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Original

Sources of Noise Pollution in Mashhad Railway Station

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Abstract

Background: Exposure to noise is an important safety and health problem in many industries. The rail transport industry is one of the industries involved with this problem due to the variety of equipment and its scope. The present study aimed to evaluate noise pollution and determine the sources of noise at Mashhad railway station. **Methods:** In this descriptive-analytic study in 2014, the departments with noise pollution were identified and studied based on an initial assessment of all parts of the railway station. Noise was measured in ten departments and units. The environmental and local noise was measured by calibrated sound level meter Model CEL485 in A and C networks according to ISO9612 and ISO 11200 standards. Then the collected data entered and analyzed in Surfer V.10 and Excel software. **Results:** The results of noise measurement showed that the average sound pressure level in units of Diesel GM, repair shop, refueling station, Diesel Siemens, and platform 3 was in hazard range. The results of measurement of the average sound pressure level in departments and units and the isosonic mappings drawn by Surfer V.10 software as well as the results of the average noise level in GM diesel showed that GM diesel (with LP=87.60 dB (A)) is the main source of noise at Mashhad railway station. The results of this study showed that diesel engines, gearboxes, moving trains, and beeps are the main noise generator components in GM diesel. The highest mean sound pressure level among these components was related to the diesel engine with an average sound pressure level of 87.60 dB (A). In general, the average sound pressure level of this diesel was 95.45 dB in the dominant frequency of 63 Hz. **Conclusion:** Based on the result of this study, GM diesel plays a major role in transporting at Mashhad railway station, accordingly the design and implementation of technical control measures such as chamber and enclosure of noise generator components are essential to reduce the average sound pressure level.

Keywords: Noise pollution; Noise source; Railway station; Diesel; Sound level meter

Introduction

Environmental pollution has attracted global attention in the last three decades and noise pollution of cities in most countries is a common problem.[1, 2] The performed studies showed that, 20 percent of urban people are exposed to noise 55 dB or more, and more than 65 percent of them experience over 55 dB in the outdoor environment.[3, 4] Today noise pollution is an important criterion for determining the life quality in cities and affects social well-being.[5] Exposure to excessive noise can have many hearing and non-hearing effects on the worker.

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Temporary and permanent hearing loss is one of the most common effects of noise on humans, which is caused by exposure to a noise pressure level more than 85dB. Also, prolonged exposure to noise in the workplace can lead to increased human error and occupational accidents due to increased fatigue and focus reduction. Other complications of exposure to noise are cardiovascular, digestive and neurological complications.[6-8]

Hence, it is necessary to consider the issue of controlling and reducing the sources of noise in macroeconomic planning in the environmental sector. Noise caused by the rail transport system is one of the most common sources of noise pollution in the urban environment.[9] The railway industry has many sources of noise, which causes intense noise around these resources, and a lot of workers and other people are exposed to this noise. The results of the conducted studies showed that the train noise is in a narrow band in terms of energy distribution and is usually in low frequency and personnel exposure during 8 hours of work (A) is 92 dB and most of them have a hearing impairment. [10-13] The noise generated by the railway is due to the use of various electric machines, locomotives, wheels on the rails, hazard signals, maintenance equipment, and construction equipment. The main sources of noise in electric wagons include the engine, gearbox, engine cooling system and wheel drive on the rails. Another important source of noise is compressed air conditioning or air-conditioning systems, especially in the case of stopping trains. Moreover, The movement of wheels on the rails, geometric shape of wagons, Curve radius of rails and brakes, has a great effect on noise formation.[14]

In this case, even if the noise produced by a device is lower than permissible level, due to the combination of different sources of noise and the phenomenon of rebounding and reflection of noise from the surfaces, the noise level can exceed to the maximum limit.[15, 16] Past studies have shown that among the railroad industry equipment, engine, gearboxes, moving trains and beeps are named as the most important sources of noise, and in some cases, the noise of these sources exceeds the recommended limits. [17, 18] In 2006, Janas Bazaras examined the noise pollution of Two types of trains include MB2 trains and TEP60 trains in Russia. Based on the results, the level of noise pressure in the driver's cabin of these two types of trains was higher than the permissible limit.[18, 19] In a study by Hamidi et al., entitled 'study of noise pollution in Urban and the suburb railway company of Tehran in 2010', it was concluded that the average of equivalent noise level in the cabin is lower than the permissible level, but inside the wagons exceeds permissible limit; Therefore, control and corrective actions to reduce the noise inside the wagons are necessary.[18]

