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Indicators of Work Accidents in Slaughter Refrigerators and Broiler Processing

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ABSTRACT

This research aims at describing data for an epidemiological profile, as well as to contribute to the improvement of systems of information, prevention and risk control of accidents in the workplace in processing and further processing broiler plants. In this study, data from documents of 1,274 investigations of typical work accidents were analyzed. Descriptive statistics were used for the analysis, and the frequency and severity of accidents were calculated according to NBR 14280:2001. The results show that men tend to have more accidents than women; 69.8% of those injured had been in the company for less than 3 years; 37% of the accidents were cuts; 35.6% were bruises; the most affected body parts were hands and fingers, representing a total of 48% of all accidents; 41.6% of victims were not using personal protective equipment (PPE) at the time of the accident; the underlying causative condition of 54.9% of the accidents was the lack of personal safety. The proportion for each accident with leave was 1.7 accidents without leave but with a need for relocation of activity and 10.9 accidents without leave without relocation. There were amputation cases among some of those given leave of absence. For every million hours worked, there were 3.2 accidents with leave and 139.4 days of absence were registered. The study concludes that accident rates in in processing and further processing broiler plants are high, and that it is extremely important to establish an epidemiological profile in order to guide prevention and control actions.

INTRODUCTION

The meat processing and further-processing industries currently make of Brazil one of the world's leading exporters of animal products (Marra *et al*., 2013). The production volume and the number of companies and employees of those industries have continuously grown worldwide, making significant contributions for the gross domestic product of many countries (IBGE, 2017; Barros & Mendes, 2014). This growth is linked to the increasing global demand for animal protein, particularly for poultry meat, considering its healthy and affordable appeal (Harmse *et al*., 2016), which has also increased the pressure for competitiveness. Consequently, the animal industry activities have been become more intensive in the search for higher productivity and better quality of foods of animal origin. However, the physical and mental fatigue of the workers of the animal industry has increased, causing work accidents and occupational diseases.

Work accidents have always been an object of study because they are the main health problem suffered by workers worldwide (Bird, 1985). Contrary to the views of many, accidents do not occur by chance; instead, they are socially-determined, predictable, and preventable (Barros & Mendes, 2014; Bird, 1985).

The pig, poultry, and small-animal processing industry in Brazil recorded 6,760 accidents in 2011, 6,652 accidents in 2012, and 6,804 accidents in 2013, as listed by the National Classification of Economic Activities (CNAE[1]), number 1012-1, which the latest statistical yearbook on accidents, and available on the Social Security website of the Brazilian government. It should be noted that these data were compiled only from the typical accident indicators with an issued work accident report (CAT[2]) (INSS, 2017), and that there were no significant reductions in the number of accidents recorded during those three years.

Despite the high number of accidents in the meat processing and further-processing sector recorded by Social Security (INSS, 2017), several studies report that these numbers do not reflect the reality because many accidents are not duly reported. This lack of information limits the planning and implementation of policies for the prevention of work accidents. Official data on occupational accidents do not accurately show the results of accidents and mishaps if a CAT is not issued (Kearney, 2010; Tappin *et al*., 2008; Reardon & Farina, 2010; Stearns *et al*., 1999).

Considering the demand for studies on occupational accidents, the frequency and the severity of accidents in the meat processing and further-processing industries, this study aimed at contributing to build an epidemiological profile of occupational accidents, as well as for the improvement of information systems, as well as the prevention and control of risks of occupational accidents with workers in the poultry processing and further-processing industries.

MATERIAL AND METHODS

According to methodological concepts, this is a cross-sectional case study carried out using secondary data obtained during the analysis of documents of work accident investigations (Yin, 2010). The study period was from January 1st to December 31st, 2016.

