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Noise, Luminance, Vibration and Non-Ionizing Radiation Evaluation in Brazilians Sawmills

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Abstract
This research was done with the purpose of analyzing the physical risks in the sawmill of the city of Itapeva - SP and region in Brazil. The results were analyzed and compared with those standards, in which it was known the risk of vibration are present in a few mills, and only those services that are beyond the sawing itself, such as planation of parts, for example. Besides the vibration, the content of luminance, noise and non-ionizing radiation were studied - which comes from the solar light. It was obtained a similar final result in measured data, which is due to several factors, such size and processing capacity, and similar machinery standardized method of sawing. The research then shows that sawmills operate mostly according to the standards expected.

1. INTRODUCTION

It is understood that physical risk agents possess material external to the human body and can be detected and also measured. Some work related diseases may be caused by these agents; However, the limits of their action are often imprecise. It is known that they often associate to determine the occurrence of health problems (BINDER et al, 1995).

The International Labor Organization (ILO) considers ionizing radiations, noise, temperature and electricity as the main physical risk factors for health workers (BULHÕES, 1994).

Lighting (Luminance)

Light deficiency in a workplace can also cause headaches, fatigue, nausea and other less frequent neurological problems. Humor can also be affected. The workers' complaints index was observed throughout the year and it was verified that those who work under natural light presented more complaints in the winter (less luminosity); Already in environments with constant artificial lighting, there was no difference in the complaints during the period considered (JAGLBAUER, 2007).

2. LITERATURE REVIEW

The perception of depth, for example, depends on factors such as contrasts and shadows that can be perceived only with good lighting. Thus, if there is a deficiency, there is a greater risk of accidents, for example, when there is a lack of visualization of stairwell depths or machine movement. Concentration on work tasks is another factor influenced by lighting. Thus, reduced lighting can lead to inattention and consequent work accidents (BERTOLOTTI, 2007).

2.1.Luminance

The importance of knowledge of the reflectance of walls, floors, ceilings and equipment is greater than usually considered. A large portion of incident light is absorbed and a small fraction is reflected, however, color change or surface type can compensate for these losses and make the design more efficient (JAGLBAUER, 2007).

2.2 Noise

According to Schrage (2005), "the sound power radiated by a sound source (acoustic energy per unit time) results in sound pressure". In this way, the sound power of the source is the "cause" of the sound, and the sound pressure in the environment is the "consequence".

The exchange factor (q), also known as Exchange Rate (ER), indicates the increase in the mean sound pressure level, so that there is a doubling in dose. An exchange factor q = 3, used in most parts of the world, for example, indicates that exposure to a sound pressure level of 88 dBA results in a dose twice as high as exposure to 85 dBA. Some organizations, such as the Occupational Safety and Health Administration (OSHA) in the United States, claim that the human ear compensates for changes in sound pressure levels, and the q = 3 exchange factor is not adequate. Thus, like Brazilian law, OSHA uses a q = 5 exchange factor to get closer to the human ear response (QUEST TECHNOLOGIES, 2006).

2.3. Vibration

The magnitude of the vibration can be expressed in dB, in fractions of acceleration of gravity or, more usually, in m / s². Although this magnitude is linked to the damage caused to the human body, there are other factors such as frequency, direction or duration of this exposure to vibration that can aggravate symptoms and diseases resulting from exposure to vibration (CUNHA, 2006).

According to Wasserman (1997), the frequency range between 4 and 8 Hz in the Z Axis (vertical direction) is one of the most important, since it resonates with the frequencies of the spine. Exposure to small magnitudes of vibration can cause serious damage to the health of the worker.

When making measurements of the vibration of hands and arms, attention should be paid to those of high frequencies. Adewusi et al. (2008) showed that measurements in situations with a frequency higher than 500 Hz are significantly influenced by the position in which the sensor of the equipment used is located and by the force exerted by the operator.

2.4.Non-Ionizing

The spectrum of non-ionizing solar radiation that reaches Earth is formed by ultraviolet (UV) radiation, visible (λ between 400 and 800 nm) and infrared (λ above 800 nm). UV radiation is responsible for the occurrence of photochemical reactions that in addition to stimulating the production of melanin, resulting in tanning of the skin, can cause from inflammations and burns to genetic mutations and dysfunctions in cellular behavior (FLOR, DAVOLOS, CORREA, 2007).

