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Original Article

Utopia of Safe Air: How Soviet Research Challenged Western Air Quality Norms, 1950s-1960s

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ABSTRACT

During the mid-twentieth century, the Soviet Union developed ambitious hygiene standards for clean air that were grounded in extremely sensitive methods of physiological research. As Western experts sought to develop universal standards for environmental regulation, Soviet hygiene research posed a challenge. This article examines the discussions surrounding the Soviet approach at international conferences on air pollution and industrial hygiene during the mid-twentieth century. The article shows that although the Soviet approach was rejected especially by United States experts, many of its qualities resonated with the ongoing discussions about environmental health in the US. The sensitive and holistic methods of the Soviets were compelling in the effort to reveal the most subtle effects environments had on human health. This article shows how the rejection of Soviet standards stemmed not from different scientific methods but from the differences in the overall ideals of environmental regulation. I argue that Soviet hygiene can be seen as an extreme version of technocratic expertise, and its failure highlights the limits of scientific expertise in managing environmental pollution.

KEYWORDS: air pollution; industrial hygiene; Soviet medicine; toxicology; environmental health; public health; occupational medicine; internationalism.

The adage "only the dose makes the poison" has served as the basic principle of toxicology since the late nineteenth century.[1] It has also become the cornerstone in the conflict over what constitutes a safe environment, how is it determined, and by whom. Although initially confined to medical therapy, the question of dosage became an essential part of environmental hygiene in the twentieth century. In the increasingly toxic industrialized environment, the means to

1 This adage is credited to the early modern polymath Paracelsus although its original meaning has been debated. Ernst Homburg and Elisabeth Vaupel, "A Conceptual and Regulatory Overview, 1800-2000," in *Hazardous Chemicals: Agents of Risk and Change, 1800-2000*, ed. Ernst Homburg and Elisabeth Vaupel (New York: Berghahn Books, 2019), 6.

determine what constituted safe exposure became a compelling way to manage environmental health.[2] This so-called threshold paradigm was first put into systematic use in the early twentieth century by industrial hygienists in the United States.[3] The idea of managing modern environments through scientifically determined safety thresholds quickly spread to Europe and to the new international authorities concerning health and well-being. However, as experts convened in international conferences to unify the standards pertaining to a clean environment, it became evident that Soviet researchers had developed their own requirements that were more restrictive than anything used in Western Europe or North America. This prompted curiosity not only regarding the Soviet standards, but also regarding the expertise itself. How could two approaches presumably based on science and medicine produce such diverging results?

The mid-twentieth century was a definitive period in the entangled histories of a healthy environment and scientific research. During this era, the relationship between the human body and its environment became a topic of rigorous scientific research, quantification, and regulation.[4] Recent scholarship has also increased the scale from local and national controversies over a toxic environment and shown the importance of international and transnational scale in the formation of what has been called regulatory regimes of environmental health.[5] Historical research about the regulation of toxic substances has been somewhat critical about the way regulatory regimes were formed during the twentieth century. The use of thresholds is seen as an expansion of industrial toxicology and its narrow views of health in the environment.[6] The determination of specific safety thresholds has been viewed as a process whereby expertise and scientific knowledge are bypassed due to industrial interests.[7] As Sarah Vogel has shown, the concept of safety in general has been continuously debated by regulators, scientists, and those in industry.[8]

This article contributes to the historical scholarship of the transnational debate over what constitutes a safe environment by examining Soviet hygiene research as a part of the transnational effort to develop medically-based standards for safe air both inside factories and on the streets in mid-twentieth century Europe and the US. By examining the reception of Soviet research in these scientific discussions the article also contributes to recent research in the environmental history of the Soviet Union. The severe environmental problems of the Soviet Union have been documented since the 1990s, although urban environmental health has not been the primary focus.[9] Later research has brought out more diverse accounts, emphasizing, for

2 Ibid., 7-13; Soraya Boudia and Nathalie Jas, "Introduction," in *Toxicants, Health and Regulation Since 1945*, ed. Soraya Boudia and Nathalie Jas (London: Routledge 2015), 5-11. The idea of safety thresholds was first adopted to modern toxicology in nineteenth-century Germany. See Dietrich Henschler, "The Concept of Occupational Exposure Limits," *Science of The Total Environment* 101 (1991): 16-19.

3 For the origins of US industrial hygiene see Christopher Sellers, *Hazards of the Job: From Industrial Disease to Environmental Health Science* (Chapel Hill: University of North Carolina Press, 1997).

4 Homburg and Vaupel, "A Conceptual and Regulatory Overview, 1800-2000," 7-13. See also, Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (Cambridge, MA: Harvard University Press, 1994).

5 Thomas Cayet, Paul-André Rosental, and Marie Thébaud-Sorger, "How International Organisations Compete: Occupational Safety and Health at the ILO, a Diplomacy of Expertise," *Journal of Modern European History* 7 (2009): 174-196; Christopher Sellers and Joseph Melling, "Towards a Transnational Industrial-Hazard History: Charting and Circulation of Workplace Dangers, Debates and Expertise," *British Journal for the History of Science* 45 (2012): 401-424; Nathalie Jas, "Adapting to 'Reality': The Emergence Of An International Expertise On Food Additives And Contaminants in the 1950s and Early 1960s," in *Toxicants, Health and Regulation Since 1945*, 47-70.

6 Linda Nash, "Purity and Danger: Historical Reflections on the Regulation of Environmental Pollutants," *Environmental History* 13 (2008): 650-655.

7 Jas, "Adapting To 'Reality,'" 52-53; Homburg and Vaupel, "A Conceptual and Regulatory Overview, 1800-2000," 37.

8 Sarah A. Vogel, *Is It Safe? BPA and the Struggle to Define the Safety of Chemicals* (Berkeley: University of California Press, 2012), 19.

9 Murray Feschbach and Alfred Friendly, Jr., *Ecocide in the USSR: Health and Nature Under Siege* (New York: Basic Books, 1992); D.J. Peterson, *Troubled Lands: The Legacy of Soviet Environmental Destruction* (Milton: Taylor & Francis Group, 1993); Donald Filtzer, *The Hazards of Urban Life in Late Stalinist Russia: Health, Hygiene, and Living Standards, 1943–1953* (Cambridge: Cambridge University Press, 2010); Randall Dills, "Forest and Grassland: Recent Trends in Russian Environmental History," *Global Environment* 6 (2013): 38–61.

example, the Soviet and pre-revolutionary environmental thought and ambitious public health ideals.[10] Scholars have also highlighted the significance of Soviet research in the international arenas of environmental research.[11] This article extends this work by showing that despite the restrictions and peculiarities of Soviet research, it contributed to the mid-twentieth century discussions about ways to manage the hazards of modern society. The divergent views between Soviet experts and especially their US counterparts highlights the arbitrariness and value laden nature of defining what is safe, harmful, or unhealthy.

This article also sheds new light on the well-known contradiction between the strict environmental and hygienic standards of the Soviet Union, on the one hand, and the deleterious state of the Soviet Union's environment on the other. As Paul Josephson has argued, the "Soviet exaggeration of modernity" may reveal important aspects about the modern Western relationship towards nature.[12] I demonstrate in this article that the Soviet exaggeration does not mean only economic expansion, but also an environmental policy based on overly confident scientific and technocratic attitudes. With strict environmental standards, the Soviets pushed the scientific expertise on environmental health to its extreme. This shows the limits of so-called regulatory science not only in Soviet Union, but also in environmental regulation in general. As such, the Soviet approach provides a way to examine the very foundations of modern scientific environmental health regulation.