Typical accidents described in accident-investigation documents were used in this study. Accidents were defined according to the internal safety and health management criteria of the company investigated, and not by the researchers, because the analyses were based on accidents previously characterized by the company and described in the documents. The following accident definitions were used: accident no leave and no need for activity relocation (ANL NR) – defined as an accident that causes work disruption, but there is no labor capacity loss, and, according to the diagnosis of the medical staff, the individual continues to perform his/her usual activities during normal working hours; accidents no leave, but with activity relocation (ANL WR) – defined as an accident with a partial loss of labor capacity or in which the individual is relocated from his/her usual activities and does not need to leave the company; accidents with leave (AWL) – defined as those in which the injured person completely loses his/her labor capacity and is no longer able to perform his/her activities on temporary and/or permanent (invalidity) basis. According to the company's accident management flowchart, all accident victims are referred to the medical outpatient clinic of the plant, where they are initially cared by nurses who assess the need for referral to external care in hospitals and specialized clinics according to the injury and/or for examination by an occupational-health physician or general practitioner, who will determine if the injured person needs to be relieved or not from his/her activities and the treatment of the injury and record the accident type (ANL NR / ANL WR/ AWL).

The objective of this study was to collect data to build an epidemiological profile of occupational accidents in order to contribute for improvement of information systems, and for the prevention and control of the risks of work accidents in broiler processing and further-processing plants.

The inductive method was applied. The data available in the accident-investigation documents completed by the health and safety teams of the plants were surveyed for later theoretical formulation of the concepts that gave support to reach the proposed objectives (Lakatos & Marconi, 2003).

The universe and sample consisted of 1,274 investigation reports on accidents in 10 broiler processing and further-processing plants belonging to a single company. Therefore, all plants applied the same methodology for the analysis and investigation of incidents and accidents. The 10 plants are located in the states of Paraná (2 sites), Santa Catarina (5 sites), and Rio Grande do Sul (3 sites). The total number of workers in the 10 locations is 15,165, out of which 8,796 are women and 6,369 are men.

Data were collected from worksheets reporting work accidents in each plant. Data were analyzed and interpreted using descriptive statistics.

[1]Classificação Nacional de Atividades Econômicas.
[2]Comunicado de Acidente de Trabalho.

The frequency and severity of incidents and accidents were calculated using the equations of NBR 14280:2001, as shown in Figure 1:

$$FR = \frac{N \times 1000}{MHT}$$

$$SR = \frac{T \times 1000}{MHT}$$

Figure 1 –Equations used for the calculation of accident frequency rate (FR) and severity rate (SR)

Source: ABNT: NBR 14280:2001

Nomenclature: FR: accident frequency rate; N: number of accidents; MHT: number of man-hours duringan established time interval; SR: accident severity rate; and T: computed time (lost days)

The data and research protocol used in the present study were provided by the company. The study was approved by the Committee of Ethics in Research of the Federal University of Santa Catarina, and was in compliance with all legal requirements. The anonymity and confidentiality of information was maintained in the data records.

RESULTS

Table 1 shows the distribution of accidents with no leave and no need of activity relocation (ANL NR), accidents with no leave but with activity relocation (ANL WR), and accidents with leave (AWL), according to worker's gender, employment period, injury classification according to the accident investigation documents of each plant, affected body part, use of PPE, and cause.

The analyzed data included 1,021 accidents with no leave and no relocation (586 (♂) and 435 (♀)), 160 accidents with no leave and relocation (106 (♂) and 54 (♀)), and 93 accidents with leave longer than one day (75 (♂) and 18 (♀)), totaling 1,274 events (ANL NR / ANL WR / AWL).

The proportions of accidents involving men (♂) and women (♀) in the studied plants were 57.4% (♂) and 42.6% (♀) for ANL NR, 66.3% (♂) and 33.8% (♀) for ANL WR, and 80.6% (♂) and 19.4% (♀) for AWL.

Relative to employment period (months), the highest ANL NR proportion was 37.1% (up to 12 months), followed by 32.7% (12 to 36 months), and the lowest was 8.3% (>120 months). The highest ANL WR proportions were 28.1% (12 to 36 months) and 26.3% (up to 12 months), while the lowest was 13.8% (60 to 120 months). The highest proportion of AWL was 47.3% (up to 12 months) and the lowest was 7.5% (60 to 120 months) and 7.5% (>120 months).

The injuries with the highest proportion in ANL NR were contusions (40.6%) and small cuts (36.6%), 50.0% cuts and 15% contusions in ANL WR, and 37% cuts and 35.5% contusions AWL.

The most affected body parts in ANL NR cases were hands and fingers (47.0%), and head and neck (14.0%). In ANL WR cases, 51.9% were injuries on hands and fingers, and 18.1% on the head and neck, while in AWL 48.0% of the injuries were on hands and fingers, and 14.1% on the head and neck.

