

Acoustic assessment of industrial noise generated by operational installations in the RA1K refinery, Skikda (Algeria)

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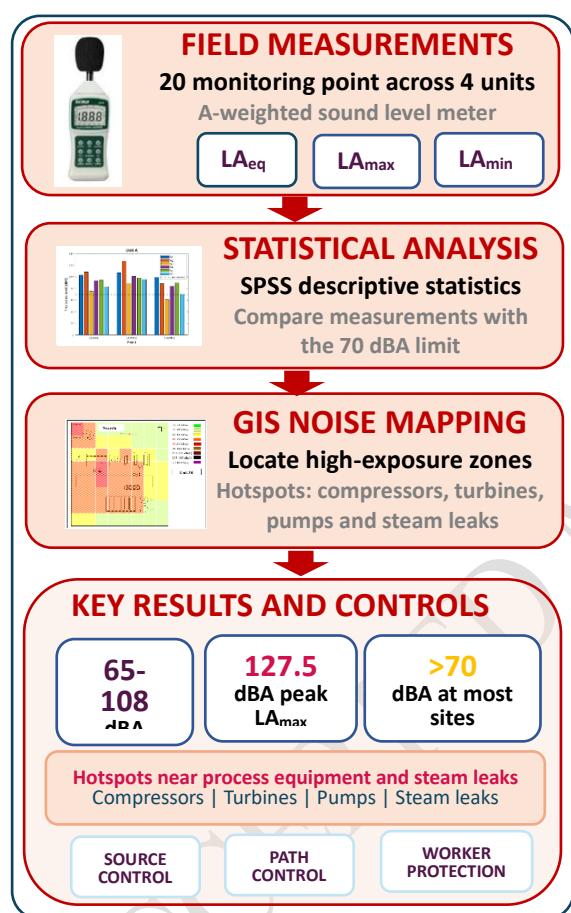
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Graphical abstract



Abstract

Industrial noise pollution poses significant occupational and environmental challenges in large petrochemical plants. This study presents an acoustic assessment and GIS-based spatial modelling of noise in the RA1K refinery, Skikda (Algeria). Field measurements using an A-weighted sound level meter were used to determine LA_{eq} (equivalent continuous sound pressure level), LA_{max} (maximum sound pressure level), and LA_{min} (minimum sound pressure level) at multiple monitoring locations.

Results show that LA_{eq} values ranged from approximately 65 to 108 dBA, with peak LA_{max} values reaching 127.5 dBA near compressors and pumps. Most monitoring points exceeded the Algerian regulatory limit of 70 dBA, indicating widespread occupational noise exposure across the refinery. High noise levels were mainly associated with compressors, turbines, pumps, and steam leakage zones.

GIS-based mapping identified strong spatial variability in noise distribution, highlighting localized high-risk areas within the industrial complex. A noise propagation model considering geometric attenuation, atmospheric absorption, and structural barriers was applied to interpret sound dispersion patterns.

The findings confirm the effectiveness of integrating field measurements and GIS techniques for industrial noise assessment and support the implementation of engineering control measures such as acoustic enclosures and silencers.

Keywords: GIS, industrial noise, pollution, RA1K refinery, spatial analysis.

1. Introduction

The rapid technological advancements worldwide have catalyzed significant transformations in the nature of work, resulting in increasingly complex systems and working environments characterized by numerous occupational hazards detrimental to workers' health. These hazards include time constraints, accelerated work pace, insufficient rest intervals, exposure to workplace noise, and handling of chemicals, particularly carcinogens (Arnaudo et al., 2010; Garg et al., 2024). These factors refer to conditions that may lead to hazardous situations capable of causing

workplace accidents or occupational diseases (Bell et al., 2017; Hemmat et al., 2023).

Noise, as a form of sound, is a prevalent environmental pollutant widely recognized for its adverse health effects. The term “noise” is etymologically derived from the Latin word “nausea,” originally referring to seasickness (Patel et al., 2024 ; Taoussi et al., 2022). From a technical perspective, noise is defined as any undesirable, unpleasant, unexpected, or excessively loud sound exceeding permissible threshold levels. Elevated noise pollution levels are responsible for a broad spectrum of health effects, ranging from mild to severe, and significantly deteriorate quality of life. It is widely acknowledged as a major environmental threat resulting from extensive industrial development over time (WHO, 2018).

With ongoing industrial expansion and population growth, noise pollution continues to increase, distinguishing itself from soil, water, and air pollution due to its diverse and widespread sources, which pose substantial health risks, particularly in urban and suburban areas. Anthropogenic activities represent the primary contributors to noise pollution; among these, industrial noise stands out as a global concern closely associated with industrial development. (Basner et al., 2019; Clark et al., 2018).

Industrial noise has a wide range of effects on both auditory and overall health, including hearing loss, psychological disorders, hypertension, and cardiac arrhythmias (Hammer et al., 2013; Münzel et al., 2018; Abaya et al., 2025).

In addition, it can lead to sleep disturbances, irritability, stress, reduced work performance, and difficulties in speech comprehension (Halonen et al., 2016; El Aarbaoui. Et al., 2017).

The primary risk associated with noise exposure is hearing impairment. Studies have shown a significant increase in hearing loss in individuals exposed to noise levels exceeding 90 dB over prolonged periods (Basner et al., 2014). Furthermore, noise pollution has been shown to negatively affect children’s cognitive development; prolonged exposure may cause substantial harm to the developing brain, potentially leading to cognitive impairments (Kageyama et al., 2016; Smith, 2005; Bilenko et al., 2015). A 2011 World Health Organization (WHO) report indicated that environmental noise reduces disability-adjusted life years in Western European populations by 1–1.6 million years (WHO, 2011;). Additionally, the 2014 European

Environmental Agency estimated that in Europe, more than 125 million individuals were exposed to noise levels of 55 dB or higher, while over 37 million were exposed to levels of 65 dB or higher (EEA, 2014).

