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MAJOR CHEMICAL ACCIDENTS AND GOVERNANCE IN BRAZIL

Introduction

The United Nations Conference on Environment and Development (UNCED) was held in the Rio de Janeiro (Brazil) in 1992. One of the objectives of UNCED was to establish common commitments by nations that would guide the sustainable development of the global community; the result was Agenda 21, (CNUMAD, 1992). Agenda 21 recognized the necessity for significant steps to strengthen national and international initiatives to reach the established goals and to fulfill the proposals for action because the countries that face the greatest challenges to sustainability are countries with the least institutional and financial capacity. Initiatives included the industrialized countries exercising their responsibilities in cooperation with industrializing countries in seeking to resolve problems related to the environment and sustainability. Careful revision of priorities and budgets must be undertaken with a view to gradually incorporating the costs of environmental protection into local economic calculations (CGG, 1995. Finkelman, 1996).

It is precisely in this context that *chemical safety* (CS) is inserted into Agenda 21. Chemical safety is understood to be a series of strategies for the control and prevention of adverse effects for humans and the environment resulting from the extraction, production, storage, transport, handling and disposal of chemical substances. CS is recognized as one of many serious and fundamental problems that need a global approach. It is necessary to widen collaborative efforts with governments, as well as with other non-governmental actors, e.g. industry, unions, consumers, non-governmental organizations (NGOs), citizens' groups, professional associations and scientific institutions. The problem of *governability* is seen as a problem confined to the role of states and governments, but needs to be transformed into one of *good governance* at national and international levels.

In October 2000, Brazil took on an international leadership role on CS when it assumed the presidency of the Intergovernmental Forum on Chemical Safety, (the mandate ran until the end of 2003). This role demanded that a wide range of sectors work together to formulate wide-ranging and effective proposals for dealing with the problems of chemical pollution. These sectors included health, work and the environment, as well as representatives of government, and social actors such as workers, businesspeople, communities and consumers exposed to chemical risks. Remaining challenges include the development of integrated methodologies specifically related to the context of the problems and which are participative in nature. More transparent and democratic decision-making processes are also needed. While important challenges lie ahead, capacities seem to be limited, particularly with respect to industrial accidents with major consequences; such accidents reveal the limits of current control and prevention strategies as well as the destructive potential of industrial society.

Chemical safety as a subject of international concern

Chemical safety appeared as an international concern at the 1972 United Nations Conference on the Human Environment (UNCHE) held in Stockholm. Recommendations from this conference led to the establishment (in 1980), of the International Programme on Chemical

Safety (IPCS) a joint program of the World Health Organisation (WHO), the International Labour Organisation (ILO), and the United Nations Environment Programme (UNEP) Arcuri et al., 1998; Plestina et al., 1996). The initial goal of IPCS was to provide an internationally recognized scientific base in order to permit different countries to develop their own chemical safety measures. (Plestina et al., 1996).

Twenty years after the Stockholm Conference, the 1992 UNCED approved Agenda 21, where chapter 19 is entirely dedicated to chemical safety. Chapter 19 points out the problems of large scale chemical pollution, (both present and future), and recognizes that the most serious situation occurs in the industrializing countries due to: 1) the lack of scientific data to evaluate the risks inherent in the utilization of numerous chemical products, and 2) the lack of resources to evaluate the chemical products for which data is already available (CUNCED, 1992).

Among the set of international strategies laid out in chapter 19, six program areas were established: A) Expansion and acceleration of the international evaluation of chemical risks; B) Standardization of the classification and labeling of chemical products; C) Exchange of information about toxic chemical products and chemical risks; D) Implementation of risk reduction programs; E) Strengthening of national capacities and power for handling chemical products; F) Prevention of illegal international trade in toxic and dangerous products. Furthermore, the International Forum on Chemical Safety was created in 1994, with the aim of constituting new cooperative arrangements between governments to promote the evaluation of the risks of chemical substances and their administration on an ecologically rational basis, seeking to integrate and unify national and international efforts and, simultaneously, to avoid duplication of activities and spending (IFCS, 1997). Although this is an intergovernmental forum, it is recognized that matters relative to *chemical safety*, particularly the six program areas defined in Chapter 19, cannot be implemented only by government actions. It is necessary to have the participation of industry, inter-governmental and scientific organizations and of different interest groups representing communities and workers exposed to risks.

All these international initiatives must be understood in context. As observed by the Commission on Global Governance (CGG, 1995), the growth in the production of chemical products has resulted in pollution levels that are altering the chemical composition of water, soil, the atmosphere and biological systems, changes that endanger not only well-being but the survival of the planet.

From World War II onwards, technological development in industrial chemical processes, propelled by competition among capitalist companies and the development of a global economy, has resulted in the worldwide expansion of production, storage, circulation and the consumption of chemical products. Global sales of organic substances provide an example, rising from 7 million tons in 1950 to 63 million in 1970, 250 million in 1985 and more than 300 million at the beginning of the 1990s (Korte et al., 1994).

According to IPCS, there are more than 750,000 known chemical elements, compounds or mixtures in the environment, either of natural origin or as the result of human activity (IPCS, 1992). About 70,000 are used on a daily basis, 40,000 of which are used in significant commercial quantities (IPCS and IRPTC, 1992). Of this total (40,000), it is calculated that only 6,000 substances have undergone a minimally adequate evaluation of their risks to human health and the environment. Added to this dramatic picture is the capacity of

technological innovation in the chemical industry, which puts between 1,000 and 2,000 new substances onto the market every year.

The growth of the chemical industry is closely related to the development of a highly interdependent and unequal global economy, in which production, trade and investments are consolidating into an international division of labor where risks and benefits are internationally distributed. While about 20% of the world population, situated mainly in the industrialized countries, consumes about 80%, of the goods produced, the other 80%, situated principally in the industrializing countries, consumes just 20% (MacNeill et al., 1992). In India, for example, where the worst major industrial accident in world history occurred in Bhopal in 1984, (more than 2,500 instant deaths), the annual consumption of products from chemical technology was 1kg per capita, while consumption in the industrialized countries was between 30 to 40kg per capita (Murti, 1991). In 1984, both Brazil and Mexico each suffered their most serious major industrial accident in the post World War II period.
Faced with the complexity and expansion of the problems caused by chemical pollution of the environment, *chemical safety* has become an issue of global governance. Chemical safety has increasingly challenged governments' capacities to guarantee health and safety of their citizens, particularly in the industrialized countries. Our common future depends not only on economic growth, but also on the improvement of the quality of living, particularly for the poorest populations, based on principles of universality, solidarity and equity, principles which should be kept in mind and guide decisions and actions related to *chemical safety* at both the global and local levels (CGG, 1995. Finkelman, 1996).