The data collected from the accident investigation reports show that, in ANL NR, only 10.1% of those injured were not required to use PPE and that 41.2% were not using adequate PPE at the time of the accident. Proportions of 15.0% (PPE not applicable) and 44.4% (did not use PPE) were recorded in ANL WR cases, and 16.1% (PPE not applicable) and 40.9% (did not use PPE) in AWL.

According to accident investigation data, the results indicate that 57.4% of ANL NR occurred for reasons related to unsafe personal factors, while 45.6% of ANL WR and 43.0% of AWL were also related to the same factors.

Table 2 shows the accident stratification in each plant, as well as total days lost due to injury treatment. The number of workers per plant and the number of hours worked in 2016 are taken into account.

The average monthly number of workers was 15,165, which corresponded to 28,633,361 hours worked in 2016.

The overall monthly ratios among AWL, ANL WR, and ANL NR were 93:160:1021. This means that, in proportional terms, for each accident with leave, there were 1.7 accidents with no leave and need of activity relocation and 10.9 accidents with no leave and no need of activity relocation.

The total number of accidents with leave accounted for 3,992 lost work days of leave. Considering the average number of employees in each plant, this would mean that three production units (equivalent to units 6, 7 and 10) that stopped for one day due to the labor shortages caused by work accidents. It should be noted that the amputations were recorded as days lost only during the researched interval of 2016 , when there may be a longer interval the return of the worker.

Table 3 shows the results obtained for the frequency and severity rates of accidents.

The result shows there were 35.7 ANL NR, 5.6 ANL WR, and 3.2 AWL per million hours worked, and 139.4 days of leave of absence.

Table 1 – Description of the results according to the type of accident registered.

Characteristics	ANL NR		ANL WR		AWL		Total	
	n	%	n	%	n	%	n	%
Sex								
Male (♂)	586	57.4	106	66.3	75	80.6	767	60.2
Female (♀)	435	42.6	54	33.8	18	19.4	507	39.8
Time of employment (months)								
Up to 12	379	37.1	42	26.3	44	47.3	465	36.5
12 ├ 36	334	32.7	45	28.1	21	22.6	400	31.4
36 ├ 60	116	11.4	26	16.3	14	15.1	156	12.2
60 ├ 120	107	10.5	22	13.8	7	7.5	136	10.7
> 120	85	8.3	25	15.6	7	7.5	117	9.2
Type of injury								
Cut	374	36.6	80	50.0	17	18.3	471	37.0
Bruises	415	40.6	24	15.0	15	16.1	454	35.6
Sprain	56	5.5	7	4.4	7	7.5	70	5.5
Burns	43	4.2	12	7.5	6	6.5	61	4.8
Amputations	0	0.0	0	0.0	9	9.7	9	0.7
Fracture	36	3.5	17	10.6	36	38.7	89	7,0
Intoxications	35	3.4	8	5.0	0	0,0	43	3.4
Crushing	7	0.7	2	1.3	0	0.0	9	0.7
Electric shock	2	0.2	2	1.3	1	1.1	5	0.4
Eye soreness	28	2.7	1	0.6	0	0.0	29	2.3
Skin soreness	4	0.4	0	0.0	0	0.0	4	0.3
Respiratory irritation	1	0.1	1	0.6	0	0.0	2	0.2
Dislocation	4	0.4	5	3.1	2	2.2	11	0.9
Not informed	16	1.6	1	0.6	0	0.0	17	1.3
Death	0	0.0	0	0.0	0	0.0	0	0.0
Afflicted body part								
Head and neck	143	14.0	29	18.1	7	7.5	179	14.1
Thorax	3	0.3	0	0.0	1	1.1	4	0.3
Abdomen	3	0.3	2	1.3	0	0.0	5	0.4
Pelvis	8	0.8	1	0.6	0	0.0	9	0.7
Back	27	2.6	0	0.0	0	0.0	27	2.1
Lower limbs (leg, knee, ankles)	138	13.5	13	8.1	11	11.8	162	12.7
Upper limbs (arms, forearms, fist)	132	12.9	21	13.1	15	16.1	168	13.2
Hand and fingers	480	47.0	83	51.9	48	51.6	611	48.0
Feet	60	5.9	8	5.0	7	7.5	75	5.9
Several body parts	27	2.6	3	1.9	4	4.3	34	2.7
Use of PPE								
Yes	497	48.7	65	40.6	40	43.0	602	47.3
No	421	41.2	71	44.4	38	40.9	530	41.6
Does not apply	103	10.1	24	15.0	15	16.1	142	11.1
Cause of accident								
Unsafe condition	282	27.6	36	22.5	35	37.6	353	27.7
Personal unsafety factor	586	57.4	73	45.6	40	43.0	699	54.9
Personal condition and factor	141	13.8	47	29.4	18	19.4	206	16.2
No characterization	12	1.2	4	2.5	0	0.0	16	1.3