The encounters between experts are examined in this article through expert conferences of industrial hygiene and urban air pollution that were held in the mid-twentieth century in Europe and the US. The present examination begins by scrutinizing a 1957 occupational health conference held in Helsinki, in which Soviet industrial hygiene was first introduced to an international audience. The 1972 World Health Organization Symposium in Moscow, which was aimed to settle the uncertainties between the two approaches, serves as an end point of the examination. International meetings have been recognized as an effective way to examine the debates over environmental health beyond local or national scales.[13] Expert conferences can be seen as one feature of the transnational cooperation that took place despite the restrictions of the Cold War era.[14]

The history of scientific conferences can be traced to the great industrial exhibitions of the mid-nineteenth century in Western Europe and their overwhelming ethos of progress, internationalism, and the power of scientific expertise. Wolfram Kaiser and Johan Schot have shown how this so-called technocratic internationalism produced transnational expert associations in various fields with their own journals and annual congresses.[15] In general,

10 Douglas Weiner, *A Little Corner of Freedom: Russian Nature Protection from Stalin to Gorbachëv* (Berkeley: University of California Press, 1999); Stephen Brain, *Song of the Forest: Russian Forestry and Stalinist Environmentalism, 1905-1953* (Pittsburgh: University of Pittsburgh Press, 2011); Christopher Burton, "Destalinization as Detoxification? The Expert Debate on Industrial Toxins Under Khrushchev," in *Soviet Medicine: Culture, Practice, and Science*, ed. Frances Bernstein, Christopher Burton, and Dan Healey (DeKalb: Northern Illinois University Press, 2010), 237-257; Jonathan Oldfield and Denis J.B. Shaw, *The Development of Russian Environmental Thought: Scientific and Geographical Perspectives on the Natural Environment* (Milton: Routledge, 2015); Stephen Brain and Viktor Pál, ed. *Environmentalism Under Authoritarian Regimes: Myth, Propaganda, Reality* (Abingdon: Routledge, 2019).

11 Julia Lajus and Sverker Sörlin, "Melting the Glacial Curtain: The Politics of Scandinavian–Soviet Networks in the Geophysical Field Sciences Between Two Polar Years, 1932/33–1957/58," *Journal of Historical Geography* 44 (2014): 44-59; Christopher Sellers, "The Cold War Over the Worker's Body: Cross-National Clashes Over Maximum Allowable Concentrations in the Post-World War II Era," in *Toxicants, Health and Regulation*, 25-46; Jonathan D. Oldfield, *The Soviet Union and Global Environmental Change: Modifying the Biosphere and Conceptualising Society-Nature Interaction* (London: Routledge 2021).

12 Paul Josephson, Nicolai Dronin, Ruben Mnatsakanian, Aleh Cherp, Dmitry Efremenko, and Vladislav Larin, *An Environmental History of Russia* (Cambridge: Cambridge University Press, 2013), 2.

13 Jas, "Adapting to 'Reality,'" 49.

14 For the multiform contacts beyond the Cold War divide, see for example, Pia Koivunen and Simo Mikkonen ed., *Beyond the Divide: Entangled Histories of Cold War Europe* (New York: Berghahn Books, 2015); Sari Autio-Sarasmo and Katalin Miklóssy, ed., *Reassessing Cold War Europe* (London: Routledge, 2010).

15 Wolfram Kaiser and Johan Schot, *Writing the Rules for Europe: Experts, Cartels, and International Organizations* (Basingstoke: Palgrave Macmillan, 2014), 21-47.

transnational cooperation and the exchange of knowledge became seen as a new necessity in every field of expertise from the mid-nineteenth century.[16] International conferences formed the basis of what has been termed the institutionalization of the international scientific community.[17] By the mid-twentieth century this cooperation had been further bolstered and spread beyond its initial base in Europe to broader international institutions that embraced rationalism and progress.[18]

As events, conferences inherit many of the features that have been highlighted in the historical works on the great exhibitions. Like exhibitions, international expert conferences act as temporary hubs that promote a universalist view on knowledge production and technical progress. As temporary hubs, these events represent the tip of an iceberg of a wider discussion and development. This was the case with regards to the scientific and medical research conferences on the environment that began to be held from the mid-twentieth century.[19] Beneath the aspiration to accumulate knowledge was a more fundamental aim to unify the concepts, methods and theories that were used and the questions and problems that were supposed to be solved. Thus, while the great exhibitions promoted a belief in technical ability to overcome problems that had been insurmountable in the past, mid-twentieth century conferences manifested a view of international scientific cooperation and the need to solve social and environmental problems by accumulating expert knowledge. And yet, similar to exhibitions, conferences also provided a venue for national self-promotion. This was the primary forum where the divergent views about environmental regulation met in the mid-twentieth century.

The International Commission on Occupational Health (ICOH) served as one of the main forums for mid-twentieth century debates on safe air. Founded at the 1906 Milan Great Expo of Work, the commission first served as a European expert organization to foster scientific progress in the field. In the mid-twentieth century the ICOH took a more international character and formed close ties with the newly-founded International Labour Organisation (ILO) and the World Health Organization (WHO).[20] Similarly, the 1950s saw the proliferation of international conferences on the public health problems of air pollution, which were organized by expert associations and the WHO.[21] The underlying assumptions were that environmental problems, such as polluted air in urban city centers and in factories, should be addressed by rational solutions stemming from objective scientific knowledge and expertise.[22] The string of conferences that were held in order to establish standards for safe air formed part of the overall ambition of technocratic management of modern society through expert knowledge.

16 Martin Kohlrausch and Helmuth Trischler, *Building Europe on Expertise: Innovators Organizers, Networkers* (Basingstoke: Palgrave Macmillan, 2014), 10-13. See also Martin Martin H. Geyer and Johannes Paulmann, *The Mechanics of Internationalism: Culture, Society, and Politics from the 1840s to the First World War* (Oxford: Oxford University Press, 2001).

17 Geert J. Somsen, "A History of Universalism: Conceptions of the Internationality of Science from the Enlightenment to the Cold War," *Minerva* 46 (2008): 361-379, 366.

18 Akira Iriye, *Global Community: The Role of International Organizations in the Making of the Contemporary World* (Berkeley: University of California Press, 2002), 5-28.

19 Taina Syrjämaa, "Global Hubs on the Move: Nineteenth-Century World's Fairs as Spaces of Imagining the World," in *Locating the Global: Spaces, Networks and Interactions from the Seventeenth to the Twentieth Century*, ed. Holger Weiss (Berlin: Walter de Gruyter, 2020), 380-385.

20 For the ICOH and other occupational health organisations, see Antonio Grieco, *Origins of Occupational Health Associations in the World* (Amsterdam: Elsevier, 2003).

21 Janne Mäkiranta, *Clarifying the Air: Finnish Air Pollution Experts and the International Quest for Safe Air, 1940s-1970s* (Turku: Annales Universitatis Turkuensis, 2022), 78-93.

22 For a broader view of how scientific expertise extended to a wide-array of social problems, see Asa Lundqvist and Klaus Petersen, ed., *In Experts We Trust: Knowledge, Politics and Bureaucracy in Nordic Welfare States* (Odense: University Press of Southern Denmark, 2010).

SOVIET INDUSTRIAL HYGIENE AND THE INTERNATIONAL OCCUPATIONAL HEALTH FORUMS

Although Western European countries initially led the field of occupational medicine in the late nineteenth century, in the early twentieth century the study of industrial environments gained an academic character in the US. The US was the first western country to develop the threshold limit values into a regulatory tool and coined the concept of MAC values in the 1940s. The MAC values presented a level for each substance under which, ideally, an eight-hour exposure on a daily basis was deemed to be safe and thus could be used as a tool to monitor the safety of occupational environments.[23] There was little novelty in the idea of safety thresholds in itself. Safety values for airborne dusts had been used in South African mines, for example, but the overall significance of threshold values in occupational hygiene was small and they were seen more as local practical tools than results of scientific research. The significance of the MAC values was that they seemed to provide universal scientific standards for occupational environments. The MAC values developed by the American Conference of Governmental Industrial Hygienists in the 1940s quickly became the most widely cited in the US and Western Europe. In 1953, the ILO adopted these values in its first recommendation for the regular monitoring of occupational environments.[24] Based on clinical trials, epidemiological surveys, and laboratory experiments, these thresholds were, at least in theory, applicable everywhere. However, as the use of MAC levels continued to increase in the 1950s, the concept and the definition of the values were revised due to ensuing debates between experts from different disciplines and in different countries.

