonly accepted in the literature and is explained by the affront shift work constitutes to the natural circadian rhythm (Colligan and Tepas, 1986; Monk, 1990; Siebenaler and McGovern, 1991). It is also commonly acknowledged that shift work tends to have an adverse effect on the workers health (Cruz, Della Rocco, Hackworth, 2000) and capacity to adjust to circadian rhythm shift

changes (Bourget-Devouassoux & Volkoff, 1991; Harma, Hakola, Akerstedt, & Laitinen, 1994; Queinnec, Gadbois & Preteur, 1995; De Zwart & Meijman, 1996; Brugere, Barrit, Butat, Cosset, & Volkoff, 1997). Although there are some research findings that tend to indicate that the impact of shift work, at least to some extent, is driven by individual differences (Koller, 1983; Colligan and Rossa, 1990) and does in and of itself not constitute the threat to health and well being as commonly described in other research. The stress generated by working other than day shift is further exacerbated by the rate of rotation, the direction of rotation and the rest period between rotations (Akerstedt, 1990; Czeisler, 1982; Gordon, Cleary, Parker et al., 1986; Keller and Koenig, 1989; Raymond, 1988; Thomas, Schwartz, Whitehead, 1994; Singer, Terborg, Mayer, 1994; Zun, Kobernick, Howes, 1998).

Having it as a given that shift work tends to be more stressful than day work, consideration can be given to the variance of the 12-hour model versus the 8-hour model. In order to answer this issue several outstanding studies will be cited as illustrative of the findings.

Baker, Olson and Morisseau (1994) in their study of work practices, fatigue and nuclear power plant safety investigated fatigue induced performance decrements in nuclear power stations. Specifically they focused on the amount of overtime worked by operations, technical and maintenance personnel as well as the 12-hour operator shift schedule. Although overtime was considered to be fairly high at the stations the researcher's analysis detected a statistical relationship only between operations overtime and plant safety performance. The results for the 12-hour operator shift were ambiguous and there were no correlational significances to safety reducing indicators. There was a conclusion made by the researchers the overtime practices as managed on some sites may generate safety concerns. It must be pointed out that these findings were not consistent over the sites and correlation cannot be confused with causation. Clearly this research effort suggests further investigation for causal variables is indicated.

Mitchell and Williamson (1999) conducted a definitive in vivo research of power plant personnel who had been working an 8-hour roster and then the work schedule was changed to a 12-hour roster. Ten months after the changeover a repeated measures design was used to reassess the functioning of the work group.

The study used indication measures based on:

- On-Shift performance
- General health and well-being
- Sleep and mood behavior
- Absenteeism records
- Accident data

Specific measurement was made using

- A modified version of the Standard Shift work Index (Barton et al., 1990),
- An employee diary which recorded sleep patterns in both quantitative and qualitative fashion,
- Mood status by means of a visual analogue scale with bi-polar points

- A small battery of performance tests extrapolated from the Information Processing and Performance Test System (Feyer et al., 1992)
- The amount of annual and sick leave taken by employees
- The number of accidents that occurred in the workplace were also monitored and compared for the two shifts.

The results of this study indicated that while some employees felt the eight hour shift had some advantage in terms of flexibility of hours and overtime pay these advantages were offset by the disturbance to family life, weekend work, restrictive social and community life and sleep disturbance.

The 12-hour shift was seen as a more favorable process in that it provided more recreation time, fewer continuous shifts, more time with family and an overall better sense of health and well-being. These findings were also confirmed in the research of Vidacek and Radosevic-Vidacek (1994). Although they concluded that there may be a "sleep debt" factor operating in prolonged night shift work, which may contribute to increased fatigue and related safety concerns.

There were no significant differences found in the amount of sleep disturbance. Extremely noteworthy was the report by the 12-hour shift group of using less sleep aid such as alcohol and or sleeping pills (17% used versus 47% users in the 8-hour shift).

There were no significant differences in the chronic fatigue scores between the 8-hour or 12 hour group. This is of paramount significance to the question of 8-hour versus 12-hour shift. While there was no significant difference between the two groups on the Physical Health Questionnaire, there was a statistically significant difference in the number of health complaints, with the 8-hour group leading the way in such complaints as headaches, arthritis, depression, hypertension, bronchial symptoms, gastro-intestinal symptoms and chronic back pain. Additionally 40% of 8-hour shift reported to be smokers, while only 25% of the 12-hour group smoked.