Another study by Halvani et al., entitled 'noise-induced hearing loss among railroad workers in Yazd' showed that hearing loss in subjects was more frequent at frequencies of 250 and 500 Hz while hearing loss in the workplace starts at 4000 Hz and then transmits to higher and lower frequencies. This may be due to the fact that the train noise is more concentrated in the low-frequency range.[13] Regarding the mentioned issues, the assessment of railway noise in terms of exposure level and noise propagation is important and can be used to determine the sources of noise in the railways and, consequently, prioritize them in order to design and implement control measures. Studies have been carried out on the evaluation and control of the noise of the rail transport system through numerical and experimental models, but in most of them after the preliminary measurement of noise level, regardless of the exact identification of noise source, control measures are proposed; while this has been taken into account in this study. The purpose of this study was to evaluate the noise pollution and to determine the main sources of noise at the railway station of Mashhad.

Methods

This descriptive-analytic study was conducted to determine the level of noise pollution and also identifications of the main sources of noise at the Mashhad railway station in 2014. In this study, department, and sections with high noise level determined in the initial assessment and sound pressure level of all department and different units was measured and departments with known noise pollution were studied. In total, ten department and units were studied. It should be noted that there are several ways to select the main source of noise among several noise sources, such as measuring the noise pressure level at intervals between the two sources on closer or away from particular sources.[20-23]

The difference between background noise and source noise is one of the most well-known methods for identifying noise sources, but due to the working conditions of the railroad, there was no possibility to use the differential between background noise and source noise to determine the main source of noise. However, in the study, due to using the network and local measurement methods and referring to

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noise maps and isosonic curves, it was easy to determine the source of noise in the measuring units. In the network measurement method, according to the ISO9612, ISO 11200 standards, department and units with noise pollution that include platform 1, platform 2, platform 3, diesel repair shop and panel room were divided into square stations 5*5 meter according to their area and the centers of these squares were designated as the measuring station. Finally, the number of stations in the high-risk area (more than 85 dB (A)) was determined and recorded in each department and unit. In the local measurement method, the noise was measured based on the stopping and moving locations of workers in the units identified, including Hitachi diesel, GM Diesel, Siemens diesel, refueling station, and moving a train. It should be noted that in order to determine the overall exposure, the overall noise level was measured in network A and to ensure the accuracy of the frequency analysis, the total noise level is measured in the network C and frequency separation (16, 5/31, 63, 125, 250, 500, 1000, 2000, 4000, 8000, 16000). In this study, the sound level meter, CEL485 model which was made in England, used to measure noise. This device is designed according to IEC61672: 2002 standard.

The sound level meter device was set on the A and C frequency weights (at different time intervals) and the slow speed[24], and calibrated before the measurement began. When measuring the noise, the microphone was at least one meter away from reflective surfaces such as walls or cars. And the microphone was placed at a height of 1.5 meters from the ground[25, 26] and as far as the arm's length from the operator's body at 90-degree angle with the noise source. When using a sound level meter, because the operator is in front of the noise source; an error of up to dB6 may be generated. Therefore, sufficient accuracy was made during the sampling to prevent errors.[26, 27]

To minimize air currents, sponge protection was applied to the sensor.[28] The measurement time at each station was one minute. Measurements were made during a month and during peak traffic, hours between 7 am and 7 pm. According to the standard, the duration of the measurement is 3 minutes, but due to the instability of the environmental conditions and sources of noise in this place, it was considered 1 minute. Measurements were made according to Reference No. 2 in the most critical case, i.e. in the month of August during peak hours. After collecting the information, measuring and recording the noise pressure level (SPL), and the frequency analysis of average sound pressure level of each unit and department, the sum of sound pressure levels, and the mean sound pressure level were calculated using the formulas 1 and 2 and Excel software:

Formula 1:

$$LPt = 10LOG[\sum_{i=1}^{n} \frac{10LPi}{10}] \quad (dB)$$

Formula 2:

$$LP = 10LOG[1/n \sum_{i=1}^{n} 10LPi/10] \quad (dB)$$

The Word V.2010 software was used in order to draw tables and Surfer V.10 software was used to perform interpolation calculations and plot mapping of noise distributions and to determine the isosonic curves.