It was at the 1957 ICOH conference in Helsinki that Soviet researchers first presented their work on hygienic norms to a wider audience of experts from Europe, the US, and South America. Soviet hygiene research had not been completely unknown in Europe or in the US before the 1950s. Overall, Soviet science and medicine had been relatively well connected to the West since the 1920s and during World War II.[25] A shadow descended over this connectedness during the early Cold War as foreign connections and influence were regarded with increasing suspicion in the Soviet Union.[26] Whether it was due to Cold War restrictions or a simple language barrier, it appears that the Soviet work on industrial hygiene norms was not widely known or noted in the West before the 1950s.[27] The appearance of the Soviet scientists in Helsinki was arguably made possible by the significant changes in the Soviet international scientific diplomacy as part of the so-called Khrushchev Thaw in the second half of the 1950s. When even the use of Western languages had previously been deemed questionable in the USSR, Soviet experts began to present their research in German and English in the late 1950s.[28] Cities such as Helsinki were also viewed as more or less neutral territories where visits from both sides of the East-West divide were politically easier.

The 1957 Helsinki conference showed that both the concept of industrial hygienic norms and the specific American MAC levels had been proliferating widely in different parts of the world.

23 Sellers, *Hazards of the Job*, 155-159.

24 ILO R097 - Protection of Workers' Health Recommendation, 1953 (No. 97).

25 See for example, Jan Arend, "Russian Science in Translation: How Pochvovedenie was Brought to the West, c. 1875-1945," *Kritika: Explorations in Russian and Eurasian History* 18 (2017): 683-708; Susan Gross Solomon, *Doing Medicine Together: Germany and Russia Between the Wars* (Toronto: University of Toronto Press, 2006).

26 Dmitriy Myelnikov, "An Alternative Cure: The Adoption and Survival of Bacteriophage Therapy in the USSR, 1922–1955," *Journal of the History of Medicine and Allied Sciences* 73 (2018): 385-411, 407-409.

27 Hervey B. Elkins, "Maximum Acceptable Concentrations: A Comparison in Russia and the United States," *Archives of Environmental Health* 2 (1961): 45-49, 45.

28 When Leo Noro, head of the Finnish Occupational Health Institute (FIOH), met the leading Soviet occupational health expert August Andreevich Letavet in Leningrad in 1953, they had to communicate via an interpreter. When they met again a year later Letavet spoke fluent German and English. See Eino Ketola, *Majakka ja Luotsi*: *Työterveyslaitos 1945-2015* [History of the FIOH] (Helsinki: Työterveyslaitos 2015), 115.

At the meeting participants from various countries presented papers on the use of threshold values in industry, generating a broad-based discussion on global use of thresholds. The US participant Charles Williams highlighted the discrepancies between the MAC levels used in different countries. To remedy this situation, Williams urged that more knowledge was needed in order to develop universal MAC values that could be used globally.[29] Participants from European countries also heeded the need to standardize the use of these norms. Although no one denied the need for MAC levels, the general consensus was that more international cooperation and refined research methods were needed in order to develop more acceptable values.[30] Thus, even though the ILO had adopted the US MAC levels as its international norm, the discussion on the matter was only at an early stage.

The presentation by the Soviet representative, Z.V. Smelyansky, signaled a blow to the unity of industrial hygiene regulation. Smelyansky showed that the Soviets had their own hygienic standards for industrial environments that were, in contrast to the US and most Western European countries, legally binding and not mere recommendations. More importantly, for many substances these values were considerably lower — up to ten times less — than the ones used in Western Europe and the US. According to Smelyansky, research to develop threshold values based on science and medicine had been a core aspect of Soviet research for decades.[31] Smelyanksy placed special importance on Soviet experiments of the central nervous system and higher nervous activities. In setting these standards, wide use was made of what Smelyansky called Pavlovian experimental physiology, in which conditioned and unconditioned reflexes were used as indicators of toxic effect. He claimed that this method enabled the observation of the most subtle effects that did not show in clinical surveys nor in animal experiments focused on tissue damage.[32] Thus in the Helsinki conference, Soviets presented a system of industrial hygiene that they believed was superior to that utilized in Western countries.

The possibility that the Soviets might have developed an advanced industrial hygiene practice should not be regarded as altogether implausible in the context of the 1950s. As Mark Field has argued, so-called socialist medicine was for a long time seen as the one redeeming quality of the Soviet system.[33] The socialist state could also be regarded as an ideal environment for the advancement of occupational health since there were no private employers or insurance companies whose interests could hinder protective measures and research. As the proletariat-friendly state ruled, it could, in theory at least, enforce clean and safe conditions for work and life in a manner that was implausible in capitalist societies. The American industrial hygienist Alice Hamilton visited the Soviet Union in the 1920s and subsequently praised the occupational research that she had observed, especially at the Obukh Central Institute of Labor Hygiene and Occupational Diseases in Moscow, which remained one of a kind in the world for over two decades.[34]

However, the ambitious preventive mission and focus on environmental hygiene in the 1920s Soviet Union had already declined by the time of the rapid industrialization of the first

29 Charles Williams, "Hygienic Standards in the Field of Occupational Health," in *Proceedings of the XII International Congress on Occupational Health, Helsinki 1.-6.7.1957*, vol. 1 (Helsinki: ICOH, 1958), 40-52.

30 Jon Glömme, "Threshold Limit Values: Some Basic Problems," in *Proceedings of the XII International Congress on Occupational Health, Helsinki 1.-6.7.1957*, vol. 3 (Helsinki: ICOH, 1958), 94-96; Kurt Winter, "Arbeitshygienische Normen Bei Jugendlichen," in *Proceedings of the XII International Congress on Occupational Health, Helsinki 1.-6.7.1957*, vol. 3 (Helsinki: ICOH, 1958), 83-94.

31 Z.V. Smelyansky, "Hygienische Begründung Der Normativvorschriften Bezüglich Maximalzulässiger Konzentrationen Toxischerstoffe in Der Luft Der Betriebsräume," in *Proceedings of the XII International Congress on Occupational Health, Helsinki 1.-6.7.1957*, vol. 3 (Helsinki: ICOH, 1958), 80-83.

32 Ibid.

33 Mark Field, "Soviet Medicine," in *Medicine in the Twentieth Century*, ed. Roger Cooter and John Pickstone (Amsterdam: Harwood Academic Publishers, 2000), 51.

34 L.C. Dunn, Carl O. Dunbar, and Alice Hamilton, "Science in the Soviet Union," *Science & Society* 8 (1944): 64-73.

five-year plan. With scarce resources, high production quotas, and technical limitations, the Soviet occupational health system reverted back to treating workers' acute conditions.[35] In addition, although the state-employed Soviet occupational doctors treated all illnesses as opposed to only work-related diseases, the compensation system granted better pay out for occupational conditions.[36] This meant that the specific etiology of a disease was important in diagnostics, as it also was in the West, due to the wide use of employer compensation schemes.[37] In other words, Soviet industrial hygiene experts were, in many ways, involved with the same structural constraints and conflicts of interest as their Western counterparts. In fact, as Christopher Sellers has argued, both Soviet and American experts required numbers and measurements, such as MAC levels, to compensate for the lack of cultural authority.[38]

Despite their apparent superiority, Soviet norms aroused skepticism. The head of the Finnish Occupational Health Institute, Leo Noro, for example, regarded the Soviet approach as theoretically interesting but doubted whether it could actually be followed in practice.[39] Discussions on the matter continued at the ICOH congresses that were held every three years. But the question of industrial hygiene norms was also taken up in other forums. The US participant Charles Williams brought a copy of Smelyansky's Helsinki presentation to the US, where it was translated and circulated among the members of the American Industrial Hygiene Association.[40] At the same time, the prominent French toxicologist Rene Truhaut, who had also been a participant in Helsinki, organized international conferences on industrial hygiene norms under the auspices of the International Organization of Pure and Applied Chemistry (IUPAC).[41]

While Smelyansky's presentation had been rather superficial, a more detailed account of Soviet hygiene research was presented at the first IUPAC International Symposium on Maximum Allowable Concentrations of Toxic Substances held in Prague in 1959. Smelyansky was again present, but a more comprehensive account of the Soviet methods and principles was given by Elizaveta Ivanovna Lyublina from the Leningrad Institute of Occupational Health. She explained the principles of Soviet hygiene research, as laid down by Nikolai Vasilyevich Lazarev, who she referred to as "the founder of Soviet industrial toxicology." An essential aspect of Lazarev's "synthetic" approach was the idea that the mechanisms and specific effects of a toxin are of secondary importance for industrial toxicology, due to the "basic fact that the individual functions of the body are mutually interrelated."[42] As Lyublina argued, "Whether or not the changes in the organism caused by the effect of toxic substances are localized is sometimes unknown to the toxicologists, but if such changes exist at all they will undoubtedly affect the whole organism."[43] In other words, the main question to be tackled by Soviet industrial toxicologists did not focus on how the substances affected, but whether they affected at all. Industrial hygiene therefore had little need for what could be regarded as traditional toxicological research,

35 Tricia Starks, *The Body Soviet: Propaganda, Hygiene, and the Revolutionary State* (Madison: University of Wisconsin Press, 2008), 5-20.