Chemical Safety and Governance in the Context of Complexity and Vulnerability
The report of the Commission on Global Governance (CGG, 1995), affirms that a great challenge for our generation is the collective mobilization of people so that life in the 21st century will be more democratic, more sustainable, and safer. As this should occur in an equitable manner, there is an implication that both nations and the world community must take greater collective responsibility regarding these intrinsically interrelated matters. Safety is no longer to be seen as a matter for states, but must become a priority for people. However, this vision should be relativized, especially in the poorer countries where levels of democratization and social welfare are low. In the current context of globalization, which reduces the capacity of Nation States to implement public policies in an autonomous manner, the situation is deteriorating, a situation that accentuates the vulnerability of countries, particularly in Latin America, Asia and Africa.

Chemical safety is understood to be one of many important dimensions related to safety, involving health, life and environmental protection, (both current and future). Seen in this context, chemical safety is a matter for governance at both global and local levels, not restricted to governments and the relationships between governments. It constitutes an important challenge in countries such as Brazil, where questions relative to democracy, safety, sustainability and equity, (all fundamental for good governance), are still relatively unresolved and receive incipient treatment. The above questions should be integrated with chemical safety issues.

The drawing up of policies related to chemical safety in industrializing countries like Brazil should face up to the complexities and uncertainties surrounding the problem. These problems are magnified by the diversity and precarious nature of conditions in industrializing countries. In other words, it is fundamental to consider elements related to different modalities and levels of vulnerability, in searching to build more contextualized and participative knowledge

and decision-making processes, at both the local and global levels, as basic prerequisites for governance.

When the notion of complexity is applied to problems related to chemical pollution, it implies that analysis cannot be reduced to that of isolated components, as is done in traditional scientific approaches. This would lead to both important losses of knowledge about the problems, thereby increasing uncertainties, and limit the formulation of prevention and risk control strategies (Funtowicz and Ravetz, 1993). Funtowicz and Ravetz (1993) distinguish three levels of uncertainty. *Technical uncertainties* are related to inaccuracies in data or analyses, and can be managed through adequate standardized routines as developed in individual scientific fields. *Methodological uncertainties* are related to the unreliability of data and involve complex and important questions relating to the information gathered, such as values and reliability. Finally, *epistemological uncertainties* are related to the margins of ignorance of scientific knowledge itself. This level is involved whenever irreparable uncertainties are at the centre of the problem (Porto and Freitas, 2003).

To face up to the *inherent uncertainties* in our current scientific ways of evaluating problems which arise from chemicals, and to understand the problem in a wide ranging and systemic manner, involves integrating multiple and simultaneous dimensions of different natures. In this perspective, global and local standards of production, transportation, commercialization, storage, disposal and safety, as well as the directions taken by the development of chemical technologies, interact simultaneously and inextricably with emissions of chemical substances which reach soil, water, the atmosphere and the food chain. Such emissions are mediated by chemical reactions and by social, cultural, economic and power relations. Emissions result in different levels of contamination of human beings and of the ecosystem. There are also differences in capacities for social responses to the problem which implies that decision-making involving chemical risks cannot be carried out solely on the basis of limited technical or scientific predictions. It is necessary for the wider issues outlined, to be included and for reference to be made to the values and interests involved, and that, in the name of governance, these complement aspects normally involved when treating public policy (Funtowicz and Ravetz, 1993). Marchi et al. (1999) observe that many new risks, such as those that originate with chemicals, combine high levels of uncertainty with the possibility of extensive and irreversible damage, and therefore require new decision making processes.

For new approaches and decision-making processes to be minimally viable, particularly in the context of industrializing countries, we should consider the concept of social vulnerability as it relates to technological risks (Horlick-Jones, 1993. Porto and Freitas, 2003). In our view *social vulnerability* should be subdivided into two distinct but interrelated areas. The first is *population vulnerability* (Morrow, 1999). This relates to the existence of population groups most at risk, due to characteristics relating to their social, political and economic status, (their ethnicity, gender, disability, age, etc), and which are a function of various forms and levels of their social exclusion. The second is *institutional vulnerability* (Barrenechea, 1998), that relates to the way in which a society operates in terms of the public policies, decision-making processes and institutional mechanisms which affect structural conditions or pressures in ways that favor or worsen risk-related situations and events. In Brazil, we believe that much still needs to be done to improve the interface between government and industry to guarantee chemical safety, especially considering that the State has been run down over recent times and has become unable to prevent chemical related problems, (an example of *institutional vulnerability).* This picture is worsened by the fact that certain social groups are exposed to

chemical substances in situations that are socially and environmentally risky, (an example of population *vulnerability).*

From this perspective, good governance can only flourish when it is founded on a strong commitment to the principles of equity and democracy and grounded in civil society. The principles of governance are compatible with the perspectives developed within the 'collective health' system in Brazil, and these should guide decisions and actions for the health-care sector, particularly when they involve environmental matters involving a broad range of actors and interests. The concept of good governance is linked to environmental justice, i.e. a series of principles and practices designed to guarantee that no social group, be it ethnic, racial, class or gender based, "supports a disproportionate share of the negative environmental consequences of economic activities, policy decisions or of federal, state or local programs, nor the lack of or omission of such policies". In this way, both just and equitable access to a country's environmental resources will be guaranteed. In addition, all groups will have access to relevant information about their own lives which favors the building of collective subjects and social movements that are capable of contributing to the establishment of alternative and democratic models of development (Phase et al., 2001).

Chemical safety and governance – the Brazilian case

Brazil, (in a similar manner to a number of other industrializing countries, e.g. India and Mexico), underwent a process of accelerated economic growth between the 1960s and the 1980s, partially financed by greatly increased foreign debt. Brazil became one of the most indebted developing nations as during this period, multinational corporations increasingly invested in the industrializing process and state investment and intervention in the economy increased. In 1990 the chemical industry represented about 19 % of the total production value of Brazil's industrial sector. According to the Brazilian State Statistical Institute's (IBGE) Annual Research of the Industrial Sector in 1997, the chemical industry was responsible for about 22% of net sales of the Brazilian industrial sector, (IBGE, 1997). Presently it is the eighth largest chemical sector in the world.

The economic development model adopted in Brazil was sustained by the absence of a democratic political system, particularly between the mid 1960s and the mid 1980s. Important transformations in the whole of society also occurred during this period and, as a result, the country suffered a process of fast and disorderly industrialization, which combined concentration of capital, exploitation of the labor force, and disregard or omission by public authorities with regards to the control and prevention of chemical risks. At the same time there was an intense process of uncontrolled urbanization, accompanied by major migratory flows principally from the countryside and poorer regions to the more important urban centers. Social, human and environmental problems were relegated to a secondary position (Becker et al., 1993). One consequence of this process was that some of these poor migrants, with low educational and skill levels, who had moved to seek better living and working conditions, settled on the outskirts of the major cities, living under precarious conditions, without access to basic goods and services like sanitation, health and education. A similar situation, in terms of precarious living and working conditions, existed for those who stayed in the rural areas. This resulted in inferior standards of safety, health and environmental protection, not only when compared with industrialized countries but also in comparison with some other developing economies. In this manner, healthy and safe areas became increasingly separated from unhealthy and unsafe ones (Guilherme, 1987; Towers, 1993; Barbosa, 1992).