Results

The results of environment noise measurements indicated that the average sound pressure level was in the danger zone in units of GM diesel, diesel repair shop, refueling station, Diesel Siemens, and platform 3. The average sound pressure level of the departments and units measured at Mashhad railway station is presented in Table 1 by the measurement station. The highest mean sound pressure level is in GM diesel (87.60 dB (A)) and the smallest is the moving train (80.11 dB (A)).

Table 1. Measurement of the sound pressure level in departments/units at Mashhad railway station

Unit / department	Number of measuring station	The number of measuring station above dB 85	Minimum (dB(A))	Maximum (dB(A))	Equivalent sound pressure level (dB(A))
Platform 1	22	0	77.19	84.33	84.48
Platform 2	37	2	66.20	93.12	82.26
Platform 3	35	5	68.21	93.16	85.88
Hitachi Diesel	6	0	77.91	84.50	81.46
Diesel GM	6	4	83.17	91.40	87.60
Engine of Diesel Siemens	6	3	81.21	89.68	85.96
Diesel repair shop	50	39	81.40	92.66	87.14
Refueling station	11	5	82.69	89.68	86.11
Panel room	9	1	70.29	92.01	83.61
Moving train	3	2	80.72	91.94	80.11

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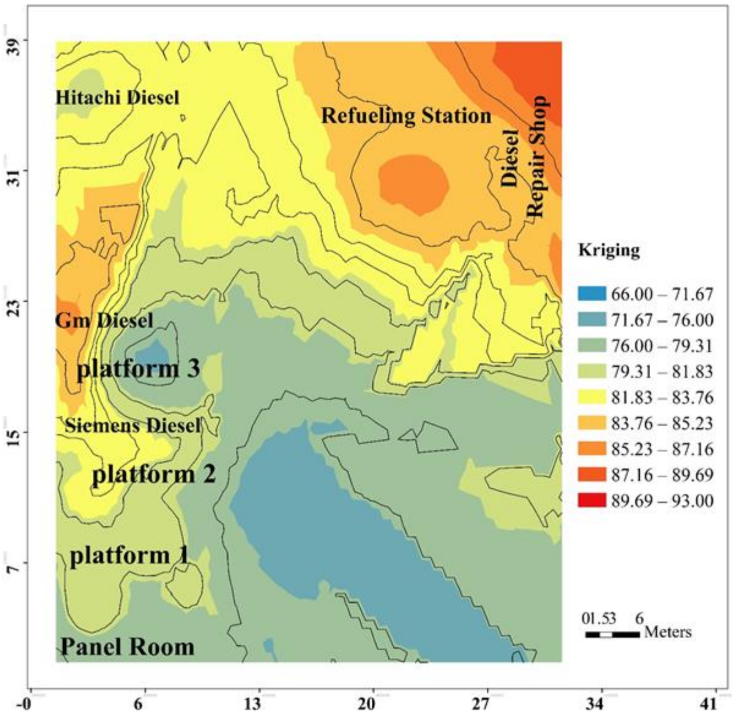

Figure 1. Isosonic map of the department and unite of Mashhad railway station.

Table 2. Results of measurement of noise pressure level in the main components of GM diesel

Unit / department	Number of measuring station	The number of measuring station above dB 85	Minimum (dB(A))	Maximum (dB(A))	Equivalent sound pressure level (dB(A))
GM diesel engine	6	4	83.17	91.40	87.60
Gearbox	8	2	83.10	88.34	84.97
Diesel horn	2	0	78.01	82.04	80.44
Moving train	3	2	80.72	91.94	80.11

Table 3. Frequency analysis and total sound pressure level of each of noise generating components of GM diesel in C network