2.4.1. Ultraviolet Radiation (UV)

Ultraviolet (UV) radiation was discovered in 1801 by the German physicist Johann Wilhelm Ritter (1776-1810). It is a small portion of the total radiation received from the Sun and has been worrying the experts, especially since the 1970s when ozone depletion was observed. The ultraviolet acts on atomic structures, dissociating molecules (breaking some carbon chains, many, essential to life), affecting living things and some materials (plastics and polymers), with ozone being its main filter.

2.4.2.Infrared Radiation (IR)

Present in sunlight, tungsten filament lamps and numerous industrial processes that use heat sources such as bakers, glass blowers, blast furnace workers, foundry and metallurgy workers, firefighters, among others. Like ultraviolet radiation, infrared is more harmful to the skin and the eyes. On the skin, it may cause burns. In the eyes, however, due to transparency of the ocular means, infrared radiation affects the retina further.

3. MATERIALS AND METHODS

3.1. Instruments and procedures in the luminance evaluation

NBR-5382 10 (ABNT, 1985) shows the measurement procedures in order to obtain an average level of illumination of the environment. The instrument used in the measurements must have photocell with correction of the cosine and correction of color, with ambient temperature between 15ºC and 50ºC, whenever possible. This means that it is not mandatory, but recommended, that the luxmeter has these characteristics. It should be remembered that this technical Axis was created to measure the ambient lighting of environments, so it should be considered that in the studied environment there may be some variations, due to the fact that most of the sawmills are only covered (with lighting different from interior). Also according to NBR-5382, after stabilization of five to ten minutes, the photocell of the luxmeter should be positioned 80 cm from the floor and note the values found. For this work, only the average value of this measurement was used according to the technical Axis, since they were made in numerous sawmills for comparison purposes. This way we can work more easily with the average value of the measures found.

Therefore, the values used in this work can vary from the topic of "Saw System" to "Selection of veneer, marquetry, inlaying" taking into account the types of tasks and similar activities. Thus, the Luminance in the outlets of a sawmill can range from 300 lux to 750 lux.

3.2. Instruments and procedures in the evaluation of Noise.

Noise limits according to NR-15 (BRASIL, 1978) has, in its Annex No. 1, the limits of tolerance for continuous or intermittent noises, that is, those that are not of impact. According to this Axis, the measurement must be made using a sound pressure level instrument positioned near the worker's ear, operating in a slow response and with compensation filter "A".

Consideration should also be given if the worker is working with noise protection equipment (EPI's), minimizing the risk by presenting.

The NR-15 does not establish a measurement time for comparing the results to the table, but it is known that measurements should be made in the main sectors of the sawmills in the longest possible time, and work with the average of these values obtained.

3.3. Instruments and procedures for Vibration measurement.

The equipment used was an accelerometer whose main function is to measure vibration relative to the worker in the X, Y and Z-Axis.

Vibration daily exposure limits according to ISO 2631 and ISO / DIS 5349 Standard.

According to ACGIH (2007), the evaluation of hand and arm vibration will be done according to ISO 5349: 1986 to compare the measures found. The limits of this daily exposure of hand and arm vibration will be presented according to table 1.

Table 1: Daily exposure limits in the X, Y and Z Axis directions.

Total duration of the daily exposure [1].	Acceleration component values dominate [2] (m / s²)
4h and less than 8h	4
2h and less than 4h	6
1h and less than 2h	8
Less than 1h	12

[1]. The total time that vibration enters the hand per day, whether continuous or intermittent. Accelerations are weighted in frequency, r, m, s.

[2]. Usually, one of the Axis is dominant over the others. If one or more of the vibration Axis exceeds, the total daily exposure will be exceeded.

3.4. Instruments and procedures in the assessment of Non-Ionizing Radiation.

According to Annex 7 of Regulatory Axis 15, non-ionizing radiation is microwaves, ultraviolet and laser. Operations or activities that expose workers to these radiations, without adequate protection, will be considered unhealthy, as a result of an inspection report held at the workplace.