36 Harold J. Magnuson, David W. Fassett, Horace W. Gerarde, Verald K. Rowe, Henry F. Smyth Jr., and Herbert E. Stokinger, "Industrial Toxicology in the Soviet Union — Theoretical and Applied," *American Industrial Hygiene Association Journal* 25 (1964): 185-197, 196.

37 On the significance of employer compensation on medical diagnosis, see Beris Penrose, "Occupational Exposure to Cement Dust: Changing Opinions of a Respiratory Hazard," *Health and History* 16 (2014): 25-44.

38 Sellers, "The Cold War Over the Worker's Body," 33.

39 Leo Noro, "Työhygieeniset normit," *Työ ja Terveys* 2 (1954): 101. Leo Noro became acquainted with Soviet research in the early 1950s through his visits to Soviet institutions.

40 John A. Zapp, "The Toxicological Basis of Threshold Limit Values: 3. Physiological Criteria," *American Industrial Hygiene Association Journal* 20 (1959): 350-356, 355.

41 This institution was established in order to standardize chemistry and to foster international cooperation. See Sellers, "The Cold War Over the Worker's Body," 38-39.

42 Elizaveta I. Lyublina, "Some Methods Used in Establishing the Maximum Allowable Concentrations," in *Proceedings of the International Symposium on Maximum Allowable Concentrations of Toxic Substances in Industry, Prague Czechoslovakia April 1959* (London: Butterworths, 1961), 109-110.

43 Ibid., 110.

which aimed to show the specific mechanisms or the "character" of a poison. Rather, it aimed for the most sensitive method possible to detect toxic effects.

Lazarev's pharmacological and toxicological studies were largely unknown in the West during the second half of the twentieth century.[44] In Soviet research, Lazarev's theories provided an approach that emphasized the unspecific subclinical effects from environmental stimuli. This approach followed the physiological theories of Ivan Pavlov, which focused on the sensitivity of an organism to its environmental conditions, in particular via the central nervous system.[45] Through Pavlovian physiology, Soviet researchers saw the central nervous system as an early indicator of toxic effect regardless of the specific effect of a toxic substance. Lyublina argued that this was the reason why Soviet industrial toxicologists were deeply engaged with the experimental study of the functional state of the nervous system unlike their Western colleagues.[46]

Presented as a combination of the theories of Lazarev and Pavlov, both largely unknown in Western industrial hygiene and toxicology, the Soviet methods were somewhat at odds with their US and European counterparts. The different traditions of industrial hygiene clashed at the Prague symposium as the US methods of mainly undertaking clinical epidemiological surveys was set against Soviet laboratory experiments, while Western Europeans were often critical of the whole concept of MAC levels. The US experts were especially doubtful about the Soviet standards and the experiments on the central nervous system on which they were based.[47]

As Loren Graham has argued, Soviet physiology was perhaps the most peculiar of all fields of research in the Soviet Union, as it followed the strongly materialistic lines of thought that had influenced Russian physiology since late nineteenth century.[48] This peculiar interest in reflexes turned into research dogma when Pavlov's theories were canonized by Stalin in the early 1950s.[49] The one-sided tendencies of the Pavlovian physiological approach in Soviet physiology were reflected in the research on industrial hygienic standards. Together with the limited international contacts during the early Cold War, the official status of Pavlov's physiology had created a field of research that was markedly different compared to its Western counterparts.

Despite the differences, Soviet research was not unanimously rejected even in the US. In his review of Soviet MAC levels, the American industrial hygienist Harvey Elkins stated that the Soviet methods had changed his idea about animal experiments in general, as he had previously considered them too crude for hygienic standards.[50] Herbert Stokinger, the chief toxicologist of the US Public Health Service (USPHS), also touted the Soviet reflex studies as the most sensitive methods to detect responses to environmental stressors.[51] More importantly, Soviet methods were also commended for their focus on the non-specific subclinical effects. At the Twentieth Annual Meeting of the American Industrial Hygiene Association, held at the same time as the Prague symposium, John Zapp from the Du Pont corporate laboratory argued that the Soviet method could be seen as a means to achieve a more subtle physiological analysis of environmental effects on health. Zapp emphasized that the task of industrial toxicology was to

44 Robert L. Lipnick and Vladimir A. Filov, "Nikolai Vasilyevich Lazarev, Toxicologist and Pharmacologist Comes in From the Cold," *Trends in Pharmacological Sciences* 13 (1992): 56-60; Vladimir A. Filov, "Biography of Nikolay Vasilievich Lazarev," *International Journal of Toxicology* 21 (2002): 235-236.

45 Daniel P. Todes, "Pavlov's Physiology Factory," *Isis* 88 (1997): 205-246; Daniel P. Todes, "From the Machine to the Ghost Within: Pavlov's Transition from Digestive Physiology to Conditional Reflexes," *American Psychologist* 52 (1997): 947-955. See also Daniel P. Todes, *Ivan Pavlov: A Russian Life in Science* (Oxford: Oxford University Press, 2014).

46 Lyublina, "Some Methods Used in Establishing the Maximum Allowable Concentrations," 110-113.

47 Sellers, "The Cold War Over the Worker's Body," 42-44.

48 Loren Graham, *Science and Philosophy in the Soviet Union* (New York: Vintage Books, 1974), 355-356.

49 Ibid., 375-376; David Joravsky, "The Mechanical Spirit: The Stalinist Marriage of Pavlov to Marx," *Theory and Society* 4 (1977): 457-477; A. García-Molina and J. Peña-Casanova, "Stalin's Interventionism in Soviet Physiology: The Pavlovian Session," *Neurosciences and History* 10 (2022): 92-100.

50 Elkins, "Maximum Acceptable Concentrations," 48.

51 Herbert E. Stokinger, "New Concepts and Future Trends in Toxicology," *American Industrial Hygiene Association Journal* 23 (1962): 8-19, 14.

make sure that not even "minimal bodily injury" was caused by the occupational environment. He argued that this included conditions that could not be verified by traditional toxicological analysis, such as impaired judgment. Drawing on Soviet studies, Zapp saw non-specific effects in physiological processes, such as elevated blood pressure, as a more prudent indicator of toxic effects.[52]

To support his argument, Zapp evoked the authority of the famous nineteenth-century physiologist Claude Bernard. He referred to Bernard's idea that the death of a complex living organism could be traced back to simple changes which escalate by "re-echoing" with other vital organs. As Zapp argued, "We may find that by paying attention to these echoes we can detect minimal toxic effects more readily than by observing the primary disturbance which may, at an early stage, be unrecognizable by our investigative techniques."[53] Zapp also found resonance in the recent work of endocrinologist Hans Selye, whose general adaptation syndrome and newly-defined concept of stress emphasized non-specific physiological disturbances caused by environmental stressors:

> Selye, to cite his recent popular work *The Stress of Life*, makes much of the adaptation to the stresses and strains of everyday life, but does not mention the possibility that among these might be considered occupational exposure to chemicals at levels below those causing definite occupational disease. If such exist and are to be recognized, physiological or functional criteria must be applied.[54]

In other words, by engaging with new reformulations of stress and older mechanistic physiological ideas, Zapp came to the same conclusion (as the Soviets had) about the limits of traditional industrial toxicology. Although his studies focused on blood pressure rather than the central nervous system both shared the idea that non-specific physiological responses were important in determining hygienic standards.