Noise pollution (Paunović et al.) poses a significant challenge for both workers and the environment in refineries, primarily due to the continuous operation of heavy machinery such as compressors, turbines, pumps, and steam release systems. These machines generate high noise levels that may adversely affect hearing and overall health. Noise levels can be extremely high and are perceptible throughout the entire refinery (Pischedda et al., 2018; Nasrolahi et al., 2025). Recent studies emphasize the necessity of managing noise levels in refineries and developing effective mitigation strategies. It is essential to ensure that noise exposure remains within safe limits for workers. Several researchers have developed frameworks to understand noise propagation within refineries and its impact on occupational exposure (Ghobadi et al., 2025). Prolonged exposure to noise may lead to hearing impairment, sleep disturbances, cardiovascular stress, and reduced cognitive performance (Quiñonez et al., 2025; Bozkurt, 2021). Current approaches include spatial noise mapping and real-time monitoring to identify high-exposure zones. Engineering measures such as acoustic enclosures, noise barriers, and operational optimization are commonly employed. Furthermore, predictive computational models are used to simulate noise distribution and support mitigation planning, thereby contributing to improved occupational health in refinery environments (Chis et al., 2025; Hamamcı et al. 2024; Tan et al., 2023).

Environmental noise pollution is a significant issue in Skikda, Algeria, where industrial activities, urban traffic, and anthropogenic sources constitute the main contributors. The eastern industrial zone, particularly the Skikda industrial area, represents a major source of noise pollution due to its extensive scale and coastal location (Asghari et al. 2024; Ghachi et al., 2015). Industrial noise and its adverse health effects have been extensively investigated, however, the application of geographic information systems for the spatial assessment of occupational noise exposure in refinery environments remains limited, particularly in Algeria. This study introduces a GIS-based approach using ArcGIS 10.4.1 to assess and visualize occupational noise exposure within the RA1K refinery in Skikda,

facilitating the identification of high-risk areas and supporting effective noise control strategies.

2. Materials and methods

2.1. Study location

Algeria's refining sector currently operates four refineries: Algiers, Arzew, Skikda (RA1K Topping and condensate), and Hassi Messaoud. Located along the northern coastline, Skikda hosts the country's largest refinery, as illustrated in Figure 1.

The RA1K refinery is situated within the eastern industrial zone of Skikda, covering an area of

more than 1200 hectares along the Mediterranean coast. With a daily processing capacity of 350,000 barrels of crude oil, it accounts for more than half of Algeria's total refining capacity. The RA1/K complex is responsible for processing crude oil transported from Hassi Messaoud. Currently, the company employs over 1,500 people (Ministry of Energy Algeria, 2020; Sonatrach., 2019).

The present study focused on four operational units: Utility CTE (Unit A), Gas Treatment Unit 30 (Unit B), Gas Separation Unit 31 (Unit C), and Aromatic Extraction Unit 200 (Unit D), as shown in Table 1 (Ministry of Energy Algeria, 2020

Table 1. Monitoring points and operational functions of the investigated refinery units.

Unit	Name	Points	Tasks
Unit A	Utility CTE	A1 (Zone 1: 1050 MP1 A-B)	Thermal power plant and utilities
		A2 (Zone 1: 1080 MK/TK)	
		A3 (Control room)	
		A4 (Zone D: turbo room (steam leak))	
		A5 (1020 MP1 A-B)	
		A6 (Under the air)	
Unit B	Unit 30	B1 (Zone E: around the 30-MP1 pumps)	Treatment and separation of gases
		B2 (30-MP7 A-B)	
		B3 (Control room)	
		B4 (30-C4 A-B)	
Unit C	Unit 31	C1 (Zone F31-MP2 A-B (steam leak))	Treatment and separation of gases
		C2 (Column 31-C1 and 31-C2)	
		C3 (Control room)	
		C4 (31-E7A)	
		C5 (31-E7A and 31-E9)	
Unit D	Unit 200 Aromatic Benzene	D1 (Zone G: 200 V1 ball)	Extraction of aromatics
		D2 (200-C 8)	
		D3 (200-V 32 and 200-V 33)	
		D4 (200-P 15)	
		D5 (Control room)	

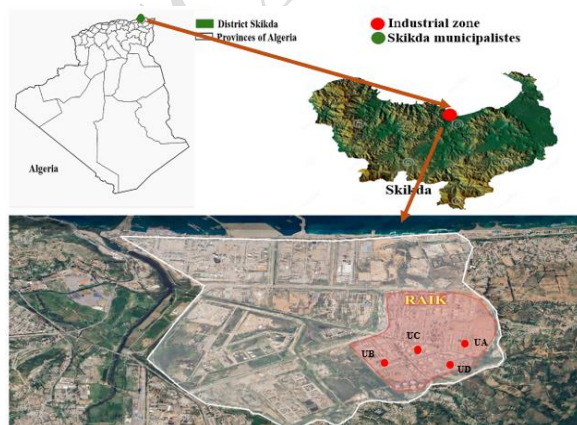


Figure 1. Location map of the RA1K refinery, Skikda, Algeria.

2.2. Measurement of noise pollution

The study concentrated on the production units exposed to daily noise, encompassing all production units (10, 11, 30, 31, 200, and the CTE utility unit) of the Skikda RA1K refinery. Manual field measurements were conducted to collect data on environmental noise levels. This approach was used to determine sound pressure level measurements at each unit, enabling the development of spatial noise maps for each unit and the identification of equipment responsible for elevated noise levels for subsequent analysis and recommendations. Sound pressure levels were measured at 30 different monitoring points distributed across six units over a six-month

period. Measurements were carried out several times per day, between 6:00 a.m. and 10:00 a.m. The recorded results at each measurement point were obtained with high accuracy, as the selected locations represented diverse geographical and environmental conditions across the study area.

After data collection, the measurements were entered into SPSS software for systematic organization and analysis. A database was created comprising all measurement points and their corresponding noise levels, facilitating accurate statistical analyses and the extraction of relevant information for assessing noise levels across the different units. SPSS was used to determine the maximum (LA_{max}), minimum (LA_{min}), and equivalent continuous sound pressure levels (LA_{eq}) at each measurement point. Noise measurements were conducted using an integrated Sound Level Meter (SLM). The instrument employed was an Extech SL120 Model 407730 operating with A-weighting, within a frequency range of 300 Hz–8 kHz and an accuracy of ± 2 dB at 1 kHz. The sound level meter was calibrated using the internal acoustic calibrator at a frequency of 1 kHz and reference sound pressure levels of 94 or 114 dB. To ensure accurate noise measurements, the microphone of the sound level meter was positioned at ear level in the worker's hearing zone.