In the rural areas, cases of workers and their families being contaminated by agricultural pesticides are well known. Inhabitants of neighboring areas are also exposed to agricultural pesticides through environmental contamination of water, air and soil and through the food chain, in a complex circuit of chemical and social interactions. Structural problems have their origins in the development models adopted in the country, the absence of land reform policy and the lack of stable rural jobs that contributed to migratory flows from the countryside not only to cities but to mining activities, (e.g. gold prospecting in the Amazon region). While gold mining activities provide the single most important source of jobs in this region (10.7%), they coexist with unsatisfactory sanitary conditions and endemic diseases such as malaria and leishmaniasis. These activities also result in important environmental degradation, profound disorganization and social marginalization (MMA, 1995). These activities are frequently illegal and involve a labor force that is unstable, unqualified, mobile and without legal rights. In some cases there is even slave labor, organized in small centers around the mines, which then establishes relations between company run, mechanized mining and manual craft mining. In the main, the techniques adopted are very rudimentary so large quantities of mercury (Hg) are used resulting in high levels of pollution to the air, mine tailings and river water. Craft miners, and the premises where gold is extracted from the ore, are also contaminated. Town populations living close to the mines and extraction premises, as well as populations that live by riversides, also end up with methyl mercury contamination because of direct or indirect interactions with the environment (MMA, 1995. Camara et al., 1993).

The complex social fabric surrounding gold mining activities combines with the environmental complexity associated with the biotransformation of mercury into its more toxic form, i.e. methyl mercury. This is aggravated by uncertainties that arise due to the lack of scientific data about the behavior of methyl mercury in tropical environments. There may also be problems in the ecological chain due to the possibility that global climate change may contribute to enrich the recycling process of this chemical agent so it becomes subject to bioaccumulation. This would result in an increase in the risks of exposure due to the evaporation of this agent, which would convert into chemical time bombs (Nriagu, 1999).
In the major urban centers, chemical problems manifest themselves in a number of ways, from production-related problems in small workshops, (e.g. in car battery factories or re-conditioners) to major industries in the chemical sector, (e.g. chemical, petrochemical and petroleum industries) that have wide-ranging effects, including at the final destination of chemical residues. One of the best known cases of environmental contamination from dangerous residues, that involved a combination of both institutional and population vulnerability, occurred in Cidade dos Meninos, in the Duque de Caxias municipal district in the state of Rio de Janeiro. When a factory belonging to the Health Ministry was shut down in 1954, about 700 tons of residues from the production of HCH, (used to fight malaria), were abandoned. Today about 1,500 people live in the area and extremely high levels of residues have been found in the environment, in the inhabitants and in the local biota (Oliveira et al., 1995).

Another serious problem occurs in small factories, (many of which operate in peoples' backyards), which use chemicals. The vast majority of car battery re-conditioners (mentioned above), are located in residential and commercial areas where low income populations live. These factories generally employ around 10 workers, characterized by low educational levels, lack of training and lacking in appropriate information about risks and safe behavior. Conditions in the workplaces are inadequate and antiquated processes are frequently employed. Not only workers are contaminated by lead, but also the surrounding areas and the neighboring population (Silva and Mattos, 1999). These workplaces have high marginal costs

and do not qualify for official subsidies granted by environmental improvement programs. These workplaces are rarely targets of government inspections which, if they were effective, could worsen the current unemployment crisis because dangerous factories would be shut down.

Major industrial accidents and good governance

In contrast to the previous examples, cases of chronic pollution and accidents in large-scale industries have frequently involved chemical industry workers. Such workers have high levels of technical qualifications, formal education and capacity to organize themselves both in the workplace through unions and nationally, so consequently such workers have a greater capacity to mobilize and exert social pressure. In spite of limitations, a number of events in the 1990s demonstrated that the mobilization capacity of these workers resulted in collective agreements and in the setting up of national commissions involving both industry and government representatives. Some of the most important cases include the benzene agreement, the boiler regulations and the building up of a national legislative framework relating to major industrial accidents. Such experiences demonstrate that it is possible to have more democratic decision-making processes as well adopting a perspective of good governance. The World Banks sees this perspective as involving predictable, transparent and scientifically oriented policy formulation, and a civil service which acts professionally with the aim to promote the public good, transparency, the rule of law and the participation of civil society.

The regulation of major industrial accidents serves as an example through which the possibilities and the limits of good governance can be explored. In the 1970s and 1980s Brazil was already the scene of several major industrial accidents, most of them involving the petroleum sector. In 1972, the explosion of a LPG tank at REDUC, in Duque de Caxias (state of Rio de Janeiro), resulted in the death of 38 workers. In 1981, a hydrosulphuric acid leak at REVAP, in São José of the Campos (state of São Paulo), killed 13 workers. In 1984, a leak in a pipeline administered by RPBC resulted in a fire that led to the deaths of more than 500 slum dwellers in Vila Socó (Cubatão, state of São Paulo). In the Campos offshore oil field (state of Rio de Janeiro), an explosion and fire on the Enchova platform resulted in the deaths of 37 workers and 19 injuries. We would like to remind readers that all these accidents occurred in a country , that had not been able to democratically choose its government since the military coup d'état of 1964 so government institutions were not subject to democratic control. During the military period the growth and enlargement of industrial capacity, including petroleum production, was a key element of the national development strategy. It was only in the 1990s, with the consolidation of democracy in the country that a series of events occurred which contributed to a better system of control and prevention of major industrial accidents. In 1991, seven years after the pipeline break and explosion that resulted in over 500 deaths, the "Risk Prevention System for Major Accidents" (SIPRAM), was created in Cubatão. In 1994, ten years after the Bhopal accident, a number of important meetings were held. The "National Seminar on the Prevention of Major Industrial Accidents" was organized by the MLE in the state of Bahia; the "Tripartite Latin American Seminar on Major Industrial Accidents" was organized in the state of São Paulo by the ILO, and the Seminar "Ten Years after Bhopal – The Major Accident Question" was organized by the Center for Worker Health and Human Ecology Studies of FIOCRUZ in the city of Rio de Janeiro. In the following year, 1995, the National Confederation of Chemical Workers, (affiliated to the Unified Labor Confederation (CUT)), organized the "National Seminar on

Major Accident Risks" in Atibaia (state of São Paulo). A formal session was held at FIOCRUZ where the CUT formally requested the Workers' Party (PT), to move forward with the ratification process for ILO Convention 174, (on major industrial accidents), in the National Congress. In the first half of the 1990s, there was a series of movements, mainly involving government bodies, international organizations, research institutes and the representatives of chemical industry workers that raised the issue of chemical safety and initiated the first strategies to control and prevent major industrial accidents.

