Section VI.A.

Guidance by source category: Annex C, Part III Source Categories

Open burning of wastes

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Best Available Techniques-Best Environmental Practices (BAT-BEP) for Open Burning of Waste

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1.0 General Guidance

For people in many parts of the world, open burning is the cheapest, easiest, most sanitary means of volume reduction and disposal of combustible materials. This is especially true for people with no access to organized waste handling who have been left to their own devices for materials disposal. And yet, open burning is an environmentally detrimental process that generates by-product POPs and numerous other pollutant products of incomplete combustion.

Open burning of waste, including burning of landfill sites for volume reduction, is listed as an inadvertent source of by-product POPs in Annex C, Part III. Most importantly, Annex C, Part V(f) refers aspirationally to "…the aim of cessation of open and other uncontrolled burning of wastes, including the burning of landfill sites."

In principle, open burning should simply be prohibited; however, there are practical considerations that speak to the wisdom of defining guidance for open burning with the proviso that it be minimized and eliminated as soon as and wherever feasible. Those considerations include lack of alternative disposal or recovery methods due to nonexistent or inaccessible infrastructure. In addition, sporadic open burning may be necessary for sanitary disposal of unusual material, to control disease or pests, or in the case of disaster or other emergency.[1]

Although the Stockholm Convention is concerned with POPs such as polychlorinated dibenzodioxins and furans (PCDD/F), HCB and PCBs as products of incomplete combustion, open burning is responsible for generation of toxic byproducts of combustion well beyond the twelve named chemicals. Other byproducts include polycyclic aromatic hydrocarbons, particulate matter, benzene and carbon monoxide. Elimination of the Stockholm POPs would not sufficiently improve the emissions from open burning so as to make it an environmentally preferred means of waste disposal. It is imperative that the focus of implementation of the Stockholm Convention be on establishing alternatives to open burning rather than simply trying to improve a bad practice. In no way should provision of guidance be construed as acceptance or justification.

Efforts to reduce open burning must focus on government support of alternative end-of-life and waste management options. The Basel Convention offers basic guidance on alternatives and how to implement them.[2] Countries should work diligently to establish and implement sound practices including resource reduction, reuse, recycling, composting, modern sanitary landfilling, and BAT incineration. Convention implementation efforts and the convention financial mechanism could be used to support the establishment of model waste management systems as alternatives to open burning.

In this part of the guidance, a number of specific types of open burning are considered in generic categories, typically because means of POPs mitigation in each category are similar.[3] Destruction of animal carcasses as noted in Part III(f); copper wire reclamation as noted in Part III(l) or Part II, (d)(i); electronics waste/copper wire burning as referred to in Part III(l) or Part II generally; and waste from shredder plants for end-of-life vehicles as noted in Part III(k) are considered in other sections of the guidance.

Additionally, accidental fires and intentional combustion of non-waste materials are not considered; however, they may also be sources of POPs. Parties to the convention are urged to take steps to reduce accidental biomass burning of all types as well as accidental fires in residences, automobiles, and places of business. Parties may wish to consider restrictions on fireworks or other open combustion for recreation as well.

1.1 General Process Considerations

Devices known as "incinerators" are sold for the purpose of burning refuse. In some cases these devices may be as simple as steel drums or barrels which contain the waste but do not constitute BAT incineration. For the purposes of this guidance, we view "open burning" as any form of combustion for waste disposal that does not meet the standards for BAT incineration of municipal, medical or hazardous waste, as defined by a party. In general, good incineration involves a combination of appropriate residence time in the flame zone, combustion gases reaching an elevated temperature of at least 800º C, in the presence of sufficient turbulence to avoid unburned material. In addition, BAT combustion will usually involve post-treatment of combustion gases to minimize the time that products of combustion spend in the temperature conditions conducive to formation of PCDD/F (ca 250-450º C).