2.3. Statistical analysis

Descriptive statistical methods were applied to analyze the collected noise data. Noise levels were expressed in terms of minimum, maximum, and equivalent continuous sound pressure levels. The measured noise levels were classified into the following risk categories: safe (70–77 dBA), low risk (75–80 dBA), guarded risk (80–85 dBA), moderate risk (85–90 dBA), elevated risk (90–95 dBA), high risk (95–100 dBA), very high risk (100–105 dBA), severe risk (105–110 dBA), and extremely high risk (>110 dBA).

The noise maps presented in this study were generated using ArcGIS software. Initially, the measured data were imported into the ArcGIS database and subsequently processed for noise mapping. This procedure involved two main steps: first, the layout of each operational unit was drawn; second, the measured sound pressure level values from all monitoring stations were entered

into the software database. Finally, contour maps of sound pressure levels at the measurement height were generated using the software tools (Faramarz Majidi et al 2016).

3. Results and discussion

Noise measurements were conducted at 20 monitoring points distributed across the four production units using a Sound Level Meter (SLM). Table 2 presents the noise level values recorded at all measurement points. The regulations established under Algerian Executive Decree No. 93-184, issued on July 27, 1993, define the permissible noise emission limits for urban and industrial areas. According to this decree, the allowable noise levels in urban areas, industrial zones, public spaces, and roads are set at 70 dBA during the daytime period (6:00 a.m. to 10:00 p.m.) and 45 dB(A) during the nighttime period (10:00 p.m. to 6:00 a.m.) (Algerian Executive Decree No. 93-184, 1993).

Figure 2 shows the noise levels measured at six monitoring points within Unit A (A1, A2, A3, A4, A5 and A6), including LA_{eq} , LA_{max} , LA_{min} , and the permissible limit. Point A2 recorded the highest equivalent, maximum, and minimum noise levels within the unit, with values of 108 dBA, 127.5 dBA and 88.2 dBA respectively. In contrast, point A3 exhibited the lowest LA_{eq} , LA_{max} and LA_{min} values among all monitoring locations in Unit A, with recorded levels of 75 dBA, 88.9 dBA, and 61 dBA. The results further indicate that the LA_{eq} values at all monitoring points within Unit A exceeded the permissible regulatory limit.

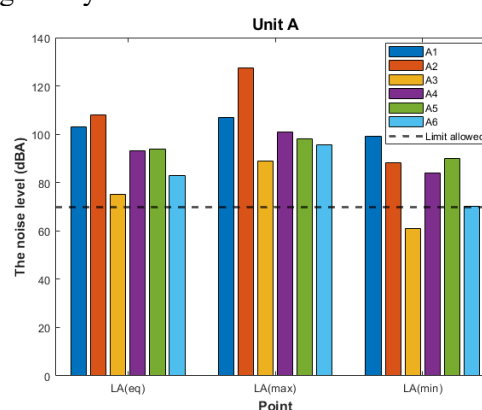


Figure 2. Measured noise levels (LA_{eq} , LA_{max} , and LA_{min}) at monitoring points within Unit A.

Table 2. Sound pressure level measurements at monitoring points within the investigated refinery units.

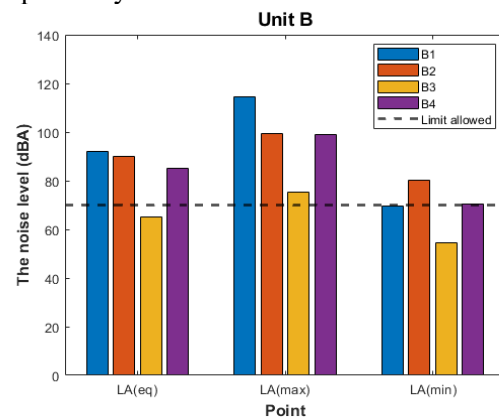
	Point	LA _{eq} (dBA)	LA _{max} (dBA)	LA _{min} (dBA)	Level of noise allowed (dBA)
Unit A	A1	103.00	106.90	99.10	70.00
	A2	108.00	127.50	88.20	
	A3	75.00	88.90	61.00	
	A4	93.00	100.80	84.10	
	A5	94.00	98.10	89.90	
	A6	83.00	95.80	70.20	
	Total LA _{eq}	92.66	103.00	82.08	
Unit B	B1	92.00	114.50	69.50	70.00
	B2	90.00	99.40	80.40	
	B3	65.00	75.20	54.60	
	B4	85.00	99.10	70.60	
	Total LA _{eq}	83.00	97.05	68.77	
Unit C	C1	100.00	108.60	91.20	70.00
	C2	90.00	99.30	80.40	
	C3	65.00	77.20	52.50	
	C4	95.00	101.60	88.10	
	C5	88.00	98.40	77.10	
	Total LA _{eq}	87.60	97.10	77.86	
Unit D	D1	97.00	101.90	91.80	70.00
	D2	94.00	105.10	82.50	
	D3	90.00	109.70	70.10	
	D4	97.00	99.80	91.50	
	D5	70.00	74.10	65.40	
	Total LA _{eq}	89.60	98.12	80.26	

Figure 3 presents the noise levels measured at four monitoring points (B1, B2, B3 and B4) within Unit B, including LA_{eq}, LA_{max}, LA_{min} and the permissible noise limit. Point B1 recorded the highest equivalent noise level (LA_{eq}) at 92.00 dBA. It also exhibited the highest maximum noise level (LA_{max}) of 114.50 dBA, while the minimum noise level (LA_{min}) was 69.50 dBA. Point B2 ranked second, with an LA_{eq} of 90.00 dBA, an LA_{max} of 99.40 dBA, and the highest LA_{min} value of 80.40 dBA. Point B4 recorded an LA_{eq} of 85.00 dBA, an LA_{max} of 90.10 dBA, and an LA_{min} of 70.60 dBA. In contrast, point B3 exhibited the lowest noise levels within Unit B, with an LA_{eq} of 65.00 dBA, an LA_{max} of 75.20 dBA, and an LA_{min} of 54.60 dBA.

The results indicate that point B3 was the only monitoring location where the equivalent noise level remained below the permissible regulatory limit.

