Appendix 4: Dioxin Abatement Measures Adopted and/or Recommended by National, International and Advisory Bodies[a]

Combustion system/process	Source	Dioxin abatement measure
Small and small-firing combustion systems	Hubner et al. (2000)[1]	*"An important measure to reduce dioxin emissions is the reduction of chlorine in fuels used for small and smallest firing installations. Dioxin emissions of domestic households and the agriculture and forestry sector can be reduced primarily by the use of "clean" fuels such as untreated wood, oil and gas together with modern firing installations. Therefore, the joint combustion of different types of waste in such installations should be banned in the view of the Austrian Federal Environment Agency."*
Incinerators and other thermal processes	Air Pollution Abatement Review Group (1995) [2]	"One of the more obvious primary ways of minimising TOMPS [toxic organic micropollutants, e.g., dioxins] in incinerators and in other thermal processes is to try to avoid (or reduce) TOMPS, their precursors or fundamental species (such as chlorine or bromine) being included in the feedstock."
Internal combustion engines, e.g., vehicles	Convention on Long Range Transport of Air Pollutants[3]	*"Avoiding halogenated additives in fuels and lubricants."*
	Schulz (1993)[4]	In 1992, the German Federal Government enacted a prohibition against using chlorinated and brominated compounds as petrol additives to reduce dioxin release via car exhausts.
Iron ore sintering	Convention on Long Range Transport of Air	*"Halogenated compounds may result in the formation of PCDD/F if they enter sinter plants in the feed materials (coke breeze, salt content in the ore) and in added recycled material …"*

[a] This compilation of policies and recommendations is not a fully comprehensive collection of all such policies and recommendations on this topic.

	Pollutants[5]	*ore) and in added recycled material …"*
Domestic heating systems	Convention on Long Range Transport of Air Pollutants[6]	*"The emissions from residential combustion appliances can be reduced by restricting the input materials to good-quality fuel and avoiding the burning of waste, halogenated plastics and other materials."*
Utility and Industrial Boilers	Convention on Long Range Transport of Air Pollutants [7]	*"It should be noted that PCDD/F emissions could increase significantly if waste material (sewage sludge, waste oil, rubber wastes, etc.) is added to the fuel."*
Copper production, primary and secondary	Convention on Long Range Transport of Air Pollutants[8]	*"Pretreating scrap, for example stripping of plastic or PVC coatings …"*
Aluminum production, secondary	Convention on Long Range Transport of Air Pollutants [9]	*"Avoidance of halogenated material (hexachloroethane)* [and] *chlorine-containing lubricants (for instance chlorinated paraffins)* …"
Non-ferrous metal production	Convention on Long Range Transport of Air Pollutants *[10]*	*"Pre-sorting scrap, avoidance of feed material like plastics and PVC-contaminated scrap …"*
Steel production	Convention on Long Range Transport of Air Pollutants [11]	*"General primary measures for PCDD/F reduction can be sorting, de-oiling and decoating of scraps, which may contain plastics, rubber, paints, pigments and vulcanizing additives."*
Medical waste incinerators	U.S. Environmental	*"Plastics and metal-containing components of the waste, such as sharps, could be segregated: this could result in lower HCl [hydrogen chloride],*

	Protection Agency (1988)[12]	*polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans, and trace metal emission rates. ... Another approach to possibly lowering HCl and PCDD/PCDF emission rates would be to have hospitals use low chlorine content plastics. This could be accomplished if the health care industry were to use plastics such as polyethylene and polystyrene in place of polyvinyl chloride, which contains over 45 weight percent chlorine."*
Recovery of nonferrous metals from scrap and residues, secondary aluminium production, production of electrosteel from scrap metal, burning of derived timber product wastes, of packaging materials, and of hospital wastes, domestic stoves, landfill fires	German Federal Office of the Environment (1992)[13]	"Non-halogenated plastics, which will not cause the creation of dioxins and furans, are as rule technically available for packaging purposes. Therefore, a substitution of PVC is required in this field to make consequent use of all means to minimize PCDD/PCDF pollution. … [L]andfilling of PVC wastes should be eliminated as far as possible … Apart from other plastics, timber, stone or metal may be regarded as major potential substituted for PVC in the construction sector. From the ecological point of view, the non-halogenated plastics polyethylene and polypropylene are generally more favourable than PVC. … [C]hlorine-free plastics such as polyethylene and polypropylene, which may be used as PVC substitutes in the packaging industry, seem to be ecologically sounder than PVC; the environmental damage caused by PVC (release of dioxin from uncontrolled fires, migration into food or rooms, increased chlorine input in incinerators) is generally not present …"
Dioxin sources	Stockholm Convention (2001)[14]	*"Promote the development and, where it deems appropriate, require the use of substitute or modified materials, products and processes to prevent the formation and release of the chemicals listed in Annex C* [byproducts, including dioxins] …
Dioxin sources	Air Pollution Abatement Review Group	*"General release reduction measures: When considering proposals to construct new facilities or significantly modify facilities using processes that release chemicals listed in this Annex* [Annex C – byproducts]*, priority*

