
AN ASSESSMENT OF ENVIRONMENTAL DAMAGE CAUSED BY NATO BOMBING OF NIS JUGOPETROL FACILITIES

*Dušanka Milošević, Aleksandar Radu, Jovica Novaković
NIS Jugopetrol, Belgrade Holding Co, Occupational Safety and
Environmental Protection, Belgrade, Yugoslavia*

ABSTRACT

This paper presents our investigation of the effects of NATO bombing of the Jugopetrol facilities in Serbia during the Spring of 1999. Concentrations of hazardous material in air, water and soil have been measured and compared to the situation before the bombing. Only partial results are presented in this paper. High concentrations of hydrocarbons were detected in the air immediately after the bombing and the destruction of installations, due to burning and evaporation of oil derivatives. A great amount of spilled mineral oils has been detected in water and soil near the destroyed installations. We have detected a noticeable increase in pollution after the NATO bombing. In addition to above mentioned pollution, the destruction of large parts of waste treatment system within the Jugopetrol's installations caused severe environmental problems. The recovery of the destroyed installation and waste treatment systems require considerable amount of money and time, and cannot be accomplished without the help of foreign investment.

Key words: oil facilities, destroying, hazardous materials, pollution

INTRODUCTION

NATO bombing of Yugoslavia, from March 24 to June 10 1999, wrought huge environmental damage. Five NIS Jugopetrol wholesale central storage facilities were heavily bombed in Belgrade-Čukarica, Smederevo, Bor, Prahovo and Niš. As an example, the largest facility in Smederevo was bombed seven times with 41 cruise missiles fired, and 37 cruise missiles were fired at the Prahovo facility, which is located in close proximity of the IHP Prahovo chemical plant. In addition, many out of 350 retail petrol stations, office buildings and equipment were damaged. Many hazardous chemicals were released causing heavy air, water and soil pollution. It is well known that the crude oil contains about 400 different chemical substances including saturated and aromatic hydrocarbons, polycyclic aromatic hydrocarbons, chlorinated hydrocarbons, etc. Released were also large quantities of

SO₂, NO₂, soot and other compounds containing heavy metals such as vanadium, zinc, chromium, nickel, cadmium, copper, selenium, lead, etc [1]. Jugopetrol team analyzed concentrations of hazardous substances in the air, water and soil. In part, the results of these analyses are presented herein. Large concentrations of total hydrocarbons, originating from evaporation of oil derivatives, were detected in the air. In the water and soil, huge amounts of mineral oils and other materials were detected providing substantive evidence for a large-scale oil pollution.

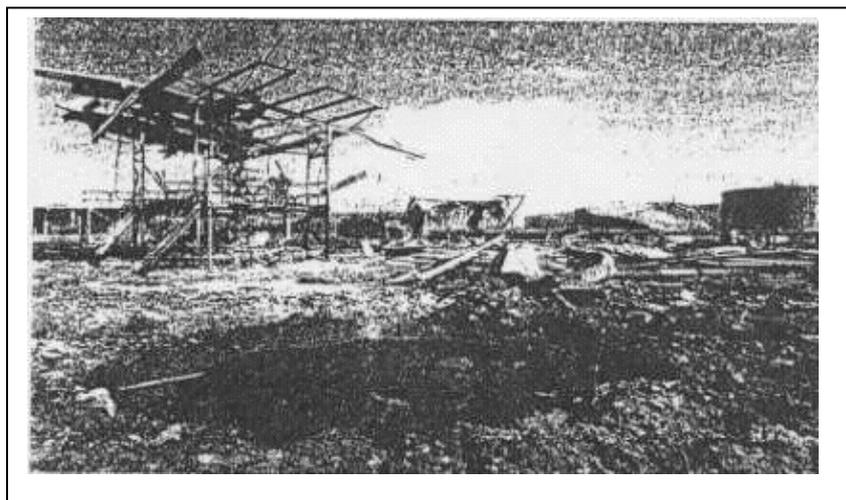


Fig.1 Bor Facility (Similar situation exists for Belgrade-Čukarica, Požega and Priština Facilities)

METHODOLOGY

Sampling was performed in compliance with the program, measurements methodology and establishment of war action consequences as prescribed by the Republic of Serbia Headquarters for Civilian Protection as well as an application of existing Yugoslav and international standards for the work place and the environment. Fig.3 displays example of a sampling station.