Figure 4 illustrates the noise levels measured at five monitoring points (C1, C2, C3, C4, and C5) within Unit C. Point C1 recorded the highest equivalent noise level, with an LA_{eq} of 100.00 dBA. This location also exhibited the highest

maximum and minimum noise levels, with LA_{max} and LA_{min} values of 108.60 dBA and 91.20 dBA, respectively.

**Figure 3.** Measured noise levels (LA_{eq}, LA_{max}, and LA_{min}) at monitoring points within Unit B.

This was followed by points C5, C4, and C2, which recorded LA_{eq} values of 88.00 dBA, 95.00 dBA, and 90.00 dBA, respectively. The corresponding LA_{max} values were 98.40 dBA, 101.60 dBA, and 99.30 dBA, while the LA_{min} values were 77.10 dBA, 88.10 dBA, and 80.40 dBA, respectively. In contrast, point C3 exhibited the lowest noise levels within Unit C, with an

LA_{eq} of 65.00 dBA, an LA_{max} of 77.20 dB(A), and an LA_{min} of 52.50 dBA. The results indicate that point C3 was the only monitoring location within Unit C where the equivalent noise level did not exceed the permissible limit.

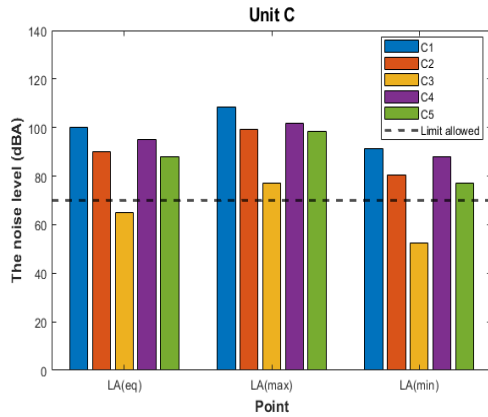


Figure 4. Measured noise levels (LA_{eq} , LA_{max} , and LA_{min}) at monitoring points within Unit C.

Finally, Figure 5 presents the noise levels measured at five monitoring points (D1, D2, D3, D4, and D5) within Unit D. As shown in the figure, only point D5 recorded an equivalent noise level below the permissible limit of 70.00 dBA, whereas all other monitoring points exhibited noise levels exceeding the regulatory threshold.

The noise measurements obtained from the four investigated units (Units A, B, C, and D), as presented in Table 2, confirm the presence of significant noise pollution within the refinery. Overall, Figures 2, 3, 4, and 5 indicate that the majority of LA_{eq} values recorded across the four units exceeded the permissible noise limit of 70 dB(A), demonstrating widespread occupational noise exposure throughout the study area.

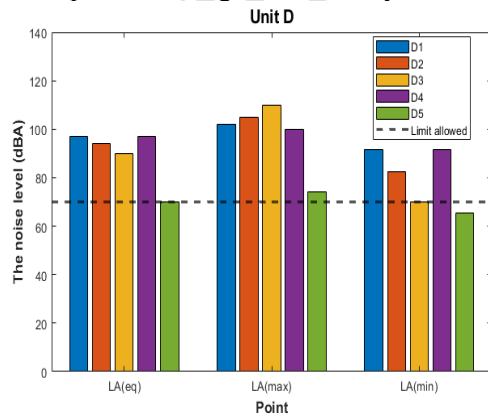


Figure 5. Measured noise levels (LA_{eq} , LA_{max} , and LA_{min}) at monitoring points within Unit D.

The average equivalent continuous sound pressure level (LA_{eq}) for the monitoring points in each unit is presented in the following order:

- Unit A: $LA_{eq}(A2) > LA_{eq}(A1) > LA_{eq}(A5) > LA_{eq}(A4) > LA_{eq}(A6) > LA_{eq}(A3)$
- Unit B: $LA_{eq}(B1) > LA_{eq}(B2) > LA_{eq}(B4) > LA_{eq}(B3)$
- Unit C: $LA_{eq}(C1) > LA_{eq}(C4) > LA_{eq}(C2) > LA_{eq}(C5) > LA_{eq}(C3)$
- Unit D: $LA_{eq}(D1) = LA_{eq}(D4) > LA_{eq}(D2) > LA_{eq}(D3) > LA_{eq}(D5)$

The total average equivalent continuous sound pressure level across the four units is ranked as follows:

- LA_{eq} : Unit A > Unit D > Unit C > Unit B.

3.1. Noise mapping

The ArcGIS software was used by importing the measured data directly into its database, which was subsequently processed for noise mapping. Initially, the layout of the four operational units was digitized, followed by the input of measured sound pressure level values for all monitoring stations into the software attribute table. Finally, using the mapping tools within the software, contour maps of sound pressure levels at the measurement height were generated for each unit. The following figures present the noise distribution maps for the four investigated units.

Unit A is divided into two zones:

- Zone 1: Boiler and air compressor zone
- Zone 2: Effluent treatment, air-cooled condenser, potable water and firefighting zone.

A. Unit A - Zone 1

Figure 7 shows the spatial distribution of noise in zone 1 of Unit A. The 85 dBA alert level is exceeded across the entire zone, while the 90 dBA danger threshold is surpassed in approximately 75% of the area, which is significant given the spatial extent of the unit. Two main equipment groups are primarily responsible for the elevated noise levels. A study on the assessment of noise pollution from the activities of the Kaduna Refining and Petrochemical Company (KRPC) (Shagari et al., 2018) also confirmed that compressors and motor pumps are the major contributors to industrial noise emissions.

B. Unit A

Figure 8 presents the spatial distribution of noise in Unit A. In this simplified mapping of a relatively large area, noise levels exceed acceptable limits mainly in the vicinity of turbine-type machinery and steam leakage points. The two areas exhibiting elevated noise levels are located near steam discharge sources, including

the turbine room and the turbo pump area (1020 to air cooler). Overall, noise levels remain within acceptable thresholds for approximately 80% of the unit (<85 dBA). However, the 90 dBA danger

threshold is exceeded in approximately 5% of the unit.