In the short term, where there are not realistic alternatives to open burning, practical process modifications that are likely to reduce unintentional POPs generation include:[4]

- Reduction in the amount of material discarded via open burning. Consistent with the convention, this is the first line of improvement.
- Removal of non-combustibles, including glass and bulk metals, and materials of low fuel value.
- Supply of sufficient air
- Steady burning or rate of mass loss
- Minimization of smoldering, possibly with direct extinguishment

And with respect to the materials burned:

- Dry, not wet, waste combustibles of high fuel value
- "Homogeneous" or well-blended combustibles
- Low density; e.g. non-compacted waste

Lower-probability techniques that may provide some reduction of PCDD/PCDF include:

- Burning in piles rather than confined in burners
- Avoiding burning waste that is exceptionally high in chloride content, noting that there is no apparent difference between inorganic chloride (salt) and organic chloride (PVC).
- Avoiding burning waste that contains metals such as copper and iron, even in small amounts.

1.2 Other Considerations

In addition to the aforementioned guidance steps should be taken to mitigate exposure routes to dioxins and furans. As is widely recognized, most human exposure comes through the food chain. Thus, necessary burning sites should be located away from the population or production of plants and animals for food, and ash from the process should be kept from forage areas. It is also good practice to locate combustion sites remote from or downwind of residential areas.

2.0 Intentional Biomass Burning

2.1 Agricultural/Crop Residue; Land Clearing Debris

2.1.1 Material Composition

In general, biomass: wood, grass, other vegetation. Depending on locality may include sisal, coffee husks, corn/maize cobs and stalks, sugarcane bagasse and rice husks, among others. This material may be composed of living plants, deadfalls or plant material that has been cut and dried. Intentional burning does not constitute well-controlled combustion although the geographical boundaries to be burned may be well defined.

Biomass materials will vary in water content (live vs. harvested material; wet vs. dry season; low vs. high humidity), fuel density (mass per hectare and degree of compaction or other measure) and species. Biomass materials vary naturally in chloride content[5,6] and may have been treated with chemicals (chlorinated pesticides or fertilizers), metals capable of catalyzing POPs formation (copper, for example as copper chromium arsenate treated wood) or inhibitors (sulfur, nitrogen containing materials), all of which may adversely impact POPs generation during uncontrolled combustion.[7,8]

2.1.2 Barriers to Elimination; Remedies or Policy to Remove Barriers

Prescribed burning may be permitted by government for perceived economic benefit (cost reduction), perceived agricultural benefit (ash as soil adjuvant), termite, reptile or other pest control, convenience, or recreation. In each of these cases the government has the power to remove permission for such burning and to educate the public regarding the detrimental nature of open burning, especially if it is conducted on a large scale. In some cases, as for termite control, open burning of biomass may be the least environmentally problematic approach. Cost and availability of alternative means of disposal or environmental management can be an overarching issue.

2.1.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste

Where possible, machine harvesting paired with alternative, non-destructive uses for harvested materials can reduce the need for wholesale burning. In areas of livestock cultivation materials may be harvested for silage. Grass may be dried for hay; other crop waste may be processed for fodder, fermented, allowed to decompose *in situ* or composted; wood of quality may be harvested for timber; yard waste can be composted and utilized as soil amendment; some nontraditional biomass can be used as a raw material for paper. In most cases, these alternatives also require markets and infrastructure.

For agriculture, "Zero-Burning" techniques as outlined by ASEAN should be applied where applicable to the region and the crops.[9] Reduction and elimination of POPs from open burning may provide an opportunity to reform agricultural practices.

2.1.4 Alternatives, Barriers to Use and Policy Instruments to Remove Barriers

Alternatives vary by situation. Barriers include lack of education, lack of government will to reduce dependence upon open burning to accomplish goals, and lack of alternative machinery or processes where open burning is an integral part of local agriculture. Cost of alternatives in any form may be a barrier, and as with any reforms, economic instruments may be necessary or desirable to induce change. Demonstration projects and research in the regions may help understanding of feasibility of alternatives.

2.1.5 Burning Techniques and Attributes, and Means of Improvement

Where open burning of biomass is permitted by government policy the process improvements noted in the general guidance should be implemented. Careful planning of prescribed burns modulated by weather conditions will allow greater control and less exposure of population to smoke downstream. After the fires, ash management may be an issue.

Application of chemicals in agriculture and forestry should be minimized consistent with local needs and good management. Where mechanical clearing and alternative use of harvested material is possible, incidental burns can be avoided; however, in certain local situations prescribed small burns may have a place in an overall land management scheme if used to prevent more devastating inadvertent burning.

Recognizing that control of prescribed burns can be lost, fire abatement procedures (training, equipment, planning), infrastructure (access, roads), and management planning are all reasonable secondary support measures.