Zapp's reasoning proved a common ground between Pavlovian physiology and Western research despite their differences. Although Pavlov's theories were compatible with dialectical materialism, the official philosophy of science in the Soviet Union, they derived ultimately from the nineteenth-century French materialistic physiology made famous by Bernard.[55] As Daniel Todes has argued, Pavlov was essentially "Bernardian" in his physiological views, emphasizing an organism's complexity and holistic approach to its functions.[56] Similarly, Selye had built his idea of stress on the anti-reductionist traditions in US medicine, which focused on the complex interactions between the body and its environment.[57] This shared interest in the sub-clinical and holistic analysis of organisms in industrial hygiene research was another instance where, as Graham has pointed out, the Eastern and Western traditions asked similar questions, sometimes gave similar answers, but had markedly different views on their meaning.[58]

THE QUESTION OF HARMFUL EFFECTS

Although the experimental physiology of the Soviets found some resonance among US experts, it was not clear how these observations should be applied to safety standards. As Zapp stressed,

52 Zapp, "Physiological Criteria," 355.
53 Ibid., 351.
54 Ibid., 350.
55 Graham, *Science and Philosophy in the Soviet Union*, 355-356.
56 Todes, "Physiology Factory," 201.
57 Russel Viner, "Putting Stress in Life: Hans Selye and the Making of Stress Theory," *Social Studies of Science* 29 (1999): 391-410, 394-396.
58 Graham, *Science and Philosophy in the Soviet Union*, 8.

"A word of caution about the use of physiological criteria in determining Threshold Limit Values is indicated. Not all physiological changes are presumptively harmful. Some may merely represent the organisms normal and completely adequate response to an environmental change."[59] The question of what constitutes harmful or safe had been at the heart of both preventive occupational medicine and the development of hygienic standards. The sensitive methods and focus on non-specific responses made the question even more pertinent. This question was also noted in the Prague Symposium. In fact, some participants, including the Soviet August Andreevich Letavet, argued that the discrepancies in this basic concept of harmful were presumably the main reason for the divergence between the Soviet and US MAC values.[60] According to the definition by the American Standards Association, the MAC levels were based on "the absence of organic or other tissue changes, on the absence of functional reactions which have no discernible untoward effects on health but cause impairments, such as incoordination and increased proneness to accidents and of discomfort or adverse sensory effects."[61]

In this regard, the sensitive animal experiments of the Soviets were critiqued on the grounds that the exposures did not actually make the animals sick or prone to accidents nor were there symptoms of disease or discomfort. A mere physiological response could not serve as a basis for safety threshold. The Soviets argued, however, that in industrial environments even a slight impairment of reflexes, which was one sign of an effect on the nervous system, could be lethal.[62] As Letavet argued, in the Soviet Union the MAC values were based on concentrations which "produce no pathological change or disease detectable by current methods of examination."[63] Thus, in addition to their sensitive methods, the Soviets appeared to have a rather different view on what was harmful and thus what kind of exposure was allowed in workplaces. For the Soviets, this was not merely a physiological theory, but also something that they claimed to have observed in regular health inspections. Smelyansky argued that clinical inspections had shown that not only did the exposures cause physiological changes in the body, but also that combinations of these changes led to long-term pathological symptoms.[64]

Despite attempts by international associations to reconcile the differences and to standardize the use of industrial hygiene norms, scientists could not reconcile Soviet and US approaches. The Prague Symposium formulated its own recommended definition, stating that MAC denotes a concentration in air which "causes no signs or symptoms of illness or physical impairment in any workers except those that are hypersensitive, during their normal day-to-day working, as judged by the most sensitive internationally accepted tests."[65] This formulation neatly bypassed contested issues by adding the vague term "signs" and by demanding that sensitive methods be internationally accepted.

The Prague conference made the Soviet approach more transparent to Western experts. However, it still failed to unify the principles and use of industrial hygiene standards. A reviewer of the conference literature argued that despite the effort, it was still unclear why the norms differed so dramatically.[66] Some were also uncertain as to what extent the Soviet norms should be taken seriously. Elkins argued that the Soviet values were mostly unnecessarily low, but that they

59 Zapp, "Physiological Criteria," 355.

60 A.A. Letavet, "Basic Concepts for Maximum Allowable Concentration of Toxic Substances," in *Proceedings of the International Symposium*, 21; G.C.E. Burger, "Aspects of Safety Limits in Industry," in *Proceedings of the International Symposium*, 92.

61 W.F. von Oettingen, "Methods used by the Committee Z37 of the American Standards Association in Establishing Maximal Acceptable Concentrations of Toxic Dusts and Gases," in *Proceedings of the International Symposium*, 115.

62 W.L. Ball, "The Toxicological Basis of Threshold Limit Values: 6. Report of Prague Symposium on International Threshold Limit Values," *American Industrial Hygiene Association Journal* 20 (1959): 370-373, 373.

63 Letavet, "Basic Concepts for Maximum Allowable Concentration of Toxic Substances," 21.

64 Smelyansky, "Hygienische Begründung," 80.

65 "Resolutions of the International Symposium," 8.

66 Ball, "Toxicological Basis of Threshold Limit Values," 6.

also indicated that many of the American MAC's were in fact too high and should be changed.[67] To try and gain a degree of certainty about the issue, a delegation of six prominent American industrial hygienists were sent to the Soviet Union in 1963 in order to familiarize themselves with the nation's hygiene research.

Through visits to many Soviet institutions, it was clear to the US visitors that the study of the central nervous system was indeed widespread. In fact, the US experts argued that Soviet experimental research was peculiarly one-sided: the equipment to study the central nervous system was first-class, while other apparatus was mostly outdated. For example, analytical apparatus, such as infrared spectrometers and gas chromatographs which had revolutionized routine chemical analysis, were a rarity in Soviet laboratories. The visitors regarded reflex studies as being rather ingenious, on the other hand, and the delegation hoped more attention would be paid to this method in the US. However, these experiments also appeared to the Americans as being poorly executed, as was the case with Soviet animal experiments in general.[68] As such, the visitors were rather unimpressed about Soviet hygiene research in practice.

Perhaps the most important observation was, however, that although the influence of Pavlovian physiology could be seen everywhere, it did not seem to solely explain the divergences in the MAC levels. Rather than differences in equipment and physiological approach, the visitors saw the underlying tenets of hygiene as being more important. It became clear that the Soviets regarded any response to an environmental stimulus as harmful. This view was then put to practice with the sensitive tests, but also with the use of considerable safety margins.[69] Thus, the delegation came to the following conclusion: "We believe that the chief explanation for the differences in threshold limit values between the United States and the Soviet Union lies in the philosophic approach to those limits and not in a difference in the sensitivity of methods used to establish those limits."[70] This conclusion supports the notion that the fundamental peculiarity in Soviet hygiene, in comparison to Western Europe and the US, was not the high status of laboratory experiments. In fact, it was not even the widespread interest in the central nervous system. Instead, it was in the fundamental holistic ideal in which all unwanted environmental effects on the body were seen as deleterious.

This was at odds with the view that industrial hygiene standards were meant to prevent diseases and discomfort. It was also at odds with Selye's new idea about environmental stress, which recognized the ability of the human body to adapt. In fact, at the next IUPAC symposia on MAC levels in 1963, the USPHS chief toxicologist Stokinger felt sufficiently confident to argue that the Soviet approach, despite the sensitive methods, was inherently flawed. Stokinger accused the Soviets of neglecting both the possibility of adaptation, and also the fact that some of the body's responses to low levels of exposure were positive rather than harmful.[71]

As Cold War tensions flared up again with the Cuban Missile Crisis, Soviet hygienists did not participate in the 1963 symposium to counter Stockinger's argument. However, the dismissal of the Soviet approach as being against the fundamental principles of physiology was perhaps not as evident as presented by Stokinger. US industrial hygienists were skeptical of non-clinical studies and high safety margins. Yet, other areas of environmental regulation in the US followed more stringent

67 Elkins, "Maximum Acceptable Concentrations," 48.

68 Magnuson et al., "Industrial Toxicology in the Soviet Union," 187-197. This was due to inadequate statistical evaluation of the results, poor testing chambers and, most importantly, an insufficient number of test animals compared to the standard procedure in the US. These observations highlighted the differences between Western animal experiments and the Pavlovian approach, which relied on long-term testing of individual animals. See Todes, "From the Machine to the Ghost Within," 947-955.