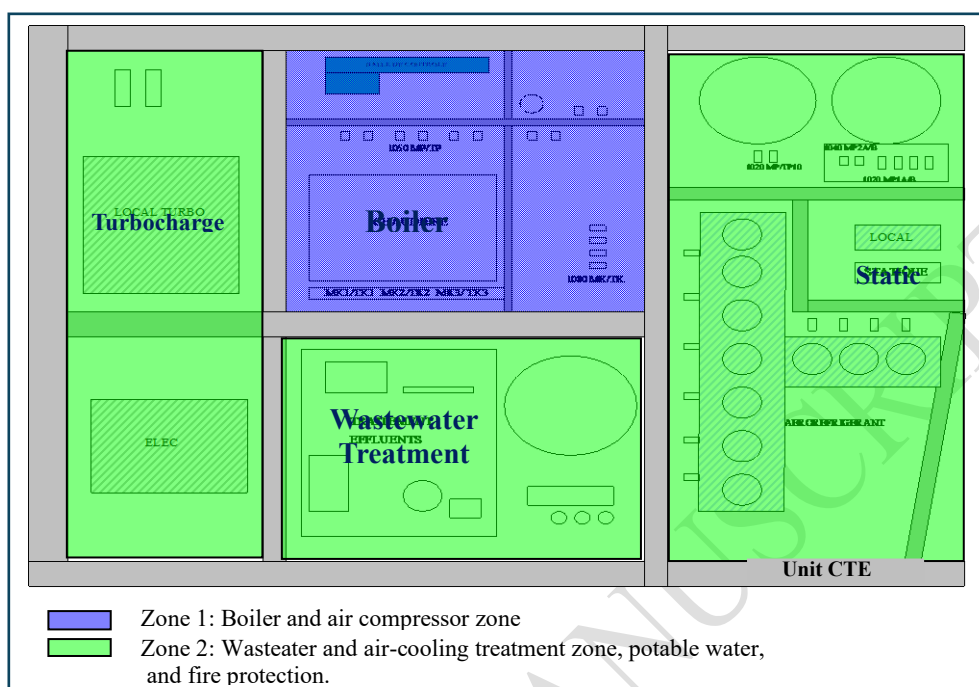


Figure 6. Spatial zoning of Unit A (Zone 1 and Zone 2).

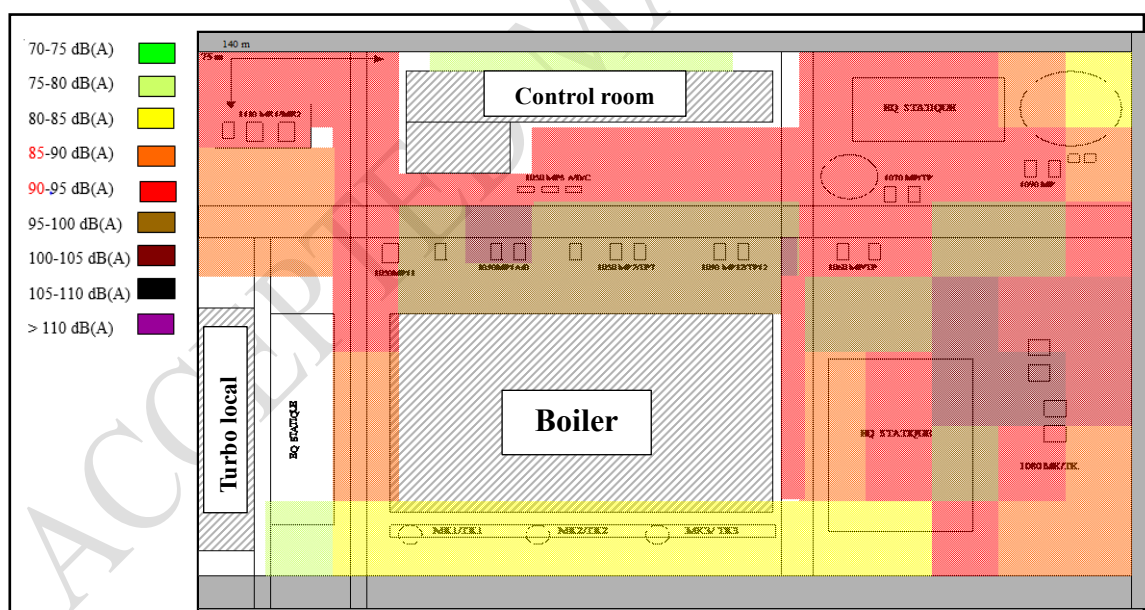


Figure 7. Spatial distribution pattern of sound pressure levels in Zone 1 of Unit A.

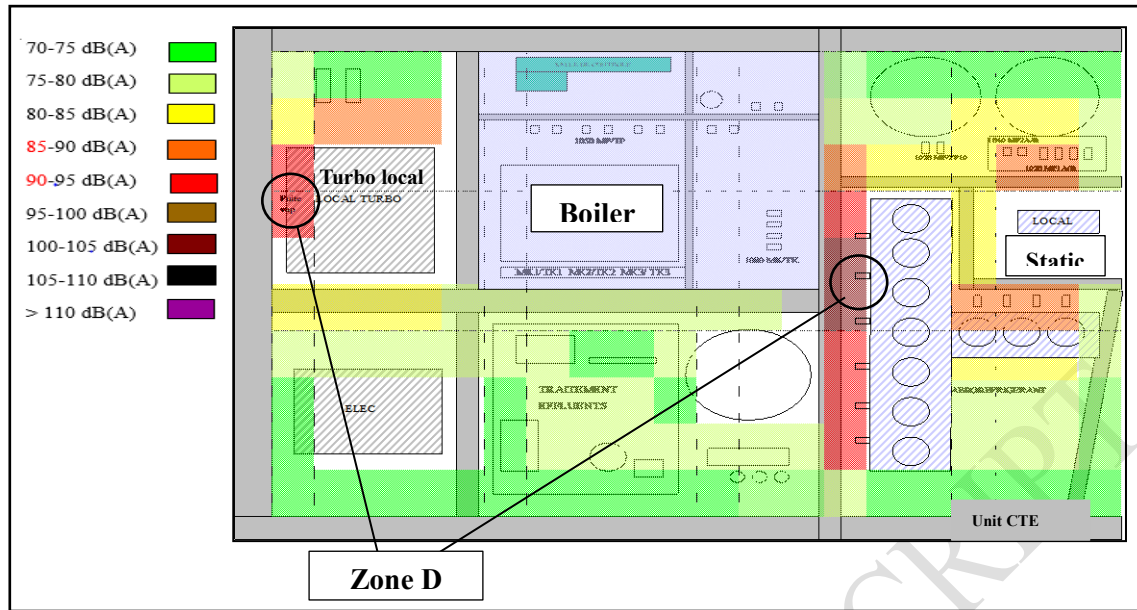


Figure 8. Spatial distribution pattern of noise levels in Unit A.