A more general move towards the institutionalization of these strategies was made only in the second half of the decade, particularly from 1998 onwards. This move resulted from high media attention paid to a number of industrial accidents and the mobilization of workers, mainly organized through the National Confederation of Chemical Workers, (linked to the CUT), allied with technicians employed in government bodies, (especially the MLE), and research institutes, (particularly FIOCRUZ). In 1998, three important accidents occurred: an explosion at Nitroquímica, (a petrochemicals company in the state of São Paulo), resulted in one death and the prolonged paralysis of a large industrial complex dependent on this factory; a fire in REGAP (state of Minas Gerais), killed 6 workers, and an explosion in an illegal fireworks factory in Santo Antônio de Jesus (Bahia state), where unregistered and underage workers were employed, resulted in 64 deaths and 5 injured workers. 1998 was a symbolic year in dialectical terms, bringing positive developments as well as exposing the limitations of governance of industrial risks. At the same time as the incapacities of major companies, (such as PETROBRAS and NITROQUÍMICA), to prevent and control major accident risks, was again highlighted. The most serious accident ever experienced in Brazil occurred (measured by the number of workers who died instantly in a single event) in an illegal factory which employed unregistered and underage workers. However, it is interesting to note that, in spite of the seriousness of the accident, it was given relatively small coverage in the media because the victims were poor, politically powerless and lived in an isolated region. This fact reveals another facet of social vulnerability - the trivialization of the tragedy and its social invisibility. In 1998, the Minister of Labor and Employment signed Administrative Order number 11 creating a Tripartite Commission to analyze ILO Convention 174 and ILO Recommendation 181, on the prevention of major industrial accidents. In the following year this commission forwarded both the Convention and the Recommendation to Congress.

Finally, after much pressure, a Tripartite Study Group was set up in 2000 to investigate the implementation of Convention 174 in Brazil. In this same year, pressure was applied by the CUT and the National Confederation of Chemical Workers allied with government technicians, and a strategy was also implemented to make the theme more visible. This strategy received an unplanned but significant boost from the giant state controlled petroleum company PETROBRAS, when two accidents occurred within a short space of time and had important repercussions in the media. These accidents demonstrated both population and institutional vulnerability and complexity, leading to demands for more effective regulatory strategies in order to guarantee control and prevention. Two pipelines broke. One at REDUC, in the state of Rio de Janeiro, resulted in 1.3 million liters of oil leaking into Guanabara Bay, provoking a large-scale environmental disaster. The second was at REPAR in Paraná state and resulted in 4 million liters of oil leaking into the Barigui and Iguaçu rivers. At the end of this same year, the third session of the Intergovernmental Forum on Chemical Safety was held in Salvador in Bahia state. "Priorities for Action after 2000" were established within Agenda 21's program area D, (implementation of risk reduction programs), with the implementation of control systems and the prevention of major industrial accidents planned in at least 70 countries by 2002. In spite of these events it was only in 2001, (six months after the gas leak

and explosion on the PETROBRAS marine Platform P-36 had resulted in the deaths of 11 workers), that Convention 174 was approved by Congress (Legislative Decree 246, of 28th of June 2001) and ratified by the ILO. The Convention was promulgated by the President of Brazil in Decree 4085, on the 15th of January 2002.

The ratification of ILO Convention 174 is an important marker in the process of increasing institutionalization of control and prevention of industrial accidents with potentially major consequences, a process that reveals both the possibilities and the limits of governance relating to the risks of industrial accidents in countries such as Brazil. On one hand, it is important to remember the value of participation of workers in the chemical and petroleum industries. These workers are well qualified technically, have a high level of formal education and a capacity for organizing themselves on a local and national basis through their unions. Consequently, these workers have the power and capacity to apply social pressure, in alliance with government technicians and academic researchers. However, during the 1990s, a process of industrial restructuring resulted in increased disorganization of work and of workers. This disorganization then increased the externalization of risks, a process which meant subcontracted or informal sector workers became the main victims of fatal accidents. Parallel to this, a strategy was implemented to reduce the strength of the organized union movement, (particularly during the two presidential mandates of the Brazilian Social Democratic Party (PSDB), when the country was governed by Fernando Henrique Cardoso), and consequently the power of the Federation of Petrol Workers was reduced. The state's role in control and preventive actions was also weakened because resources were limited, replacement of staff was slow and insufficient and, in addition, activities were restructured.

The strategy to weaken organized labor was associated with a rising number of workers in insecure positions in the labor market, i.e. workers lacking in organizational capabilities, especially subcontracted or informal sector workers who worked in dangerous industrial activities. These workers became more vulnerable and hindered the possibilities of governance of major industrial accidents even though a process of institutionalization of control and prevention mechanisms occurred throughout the whole decade. It must also be stressed that this process of reducing the role of the state was also associated with sporadic and fragmented action, (characteristic of the operation of the Brazilian state), that contributed to a situation where important ministries were unable to function satisfactorily. For example, the Environment Ministry has so far played only a very small role in inter-sectoral commissions in spite of the important role that various bodies within the national environmental system have in the prevention and control of major industrial accidents. This reveals one of the limitations on a broad and inclusive strategy for the governance of industrial risks. However, much progress has been due to the persistence of action by organized workers which demonstrates that the democratic content of decision-making processes can improve governance.

Conclusions

Using the above cases as reference points, (particularly for major industrial accidents) it is clear that there has been growth in problems related to chemical safety in Brazil, and this growth has been greater than the country's capacity to cope. In this context, the recognized complexity of Brazil's socio-environmental system, associated with social vulnerabilities (population or institutional), has stimulated the indiscriminate use and contamination of natural resources over decades. This process has occurred because archaic production systems

coexist with advanced technology, resulting in different forms and levels of social inclusion and chemical pollution.

The current government administration of chemical safety in Brazil, (federal, state or municipal), is inefficient and there is little integration among the various sectors and social groups involved. There are jurisdictional conflicts between different government bodies, omissions and failures in the mobilization of existing human and technical resources, particularly in relation to the protection of health and the environment. Although the available legal framework can be considered to be relatively complete, in practice there is a lack of operational capacity due to the continuous restructuring of government agencies, discontinuities in public policies and a lack of financial resources, particularly in the environment and health areas.