Activities or operations that expose workers to black light radiation (ultraviolet in the range - 400 ~ 320 nanometers) will not be considered unhealthy.

It can be considered that workers in sawmills, if they work in courtyards and environments where they have a direct incidence of non-ionizing radiation, should always be adequately protected, ie, clothing covering the whole body (long-sleeved sweaters, Footwear, etc.) and be wearing some kind of face protection (hats, caps, among others).

4. Results And Discussions

4.1. Results in the measurement of Luminance.

Measurements of the Luminance content (measured in Lux) were done at five random points inside the sawmills, so that they were not made in open places. Table 2 shows the measured values for "Sawmill A".

All measurements were taken in an average of approximately one minute each, due to the various sawmills visited.

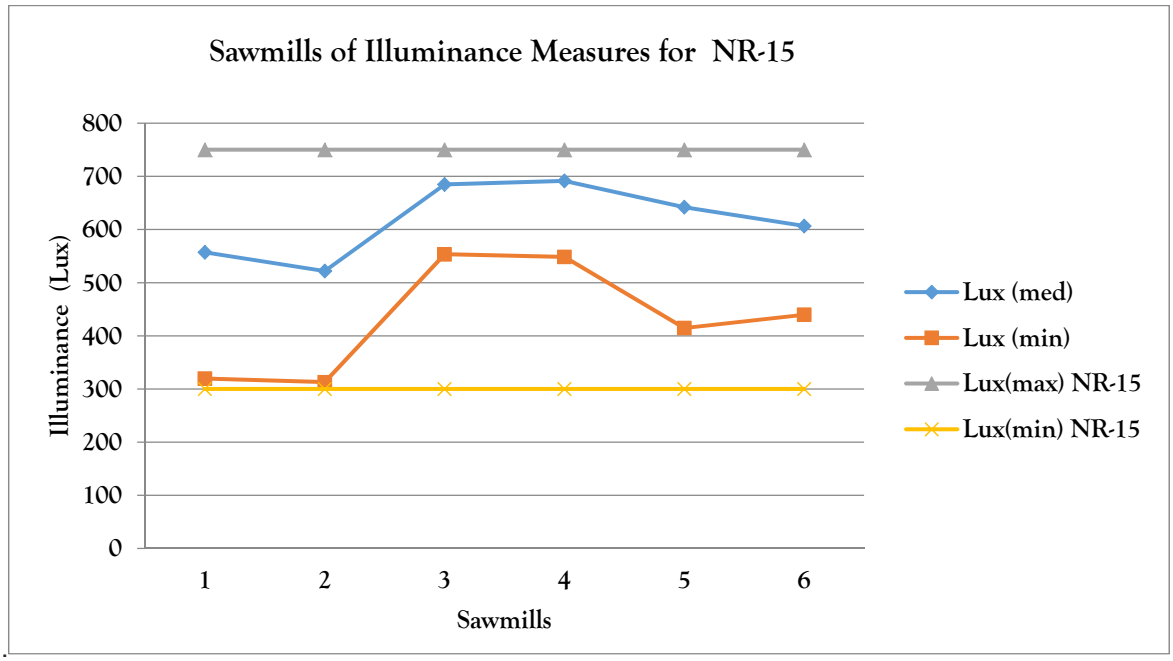
NBR ISO / CIE 8995-1: 2013 was stipulated with average values between 300 lux and 750 lux, and the respective values were found accordingly. It is also defined that if some minimum measure is below that allowed, the activity will be considered unhealthy, that is, of the five points measured, four are below the allowed, two in Sawmill A (points 1 and 2) and two in Sawmill B 2 and 3).

Taking into account the values of the measurements made in all the sawmills, the average and minimum values can be compared with the NR-15, as shown in the graph below (Figure 1).

Table 2: Measurements of Luminance in sawmills.