3.0 Open Burning of Mixed Consumer Waste

3.1 Household Waste, Landfill/Dump Fires; Industrial Non-hazardous Waste

3.1.1 Material Composition

Household waste and the composition of landfills and dumps may be qualitatively very similar. They differ importantly where modulated by programs (such as recycling, scavenging, composting or other segregation) which remove specific streams from waste between household and repository. Industrial non-hazardous waste may arise from commercial establishments such as shops, restaurants and light manufacturing. It will differ according to the exact commercial source but may contain many of the same materials as found in household waste.

Open burning of waste has been the topic of significant study.[7] There seems to be very little data regarding dump fires and POPs.[3]

Waste composition studies show variation in waste among countries and especially between developed and developing countries. In developing countries as much as 50% of waste composition may be putrescibles such as kitchen waste. In developed countries, more convenience packaging and electronics may be found unless these materials have been removed by other end-of-life systems. Significant differences also may exist between urban and rural waste and among wastes from different regions, regardless of development. In general, household waste streams, and landfill waste will contain paper, plastic, organics such as food refuse, glass, metal, wood, leather and miscellaneous other materials. Under poorly controlled conditions, household hazardous waste such as cleaners, paints and solvents may find its way into a non-hazardous-rated landfill or dump.

Management approaches will change the composition and performance of a landfill/dump. In a modern, compartmentalized landfill, daily cover consisting of soil or clay will be added to the refuse. A traditional dump, by comparison, is far less well-organized.

Compartmentalization, addition of inert materials (daily cover), and compaction, over time, reduces the moisture content of the landfill and also the likelihood of spontaneous ignition. Traditional dumps are more likely to burn.

All disposal sites will generate some combustible gas (e.g., methane) from anaerobic degradation of organic materials contained within. Unless this gas is controlled it constitutes a highly combustible fuel for either spontaneous or illicit anthropogenic ignition. It is also a potent "greenhouse gas."

3.1.2 Barriers to Elimination; Remedies or Policy to Remove Barriers

Household waste will be burned in the open where cost, convenience or local custom/social acceptability make that option attractive to citizens or groups of citizens. The preferred combustion alternative is BAT incineration with energy recovery, however combustors run the gamut from BAT incineration through a continuum of decreasing technology and efficiency to open pile or pit or "barrel" burning. In cases where people live far outside municipal governance, solutions to waste disposal will undoubtedly be *ad hoc*. Without appropriate systems they will be *ad hoc* even within municipal governance.

In order to eliminate open burning, reasonable alternatives must exist and the public must be educated regarding their availability as well as the harm of open burning.
At-source or centralized collection, recycling or other disposal must be affordable and effective. Landfills must be designed and operated according to modern standards.[10]
Government must accept responsibility to create waste reclamation/disposal systems as a public utility/service. Countries and municipalities must then have the will to mandate an end to garbage burning and accept the responsibility for enforcement of those laws.
Additionally, where modern landfill is an option, waste management plans and regulations must include provisions for siting new landfills so as to maintain disposal capacity.

Simply accepting the responsibility for providing waste management systems may not in itself mean the end of open burning. Garbage could be collected and deposited in landfills or dumps, which can themselves be sites for open burning. Policies and practices must be developed and applied to these centralized services. Spontaneous ignition/combustion can be reduced by collection of landfill gas or regulations requiring modern landfill construction techniques along with permanent closing of obsolete dumps.

Accidental anthropogenic combustion in dumps can be reduced by prohibiting, licensing or limiting access to landfills/dumps. In many cases fires are set by scavengers living and working in these areas. Fires, accidental or intentional, can ignite discarded materials or landfill gas. Authorities must accept responsibility and enact regulations organizing scavenging activities, providing safe conditions for workers and limiting access to and overt residence on landfills.

Intentional anthropogenic combustion; that is, burning dump contents for volume reduction, must be prohibited by authorities. In order to avoid the need for dump burning sufficient planning must be given to landfill size, space, location and management and waste reduction/elimination programs so as to obviate the need.

Waste management is a system. Where the system works to make final disposal of true waste a collective responsibility rather than an individual responsibility, direct economic costs may rise, but in general environmental costs and impacts will fall.