In the current context, self-regulatory policies, such as certification by the ISO 14,000 standard, or voluntary programs such as the "Responsible Performance in the Chemical Industry" program, run the risk of inappropriately replacing absent public policies. This is even more likely when consideration is given to the relative economic stagnation which has occurred over the last two decades, allied to the structural unemployment which is part and parcel of the current model of economic development. Social marginalization has been growing and this reduces the capacity of society to exert pressure for meaningful change. Industrial workers are an important pressure group for improved chemical safety and played a fundamental role in some of the cases examined in pressuring for good governance.
The Brazilian state, (as in some other industrializing countries), has been involved in a serious and dangerous process of deterioration, increasingly alienated from and indifferent to the population's needs and demands. In such a context, Finkelman (1996) sees a necessity to redefine the role and actions of the state at all level, in relation to chemical safety. This redefinition is particularly needed in the areas where the state has direct responsibilities, as is the case of those institutions which deal directly with the population's health and those which are responsible for protecting and monitoring the environment.

Chemical safety is one of the serious problems faced by countries like Brazil, a problem which raises the need and the challenge to build new social arrangements at the global, national, regional and local levels which will provide a model of sustainable development based on principles of equity and democracy. Another challenge is the need for an approach to science that is more deeply embedded in the context of our reality, based on integrated and participatory approaches. Such approaches would include the analysis of chemical, physical and biological affects combined with analyses of social, political, cultural, ethical and moral processes, thereby contributing to the search for more widespread and durable solutions. Chemical safety is a subject which has a specific context in today's world where most of the planet's population is excluded from the benefits of modernization and globalization. The excluded population suffers from the risks of a development model and international division of labor that is naturally and dynamically iniquitous. Few attempts have been made in recent years to correct this situation. Although many indicators of social progress (e.g. infant mortality, education, nutrition levels and life expectancy), have improved significantly at a global level, millions of people exposed to chemical pollution still live without adequate drinking water and sanitary facilities (CGG, 1995).

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THE BENZENE AGREEMENT

The first laws aiming to control occupational exposure to benzene in Brazil were passed in 1928 (Carvalho, et al, 1995). However, in the past 50 years, almost all the actions related to benzene have been of a legislative nature, (e.g. the establishment of an exposure limit by the Ministry of Labor's Regulatory Norm 15), or related to scientific research (Wakamatsu, 1976; Morrone & Andrade, 1974).

At the beginning of the 1980s, action on the question of benzene changed direction as a consequence of renewed trade union mobilization following the discovery of a "benzene epidemic" by the Santos Metalworkers' Union in the state of São Paulo. Several cases of leucopenia, caused by exposure to benzene, were found among workers in the São Paulo Steelmaking Company (COSIPA) in the city of Cubatão. Following this discovery, the Construction Workers' Union in Santos also proved cases of benzene intoxication among maintenance workers and machine fitters in the same company.

The accusations had nationwide repercussions and new cases were detected in company after company where benzene was likely to be found, including steelworks, petrochemical plants, chemical industries, petroleum refineries, and anhydrous alcohol manufacturing plants. Most of the action spread throughout cities where steelworks were to be found, (i.e. Cubatão; Volta Redonda in the state of Rio de Janeiro; Ipatinga and Ouro Branco in the state of Minas Gerais, Serra in the state of Espirito Santo) and also to regions where there were petrochemical plants, (i.e. Cubatão and the Greater ABC region in the state of São Paulo; Camaçari in the state of Bahia; Triunfo in the state of Rio Grande do Sul). In this period over 3,000 workers were placed on sick leave because of benzene intoxication.

These events led to various union, employer and government actions.

The problem of occupational exposure to this agent led a FUNDACENTRO researcher, Tereza Carlota Pires Novaes, to conduct research into the presence of benzene in commercial products. (Novaes et al, 1981). (This researcher was also involved in government actions relating to exposure to benzene in the steelmaking industry.) This research was one of driving forces for the publication of the 1982 Inter-ministerial Administrative Order no. 3, issued by the Labor and Health Ministries, which prohibited the manufacture of products containing benzene and limited its presence to a maximum of 1 % by volume, as an impurity. In effect, this was first important action to control exposure to this agent in Brazil. The Administrative order principally affected those who worked with solvents, inks, glues, varnishes, etc. Table 1 shows some of the results that were discovered and gives an idea of the seriousness of the situation.

Table 1. The origin and percentage of benzene in commercial samples, analyzed before 1981. Source: Novaes et al, 1981.

Product	State of origin of the sample	% of benzene in sample (by volume)
Thinner extra	São Paulo	10.40
Thinner	São Paulo	5.20
Restoring agent for a printing press cylinder	São Paulo	Above 90 (analysis carried out on the volatile part)
Toluene for use in steelmaking	São Paulo	1.51
Thinner	Minas Gerais	17.41
Thinner	Pernambuco	6.70
Thinner	Espírito Santo	20.03
Thinner	Espírito Santo	73.58
Thinner	Brasilia	3.91
Thinner	Rio de Janeiro	16.00
Thinner	Rio de Janeiro	17.17

At this time Soto and Novaes (1983), drew up a list which elucidated various uses of benzene and this list became a reference for those seeking to control occupational exposure from both the union movement and the public sector. For example, the list indicated that benzene was being used to produce anhydrous alcohol, in spite this process being forbidden by legislation.

In the 1980s, several trade unions took action (Carvalho et al, 1995). In 1985, the Volta Redonda Metalworkers' Union in the state of Rio de Janeiro denounced the existence of 50 leucopenia cases at the National Steelworks Company (CSN). The Chemical and Petrochemical Industries Union of the ABC region in the state of São Paulo verified that a half of the workforce in the powerful Matarazzo group's BHC factory, a total of 60 workers, had leucopenia, including an acute case of medullar leukaemia, (the worker, Pedro Mangueira Filho, died in 1984). This particular case was historically important because it resulted in the first closure of a factory by the state of São Paulo's branch of the Ministry of Labor (DRT/SP). In 1986, the factory was permanently closed down in spite of the fact that the company had made all the improvements it deemed necessary, reducing its benzene concentration from levels as high as 1,000 ppm, to the still unacceptable level of 200 ppm.

In 1985 DRT/SP set up and coordinated an Inter institutional Commission to both demand control measures for benzene exposure, to be evaluated by the major steel making company COSIPA.

In 1986, after sick leave had been granted to a large number of workers, Circular no. 297, "Criteria for characterizing leucopenia", was issued by INAMPS through the Regional Secretariat of Social Medicine in São Paulo. This circular established criterion for the legal recognition of cases of leucopenia due to benzene exposure and was originally restricted to the industrial city of Cubatão but subsequently used in the whole state of São Paulo. At that time, the main haematological alteration that was investigated to verify benzene intoxication was leucopenia (decreased leucocytes in the blood).

In 1986, the São Paulo state government's Health Secretariat included haematological alterations due to benzene exposure in its epidemiological monitoring system for occupational diseases.

Due to the early detection of benzene related cases in Volta Redonda, and the resulting trade union action, the Regional Secretariat of Social Medicine in the state of Rio de Janeiro temporarily adopted the criteria established by São Paulo's INAMPS in 1987.