69 Margins of safety were also used in the American MAC levels, especially with data from animal experiments, but they were usually low and there was no systematic way of implementing them. This was an important point of criticism by some Europeans in the Prague conference. See Burger, "Aspects of Safety Limits in Industry," 92.

70 Magnuson et al., "Industrial Toxicology in the Soviet Union," 197.

71 Herbert E. Stokinger, "International Threshold Limits Values — 1963," *American Industrial Hygiene Association Journal* 24 (1963): 469-474.

approaches. As the US visitors to the USSR noted, the zero tolerance view of the Soviets was similar to the one used by the US National Committee on Radiation Protection.[72] Indeed, by the late 1950s, both US and European authorities had adopted the so-called no-threshold approach to ionizing radiation, which required the use of hefty safety margins.[73] In a similar manner, the regulation of food additives in the US was based on an approach that used sensitive animal experiments and additional hundredfold safety margins. In other words, there were regulatory practices in use in Western countries that were similarly strict to the Soviet levels of industrial hygiene.

The argument against these approaches in industrial hygiene was that whilst they could perhaps be used in some areas of society, if only to be on the safe side, they were impossible to implement in industry without disastrous economic costs.[74] The same argument could be made against Soviet methods. In their report, the US visitors considered the Soviet standards as "aspirations based upon medical grounds" rather than limits that could be actually enforced.[75] They further pointed out that, "were the Soviet limits rigidly enforced, the economic costs involved would probably result in a re-evaluation of the validity of the concepts underlying their limits."[76]

Soviet industrial hygiene, in other words, was based on a physiological view that the Western experts regarded overprotective and unrealistic in industrial environments. However, at the same time, the concept of medically-based threshold norms was proliferating into another arena of environmental regulation where it had previously not been used: urban air pollution. The proliferation of the threshold concept was one part of the phenomena in which the methods and principles from industrial hygiene became incorporated into environmental health issues in general in the mid-twentieth century.[77] As Lynn Page Snyder has argued, through the prevalent threat of air pollution, the industrial environment began to be seen as analogous to the general environment.[78] As the question of harmful exposure to airborne substances became current in public health, Soviet hygiene research again provided its own approach. In comparison to the special circumstances of an occupational environment, the quality of urban air presented a different kind of problem whereby the Soviet approach could not be so easily argued against.

SOVIET HYGIENE AND THE SEARCH FOR INTERNATIONAL AIR QUALITY STANDARDS

If the ICOH conference in Helsinki marked the beginning of international debate on industrial hygiene norms, the 1958 World Health Organization conference in Milan served the same purpose for urban air pollution. It was the first post-WWII air pollution conference that attracted participants from the US, Europe, and the Soviet Union.[79] The Milan conference shows how the idea of hygienic threshold values also held a strong appeal in regard to urban air. The rationale for hygienic norms based on these values for urban air mostly went unquestioned, and medical research of air pollution set out to decipher the relationship between urban air and human health.[80] The WHO set out to develop international guidelines for air pollution that were similar to the

72 Magnuson et al., "Industrial Toxicology in the Soviet Union," 187.

73 Soraya Boudia, "From Threshold to Risk: Exposure to Low Doses of Radiation and its Effects on Toxicants Regulation," in *Toxicants, Health and Regulation*, 71-75.

74 Burger, "Aspects of Safety Limits in Industry," 91.

75 Magnuson et al., "Industrial Toxicology in the Soviet Union," 187.

76 Ibid., 197.

77 Nash, "Purity and Danger," 651-655.

78 Lynn Page Snyder, "Revisiting Donora, Pennsylvania's 1948 Air Pollution Disaster," in *Devastation and Renewal: An Environmental History of Pittsburgh and Its Region*, ed. Joel A. Tarr (Pittsburgh: University of Pittsburgh Press, 2003), 126-144.

79 Some international conferences were held in the US before, but they did not attract foreign participants save for a few British experts.

80 Mäkiranta, "Clarifying the Air," 77-93. For a rare contemporary criticism, see A. Giovanardi, *Biological and Health Aspects of Air Pollution. Conference on the Public Health Aspects of Air Pollution in Europe, Milan 6-14-11-1957* (Copenhagen: WHO Regional Office of Europe, 1957).

recommendations of the ILO for industrial air. Again, the international expert community was coming together in order to foster cooperation and develop universal standards for clean air.

Unfortunately, the health effects of urban air appeared to be a hopelessly complicated issue. Much of what was known about the specific health effects of urban air in medical thinking in the 1950s came from industrial hygiene and occupational medicine, including the concern about long-term exposure to low levels of pollution. But the quantities of different substances in urban air were miniscule compared to air inside factories and the exposed population was also more heterogenous, consisting of such groups as children, pregnant women, the chronically sick, and the elderly. In addition, the effects of air pollution were bound to be mixed with other health effects of urban life, making cause and effect deductions difficult.[81]

When the state of air quality and its effects in different countries was compared at the Milan conference, most countries emphasized the uncertainty about the specific health effects of air pollution and about how difficult it was to prove them. In fact, urban air quality was only being measured more or less regularly in Great Britain, the US, and the Soviet Union. It was quite unanimously argued by US and European experts that although some kind of hygienic standards would most likely be useful for regulation in the future, it was too early by far to develop these standards due to a considerable lack of knowledge.[82]

As in the case of industrial air, Soviet participants presented an alternative approach. In Milan the Soviets made outright claims to have demonstrated the significant health effects of air pollution in clinical studies. They had also developed legally binding air quality standards for no less than twenty different substances. In addition, the Soviet delegation emphasized the increasing threat for urban air posed by tetraethyl lead in gasoline, something that became a concern in the West in the late 1960s.[83] If Soviet industrial hygiene appeared to have been superior when it was presented in Helsinki, their air pollution research appeared to be of even higher standard.

Western experts nonetheless gravitated towards the US, which became viewed the leading nation in the development of air quality norms.[84] The implementation of air quality standards proliferated rather slowly, however, compared to industrial MAC levels. Even in the early 1960s, only a few countries used them as legislative norms.[85] As the need for some kind of air quality norms became more evident in the US and Western Europe in the 1960s, and the discussion about their development increased, the Soviet approach also had to be taken into consideration.

In addition to the conference proceedings, Soviet air pollution research became known in the West most notably through an extensive translation project conducted by the USPHS. From the late 1950s to the late 1960s, USPHS scientist Benjamin Levine translated Soviet publications about air pollution, producing a massive eighteen-volume *Survey of U.S.S.R. Literature on Air Pollution and Related Occupational Diseases*. Through Levine's translations, the work undertaken in the Soviet Union became more readily available for the English-speaking audience in the US and also in Europe.[86] The spokesperson of Soviet air pollution in the West was Vladimir

81 Air pollution disasters, such as the London Smog in 1952, have been seen to provide assurance of the health effects of air pollution. However, these disasters provided little knowledge about the specific causes of the deaths or the life-long daily exposure to urban air that was the main concern for the experts. Mäkiranta, "Clarifying the Air," 77-93.

82 *Conference on the Public Health Aspects of Air Pollution in Europe, Milan 6-14-11-1957* (Copenhagen: WHO Regional Office of Europe, 1957), 1-19.

83 V. Zhdanov, "Communication on Air Sanitation in the USSR," in *Conference on Public Health Aspects of Air Pollution, Milan, 6-14.11.1957. Report* (Copenhagen: WHO Regional Office of Europe, 1957), 267-279.

84 As Frank Uekötter has noted, even West Germans saw US air pollution research as more advanced, although this was truly the case only in some specific fields. Frank Uekötter, *The Age of Smoke: Environmental Policy in Germany and the United States, 1880-1970* (Pittsburgh: University of Pittsburgh Press, 2009), 146-148. The newly founded OEEC also organised a trip to the US in order to study the management of water and air pollution. *Air and Water Pollution: The Position in Europe and in the United States* (Paris: OEEC 1957).