Noise generating components of diesel	Frequency (Hz)											SPL (dB(C))
	16	31.50	63	125	250	500	1000	2000	4000	8000	57	
Diesel engine	70.00	98.64	100.53	96.70	89.50	92.05	90	92	92.40	81.50	59	95.45
Diesel gearbox	80.10	91.15	97.96	101	95.08	94.13	89	86	83.20	79.00	47	93.94
Moving train	74.50	80.13	85.01	84.10	90.56	90.61	87	80	71.70	68.10	61	94.91
Diesel horn	66.00	86.00	83.63	81.60	79.12	80.53	89	89	89.00	75.00	57	83.51

Isosonic map of the department and unite of Mashhad railway station is presented in Fig 1.

According to the results of Fig. 1, the highest mean sound pressure level is related to the stations around the GM diesel, diesel repair shop, refueling station, Siemens diesel, and platform 3. The results of measurement of an average sound pressure level in departments and sections and the isosonic mappings drawn by Surfer V.10 software as well as the results of the average noise level in GM diesel showed that GM diesel is the main source of noise at the Mashhad railway station.

To determine the noise of each component of this diesel, the noise of each component including the GM diesel engine, diesel gearbox, moving train with GM diesel and diesel horn, was measured and the average sound pressure level of each of them, and the sum of the noise pressure levels along with frequency analysis is presented in Tables 2 and 3. As it can be seen, according to Table 2, the highest average sound pressure level is related to the GM diesel engine (87.60 dB (A)) and is in the

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unauthorized range. Thereafter, gearboxes, beeps, and moving trains are located where the average sound pressure level is at the allowed level. The moving train has the lowest average sound pressure level (80.11 dB (A)). Also, according to Table 3, the highest sound pressure level is related to the diesel engine GM (95.45 dB (C)). This diesel has the highest sound pressure level (100.53 dB (C)) at 63 Hz frequency. The lowest total sound pressure level was related to the noise of diesel engine horn (83.51 dB (C)). In noise generating components in GM diesel, the frequency of 500 Hz is the predominant frequency.

Discussion

The purpose of this study was to assess the noise pollution of Mashhad railway station and determine the sources of sound in order to prioritize the implementation of control programs The results of the environmental noise measurement showed that the average sound pressure level was in the danger zone in units of GM Diesel, repair shop, refueling stations, Diesel Siemens, and platform 3. The highest mean of a noise pressure level in units and departments was related to GM diesel and the lowest was for the moving train. The application of diesel GM in most units and departments that have average noise pressure level above the permissible limit, isosonic mapping, and isosonic curves, as well as measurement results of the noise level in diesel GM showed that this diesel is the main source of noise at Mashhad railway station.

The high average sound pressure level in diesel GM can be attributed to its constituent parts, including the diesel GM engine, diesel gearbox, and beep and diesel motion. Also, the results of measuring the mean sound pressure level of noise-producing components in GM diesel showed that among the four components of this diesel, the highest mean sound pressure level is related to engine of diesel GM which is within the range of danger.

According to the results of this study, among other components of diesel GM gearbox, beeps and diesel motion have the highest average noise level, respectively. However, their average sound pressure level is within the allowed range. The moving train has the lowest level of sound pressure. The aerodynamic noise from moving the train at high speeds, the noise from the movement of wheels on the rails, the geometric shape of the wagons and radius of curvature of rails, and brakes creates high-level noise in these trains.[14]

Building materials used at the internal surface of units and departments as well as the type of wagons and diesel and the construction of various parts of Mashhad Railway Station such as the repair shop and the number and type of metal equipment and diesel engines can increase the reflection of the surface, thereby exacerbating the noise pressure. The results of this study are consistent with other studies carried out at railway stations. For example, Hu Da and Chen Yafei studied the effects of railways noise in residential areas of Beijinyuan in 2010, which the results showed that noise was higher than the standard level.[29, 30] Also, Gorgani et al. (2013) studied sources of noise pollution in the rail system and provided control measures.[31, 32] In the study by Ali-Mohammadi et al. in 2008, the noise pollution caused by railway lines in west of Ahwaz was investigated and the results showed that train noise was higher than standard and noise control solutions were proposed for noise reduction.[30-32]