Two big campaigns, focused on the benzene issue, were organized by the workers' movement. One was launched in 1988 by the Inter Union Department for the Study and Research of Health and the Working Environment (DIESAT) by a seminar entitled "Leucopenia: Slow Death". Another campaign, called "Operation Hunt Benzene" was launched in 1991. Coordinated by the National Institute of Work Health associated with the Unified Labor Confederation (CUT), this campaign involved unions representing several categories of workers in various regions.

Three important technical and scientific events also occurred in the 1980s. The "Seminar on the Toxicology of Benzene - Risks and Means of Control", was organized as a part of the 42nd anniversary commemorations of the Brazilian Accident Prevention Association in May 1983. A "Symposium on Leucopenia" was held in 1987 in the town of São Roque, in the state of São Paulo, organized by the Brazilian Haematology Society, the Brazilian College of Haematology and the Social Service of Industry (SESI). Finally, in 1988 the "National Seminar on Benzene Exposure", was promoted in São Paulo city by FUNDACENTRO.

All these actions in the 1980s marked a change of focus on questions related to occupational exposure to benzene and to workers' health more generally. Three major changes can be identified: increased awareness among workers and the technical community as to the importance of problems caused by benzene; the mobilization of social movements around the problem; administrative and political action by the state on compensation for victims and prevention strategies. These changes coincided with the end of the military dictatorship and the beginning of the return to democracy in Brazil when autonomous social actors who identified with the trade union movement developed and greater freedom of action for government agencies was allowed, as exemplified by the setting up of several inter-institutional commissions.

At the beginning of the 1990s, this trend consolidated. Inter-institutional actions occurred in several states: São Paulo, Minas Gerais, Bahia, Rio Grande do Sul and Espirito Santo (Carvalho et alli, 1995). In Bahia, two fatalities caused by benzene were diagnosed, (a work doctor died from aplasic anaemia and a petrochemical industry operator died from leukaemia), which led to the creation of an Inter-institutional group in this state. In 1991 this group organized a seminar at which a Protocol of "Intentions for the Control of Benzene related illness and other Occupational Diseases in the Petrochemical Complex at Camaçari" was approved. In 1991 a "State Committee on Benzene" was formed in Rio Grande do Sul.

In 1992, an important initiative occurred as fruition of all the previous mobilizations. Dr. Francisco Lacaz, head of the Sanitary Monitoring Service of the São Paulo State Health Secretariat, had one of the most important doctors involved with the benzene question, Dr. Lia Giraldo Augusto, as a member of his advisory team. This team created a tripartite group which drew up a state regulation specifically to deal with benzene, in terms of medical treatment and specialist diagnosis for social welfare purposes and exposure prevention. This

was the first "tripartite" experience in establishing technical rules relating to workers' safety and health in Brazil and reflected the accumulation of technical experience of all those involved with the question over the previous decade. The text of the technical regulation, (Resolution SS-184), was adopted on the 8 June 1993, and officially published on the following day.

The main aspects of the technical regulation are:

- The recognition that benzene is a product that causes cancer (a carcinogen) which means that no occupational exposure should be permitted if damage is to be prevented;

- With respect to haematological changes, the regulation breaks away from a reliance only on narrow numerical criteria, it enlarges criteria to include qualitative dimensions, incorporating a new manner of using hemograms in the examinations that lead to the diagnoses made by the Social Welfare Ministry's specialists.. Until this point, leucopenia had been one of the only changes considered, to the extent that haematological alteration was practically taken as a synonym for benzene related illness;

- It affirms that the reversal of a marginal haematological state of a worker diagnosed with benzene related illness (due to alterations in blood cell count), back to values considered to be "normal", does not imply "a state of cure". The regulation considers the possibility that the health status of those with benzene related illness could deteriorate later in life with the development of delayed malignant blood diseases;

- The regulation clearly indicated that in addition to cytogenetical alterations, the effects of benzene on the endocrinological, immunological and central nervous systems should be considered in clinical examinations;

- The standardization of social welfare practices and criteria;

- In relation to social welfare benefits, the regulation defines that the causal connection between alterations to workers' health due to benzene exposure should be presumed where working environments and activities undertaken are characterized by some degree of presence of the agent, and that this should be interpreted in accordance with the existing legislation;

- The regulation declared that the idea of establishing an 'Environmental Tolerance Limit' was not valid for prevention purposes because benzene's carcinogenic effect was recognized;

- Benzene use was restricted for all purposes unrelated to its role in chemical synthesis. The regulation prohibits the use of benzene in the production of anhydrous alcohol;

- Clear and precise criteria for the implementation of Programs for the Prevention of Benzene Exposure were defined. (This occurred at a time when the very idea of building prevention programs was incipient);

- It recognized that urinary phenol is a poor indicator of benzene exposure and its use was not recommended;

- Quantitative environmental evaluations were defined as having the specific goal of indicating levels of benzene related environmental contamination and would no longer be used to compare measured levels with "tolerance limits";

- It was established that Benzene Exposure Prevention Programs should be able to be evaluated by government inspectorates and workers' representatives.

There can be no doubt that this regulation served as an important reference for the current legislation on benzene, especially as several people who helped elaborate it also contributed to the writing of this legislation.

In March 1993, the "National Seminar on Exposure to Benzene and other Myelotoxic Substances" was held in Belo Horizonte and recommended that the legislation on benzene be revised at ministerial level. The first result of this recommendation was the National Social Security Institute's (INSS) 1993 "Technical Regulation on Benzene Intoxication" Which incorporated all the recommendations of Resolution SS-184. However, the regulation provoked employer reaction and critical documents from the sector's employers' union SINPROQUIM (1993) and the Tubarão Steel Company (CST, 1993), were sent to the Minister of Social Welfare. For example, the documents criticised the following definition of 'exposed worker':

> "Occupational exposure; [means the] presence of workers in areas where there are negative agents in concentrations or environmental levels that are above 50% of the tolerance level. This concept does not consider the fact that carcinogenic substances have no safe exposure limits and ignores the possibility of accidents or leaks."

The Benzene Agreement

Due to a recommendation made at the Belo Horizonte seminar, the Ministry of Labor initiated a process of revision and update of the Regulation NR 15 in 1993. This process led to the current agreement and legislation on benzene.

In this same year, the Ministry of Labor created a Technical Working Group to propose new legislation. After collecting information, the group wrote a document "Benzene - Technical Support to OHS Secretariat" for the Ministry of Labor, which brought together data on the Brazilian situation and proposed several measures for controlling exposure.