Nomenclature: n – number; ANL NR – accident no leave and no need for relocation of activity; ANL WR – accidents no leave but with relocation of activity; AWL – accidents with leave; PPE – personal protective equipment.

Table 2 – Indicators for number of workers, hours worked, and days of leave by plant.

Plant	Average number of workers per month	Number of workers in a year	H in a year	ANL NR	ANL WR	AWL	TD	TD/T (%)
1	1,918	23,012	3,674,316	221	17	7	383	19.9
2	1,142	13,701	2,057,926	117	19	3	18	1.6
3	1,901	22,812	3,729,158	66	19	17	769	40.5
4	1,672	20,059	3,056,372	61	25	7	310	18.5
5	1,812	21,745	3,471,958	74	13	24	351	19.5
6	1,329	15,950	2,478,898	117	13	15	483	36.3
7	1,218	14,617	2,249,258	94	8	8	416	34.2
8	1,524	18,289	2,891,496	48	19	5	402	26.4
9	1,438	17,252	2,650,156	37	8	5	748	52.0
10	1,212	14,540	2,373,823	186	19	2	112	9.2
Total	15,165	181,977	28,633,361	1021	160	93	3992	26.3

Nomenclatures: H – amount man-hours; ANL NR – accident no leave and no need for activity relocation; ANL WR – accidents no leave but with activity relocation; AWL – accidents with leave; TD – total days with leave; TD/T (%)percentage of total days lost per average number of workers monthly.

Table 3 – Frequency and severity rates by plant.

Plant	FR ANL NR	FR ANL WR	GR AWL	GR
1	60.1	4.6	1.9	104.2
2	56.9	9.2	1.5	8.7
3	17.7	5.1	4.6	206.2
4	20.0	8.2	2.3	101.4
5	21.3	3.7	6.9	101.1
6	47.2	5.2	6.1	194.8
7	41.8	3.6	3.6	184.9
8	16.6	6.6	1.7	139.0
9	14.0	3.0	1.9	282.2
10	78.4	8.0	0.8	47.2
Total	35.7	5.6	3.2	139.4

Nomenclature: FR – Frequency rate and GR – gravity rate, ANL NR – accident no leave and no need for activity relocation; ANL WR – accidents no leave but with activity relocation; AWL – accidents with leave.

DISCUSSION

For the three criteria defined by the company and analyzed in the study (ANL NR: ANL WR: AWL), the proportion of injured males was higher (60.2%). Similar results are reported in other studies conducted in slaughterhouses (Pegatin, 2009; Vasconcellos *et al*., 2009). It should be noted that in all 10 plants of the studied company, there were more female (58%) than male (42%) workers.

The number of accidents apparently reduced as the length of employment in the company increased; the shorter employment length, the higher the number of accidents. Out of the total number of workers, 67.9% (ANL NR: ANL WR: AWL) were injured when employed for than 36 months, and 47.3% of accidents with leave – the largest proportion – occurred when the workers were employed for 12 months or less. This is consistent with the finding of Vilela *et al*. (2012), who also found that the highest rates of accidents requiring leave happened within the first 12 months of employment, and recorded that the workers complained not having received proper training to safely carry out their activities, such as on the use of knives for carcass cut-up. Most accidents happen with less experienced workers (Araujo, 2008; Vilela *et al*., 2012). Studies in slaughterhouses in the USA indicate that workers receive little training and are often forced to work under the threat of dismissal if they refuse to work (Harmse *et al*., 2016; Human Rights Watch, 2004; Lipscomb *et al*., 2007).