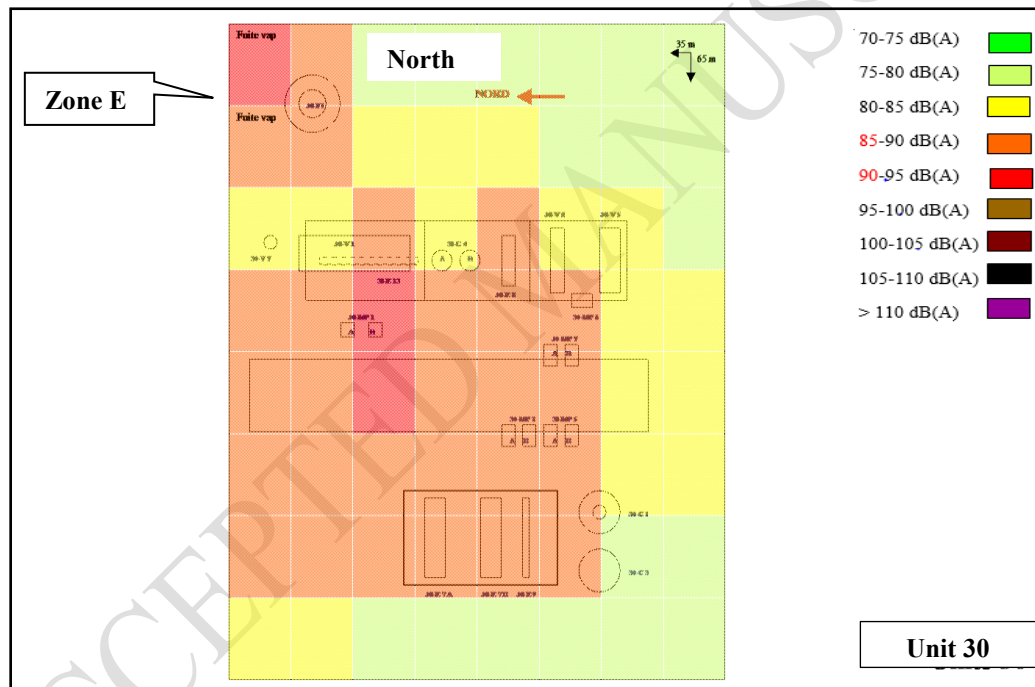


Figure 9. Spatial distribution pattern of noise levels in Unit B.

Figure 9 illustrates the spatial distribution pattern of noise levels in unit B. The alert threshold of 85 dBA is exceeded in approximately 45% of this unit, while the danger threshold of 90 dBA is surpassed in about 5% of the area. A slight increase in noise levels is observed around vertical pumps 30-MP1 and in the vicinity of a steam leak (Zone E).

Figure 10 presents the spatial distribution pattern of noise levels in Unit C. The alert threshold of 85 dBA is surpassed in approximately 45% of the unit, while the danger level of 90 dBA is exceeded in about 12% of the area. Elevated noise levels are

observed around a steam leak, resulting in high noise exposure in adjacent areas. Near the leakage point, sound pressure levels approach 100 dBA. The spatial distribution pattern in unit D is displayed in Figure 11. Approximately 42% of the unit exceeds the danger level of 90 dBA, while nearly 85% of the unit exceeds the alert threshold of 85 dBA. Leak occurrences have been reported in Zone G, which contributes to the elevated noise levels in this area.

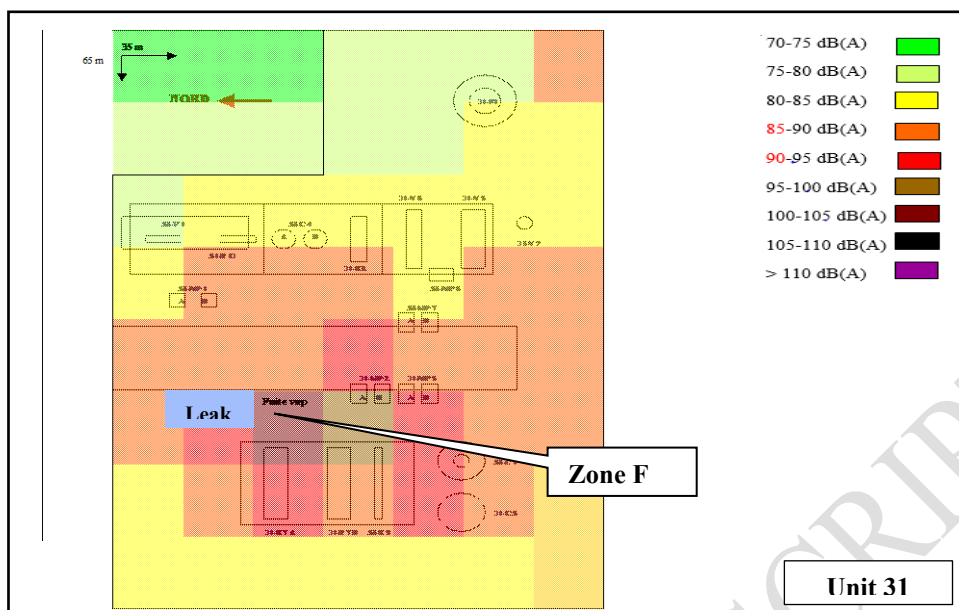


Figure 10. Spatial distribution of noise levels in Unit C.