In 1994, on the eve of a presidential election, there was the possibility of both ministerial change and change in the Safety and Health at Work Secretariat (SSST), (the latter actually occurred, when the Minister Walter Barelli left office as did the Ministry's head OHS officer, Raquel Rigotto). Faced with the need to keep the discussion about benzene alive, a new regulation was promulgated (Decree No.3 MLE of March 10th, 1994). This decree included benzene in a list of carcinogenic substances in the 13th annex to NR15. A major merit of this regulation was that benzene was recognized as a carcinogenic substance and therefore no exposure should be permitted and could only be used in a totally sealed system. The decree

was presented at the FUNDACENTRO on March 11th 1994, with the Minister of Labor and the national OHS secretary present. The ”Project for the Control of the Occupational Exposure to Benzene" was also presented.

This decree mobilized employers’ groups linked to steelworks and petrochemical industries, (as can be seen clearly in the publication ‘Informativo SINPROQUIM’ (SINPROQUIM, 1994), subtitled "SINPROQUIM Starts a National Employers’ Mobilization”). One of the main reasons for the mobilization of employers was that they considered it was no longer possible to use benzene because use was restricted to hermetically sealed systems, with no possibilities of leakage. Companies alleged that this implied an environmental concentration of benzene of ‘zero’, and that was not possible in practice. However, this was the employers’ interpretation and it didn’t correspond to the text of the regulation.

The companies succeeded in postponing the implementation of the administrative order for six months, and a tripartite technical group was constituted to reformulate it. This tripartite group was formed in consultation with the new Minister of Labor and included professionals who were nominated in an unrepresentative manner. Because of this, sectors of the trade union movement and technicians employed by government mobilized and demanded that membership of the group be changed because they did not consider the group to be genuinely tripartite. Their principal objection was that some government nominees strongly identified with employer positions. At the group’s first meeting on September 2nd 1994, a busload of union representatives arrived to FUNDACENTRO and distributed a “Manifesto in Favor of ethics".

A new commission was established by Administrative Order no. 10 issued on 08/09/94, composed of government representatives (Ministry of Labor, FUNDACENTRO, Ministry of Health, Social Welfare Department), workers’ representatives (CNTI - National Confederation of Industrial Workers, CNTM - National Confederation of Metallurgical Workers, CUT – Unique Labor Confederation) and employers (IBS – Brazilian Steelworks Institute, ABIQUIM - Brazilian Chemical Industry Association, CNI - National Industrial Confederation and SIMPROQUIM – Union of Chemical Products Industries for industrial objectives and of Petrochemicals in the state of São Paulo). Each party relied on the support of three advisory staff and four technical advisers seconded to the commission.

The "Tripartite Working Group on Benzene" began work on September 28th 1994, and a proposal for the group’s work was agreed upon and as were issues such as the locations of future meetings, the nature of administrative support, limits of access to meeting rooms, the form of meeting minutes, prohibition of tape recording, the manner in which the meetings’ minutes would be released to the press, the principle that consensus should be sought on decisions, the modus operandi of the technical advisers, the sharing of technical knowledge among all parties, and the order of the day and date of the following meeting.

One of the first points to be agreed upon related to the technical question of the levels (values) of benzene concentration that were considered technically attainable but which did not preclude risks to health. "In this way, from a practical viewpoint, protection measures and improvements should be adopted so as to achieve ever smaller concentrations." (Meeting minutes, 31/10/94). In the group’s final document this concept was referred to as a "technological reference value". It had been agreed that the regulation to be adopted would classify areas of a company according to varying degrees of risk. However, consensus was

never developed on this subject and the final agreement instead favoured the monitoring of individual exposure levels.

Sub-commissions were constituted to discuss medical monitoring which required in-depth debate due to the conflicting interests around many points: quantitative environmental evaluation, acceptable levels of concentration, average exposure limits over time and possible maximum exposure limits. Agreement was not reached on these points.

It was agreed that workers should participate in follow up on the benzene agreement and a group representing benzene workers (GTB), was set up.

With regards to fixing threshold values, the employers suggested 5 ppm for the environmental concentration of benzene. This was not accepted by the other two parties and after a great deal of debate, a meeting in May 1995 agreed on the concept of a “Technological Reference Value” (VRT). Tripartite negotiations defined the concentration of benzene in the air which was considered feasible from a technical viewpoint, however, this level should be considered only as a reference for programs which seek to improve the working environment. The reaching of the VRT is compulsory and does not eliminate health risks.

VRT-MTP values were defined as “technological reference values for average level of concentration weighted over time, for an 8 hour working day, to be obtained in the respiratory zone”. The established values were 2.5 ppm in steel manufacturing industries and 1.0 ppm for other companies covered by the agreement. The values are different because these two types of industry are in different stages of technological development. Steelmaking companies use processes that are more difficult to control and for this reason were able to justify a higher value for the VRT in negotiations.

These values and concept of VRT were inspired by German legislation which also establishes a concept of VRTs for carcinogenic substances and proposes similar values for steelmaking and other industries.

Gradually agreements were made and some questions were left aside with recommendations that they be treated in subsequent agreements, as in the following list:

a) Definition of Indicators of Biological Exposure;
b) An International Seminar on benzene;
c) Discussion of activities that lie outside the scope of the agreement, such as the use of benzene in fuels such as gasoline;
d) Reduction of benzene concentration in manufactured products;
e) Substitution of benzene in the production of anhydrous alcohol, and in other fields where there is a technically viable possibility and need for substitution.

Some questions were never agreed upon, for example the rights of those laid off work because of benzene poisoning or the establishment of a technological reference value for short-term exposure.

In September 1995, the technical group handed their report to the Ministry of Labor. This report was made up of four documents: the Benzene Agreement, an Administrative Order to be included in the 13th Appendix to the Ministry of Labor’s Regulation no. 15 (Appendix 13 A), and two regulatory instructions ("Evaluation of Benzene Concentrations in Workplaces"

and "Monitoring of Worker Health aimed at the Prevention of Occupational Exposure to Benzene"). The Administrative Order was published on December 20th 1995 (FUNDACENTRO, 1995).

The main points of the agreement are as follows:

- The establishment of jurisdictions for those involved (Ministry of Labor, FUNDACENTRO, Ministry of Health), companies and workers.

- The creation of a “Permanent National Commission on Benzene” (CNPB), a tripartite body formed to discuss, negotiate and monitor the agreement. Its main responsibilities are to complement the agreement in relation to questions relating to alterations in workers' health status, and to propose and monitor studies, research, scientific events and changes in legal instruments

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- The creation of groups representing benzene workers (GTBs) in companies, with at least two elected workers who should receive special training and keep up to date with all actions in the company related to the prevention of occupational exposure to benzene.

- The establishment of time limits for companies to adapt to the new environmental concentration values.

- The creation of certification for the controlled use of benzene

- The establishment of penalties for those who do not adhere to the agreement.

Administrative Order No. 14 alters the item “Carcinogenic Substances" in Appendix No.13 of the NR15 - Activities and Operations in Unhealthy Conditions - of the Ministry of Labor by including appendix 13A. This appendix includes the following main points:

- The regulation of actions, responsibilities and procedures to prevent occupational exposure to benzene.