The most common injuries among the three assessed criteria (ANL NR: ANL WR: AWL) were cuts and contusions. The body parts with the highest injury index were hands and fingers, which is consistent with other studies in slaughterhouses in Brazil and other countries, such as the USA, Portugal, New Zealand, Denmark, and Canada (Araújo, 2008; Buzanello & Moro, 2012; Health & Safety Executive, 2017; Musolin *et al*., 2013; Reis, 2012; Schulz *et al*., 2012; Thomsen *et al*., 2007; Vasconcellos *et al*., 2009).

Other authors attribute the high number of cut injuries to activities that require the use of knives and cutting equipment, such as saws and scissors, as well as to the strength and repetitive movement of the upper limbs, and to the workers' lack of training (Araújo, 2008; Buzanello & Moro, 2012; Musolin *et al*., 2013; Schulz *et al*., 2012; Vilela *et al*., 2012).

It should also be noted that the accident investigation documents used in this study indicate that in 41.6% of accidents, workers were not using personal protective equipment at the time of the accident. This may be related to several factors, such as a failure to provide PPE, inadequate PPE, lack of training on the proper use of PPE, and/or worker behavior in terms of disregarding the risks they are exposed to when performing their activities (Araújo, 2008).

In addition, Brazilian and international studies in slaughterhouses demonstrate that the speed of the processing lines is set according to the production process, regardless of worker capacity. This contributes to accidents that may occur when handling cutting equipment (Barros & Mendes, 2014; Lipscomb *et al*., 2007; Vasconcellos *et al*., 2009).

Considering the need of using cutting equipment and the high rate of accidents (41.7%) recorded because the workers were not using PPE at the time of the accident, there is a need to introduce new training methods of accident prevention, to determine criteria for the identification and control of occupational hazards, to carry out risk assessments of each job, considering the individual capacity of workers, and to provide training on the appropriate use of personal protective equipment, focusing on the development and improvement of a culture of work safety.

According to Table 1, among 1274 accident investigations, the unsafe personal factor accounted for the highest frequency of accidents, with 71.1% of the total.

As established in previous studies, a large proportion of the accidents are attributed to the unsafe personal factor, corresponding to about 70 to 80% of cases (Reason, 1990), in agreement with the results of the present study. However, stating that accidents occur due to personal recklessness is not sufficient to explain the causes of accidents at a level that can be used for organizational learning (Vilela *et al*., 2012). It should be kept in mind that human failure is the consequence and not the cause of the problem (Reason, 2002). A worker is influenced and provoked by factors concerning the work environment, and by organizational and managerial aspects (idem).

One of the options to diagnose the possible causes is to investigate accidents with the aim of understanding the possible determinants behind mishaps. The purpose of an investigation should not be to determine worker mistakes, but rather to understand the reasons why his/her actions or assessments made sense at the time of the accident (Dekker, 2002).

It is emphasized that accidents happen when a series of factors or causes converge under certain circumstances. There are only a few cases in which an accident or incident can be attributed to a single cause (Vilela *et al*., 2012). Companies and employees are generally aware of the factors and causes that lead to accidents.

Another important finding of the present study was that, for each accident resulting in registered leave, there were 1.7 accidents with no leave and need for activity relocation and 10.9 accidents with no leave and no need for activity relocation. This indicates that in the analyzed processing plants, accident distribution does not follow Frank Bird's pyramid theory, which is typically used to assess the probability of a possibly serious accident. This theory considers the ratio of 1:10:30:600, meaning that, for each serious accident, there are 10 minor ones, 30 with property loss and 600 minor accidents or near-miss accidents (Bird, 1985).

The analyses of the criteria of Frank Bird's pyramid and the results of the accident investigation documents show that the company's evaluation methodology is restricted to only two levels of the pyramid, which are major accidents and minor accidents, and that property damage and particularly near-misses, which theoretically are the base of the pyramid and the result of unsafe conditions, unsafe acts, and undesirable behaviors. The concept of Frank Bird's pyramid serves as a tool to analyze the risks and the prevention of accidents in a management system, aiming at the continuous improvement, minimization, and even elimination of unwanted events and their impacts. The lower in pyramid's base, the smaller are the chances of a major accident occurring (Bird, 1985).