The process of identification and establishment of the hazardous material concentrations was based on applications of analytical methods and techniques such as gas chromatography, IC spectrometry, atomic absorption spectrometry, atomic emission electrometry, mobile system for water analysis, Multi Lab P-5, Kane Quintox Gas Analyser KM 9106, etc.

Wastewater data taken from installations in Belgrade and Bor in 1995 and Smederevo in 1996 have been used. There were no pre-bombing data for the presence of heavy metals and mineral oils in the soil. They were substituted with values for the allowable content of heavy metals in the agricultural lands (Sl. Glasnik RS, 1990). An estimate of air pollution was based on the samples taken at the installation perimeters at the level of human breathing organs using Kane-May Quintox Gas Analyzer KM 9106. The results for the total hydrocarbons are displayed. The pollution levels presented should be viewed as indicative. The continuous monitoring over long time intervals was not feasible.

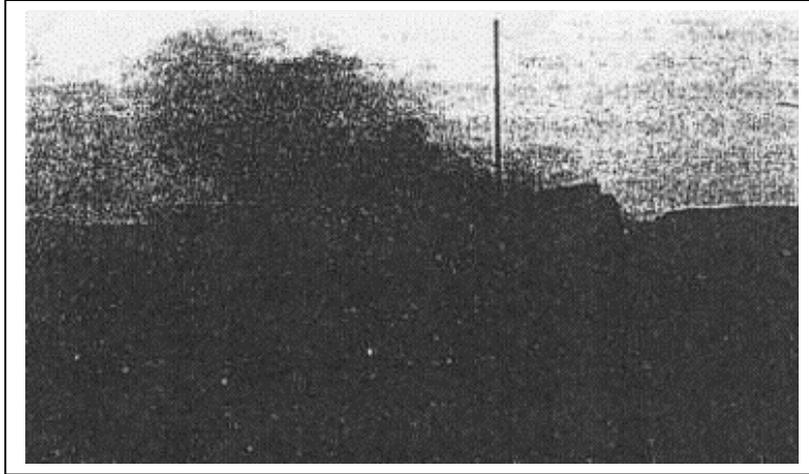


Fig.2 Hydrocarbon Release into the Atmosphere

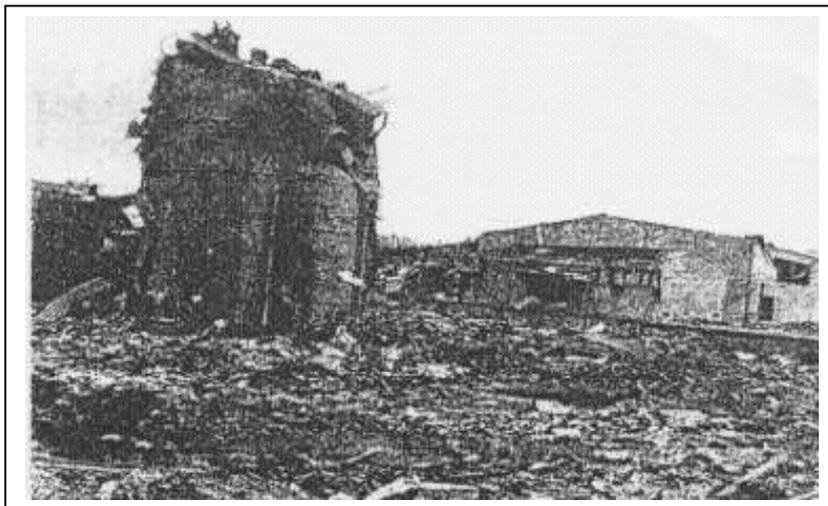


Fig.3 Typical Sampling Station

RESULTS AND DISCUSSION

Only partial results are presented in this paper as the data analysis is not complete yet. The results for hazardous substances at various locations are summarized in the tables presented below.