- Defines application of the Administrative Order to: those companies that produce, transport, store, use or handle benzene and liquid containing 1% or more benzene by volume, and to those hired by such companies and to others as may be relevant

- Prohibits the use of benzene, (as of 1/1/97), except in industries or laboratories that: produce it, use it in chemical synthesis processes, employ it in fuels derived from petroleum, employ it in laboratories for analysis and research, in conditions where its substitution is not possible, employ it as an azeotrope for making anhydrous alcohol, until the definition of a date for its substitution (the proposed date was 31/12/96)

- Obliges companies covered by the Appendix to register

- Sets a period of 180 days after the publication of the Appendix, for the presentation of a program for the prevention of occupational exposure to benzene

- Establishes the contents of the above program

- Establishes the concept of VRT (Technological Reference Value)

- Defines VRT-MTP, as the technological reference values for average level of concentration weighted over time, for an 8 hour working day, to be obtained in the respiratory zone

- Establishes VRT-MTP values

- Establishes indications for signposting areas where benzene is used and labelling /all products containing benzene

- Establishes requirements for emergency situations.

The Permanent National Commission on Benzene was installed on March 26th, 1996 and has met periodically since then and conducted company visits.

Implementation and progress

The actions on benzene that emerged in Brazil have resulted as a consequence of important social mobilization and an intense negotiation process involving various social actors, especially representatives of workers and employers in those companies using benzene.

Among the actions and progress which occurred from 1995 onwards the following can be highlighted:

- The setting up of the Permanent National Commission on Benzene which served as a model for negotiations that were later carried out in several other areas, and which still meets and exercises a role;

- Effective legislation prohibiting the use of benzene in the production of anhydrous alcohol was passed. This measure prevented the exposure of thousands of workers, and avoided benzene being transported by hundreds of tanker lorries on the highways. This measure came into effect in May 2000;

- A biological indicator of benzene exposure was established through testing of muconic acid levels. This was established as an indicator for the first time following academic research (which resulted in doctoral and masters theses and in three workshops);

- The reduction of benzene in gasoline to a maximum of 1%. This changed the National Petroleum Agency's previous administrative order which permitted up to 2 %;

- The writing of a technical note explaining the coverage of the agreement and legislation, including coverage of petroleum platforms and terminals;

- An agreement to decrease the benzene content in manufactured products to a maximum of 0.1% by the year 2007;

- The establishment of a regulation by the Ministry of Health for the monitoring of exposed workers, with the development of clear criteria for diagnosis, sick leave, etc;

- The development of a “System for Monitoring Populations Exposed to Chemical products produced with Benzene” (SIMPEAQ);

- The organization of courses, lectures, and seminars including an international seminar;

- The production of videos;

- The presentation of scientific and technical papers in national and international congresses and publications;

- The publication of material for training members of GTBs;

- The organization of regional benzene commissions. Currently there are commissions in the following states: Bahia, Espirito Santo, Rio de Janeiro, Minas Gerais, Paraná, Rio Grande do Sul and São Paulo. In São Paulo there are two regional commissions, one in the area of Santos and the other in the industrial municipalities of São Paulo City’s metropolitan area known as the Greater ABC;

- The organization of national meetings of the regional benzene commissions;

- The organization of meetings of GTBs;

- The organization of a workshop to discuss and make proposals on working conditions in the steelmaking industry;

- The organization of a workshop to discuss and make proposals on working conditions in the petrochemical industries;

- A recommendation to create centres for the diagnosis of benzene related illness, with the participation of the Ministries of Labor, of Health and of Social Welfare as well as with Haematology Centres;

- The establishment of criteria for workers to return to work after they have obtained a medical discharge after being on sickness leave due to benzene related illness;

- The provision of incentives for petrochemical companies to invest in controls that collectively protect workers from risks;

- The encouragement of steelmaking companies to invest in controlling leaks;

- The production of a CD-ROM "Brazilian Repertoire on Benzene" - 1st edition, 2001, 2nd edition, 2002, and 3rd edition 2003;

- Numerous visits to steelmaking, chemical and petrochemical plants and refineries where benzene is used in the production process.

These improvements have resulted from a great deal of social mobilization, mostly by trade unions, and the actions of government bodies concerned with the prevention of benzene-related illnesses. Companies have also made more efforts to control exposure, although there is still a lot to be done in this respect. All of this work has an inter-institutional and multidisciplinary character, and has been built up in a dynamic manner. It has always been necessary to adapt the approach to the regions where recommendations are to be implemented and to manage the difficulties revealed during the implementation. We believe that this effort exemplifies the need for a complex approach which brings together many institutions and scientific disciplines if sustainable development is to be achieved.

We can summarize some fields where monitoring has been consolidated by this particular experience with benzene (Machado, 2003):

1. Technological monitoring, risk reduction and elimination. This has occurred through the implementation of replacement technologies, hermetic sealing, the elimination of emissions into the atmosphere, and the removal of benzene from several products. Recommended procedures have been established for activities involved in transport and in laboratories (principally in the washing process). Procedures for collecting samples and draining lines have been developed along with projects designed to reduce emissions in water-oil separators. Old equipment has been replaced and better procedures developed for line and equipment maintenance used in processes that use benzene.

2. Epidemiological monitoring and evaluation of the effects and forms of exposure. Information on past cases has been organized. There is time series of workers exposed to risk situations, and records also the adaptation of health services of companies, of the public health system and of INSS diagnosis specialists to identify and monitor cases of benzene related illness. Processes have been introduced for monitoring the morbidity and mortality of workers exposed to benzene, establishing cases of benzene related illness and monitoring possible cases among members of exposed occupational groups. A flow of information, vital for the public health system, has been established as a result of the information that is communicated between companies and other organizations as a result of the implementation of SIMPEAQ.

3. Environmental monitoring of exposure, incorporating participative methodologies and industrial hygiene. Systematic monitoring in workplaces, with the participation of workers, has been developed (Oddone, 1986). Symbolic of this approach are discussions within companies held by the GTBs (groups representing benzene workers), on the control of atmospheric emissions of benzene, the establishment of feasible technological exposure limits and technical indices, and the need to consider the existing technological base in each sector.

Monitoring of the national benzene agreement in workplaces still requires the development of a methodology for interpretation of the results of environmental evaluations. A number of revisions are also required including: the types of sampling procedures adopted; processes used to validate the results of laboratory tests; the establishment of quality control programs between laboratories through the organization of reference networks. It is also necessary to revise the methodology and identification of biases involved in selecting homogeneously exposed groups.

The benzene agreement is considered to be a national and international benchmark, as was evident when both the agreement and the legislation were presented at a recent meeting of the Ministers of Labor of the Organization of American States.

(http://www.oas.org/main/main.asp?sLang=E&sLink=http://www.oas.org/oaspage/searchform.asp).