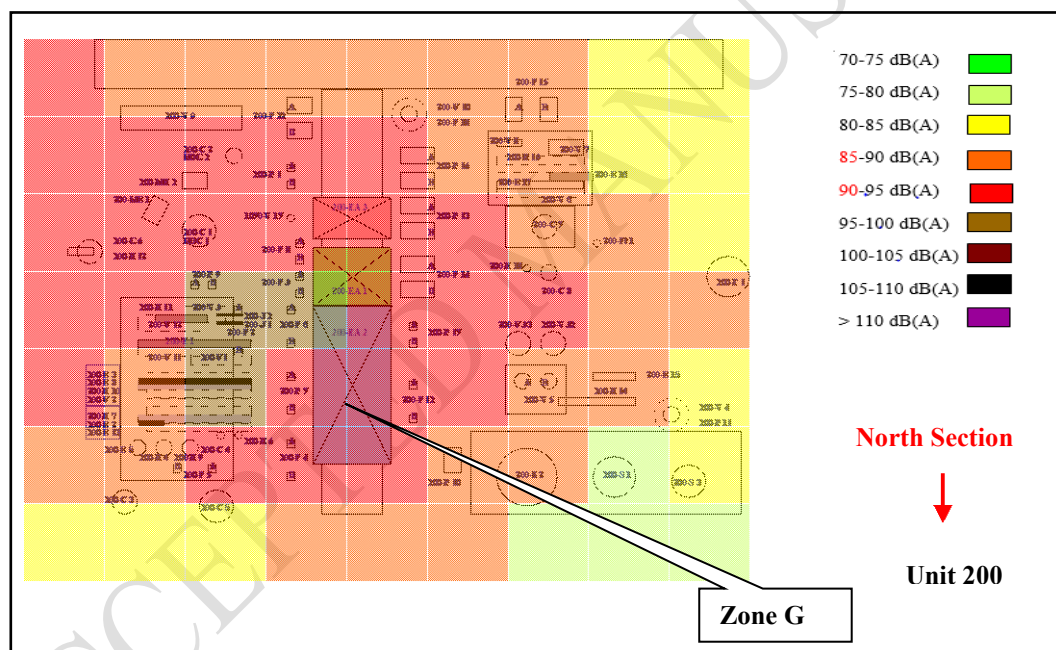


Figure 11. Spatial distribution of noise levels in Unit D.

The results obtained at the RA1K refinery are consistent with those reported in other refinery complexes, where the highest noise levels are typically recorded in the vicinity of compressors, turbines, pumps, and steam leakage points.

At Kaduna, average noise levels measured in operational areas ranged from 66.0 to 107.4 dB, with particularly elevated values observed in turbine rooms and compressor stations (Shagari, et al., 2018). Similarly, in Warri, average noise levels reached 91.8 dBA at steam turbines, 93.31 dBA at gas turbines, and 96.55 dBA for the compressors, while lower levels were

recorded in less active areas such as wastewater treatment units (Osarenmwinda & Onojoserio, 2015). In the Tehran refinery, the equivalent 8-hour exposure level was estimated at 89.5 dBA, with peak values approaching 109 dB (Golmohammadi, et al., 2010). Another study focusing on a steam vent reported an average noise level of 90.3 dB (Monazzam, et al., 2011). Overall, the RA1K findings confirm that industrial noise in refinery environments represents a persistent and structural occupational hazard, primarily associated with the operation of critical process equipment. This underscores the

necessity for implementing source-control measures, localized acoustic treatments, and reinforced worker protection strategies.

4. Conclusion

This study investigated occupational noise exposure and its spatial distribution within the RA1K refinery using field measurements, statistical analysis, and GIS-based noise mapping.

The results demonstrate that noise levels in most operational units systematically exceed the permissible exposure limit of 70 dB(A), confirming the presence of significant occupational noise pollution across the facility. The spatial analysis further revealed pronounced heterogeneity in noise distribution, with critical exposure zones concentrated around compressors, turbines, pumps, and steam leakage sources.

The integration of measurement data with GIS-based mapping proved to be an effective approach for visualizing noise propagation patterns and identifying high-risk areas. This combined methodology enhances the interpretability of noise exposure data and provides a reliable basis for occupational risk assessment and industrial hygiene decision-making.

Overall, the findings highlight that industrial noise in refinery environments remains a persistent occupational hazard requiring systematic control. Priority mitigation measures should include engineering controls at the source, such as acoustic enclosures and silencers, in addition to the reinforcement of personal protective equipment for workers in high-exposure zones.

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References

- Abaya. S, Bratveit. M, Deressa. W, Kumie. A, Moen. B. (2025). Occupational noise exposure and self-reported hearing loss amongst workers in primary coffee processing factories in Ethiopia. *Noise Health.*, 27(127); 516–525.
- Adulaimi. A.A.A, Pradhan. B, Chakraborty. S, Alamri. A. (2021). Traffic noise modelling using land use regression model based on machine learning, statistical regression and GIS. *Energies.*, 14(16); 5095.
- Algerian Executive Decree No. 93-184 (1993). Regulation relating to noise emissions and environmental protection, Official Journal of Algeria, No. 46.
- Arnaudo. B, Léonard. M, Sandret. N, Cavet. M, Coutrot. T, Rivalin. R, Thierus. L. (2013). Les risques professionnels en 2010, *Références en Santé au Travail*, 130 ; 59-74.
- Asghari. M, Gorji. R, Moradzadeh. R, Kohansal. B, Abbasinia. M, Goudarzi. F. (2024). A risk model for occupational noise-induced hearing loss in workers, *Work*, 77(3); 1017-1022.
- Basner. M, Babisch. W, Davis. A, Brink. M, Clark. C, Janssen. S, Stansfeld. S. (2014). Auditory and non-auditory effects of noise on health, *Lancet*, 383(9925); 1325-1332.
- Basner. M, McGuire. S. (2019). WHO environmental noise guidelines for the European region: implications, *J. Acoust. Soc. Am.*, 146(2); 707-708.
- Bell. L.H, Bell. D.H. (2017). *Industrial Noise Control: Fundamentals and Applications*, CRC Press.
- Bilenko. N, Rossem. L.V, Brunekreef. B, Beelen. R, Eeftens. M, Hoek. G, Gehring. U. (2015). Traffic-related air pollution and noise and children's blood pressure: results from the PIAMA birth cohort study, *Eur. J. Prev. Cardiol.*, 22(1); 4-12.
- Bozkurt. T.S. (2021). Preparation of industrial noise mapping and improvement of environmental quality, *Curr. Pollut. Rep.*, 7(3); 325-343.
- Chis. T.V, Cioca. L.I, Badea. D.O, Cristea. I, Darabont. D.C, Iordache. R.M, Barsan. V.A. (2025). Integrated noise management strategies in industrial environments: a framework for occupational safety, health, and productivity, *Sustainability*, 17(3); 1181.
- Clark. C, Paunovic. K. (2018). WHO environmental noise guidelines for the European region: a systematic review on environmental noise and quality of life, wellbeing and mental health, *Int. J. Environ. Res. Public Health*, 15(11); 2400.
- El Aarbaoui. T, Méline. J, Brondeel. R, Chaix. B. (2017). Short-term association between personal exposure to noise and heart rate variability: the RECORD MultiSensor Study, *Environ. Pollut.*, 231; 703-711.
- European Environment Agency. (2014). *Noise in Europe 2014*, Publications Office of the European Union, Luxembourg.
- Faramarz Majidi, Nahid Rezai (2016) *Study of Noise Map and its Features in an Indoor Work Environment through GIS-Based Software*, *J. Hum. Environ. Health Promot.*, (3);138-142
- Garg. N, Gautam. C, Rab. S, Wan. M, Agarwal. R, Yadav. S, eds. (2024). *Handbook of Vibroacoustics, Noise and Harshness*, Springer Nature.
- Ghachi. A, Khaled. F, Djedaiet. K, Meddour. O. (2015). Characteristic feature of flood vulnerability in urban areas: case of Skikda city, *Environmental Study Report*.
- Ghobadi. M, Birjandi. N. (2025). Environmental risk assessment of petrochemical complexes using a