Table 1 Range of concentrations in mg/m³ for all hydrocarbons at damaged facilities

Location Number	Location Name – City Name	Range of concentration for all hydrocarbons in mg/m ³ (14 – 19. June 1999)
1	Beograd	98.8 – 525.3
2	Smederevo	103.3 – 1647.8
3	Bor	125.7 – 552.2
4	Prahovo	98.8 – 731.8
5	Nis	94.3 – 1315.5

The displayed large concentrations originate from evaporation of released hydrocarbons from damaged tanks. Sampling was performed at several points in close proximity of damaged tanks. These temporary concentrations were extremely high and remained high even a month later. Given prevailing meteorology (high temperatures and windless conditions), the high concentrations are fully compatible with expectations.

Tables 2 Mineral oils and Heavy metals soil concentrations in µg/g

Location Name	Mineral Oils µg/g	Cr µg/g	Pb µg/g	Cd µg/g	Zn µg/g	Ni µg/g
Beograd	25 –87	11.1-19.2	1.6-2.5	0.7-1.9	34.6-53.4	17.3-35.5
Smederevo	3.8 –13.8	11.1-19.1	6.2-15.4	1.0-2.9	151-268	14.2-23.8
Bor	25.6-56.2	12.9-21.4	18.7-41.3	1.2-1.5	85.3-109.2	16.7-22.2
Prahovo	3.48-14.6	9.8-23.0	16.4-75.2	1.1-2.0	23.5-120.1	22.4-28.5
Nis	3.0-212.5	39.6-51.8	42.7-436.3	1.1-1.3	86.5-128.5	26.7-53.4
MDK		100	100	2	300	50

Tables 2a Mineral oils and Heavy metals soil concentrations in µg/g

Location Name	Mineral Oils µg/g	Mn µg/g	Cu µg/g	Fe µg/g	As µg/g	Hg µg/g
Beograd	25 –87	87.5-125.6	5.7-10.4	3610-6120	7.5-12.8	<0.5
Smederevo	3.8 –13.8	37.9-102.7	26.3-51.4	1732-5424	8.9-10.0	<0.5
Bor	25.6-56.2	28.1-42.4	95.5-135.7	1432-1849	10.2-10.4	<0.5
Prahovo	3.48-14.6	127.4-233.9	4.8-11.0	1084-12162	8.9-9.75	<0.5
Nis	3.0-212.5	24.7-51.6	15.5-21.1	1527-1944	10.0-10.6	<0.5
MDK		400	100	-	25	2

The values displayed in Table 2 are respectively minimum and maximum ones at given sites as the samples were taken at several locations within and around the facilities. All soil samples taken show substantial mineral oil contamination while the heavy metal concentrations are within the prescribed limits with the exception of the crater associated with the tank #7 in Nis which exhibited high lead content. The principal cause of lead soil

contamination is attributable to exhaust gases from the motor vehicles [2]. Existence of lead around the crater points to pollution associated with burning of oil in the tank.