Sawmill A	Point 1	Point 2	Point 3	Point 4	Point 5
Lux (max)	829	1021	939	891	1024
Lux (med)	476	538	499	641	632
Lux (min)	208	275	355	390	370
Sawmill B	**Point 1**	**Point 2**	**Point 3**	**Point 4**	**Point 5**
Lux (max)	1138	496	1260	850	1230
Lux (med)	599	329	621	498	563
Lux (min)	306	267	292	390	309
Sawmill C	**Point 1**	**Point 2**	**Point 3**	**Point 4**	**Point 5**
Lux (max)	780	1511	866	777	844
Lux (med)	683	724	635	701	681
Lux (min)	518	663	591	530	465
Sawmill D	**Point 1**	**Point 2**	**Point 3**	**Point 4**	**Point 5**
Lux (max)	708	1124	884	1584	1222
Lux (med)	617	698	703	750	689
Lux (min)	544	480	559	611	548
Sawmill E	**Point 1**	**Point 2**	**Point 3**	**Point 4**	**Point 5**
Lux (max)	1031	1496	1169	850	1260
Lux (med)	599	729	621	598	663
Lux (min)	406	567	392	400	309
Sawmill F	**Point 1**	**Point 2**	**Point 3**	**Point 4**	**Point 5**
Lux (max)	791	887	801	906	1870
Lux (med)	512	559	621	601	740
Lux (min)	406	339	458	509	487

Figure 1: Average and minimum measurements of Luminance in the sawmills in the region of Itapeva -SP



Comparing with the norm, it is noticed that the average values of Luminance are between the permitted range and the minimum values are above the minimum, and there is no need for drastic changes to improve this risk. During the measurements it was noticed that when the area covered in which the Luminance measurement was larger, the lower the content of Lux according to which one moves to the center of that area. If there is a need for change due to lack of Luminance in a given location, it is sufficient to subdivide the initial area into smaller portions, so the incidence of light will be greater. Recalling that this change, if necessary, should not harm other sectors.

4. 2. Noise

The results of the sawmill noises visited are shown in Table 3 below so that five measurements were taken in the spaces where the highest percentage of noise occurred and more people worked.

The same Luminance measurement time value was adopted for the noise, which is approximately one minute for each measurement.

According to the values cited by NR-15, where the maximum permitted noise levels are demonstrated by the number of hours in which the worker is on display, a total of 8 hours of workload was considered for Itapeva sawmill workers -SP and region, due to the work period being in the morning and afternoon.

Table 3. Measurements of noises in dB in 6 Sawmills

Sawmill A	**Measures 1**	**Measures 2**	**Measures 3**	**Measures 4**	**Measures 5**
dB(max)	91	92	91	94	93
dB (med)	87	87	87	88	88
dB (min)	80	81	80	80	80
Sawmill B	**Measures 1**	**Measures 2**	**Measures 3**	**Measures 4**	**Measures 5**
dB (max)	94	94	97	95	93
dB (med)	89	89	91	87	87
dB (min)	83	82	84	82	81
Sawmill C	**Measures 1**	**Measures 2**	**Measures 3**	**Measures 4**	**Measures 5**
dB (max)	93	93	95	93	95
dB (med)	87	84	86	89	90
dB (min)	81	81	83	82	80
Sawmill D	**Measures 1**	**Measures 2**	**Measures 3**	**Measures 4**	**Measures 5**
dB (max)	94	97	95	90	91
dB (med)	91	91	86	88	85
dB (min)	83	84	81	84	79
Sawmill E	**Measures 1**	**Measures 2**	**Measures 3**	**Measures 4**	**Measures 5**
dB (max)	93	95	93	94	93
dB (med)	90	91	90	86	87
dB (min)	84	78	81	81	82
Sawmill F	**Measures 1**	**Measures 2**	**Measures 3**	**Measures 4**	**Measures 5**
dB (max)	91	90	95	93	91
dB (med)	87	86	86	85	83
dB (min)	83	81	81	82	78

The maximum allowable value is 85dB (dB (max) NR), but the Axis also states that if the worker is using noise-reducing PPE (earphones), this risk can be minimized. In all six sawmills visited, practically 100% of workers were with regular EPI's and according to the norm. It should be remembered that values above 115dB are considered an extreme risk to the safety of workers.

4.3.Vibration

The results of vibration measurement in machines where there is hand and arm contact of the worker (VMB), were made in only two sawmills of the six visited. For each of these sawmills, five measures were taken for calibration at different points. From the generated graphs, the average and the maximum and minimum values of the acceleration (m / s²) in the three directions (X, Y and Z) can be taken for each visited sawmill, as shown in Table 4.