In this context, statistically, in order to increase the possibilities of reducing accidents, especially those considered serious, it is essential to identify the data that compose the base of the accident pyramid, because only then it will be possible to propose actions to identify and control unsafe conditions and behaviors. It should be noted that, when identifying the causes of accidents in the present study, the causative condition of 71.1% of the accidents was attributed to the unsafe personal factor, which emphasizes the need to acknowledge the base of the pyramid.

Despite not following this theory, risk management becomes easier when an organization enters its own data and builds its own pyramid. Data are analyzed more easily and effectively and, more importantly, make sense to decision makers (Bird, 1985).

Considering the accident and incident frequency rates, for every million hours worked, rates of AWL: 3.2; ANL WR: 5.6 and ANL NR: 35.7 were calculated. These indicators can be used to control and to prevent accidents, as well as to compare companies of the same industry that have similar risk exposure, taking into account the time workers were exposed to risks (H) and extrapolating the indicators to 1,000,000 work hours.

Overall, the results indicate that the number of accidents in the analyzed processing plants is high, considering the frequency and severity rates, and is mainly due to serious accidents resulting in amputations. According to a study carried out in the USA, the slaughter and broiler processing industries have the highest accident and disease rates, more than double the averages of manufacturing activities (Human Rights Watch, 2004; Linder, 1995). The high number of accidents seems to be characteristic of the slaughtering and meat processing industries and is a problem for slaughter companies and particularly for society as a whole, which highlights the need to establish mitigation actions to reduce accidents in this sector.

It should be noted that there were serious accidents requiring amputations that counted as days with leave (300 days in unit 1; 600 days in unit 3; 100 days in unit 5; 75 days in unit 6; 60 days in unit 8; and 600 days in unit 9). Major hazards are one of the main reasons for controlling less serious incidents and accidents, according to accident-control theories (Bird, 1985): the greater the control of "deviations" or "incidents", the greater the chances of controlling major accidents.

It is observed that the consequences of accidents are indeed comparable with theories that maintain that the damage caused affects the victims, companies, and society alike. The outcomes include amputations, absence of 26% of the workforce for a day in a year, and 3,992 days with leave (possible workers removed by INSS).

It should be pointed out that in the study of Vilela *et al*. (2012), published before the issue and mandatory implementation of NR 36, the same proportion of 26% of workers off work was diagnosed, a value similar to that obtained in this study in plants that had already implemented the compulsory actions on specific work health and safety in slaughter and meat-processing companies established in the NR 36 regulation (NR 36: 2014). This regulation of the Brazilian Ministry of Labor, issued on April 18, 2013, NR 36 establishes the minimum requirements for the evaluation, control, and monitoring of risks in the activities undertaken in meat processing plants for human consumption, aiming at ensuring permanent workplace safety, health, and quality of life at work, without prejudice to compliance with the provisions of the other regulations of the Ministry of Labor (NR 36: 2014).

The results of the present study showed that application of the NR 36 requisites have not yet reduced the percentage of absenteeism in the evaluated processing plants.

In summary, accident prevention is the key to the effective management of the health, safety, and environment of any organization. Understanding the indicators of undesirable events helps to prevent the recurrence of accidents in general and those with a greater impact on the physical integrity of workers.

There is limited research on accidents in meat processing plants, and most studies focus on ergonomics (Buzanello & Moro, 2012; Santana, 2014; Vilela *et al*., 2012), despite the significant impact accidents have on this industry. Therefore, further research on the various risks involved in slaughter and meat-processing activities are needed to establish a corporate safety culture and to develop risk specific prevention tools (Harmse *et al*., 2016). In addition, such studies may aid the understanding the extent of risk exposure arising from those activities with the aim of maintaining workers' health and physical integrity, and of ensuring high productivity and a favorable perception of the meat-processing industry by the public.

CONCLUSIONS

The information obtained in the present study provides a diagnosis for managers, as well as health and safety prevention teams of meat-processing plants to allow them to act upon the causes of accidents, in addition to monitor and to compare indicators of accidents with no work leave in order to eliminate or to reduce the most frequent mishaps that require workers to be absent from work. This study aims at contributing to the current knowledge on this subject and at developing an epidemiological profile of occupational accidents in broiler processing and further-processing plants slaughterhouse and broiler processing industry that may aid to continuously improve working conditions.

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