85 These were Czechoslovakia, the Federal Republic of Germany, the US states of California and Oregon, and the Soviet Union.

86 For example Leo Noro, the head of the FIOH, ordered Levine's translations from the US government despite his connections and geographical closeness to the USSR.

Ryazanov, the head of the Soviet Committee on the Determination of Limits of Allowable Concentrations of Atmospheric Pollutants.

The Soviet standards for urban air were based on a similar logic as the ones in industrial hygiene. As Ryazanov stated, "Accordingly, an allowable air pollutant concentration should have no direct or indirect harmful or unpleasant effect on man, it should not lower his efficiency and should not negatively effects man's general feeling of wellbeing, which also includes his state of mind."[87] In practice, this goal was sought by grounding the threshold on the most sensitive reaction that a substance in urban air can cause, including odors and damage to plant life. Since the odor threshold of many substances is rather low and plants are very sensitive to many common air pollutants, such as sulfur dioxide, the result was that Soviet air quality standards were extremely restrictive.

Ryazanov saw the socialist system superior in areas of environmental sanitation compared to Western society, but he also gave strong emphasis to the fundamentals of Soviet life sciences: the view that all organisms are vitally interconnected to their living environments.[88] As in industrial hygiene, the holistic approach in the spirit of dialectical materialism was set against what Soviet scientists saw as a reductionist Western model. It is notable that unlike in industrial hygiene, laboratory experiments played little role in the initial development of the Soviet air quality standards. The sensitive experiments on the central nervous system, especially the encephalographic method on humans, were used in air pollution research only since the late 1950s. In fact, the first standards were in many cases based on rather crude knowledge or mere assumption, which Ryazanov freely admitted. He emphasized the practical need for some standards in regulation and that these values could be modified later with more adequate knowledge.[89] This supports the argument that the peculiarity of the Soviet hygiene was not essentially in the central role of laboratory experiments. Rather, it was in the more fundamental idea about the sensitivity of human body to environmental effects and the aspiration to prevent these effects with strict hygienic standards.

Following this ambitious hygienic idea, some Soviet scientists proposed a style of regulation which would be based on actual clean air. By this they meant that the standards for acceptable air would be based on measurements made in a location completely free of any pollution by industry or settlements.[90] These standards would obviously be impossible to meet in an urban or industrial area, but that was not what bothered Ryazanov. Rather than viewing them as impractical, he saw them as being unnecessarily strict for the purpose of public health. Referring to Lazarev, Ryazanov pointed out that most substances had a threshold under which they caused no harm to humans or their environment.[91] Thus, despite its extreme sensitivity the Soviet hygiene program ultimately followed the same basic toxicological logic of "the dose makes the poison" that directed Western scientists. If anything, the Soviet approach placed special confidence in scientific knowledge in general, and in their own physiological principles in particular, in creating a safe living environment by rational means.

In the US, Ryazanov's translated publications received interest, but also criticism. Hygienic norms for air were regarded as a good development in principle and the Soviet Union was perceived in a similar manner as California, that is, as a forerunner in air pollution control. Soviet air quality standards also became an attractive point of reference for those who wanted to highlight

87 Ryazanov, "Basic Principles," 8.

88 Vladimir Ryazanov, "The Sanitary Protection of Atmospheric Air" (Moscow: Medgis, 1954), supplement in *Limits of Allowable Concentrations Atmospheric Pollutants*, Book 2, ed. V.A. Ryazanov, trans. B.S. Levine (Washington D.C: U.S. Department of Commerce, 1955), 132-146.

89 Ibid., 11-12.

90 Ibid., 6-7; Ryazanov, "Limits of Allowable concentrations of Sulphur Dioxide in the Atmosphere," in *Limits of Allowable Concentrations*, Book 1, 24-25.

91 Ryazanov, "Basic Principles," 6-7.

the severity of the air quality problem in the US. The critics of this practice argued that the Soviet values were unrealistic and "factitious" and should not be used as points of comparison.[92] Other critics pointed out that the hygienic standards used by the Soviets flew in the face of the consensus that no medical or biochemical method was as yet capable of determining safe levels of urban air pollution. Moreover, it was doubted whether one-sided adherence to Pavlovian physiology was the proper way to determine harmful effects, instead of more diverse research practices. As the US air pollution expert George Tipikin argued in his review of Ryazanov's books, "The contents reflect the tendency of Russian scholars to follow an isolated path."[93]

The most obvious problem with the Soviet air quality norms was that they appeared to be totally unrealistic, as they were in industrial hygiene. When Ryazanov presented Soviet research in the Fifth Californian Air Pollution Medical Research Conference in 1961, his audience in the conference confronted him with the fact that the air pollution standards were not met even in the Soviet Union where they were legally binding. Rather than denying the accusation, Ryazanov freely admitted that some of the standards were impossible to meet anywhere at the present time. However, Ryazanov saw this as a redeeming quality:

> As scientists and as physicians, we cannot consider whether these standards are practical. We simply must state what the requirements for a clean atmosphere are, and in this way force our technology to seek methods of improving and coming near those standards we seek. I think if we, for the purpose of being more realistic, decreased our standards by 10, (that is used values 10 times greater than we do) in order to make them more realistic for the present moment, we would make the conditions in our city healthful only in paper.[94]

Thus, while critics saw the Soviet standards as unrealistic and "factitious," Ryazanov turned the issue around and presented realistic standards as something akin to deception.

Whether or not Ryazanov's counterargument depicted the genuine public health policy in the USSR, it did point out the inherent problem in hygienic standards for urban air. After all, the justification for the standards was that they were based on scientific and medical knowledge. If this knowledge was accommodated to the practical realities of the present society, was it really any different from the so-called best available technique approach that had already been adopted since the nineteenth century in smoke abatement? This question was especially important for the WHO's mission to provide international guidelines for urban air.

As the discussion over air quality norms increased in the 1960s, the WHO also ramped up its activities and hosted many conferences on the issue. The WHO regarded its task as one to provide guidelines that were universally acceptable. Thus, they deemed that it was essential that they should only be based on sound scientific evidence and theory. Here, the Soviet approach initially appeared rather persuasive. It was noted in a WHO air pollution symposium in 1967 that the traditional toxicological methods had proven inadequate in establishing hygienic standards for air and there was a need for more subtle methods from physiology and pharmacology. From a theoretical point of view, the Soviet method was in accordance with the general idea of hygiene and the WHO's definition of health.[95] The WHO even attempted to reproduce Ryazanov's reflex studies on human subjects using the encephalographic method, which

92 Louis C. McCabe, Willard Machle, and David P. Barnes, "Evaluation of Air Pollution Data," *Journal of the Air Pollution Control Association* 14 (1964): 107-109.

93 George Tipikin, "A Critical Review of Two Recent Russian Books on Air Pollution," *Journal of the Air Pollution Control Association* 7 (1957): 227-233.

94 V.A. Ryazano, "Sensory Physiology as Basis for Air Quality Standards: The Approach Used in the Soviet Union," *Archives of Environmental Health: An International Journal* 5 (1962): 480–494, 492.

95 *The Health Effects of Air Pollution: Report on a Symposium Convened by the Regional Office for Europe of the World Health Organization, Prague, 6-10 November 1967* (Copenhagen: WHO Regional Office for Europe, 1968), 51-58.

appeared to be the most sensitive method available. With regards to Soviet hygiene research in general, the WHO planned a conference specially aimed to examine the differences between Western and Eastern approaches. This plan materialized in the 1972 Moscow meeting.[96] As in the case of industrial toxicology, Soviet air pollution research seemed to ask the same questions that bothered Western experts.

The fact that Soviet hygiene was appealing for the purposes of the WHO also highlights the similar attitudes with regards to scientific expertise and health. The famous definition of health by the WHO, which stated that it is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, shared the same ideal as Soviet hygiene. More to the point, the attempt to provide universally acceptable air quality guidelines reflects the adamant faith in rational solutions and scientific knowledge in solving the problems of modern society, something that was common to the United Nations.[97] It could be said that this confidence in objective rationality and science in order to transcend national and cultural differences resonated with Soviet hygienists' approach to disregard present conditions and technological know-how in the development of medically-based standards for safe air.