The results of noise measurements in units and department of Mashhad railway station and its interpolation by Surfer V.10 revealed that noise emission around diesel GM was in the highest value and, in most cases, its value is in risk level (85 dB), and in some cases, it exceeded 100 dB (A). The cause of high noise caused by diesel is due to its large dimensions, the mechanical complexity of its components, the friction of components within the equipment such as engines, gears and wheels, and old and worn out diesel. In the present study, the result of noise measurement by the local method in diesel GM and its components showed that the average sound pressure level of the engine of diesel GM is at highest level compared with other noise-generated diesel GM engine components. Based on the above, the design and implementation of noise control measures in diesel GM are prioritized to reduce noise to acceptable limits. In other words, given that noise generator components in GM diesel, especially the diesel engine, have the highest average sound pressure level, the design and implementation of control measures, including the design and installation of the chamber and the enclosure of the engine, can have a significant effect on reducing the noise of this source and total diesel, and ultimately reducing the noise of units and departments. In general, the following

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noise controls measures are recommended for noise control:

1. Daily inspections of equipment, especially diesel equipment, as well as their proper maintenance.

2. Installing a noise absorbent with a dominant frequency of 1000-500 Hz on the surface of equipment producing noise sources and surfaces such as concrete walls, ceilings, ventilation and so on, which has low absorption coefficients.

3. Designing and installing a chamber with compact layering on the engine of diesel GM.

All methods are practicable and even in some cases, as in the case of 1 and 2, it is quite possible

Conclusion

The results of this study showed that the average sound pressure level in units of GM Diesel, repair shop, refueling stations and platform 3 was in the danger zone. Among the units and departments where the average noise level is unauthorized, diesel GM is known as the main source of noise. And among the noise-generating components in the diesel GM, which included a diesel engine, gearbox, diesel engine, and train movement, the diesel engine has a major role in causing noise pollution. Therefore, it is necessary to design and implement control measures to reduce the average noise pressure level in these components and equipment.

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References

1. Girard SA, Leroux T, Courteau M, Picard M, Turcotte F, Richer O. Occupational noise exposure and noise-induced hearing loss are associated with work-related injuries leading to admission to hospital. Injury prevention. 2015;21(e1):e88-e92.
2. Fathi S, Nassiri P, Monazzam EPM, Mansouri N, Razzaghi BF. Study of noise pollution in the district 5 of tehran municipally. Environmental science and technology. 2015;17(2):1-7. [Persian]
3. Gheorghe A, Stanners D, Henrichs T. Europe's environment: the fourth assessment: european environment agency. EU: European Environment Agency; 2007.
4. Sheng G. Vehicle noise, vibration, and sound quality. US: SAE; 2012.
5. Ghatass ZF. Assessment and analysis of traffic noise pollution in Alexandria City, Egypt. World Applied Sciences Journal. 2009;6(3):433-41.
6. Amjad-Sardrudi H, Dormohammadi A, Golmohammadi R, Poorolajal J. Effect of noise exposure on occupational injuries: a cross-sectional study. Research in health sciences. 2012;12(2):101-4.
7. Eriksson HP, Andersson E, Schiöler L, Söderberg M, Sjöström M, Rosengren A, et al. Longitudinal study of occupational noise exposure and joint effects with job strain and risk for coronary heart disease and stroke in Swedish men. BMJ open. 2018;8(4):e019160.
8. Jahangiri M, Golmohammadi R, Aliabadi M. Determination of main noise sources in a thermal power plant. Health and Safety at Work. 2014;4(3):13-22. [Persian]
9. Abbaspour M, Karimi E, Nassiri P, Monazzam MR, Taghavi L. Hierarchal assessment of noise pollution in urban areas–A case study. Transportation Research Part D: Transport and Environment. 2015;34:95-103.
10. WHO. Health hazards of the human environment. US; WHO: 1972.
11. McReynolds MC. Noise-induced hearing loss. Air Medical Journal. 2005;24(2):73-8.
12. Henderson D, Saunders SS. Acquisition of noise-induced hearing loss by railway workers. Ear and hearing. 1998;19(2):120-30.
13. Halvani GH, Barkhordari A, Askarshahi M. Noise-induced hearing loss among rail road workers in Yazd. 2005;13(2):56-62.
14. Abbas Pour M, Mir HeidariF. Measuring the noise caused by Tehran Metro. Bimonthly Audiology-Tehran University of Medical Sciences. 1999;7(1-2):58-63.[Persian]
15. Virkkunen H, Kauppinen T, Tenkanen L. Long-term effect of occupational noise on the risk of coronary heart disease. Scandinavian journal of work environment and health. 2005;31(4):291-9.
16. Noorpoor A, Bayatian M, Motaghed S, Jamshidi Moghadam A, Rahmati N. Survey and Analysis of Noise Pollution in the Bidboland Gas Refinery. Pollution. 2016;2(3):331-8.
17. Mehrzad S. Pollution noise of subway train. University of science and industry, Faculty of railway. 2001.
18. Hamidi M, Kavousi A, Nasiri P, Hamedani A, Kiani S, Dehghan H. Study of noise pollution in urban and the suburbs railway company of Tehran in 2010. Iran occupational health. 2012;9(1). [Persian]
19. Bazaras J. Internal noise modelling problems of transport power equipment. Transport. 2006;21(1):19-24.
20. 20-Rasmussen G. Determination of sound power levels of noise sources using sound intensity points versus scanning. [POSTER] at: proceeding of the International congress on noise control engineering; 1996 Jul 30- Aug 2. Liverpool, UK. St Albans: Institute of Acoustics; 1996.
21. Golmahamadi R. Noise characteristics of pumps at tehran's oil refinery and control module design. Pakistan journal of scientific and industrial research. 2009;52:167-72.