Table 3. Some water quality parameters in 1995 and 1999 measurements

Parameters		Beograd		Smederevo		Bor		Nis	Prahovo
		1995	1999	1996	1999	1995	1999	1999	1999
HPK (mg/l)	Atmo*	-	240	-	457	-	320	335	3200
	NP**	80	6618	67	4950	-	680	-	5300
	P***	63	745	2.1	890	8.4	420	-	256
BPK (mg/l)	Atmo*	-	190	-	335	-	215	242	2300
	NP**	412	5011	360	3675	-	525	-	4100
	P***	273	530	3.6	620	14.5	330	-	195
O ₂ (mg/l)	Atmo*	-	6.8	-	5.5	-	5.6	5.7	0.0
	NP**	0.7	2.7	0.75	0.4	-	4.5	-	0.0
	P***	0.9	6.8	6.7	1.2	0.4	6.5	-	6.1
Mineral Oils (mg/l)	Atmo*	-	68	-	241	-	27	57	>30000
	NP**	218	37618	340	25000	-	450	-	>50000
	P***	28	280	0.02	125	9	135	-	7.5

*Atmo-crater water as well as all surface water in vicinity of the installation not belonging to the purification system
 **NP -non-purified water prior to entering the separator
 ***P -water from the purification system exiting the separator

The parameters displayed in Table 3 are directly dependent on the level of pollution from the oil or oil products [3]. For the purpose of the work presented herein, sampling was not limited to installation craters but included the surrounding water outside the installations (e.g. irrigation canal adjacent to the installation in Smederevo). In case of Prahovo and Belgrade-ukarica, the crater bottom contained underground water associated with the river proximity. The wastewater from the installations (before and after separation) is shown as non-purified and purified water.

The results clearly show that post NATO bombing measurements are much higher than the 1995 values. Exceptionally high mineral oil quantities are present throughout, both in atmospheric and purified waters. It can be concluded that NATO bombing not only resulted in high mineral oil concentrations but in substantial oxygen consumption and reduced concentration of dissolved oxygen. The pollution of observed waters is the direct consequence of NATO bombing.

Given that some installations are located in close proximity of rivers (Belgrade-Čukarica near Topčiderka river and Smederevo and Prahovo near Danube), the river pollution was also investigated. The results were compared with the maximum permissible concentrations for the class II waters per regulation for hazardous materials in waters (SI, Republic of Serbia Glasnik, 31/82).

Table 4 Some Water Quality Parameters in Rivers

Location		Parameters in (mg/l)			
		HPK	BPK	O ₂	Mineral Oils
Topčiderka		116	84	7.8	400
Smederevo	Upstream	5.1	4.0	10.2	0.0
Dunav	Downstream	7.5	5.7	8.9	2.5
Prahovo	Upstream	6.0	4.5	7.6	0.0
Dunav	Downstream	26.5	21	7.6	5.8
MDK for water class II			4.0	<6.0	0.05

We note high mineral oil concentrations in the Topčiderka river and in Danube downstream of the installations. These high concentrations have resulted in water quality changes such as chemical and biological oxygen consumption. This effect may lead to disturbances in the river life cycles as well as in imbalances material exchanges with negative impact on the living organisms.

The authors are hopeful that further data analyses will result in broader and clearer picture of the NATO bombing consequences. In addition, the authors are hoping that these analyses will be only a stepping stone towards long-term monitoring which should encompass all damaged facilities. This would provide an integral picture of the impact of NATO bombing on the environment.

REFERENCES

1. Djurić D., Petrović Lj.: "Zagadjenje životne sredine i zdravlja čoveka – ekotoksikologija", Velarta, Beograd, 1996.
2. Kastori R., editor: "Teški metali u životnoj sredini", Naučni institut za ratarstvo i povrtarstvo, Novi Sad, 1997.
3. Milošević D.: doktorska distertacija, Fakultet zaštite na radu, Univerzitet u Nišu, 1997.
4. Veselinović D., Gržetić I., Djarmati S., Marković D.: "Stanja i procesi u životnoj sredini", Fakultet za fizičku hemiju Univerziteta u Beogradu, Beograd, 1995.
5. Golovko A., Turov Y., Gooznajaeva M.: "Distribution and Degradation of Oil Pollution Under Climatological Factors", III Yugoslav Symposium Chemistry and Environmental Protection, Vrnjačka Banja, 1998.