There appeared to be no difference for the Cognitive-Somatic Anxiety Questionnaire. With regard to social domestic situation and coping there was a significant difference between the two groups. In both categories the 12-hour group indicated that they were more satisfied with their social as well as their domestic live. There was no difference in the satisfaction of their non-domestic live. This later category includes such aspects as banking, shopping and the like. As a related result the 12-hour group felt that they were coping well with their social and home life, while the eight hour group was dissatisfied with their coping capacity in this area.

The results on individual factors indicated no significant differences on the Circadian-Type Inventory in either languidity/vigor or scores of flexibility/rigidity, nor were there any variances in neuroticism as measured by the Essence Personality Inventory.

In considering the results of the employee diaries there appeared no significant difference in the hours of sleep, however the number of sleep periods was significantly higher for

the 8-hour group indicating more disturbed, broken sleep than the 12-hour group. This of course also meant more awakenings that would further reduce the quality and restfulness of the sleep. The subjective ratings of the groups bore this out when the 12-hour group reported a significantly better quality of sleep. The 12-hour group also reported being more refreshed by their sleep and thought they slept deeper than the report of the 8-hour group.

Analyzing the performance function of the two groups further advanced the merits of the 12-hour shift. The 12-hour group was significantly faster in decision time than the 8-hour group. There was also the reality that the 12-hour group had a faster reaction time at the end of their 12-hour shift than at the beginning of their shift, (this finding is consistent with other independent research efforts). There were however indications that the error rate seemed to increase toward the end of the shift in response to frequent stimuli, whereas there was no difference in tracking task accuracy.

The conclusion of this study was that by going to a 12-hour shift system there were several areas of significant improvement. Specifically they were in the areas of sleep pattern, mood status and Standard Shift work Index.

There were significant improvements in the sleeping behavior of the 12-hour group. This improvement was noted in longer duration, less broken sleep, higher quality, greater depth, and more refreshing sleep. Other researcher finding similar results are Peacock et al., 1983; Duchon et al., 1994 and Williamson et al., 1994. The admonition in these findings was provided by Rosa et al., (1998), when it was indicated that while the 12-hour group indeed slept longer they failed to rate the quality of sleep as high. This finding, while appearing contradictory was correct in that particular study because the subjects were "on-call" or on "stand-by" status consequently reducing the quality of rest (Berger, 1989; Williamson et al., 1994)

The mood status of the 12-hour workers was significantly higher than the 8-hour shift workers in that they reported to work feeling more refreshed and it appears that the 12-hour group did not feel the extra hours constituted a concern or problem. This finding was also supported by Williamson et al. (1994) and others.

Further findings of the Mitchell, Williamson study clearly indicate the advantages of the 12-hour shift as measured by the employee attitude toward increased quality of life in family and community function as well as in general health and well being.

The findings of this research have wider implications with regard to work attitude, atmosphere and moral, for it was seen in the research of the impact of down sizing at Oak Ridge, Pantex, Nevada Test Site, and Los Alamos (Pepper, 2000) when workers have positive attitude and a perception of fairness, open communications and honesty they are more able to cope with even higher work output demands.

Smith, Folkard, Tucker, and Macdonald (1998) in their review of the shift literature also concluded that the bulk of evidence in the literature provided an unequivocal affirmation

of the use of the 12-hour shift. They concluded that there were sufficient indications that the 12-hour system indeed provided significant advantages in such areas as lower stress levels, better physical and psychological well-being, improved duration and quality of off-duty sleep as well as improvements in family relations. They did acknowledge that their research was inconclusive regarding fatigue, and safety.

As will be noted in the Queensland study, to follow, these concerns appear to have no support in applied statistical investigations of accident and lost time incident actuarials.

Pierce and Dunham (2001) in their study of a police force's changeover from an 8-hour shift schedule to a 12-hour schedule tended to confirm Mitchell and Williamsons findings. They found that there were significant improvements in attitude, general affect and stress reduction as well as reported fatigue reduction when the police force went to a 12-hour schedule. It is critical to note that the 12-hour shift was couched in a 4 on 4 off framework, similar to that which was used in the Mitchell, Williamson study at the electrical generating station.

In their study they reconfirmed the general issue of dissatisfaction with the 8 hour shift due interfering with the officers' quality of life as it impacts family and social functioning (Hodge & Tellier, 1975). As a consequence the officers and their families experience more frequent family disturbances (Staines & Pleck, 1984) as well as disruptions in their community involvement efforts (Dunham, 1977). They further reaffirm the fact that shift work has been shown in other research to be deleterious to the employee's health. Orth-Gomer, Perski, and Theorell (1983) suggest that shift work is related to accelerated cardiovascular risk. Akerstedt (1988) indicated noticeable sleep disruption in shift workers. Smith & Colligan (1982) found shift work to have adverse impact on appetite and digestive processes.