Table 4: Vibration measurements on X, Y and Z Axis in Sawmill A

MEASURENT 1	Axis X	Axis Y	Axis Z	Time (s)
Average (m/s²)	0,54137	0,30347	4,12609	
Max Value (m/s²)	5,79396	2,6265	16,97555	60,0244
Min. Value (m/s²)	0,00042	0,00089	0,00485	
MEASURENT 2	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,490772	0,408386	4,047936	
Max Value (m/s²)	4,17578	3,97216	16,42707	60,3340
Min. Value (m/s²)	0,00022	0,00073	0,00755	
MEASURENT 3	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,459359	0,355079	3,913324	
Max Value (m/s²)	5,90696	2,51295	16,41442	60,6470
Min. Value (m/s²)	0,00034	0,0002	0,00143	
MEASURENT 4	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,530665	0,293245	3,126053	
Max Value (m/s²)	3,72348	2,78421	15,63729	63,0540
Min. Value (m/s²)	0,0001	0,0001	0,00659	
MEASURENT 5	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,465415	0,303861	3,411378	
Max Value (m/s²)	3,06289	2,02717	15,07699	60,0740
Min. Value (m/s²)	0,00018	0,0003	0,00153	

The Table 4 above demonstrates more clearly and better understanding the average values of the values obtained from "Sawmill A" in relation to hand and arm vibration (VMB) in the three directions: It was noticed that the two sawmills that contained risk of vibration, presented similar results according to the data of the table and graph below.

The same table was created for the second sawmill (Sawmill E) where the risk of vibration was also found (Table 5).

Table 5: Vibration measurements on the X, Y and Z-Axis in the Sawmill E

MEASURENT 1	Axis X	Axis Y	Axis Z	Time (s)
Average (m/s²)	0,74137	0,20347	3,42609	
Max Value (m/s²)	6,79231	3,62345	21,93245	61,3441
Min. Value (m/s²)	0,00087	0,00156	0,00291	
MEASURENT 2	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,459823	0,234989	3,032931	
Max Value (m/s²)	5,17578	3,97216	16,42707	59,9912
Min. Value (m/s²)	0,00044	0,00038	0,01389	
MEASURENT 3	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,459359	0,355079	4,14324	
Max Value (m/s²)	5,151987	2,51295	19,41442	60,3912
Min. Value (m/s²)	0,00009	0,00052	0,00846	
MEASURENT 4	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,530665	0,293245	4,52345	
Max Value (m/s²)	6,94273	2,78421	17,52623	62,0491
Min. Value (m/s²)	0,00023	0,000123	0,00659	
MEASURENT 5	**Axis X**	**Axis Y**	**Axis Z**	**Time (s)**
Average (m/s²)	0,56324	0,303861	4,432491	
Max Value (m/s²)	7,3241	2,02717	18,04236	60,9381
Min. Value (m/s²)	0,00027	0,0004	0,00234	

The highest values were obtained in the Z Axis, both according to the mean (Mean) and the maximum value (Vmax) found, that is, the vibration occurs basically in the horizontal direction the hand and arm of the worker.

The Axis defines a maximum value for vibration for any Axis, X, Y or Z of 4 m / s² during a daily exposure period between 4h and 8h. By analyzing the graphs shown, we can see that the average value of vibration does not exceed this limit, the worker will be able to work a maximum of 8 hours per day (maximum duration) in machines that cause him to suffer from this risk.

4.4. Results in the evaluation of Non-Ionizing Radiation

The use of PPE for non-ionizing radiation is directly related to the clothing that protects the worker from the rays emitted by the sun, such as: clothes that cover the largest percentage of skin possible (shirt with long sleeves, gloves, hats, caps, among others). Among the sawmills visited, they were analyzed which were in agreement with the norm relating the PPE's against non-ionizing radiation and all presented conformity to the Axis.

CONCLUSION

Therefore, it can be noticed that there is a high level of awareness of the sawmill owners in the municipality of Itapeva-SP and region, which mean that their workers do not abandon their protective equipment at any time during their shift. We can say that the risk of non-ionizing radiation is totally prevented with the use of PPE's, and then the total risk elimination.

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