- fuzzy systematic analysis approach, *Avicenna J. Environ. Health Eng.*, 12(1); 10-20.
- Golmohammadi. R, Monazzam. M.R, Nouroollahi. M, Nezafat. A, Momen Bellah Fard. S. (2010). Evaluation of noise propagation characteristics of compressors in Tehran oil refinery center and presenting control methods, *Journal of Research in Health Sciences*, 10(1); 22-30.
- Halonen. J.I, Blangiardo. M, Toledano. M.B, Fecht. D, Gulliver. J, Anderson. H.R, Tonne. C. (2016). Long-term exposure to traffic pollution and hospital admissions in London, *Environ. Pollut.*, 208; 48-57.
- Hammer. M.S, Swinburn. T.K, Neitzel. R.L. (2013). Environmental noise pollution in the United States: developing an effective public health response, *Environ. Health Perspect.*, 122(2); 115.
- Hamamcı. S.F, Doğru. A.Ö. (2024). Low-cost real-time environmental noise monitoring system design and implementation, *Int. J. Environ. Stud.*, 81(3); 1045-1057.
- Hemmat. W, Hesam. A.M, Atifnigar. H. (2023). Exploring noise pollution, causes, effects, and mitigation strategies: a review paper, *Eur. J. Theor. Appl. Sci.*, 1(5); 995-1005.
- Kageyama. T, Yano. T, Kuwano. S, Sueoka. S, Tachibana. H. (2016). Exposure-response relationship of wind turbine noise with self-reported symptoms of sleep and health problems: a nationwide socioacoustic survey in Japan, *Noise Health*, 18(81); 53-61.
- Ministry of Energy Algeria. (2020). National Energy Balance and Refinery Infrastructure Report, Government Publication.
- Monazzam. M.R, Golmohammadi. R, Nouroollahi. M, Momen Bellah Fard. S. (2011). Assessment and control design for steam vent noise in an oil refinery, *Journal of Research in Health Sciences*, 11(1); 14-19.
- Münzel. T, Schmidt. F.P, Steven. S, Herzog. J, Daiber. A, Sørensen. M. (2018). Environmental noise and the cardiovascular system, *J. Am. Coll. Cardiol.*, 71(6); 688-697.
- Nasrolahi. S, Sabzalipour. S, Mmohammadiroozbahani. M, Abbasi. A.M, Attaroshan. S. (2025). Impact of noise exposure on workers' health in the petrochemical industry, *Environ. Water Eng.*, 11; 429-437.
- Osarenmwinda. J.O, Onojoserio. A.A. (2015). Noise pollution in a Refining & Petrochemical Company in Nigeria, *International Journal of Engineering Research and Applications*, 5(4); 1-5.
- Patel. R, Singh. P.K, Saw. S, Tiwari. S. (2024). Assessment and prediction of noise pollution-induced health impacts in urban environment: a structural equation modeling (SEM)-based approach, *Arab. J. Geosci.*, 17(11); 305.
- Paunović. K, Ristovska. G, Argalasova. L, Dzhambov. A.M, Andersen. Z.J. (2025). How are Eastern European countries addressing environmental noise issues? A post-conference expert discussion. *Noise Health.*, 27; 201–202.
- Pischedda. P, Cormier. K, Mohamed. I. (2018). Management at corporate level of noise exposure assessment and control for Petrobras refining, *J. Phys. Conf. Ser.*, 1075(1); 012039.
- Quiñonez Hurtado. V.A, Medrano Aulestia. J.V, Núñez Solano. S.J. (2025). Hearing impairment due to occupational noise exposure in workers in a plastics industry, 2024, *Lex Localis: Journal of Local Self-Government*, 23.
- Shagari. S.U, Garba. A.D, Butu. A.W. (2018). Assessment of noise pollution from the activities of Kaduna Refining and Petrochemical Company (KRPC) Limited, Kaduna, Nigeria, *International Journal of Environmental Studies and Safety Research*, 3(1).
- Smith. A. (2005). Aircraft and road traffic noise and children's cognition, *Lancet*, 366(9487); 715-716.
- Sonatrach. (2019). Skikda Refinery Complex, Technical and Operational Overview, Corporate Report.
- Taoussi. A.A, Yassine. A.S.A, Malloum. M.S.M, Assi. C, Fotelossou. T, Ali. Y.A. (2022). Effects of noise exposure among industrial workers in power plants of the National Electricity Company in N'Djamena, Chad, Egypt. *J. Otolaryngol.*, 38(1); 63.
- Tan. L.H, Lee. Y.L, Lim. M.H, Tan. O.K. (2023). Effective engineering noise control strategies with the stochastic noise mapping simulation method: a case study in palm oil mill, *IEM J.*, 84(1).
- World Health Organization. (2011). Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe, World Health Organization Regional Office for Europe.
- World Health Organization. (2018). Environmental Noise Guidelines for the European Region, WHO Regional Office for Europe.