Pierce and Dunham in part initiated this particular study in an attempt to further clarify conflicting results regarding the impact of the 12 hour 4 by 4 shift concept, for instance Hartman and Weaver (1977) reported productivity increases while Goodale and Aagaard (1975) found no significant increase. To aid in clarifying the question of 12-hour shift impact regarding productivity they set out to measure this shift impact along three major variables.

- Work schedule impact on personal activity function. This encompassed work hours, leisure time, organizational and job satisfaction.
- Stress and fatigue; this was measured by assessing physiological and psychological symptoms of stress (Patchen, 1970; Gardner & Warrick, 1984), fatigue (Dunham et al., 1987) as well as organizational commitment (Porter, Steers, Mowday, & Boulian, 1974), job involvement (Lodahl & Kejner, 1986), and intrinsic motivation (Lawler & Hall, 1970).
- Organizational effectiveness was assessed by a variety of law enforcement related performance indicators and general service delivery indicators.

The results of this research effort once again strongly support the move to a 12 hour shift system in that they found significant improvement in work attitude, significant

improvement in job, leisure time and life satisfaction. Furthermore there was significant reduction in perceived stress and fatigue by the officers on the 12-hour schedule. There was significant improvement in organizational effectiveness measures such as work conditions and servicing external constituents. Patrol function did not decline with the 12-hour schedule. Organizational commitment, job involvement and motivation showed no decrease consequent to the 12-hour workday.

The conclusion of Pierce and Dunham was a significant affirmation of the change to 12-hour workday. The gains in officer well being regarding family and community function, decrease in perceived stress and fatigue appeared to effectively overcome any negative concepts which the work force might have harbored toward the 12 hour shift concept resulting in a positive impact on organizational effectiveness.

Additional similar findings with regard to the 12-hour shift were also detailed in several studies in the mining industry, and on offshore oilrigs as well as in refineries.

Of special interest was a study commissioned by the Queensland Mining Counsel for the period 1998/99 and published in 2000. This study among other efforts made a detailed study of the time of accident occurrence. This was seen as a vital piece of information with regard to the argument of fatigue function and accident proneness of the 12-hour shift. The unsubstantiated statement had been that there would be a greater number of accidents later in the shift due to fatigue. The findings of the Queensland study indicate the accident frequencies to be concentrated early in the shift. Specifically the data shows the accident rate to peak twice in a 12 hour shift once 3 hours on shift (12%) and then again 5 hours on shift (12%), with a commensurate decline to about 4% at the end of the shift. It appears there is a similar function in the 8-hour shift with 16% at the first hour, 17% at the third hour and 11% at the sixth hour of an eight-hour shift.

Further similar findings have been found in FAA studies of air traffic controllers where the accident rate tended to peak during the first one and one half hours after assuming or reporting for duty (Della Rocco, Cruz, Clemens, 1999; Gregory, Oyung, Rosekind, 1999). This tends to lead to speculation that accident causation may be more a function of acclimatizing to work rather than fatigue. Ribak (1984) also confirmed that the Air Force accident data indicated that a vast majority of flight accidents occurred during the first hour at work after awakening, with a secondary increase in late afternoon.

Interestingly the Queensland study also could not find a peak of accident occurrence between the hours of 0200 and 0500. Therefore this data fails to support the concept of the 0300 "black spot" often alluded to in the literature, on the contrary the data indicates multiple peaks and valleys throughout the day and night. The peaks seem to occur at 0100, 0500, 0800, 1000, 1100, 1300, 1400, 1600, 2100, and 2300, with the greatest being at 0100 and 0800 for rotating shift in general.

Further investigation into the safety risk of the extended shift function could not establish any significant difference in the number of days lost due to accidents between the 8-hour and 12-hour shifts.

This finding was acknowledged by Towart (2000) in his November Labor Review where he states, "there is no evidence for an increase in the risks associated with the introduction of the 12 hour shifts.

The Queensland study was based on data gathered for 204 mines over the two years period 1998-1999. The conclusion of this massive study indicates that the 12-hour shift is used in 73% of the mines. In comparing the experience of operational reality to theoretical and academic research finding there seems to be a significant discrepancy. It appears that while some research seems to suggest that the 12-hour shift concept is more error and accident prone, the analysis of experiential reality tends to indicate that in fact there is, for the most part, no significant difference in the accident rate between the shift length experiences. When there is a difference it tends to favorably emphasize the greater safety of the 12-hour shift.