[DOI: 10.18502/aoh.v3i2.669]

22. refinery. Research in health sciences. 2011;11(1):14-9.
23. Nassiri P, Monazzam MR, Farhang Dehghan S. Evaluation of noise pollution and possibility of its control in a petrochemical plant. Health and safet at work. 2011;1(1):1-8.
24. ISO E. 11200 (1995) Acoustics–Noise emitted by machinery and equipment–Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and other specified positions (ISO 11200: 1995). European Committee for Standardization (CEN), Bruxelles; 2014.
25. Irwin JD. The industrial electronics handbook US: CRC Press; 1997.
26. Nassiri P, Zare M, Golbabaei F. Evaluation of noise pollution in oil extracting region of Lavan and the effect of noise enclosure on noise abatement. Iran occupational health. 2007;4(3):49-56. [Persian]
27. Newaz MT, Davis PR, Jefferies M, Pillay M. Developing a safety climate factor model in construction research and practice: A systematic review identifying future directions for research. Engineering, construction and architectural management. 2018;25(6):738-57.
28. Rynell A, Efraimsson G, Chevalier M, Abom M. Acoustic characteristics of a heavy duty vehicle cooling module. Applied acoustics. 2016;111:67-76.
29. Da Hu. Yafei C. Discussion on the applicable standards of railway environment noise SICoMAaCE-J. [POSTER] at: proceeding of the Second International Conference on Mechanic Automation and Control Engineering; 2011 Jul. 15-17 Hohhot, China. New York: IEEE; 2011 :5741-3.
30. Seyyed KHandan Z, Fadavi Hosseini H, Rahnavard A. Investigation of noise pollution caused by passing of train in residential areas of Sari city. [POSTER] at: Proceeding of the First National Conference on Environment, Energy and Bio-Defense; 2018 sep. 29; Iran, Tehran. Tehran: Higher Education Institution of Mehr Arvand, Promotiondepartment of Environmental Lovers; 2018. [Persian]
31. Gorgani H, GHasempour SH. The sources of noise pollution in the rail system and the provision of control measures,. [POSTER] at: proceeding of the third conference on recent developments in railway engineering; 2013 Apr30-1May. Tehran: University of Science and Technology; 2013. [Persian]
32. Alimohammadi I. Measuring sound volume and providing sound maps in sensitive areas around the railway of west ahwaz and providing ways to reduce its effects, Eleventh National Conference on Environmental Health; 2008 oct. 28; Zahedan. Zahedan University of Medical Sciences, School of Public Health;2008. [Persian]

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