Viewed as being holistic and sensitive, the Soviet approach could be presented as something Western experts and regulators could learn from, especially in the wake of increasing concern about environmental contamination in the late 1960s.[98] In practice, however, the significance of Soviet hygiene in air pollution research remained limited in the West. Ryazanov's ideas provided seemingly little to the development of the guidelines of the WHO. When the first figures were published in 1972, it was noted in the report that some experts regarded any physiological deviations from normal as deleterious. This was more of a gesture, however, since neither this principle nor the sensitive experimental methods on the central nervous system were used in any of the guidelines.[99] As the report and the related material indicate, the determination of the WHO guidelines reflected more the ability to reach a scientific consensus in order to have plausible figures, rather than the most sensitive or precautionary approach.[100] The MAC levels for industry fared better, as they were included in an ILO catalogue in 1972.[101] Whether they were actually used outside of the Soviet sphere of influence in regulation is another matter.

In other words, the Soviet approach ultimately failed to influence on the toxicological regulatory regime in US and Western Europe. At the same time the strict environmental norms in the Soviet Union failed to prevent environmental degradation. The contradiction between strict environmental standards and significant environmental problems is well known in the history of Soviet Union. The reasons for the inefficient enforcement of these standards have been sought from the various aspects of the Soviet system, such as the high primacy of economic performance in the priorities of the state.[102] The development of air quality standards presents a different direction to approach the issue. Legal standards preventing pollution are usually seen as important milestones in environmental history. While this is arguably the case, it should be noted that air quality standards, for example, were criticized in the 1960s by many Western experts as secondary and even unnecessary tools of air pollution control. In addition to scientific controversies, they pointed out that effective enforcement of these norms was difficult

96 Correspondence in A 6/445/3, Archives of the WHO, Geneva.

97 Akira Iriye, *Global Community: The Role of International Organizations in the Making of the Contemporary World* (Berkeley: University of California Press, 2002), 5-28.

98 For example, Theodore F. Hatch, "The Role of Permissible Limits for Hazardous Airborne Substances in the Working Environment in the Prevention of Occupational Disease," *Bulletin of the World Health Organisation* 47 (1959): 151-159.

99 *Air Quality Criteria and Guides for Urban Air Pollutants*, WHO Technical Report Series, No. 506 (Geneva: WHO, 1972), 11, 20-21, 26, 28.

100 *Air Quality Criteria*, 7-10; Letter from James L. Whittenberger to the WHO's Environmental Health Division, 31.1.1966, a 1, A6/445/3, Archives of the WHO, Geneva.

101 Sellers, "The Cold War Over the Worker's Body," 44.

102 Josephson et al., *Environmental History of Russia*, 90, 217, 251.

and required significant resources and technical expertise. According to the critics, the strong support for regulatory norms was due to the political and scientific prestige of the standards, rather than their effectiveness.[103] In fact, when the air qualities in United Kingdom and Russia were compared in the 1990s, it was noted that enforcement of air quality regulation was rather weak in both countries.[104]

Although the air quality standards have since proved their effectiveness, this criticism, and the differing views examined in article indicate that the strict environmental standards of the Soviet Union could be seen as something that Loren Graham has termed "presentation technology," a technology designed to be impressive and to please those in power.[105] Seeing environmental standards as high-end technology rather than legal triumphs can help to situate the Soviet approach as part of the more general problem of technological development in the Soviet Union. In other words, high quality scientific and technical innovation was hampered by the lack of maintenance and problems in long term development.[106] As Kirill Chunikhin has shown, similar contradictions ensued when Soviet Union attempted to solve the occupational respiratory hazard issue by developing efficient gas masks. Despite high quality research and innovation, efficient use of gas masks faced continuous problems ranging from production quotas to cultures of maintenance.[107] Gas masks and strict hygiene standards can be seen as technical solutions that shared the same Soviet ideals of public health and the same problems of efficient implementation. From this perspective the apparent contradiction with strict standards and high-quality research on the one hand, and their poor performance in practice on the other, seems less paradoxical.

CONCLUSION

This article has shown how Soviet research on industrial hygiene and air pollution presented a predicament to those seeking to unify the ways by which the toxic menaces of modern society were controlled. The Soviet approach presented itself as more nuanced and more attuned to modern environmental health problems compared to the biomedical reductionism prevalent in the West. Although the Soviet approach ultimately did not change the regulatory regime in the US or Western Europe, many of its features found resonance in the discussions about the relationship between humans and the modern industrial environment. As discussions in multiple international conferences showed, the difficulty in bringing the two sides together did not lay merely in different scientific methods, but in different physiological standpoints and, perhaps most importantly, in different ideals of environmental regulation.

The fact that the encounter of the two approaches was not only a clash but also brought out mutually shared concerns supports the arguments of those who have emphasized the importance of Soviet scientific work in international environmental questions. As Loren Graham has argued, the influence of dialectical materialism in Soviet science was not simply harmful to Soviet science; its disdain for reductionism also encouraged Soviet scientists to search for novel synthetic approaches.[108] Thus, although the canonization of Pavlovian theories restricted Soviet

103 Mäkiranta, "Clarifying the Air," 146-169.
104 Olga Bridges and J.W. Bridges, "Comparison of Air Quality in the UK and Russia," *Environmentalist* 15 (1995): 139-146.
105 Loren Graham, "The Fits and Starts of Russian and Soviet Science and Technology," in *Technology, Culture and Development: The Experience of the Soviet Model*, ed. James P. Scanlan (New York: Sharpe, 1992), 1-19.
106 Kendall Bailes, *Technology and Society under Lenin and Stalin: Origins of the Soviet Technical Intelligentsia, 1917-1941* (Princeton University Press, 1978); Graham, "Fits and Starts of Russian and Soviet Science and Technology."
107 Kirill Chunikhin, "Risk and Respirators: The Hazardous Trajectories of Soviet Occupational Safety, 1940s–80s," *Technology and Culture* 63 (2022): 603–633.
108 Loren Graham, *Science in Russia and the Soviet Union* (Cambridge: Cambridge University Press, 1993), 99-101.

physiology and toxicology, it also ushered the research towards questions that were beginning to raise interest in the US and Western Europe during the 1950s.

One could argue that the Soviet approach was pioneering vis-à-vis a future regulative regime. After all, since the late 1960s the regulation of toxic substances in the environment became increasingly strict. This was related to many developments, such as the debate about low dose use of carcinogens, the new concept of environmental toxics, and the general rise of concern over pollution. As a result, even in the contested issue of air pollution increasingly strict hygienic guidelines were implemented with scarce knowledge.[109] As Sellers has argued, the Soviet research tradition should be seen as a part of this development towards more precautionary practices of environmental regulation.[110] Indeed, many of the central aspects of what became known as the precautionary principle, such as the use of wide safety margins in the face of uncertainty, were already used in Soviet hygiene.

At the same time, Soviet hygiene research and the reception it received in the West highlights the issues confronted in the attempt to solve the problems of polluted air by medical and scientific expertise. The regulatory regimes that were created in mid-twentieth century Europe and the US have been criticized for suppressing science because of political and economic interests. The idea of politics and financial interests meddling with science in general has become an important narrative in environmental history.[111] Mid-twentieth-century Soviet hygiene research presented itself as entirely free of such influences and apparently could issue very high hygienic standards based solely on medical research. The Soviet way was, however, too scientific even for their Western counterparts who were deeply involved in technocratic internationalism to regulate environmental health. Even the WHO, despite its similar ideals, had to resort to a more consensual approach in the development of international air quality guidelines. By taking the technocratic approach and physiological criteria to its extreme, the Soviet experts effectively made visible the limits of scientific and medical knowledge in solving environmental health problems of modern society.

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109 Uekötter, "Age of Smoke," 180.
110 Sellers, "The Cold War Over the Worker's Body," 43-44.
111 Arguably the most famous work on this theme is Naomi Oreskes and Eric Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Climate Change* (New York: Bloomsbury Publishing, 2010).