According to this study more significant indicators of accident potential seems to be shift start time (with day shift start at 0600 having higher lost time incidents than a start time of 0700.

Another greater risk factor than length of shift is the direction of shift rotation with the backward rotation being a higher risk than the forward rotation regardless of length of shift.

A final indicator of greater risk is the number of shifts worked on succession. It appears while this is an independent variable, there seems to be a noticeable correlation between numbers of shifts worked in succession and a commensurate increased safety risk. Working three to four 12-hour shifts in succession seems to constitute the safest practice.

Similar conclusions were reached by Duchon, Keran, and Smith in their study for the U.S. Bureau of Mines. Their results of an encompassing research effort of the personnel working in underground mines in western Canada indicated an almost unanimous acceptance and improved sleep quality associated with the change from 8-hour to 12-hour shift length. Furthermore their research efforts in general showed that fatigue sensitive behavior and physiological performance measures showed either no decline or notable improvements with the 12-hour shift schedule. Most notable were the positive effects on reduced absenteeism, reduced reported health problems, reduced stress, improved eating habits, enhanced family life, and more effective sleep quality and quantity. Performance indicators did not decline with the 12-hour shift and physiological measures did not show indications of physical fatigue associated with the 12-hour shift either.

A final study worth noting in this review is that of Frese and Semmer (1999). Their well-controlled study was carried out on 3446 blue-collar workers in the chemical industry of Germany. This study is noteworthy in that it controlled for stress at work as well as a number of other confounding factors. In doing so the results of the data collected indicate that there is no significant difference in the worker's health between those working a

rapidly rotating (every 2 to 3 days) 12-hour shift and those working a slower (every 5 to 7 days) 8-hour shift.

Conclusion

There are innumerable studies further establishing the primary points which by now are becoming self evident, however for the purpose of parsimony only a few cross sectional research representations have been presented here to provide the reader with a working knowledge of the existing research regarding the issues of 12 versus 8 hour shift function. The accompanying references and bibliography may function as a guide for further study of this subject for those so inclined. A more definitive treatise of this document will be available shortly.

The concluding caveats of this effort can be brutally summarized as follows:

- All shift work has an adverse effect on the employee who is engaged in such work practices. There are clearly individual differences as to the coping capacity to do shift work. There appears to be no discriminate function of the impact of shift work and the age of the employee. It is indicated that the general trend is the longer one is engaged in shift work, the greater the potential of developing health issues.
- There appears no notable discernibly significant deleterious effect on individuals working 12-hour shifts. Indeed the opposite appears to be in evidence. Individuals who work 12 hour shifts appear to experience significantly improved;
 - Personal life quality
 - More effective rest
 - Enhanced work attitude
 - Improved work safety
 - More positive morale
 - Higher levels of organizational and job satisfaction
 - They report experiencing lower fatigue levels (this a self report phenomena; actual research presents conflicting evidence in this area)
 - Reduced health risk
- It appears that the critical variables in shift work are;
 - Adherence to scheduled rest times between shifts
 - Proper management of shift schedules
 - Forward rotation of shift
 - Slow rotation rate
 - Limited (3-4) shift sequences prior to a rest period
 - Commensurate rest periods must be appropriately scheduled and upheld (4 on-4 off [assuming an 8 day week] or 4 on-3 off, or 3on-4 off [assuming a 7 day week])
 - Individual psychosocial hygiene practices and sleep management (this is both an individual and corporate education responsibility)

Clearly the conclusions of the research show that a 12-hour shift schedule with slowly rotating forward shifts, and with adequate rest periods properly maintained and observed served as a significant improvement over the 8-hour shift schedule. The 12-hour concept enhanced the employee's personal life, gave them better rest, a higher degree of moral and job satisfaction as well as increase job safety, provided the same if not reduced fatigue levels, and held or increased job performance effectiveness and efficiency.

There is a clear need for continued research into this area, specifically well controlled research with clear and commonly acceptable definitions of the key variables. This future research also needs to utilize specific and applicable outcome measures, which assess applied indicators at the actual work-site. We have a strong base on which operational decisions can be made, but the dynamic functional changes of the security mission in the nuclear industry will continue to demand creative thinking based on scientific knowledge to continue to generate innovative approaches to continue to provide the highest caliber of security assurance at realistic affordability.

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