	(1995) [15]	*should be given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of such chemicals."*
PVC	Swedish Chemical Policy Committee (1997)[16]	*"Taking into consideration the precautionary principle and the present limited knowledge of its long-term health and environmental effects, PVC plastic materials do not belong in the future ecocycle society. As soon as possible, and no later than 2007, PVC plastic materials should be substituted by materials that are environmentally compatible in the long term"*
PVC	Ecocycle Commission (1994)[17]	*"PVC contains 57 percent chlorine. The presence of chlorine in the waste that is incinerated can give rise to the formation of dioxins and other chlorinated hydrocarbons, as well as the formation of hydrogen chloride, which is acidifying and highly corrosive. … The chlorine content of incinerated waste poses risks of dioxin formation. Due to the chlorine content of the waste, special treatment stages for the flue gases and corrosion- resistant equipment in the incineration plants are required. … High chloride concentrations in the waste also make it difficult to stabilize the ashes prior to landfilling. … The importance of PVC for the formation of dioxins and other chlorinated hydrocarbons in connection with incineration is debated. … Other dioxin emissions where PVC may be the source are uncontrolled fires on waste landfills, illicit incineration of cable and remelting of PVC-covered steel sheet. … One way to prevent environmental impact from PVC is to phase out its use. … A phase-out through the active employment of the substitution principle can be effective in sectors where alternative materials exist or can be developed, which applies to a large portion of PVC usage. Such a phase-out should also apply to imported products. … The Ecocycle Commission is of the opinion that the strategy decided on by the Riksdag of phasing out short-lived PVC products by substitution can and should be implemented at once. … The Ecocycle Commission recommends that today's plasticized*

		PVC and rigid PVC with environmentally harmful additives be phased out as soon as possible."
PVC	Central Pollution Control Board of India (1996)[18]	Polyvinyl chloride (PVC) can no longer be burned in medical waste incinerators.

[1] Hübner, C., Boos, R., Bohlmann, J., Burtscher, K., Wiesenberger, H., **2000**. State-of-the-art measures for dioxin reduction in Austria. (In Österreich eingesetzte Verfahren zur Dioxinminderung - Deutsche Zusammenfassung) Wien, 2000. (Monographien; Band 116)
[2] Air Pollution Abatement Review Group. **1995**. Report on the Abatement of Toxic Organic Micropollutants (TOMPS) from Stationary Sources 1995. Prepared at the request of Air Quality Division, Department of the Environment, AEA Technology, National Technology Centre, Abingdon, Oxfordshire, UK.
[3] LRTAP, ANNEX VII, RECOMMENDED CONTROL MEASURES FOR REDUCING EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MOBILE SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[4] Schulz, D. 1993. PCDD/PCDF - German policy and measures to protect man and the environment, Chemosphere 27 (1-3): 501-507.
[5] LRTAP, ANNEX V, BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[6] LRTAP, ANNEX V, BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[7] LRTAP, ANNEX V, BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[8] LRTAP, ANNEX V, BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[9] LRTAP, ANNEX V, BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[10] LRTAP, ANNEX V, BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[11] LRTAP, ANNEX V, BEST AVAILABLE TECHNIQUES TO CONTROL EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS FROM MAJOR STATIONARY SOURCES. Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants.
[12] U.S. Environmental Protection Agency .**1988**. Hospital Waste Combustion Study: Data Gathering Phase. EPA-450/3-88-017, Washington, D.C., December 1988.
[13] German Federal Office of the Environment (Umweltbundesamt UBA), **1992**. Environmental Damage by PVC – An Overview. Berlin, June 1992.
[14] Stockholm Convention on Persistent Organic Pollutants, 2001. Final Act of the Conference of Plenipotentiaries on the Stockholm Coinvention on Persistent Organic Pollutants, Appendix II, UNEP/POPS/Conf/4, 5 June 2001.

[15] Air Pollution Abatement Review Group. **1995**. Report on the Abatement of Toxic Organic Micropollutants (TOMPS) from Stationary Sources 1995. Prepared at the request of Air Quality Division, Department of the Environment, AEA Technology, National Technology Centre, Abingdon, Oxfordshire, UK.
[16] Swedish Chemical Policy Committee, **1997**. *Swedish Government, Stockholm, June 1997*
[17] Ecocycle Commission, **1995**. Report to the Government on PVC. PVC - a plan to prevent environmental impact SOU 1994:104, Stockholm.
[18] Central Pollution Control Board, Ministry of Environment and Forests, Government of India, **1996**. "Environmental Standards and Guidelines for Management of Hazardous Waste," New Delhi, India, 12 July 1996.