3.1.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste

Source Reduction. Careful study of local waste composition may lead to specific programs for reduction of large volume streams. As an example, in certain cases bulk purchase of products can reduce the need for individual product packaging. This and other strategies may be modulated by population density.

Composting. Where significant fractions of household waste will biodegrade, and where the population density will allow it, municipalities should provide education on cost- and space-effective composting. Included in this strategy is appropriate diversion of organic waste to animal feed or other similar productive use, modulated by a concern for spread of disease. Education must include means for vermin and disease vector control. Some organic wastes may contain POPs or materials that could be converted to POPs under composting conditions, and they should be treated separately in order to guarantee a high-quality, low-POPs-content compost. In some cases, composting can be enhanced by substitution of certain biodegradable materials for alternatives.

Reuse. Where parts or entire devices can be recovered, washed, repaired or reclaimed as fabricated articles the need for disposal can be reduced. In many cases, labor involved in such reclamation/value creation can be cost-effective and an economic benefit vs. purchase of new devices.

Recycling. Many waste streams contain valuable, reclaimable items. Metals, glass, clean dry paper, corrugated board, cloth, plastics and wood are recyclable streams. Depending

on situations, centralized collection and recycling infrastructure can be cost-effective. In other situations, simply providing a safe staging area at a disposal site and encouraging development of markets for recycled material can facilitate recovery by scavengers.

Incineration. In some situations BAT incineration, especially with energy recovery, and open burning may coexist. Where they do, incineration is preferable to open burning, but may not be the only alternative. Authorities must take care to understand specific local barriers to elimination of open burning in favor of less environmentally burdensome disposal including source reduction, reuse, recycling and BAT incineration. Collection and cost may be one such barrier; however, BAT incineration coupled with energy recovery may mitigate that cost and provide significant energy benefit.

Modern Landfill. Given the differences between modern engineered landfills and dumps, modern landfill construction with collection of gas and leachate, appropriate opportunity for recycling and reuse is preferable to open burning. As noted above, authorities will need to accept that education and cost-effective waste disposal options must be provided if open burning is to be eliminated.

Modern landfills differ from dumps in many ways. As engineered constructions, they are typically safer, more sanitary and less prone to anthropogenic combustion. They also require active management and security measures to exclude unauthorized people (e.g. scavengers) and may be relatively more expensive than open burning or low-tech dumping.

Policies that prohibit disposal of hazardous industrial and infectious wastes in the normal waste stream will enhance the safety of the municipal disposal system. Governments can encourage use of alternative methods listed above by implementing legal restrictions on open burning; mandates for composting, recycling or recovery; taxes on excessive waste placed into the disposal system or institution of lower-cost and more convenient resource management systems.

3.1.4 Alternatives, Barriers to Use and Policy Instruments to Remove Barriers

Strategies for waste reduction and available alternatives to open burning are largely the same.

3.1.5 Burning Techniques and Attributes, and Means of Improvement

Where none of the previously mentioned alternatives are feasible or when alternatives cannot be implemented in a timely fashion, governments may wish to educate citizens on ways to reduce the impacts of open burning. Those process improvements have been outlined in the general guidance.

3.2 Construction/Demolition/Post-disaster Debris

3.2.1 Material Composition

Construction waste will consist of the usual materials of construction and potentially the packaging in which the materials are brought to the site (pallets, sacks, etc.). Materials of construction of buildings vary by size, type and geographic location. Types of buildings,

whether commercial, office, multi-family or single-family will differ significantly between developed and developing countries and among regions. Common combustible materials of construction include wood, paper and other cellulosics, asphalt, paint and various plastics. Metal contamination of combustibles is not unknown.

Demolition waste, and particularly post-disaster debris will contain other occupant belongings. These materials also vary with the type of building, geography and development of the economy. Partially burned remains of a fire in an industrial operation may also qualify as post-disaster debris or hazardous waste.

For dwellings, this similarity will be to household waste, and will be greater in developing countries; in developed countries, given more possessions, there will be an increase in fabric (clothes), foam (furniture), rigid plastics (appliances) and fiber (carpeting).

For commercial buildings the contents will be representative of the business and will include furnishings and fiber similar to those in dwellings as well as electronics and volumes of paper (offices) or concentrations of products for sale.

3.2.2 Barriers to Elimination; Remedies or Policy to Remove Barriers

Intentional combustion of waste derived from construction or demolition is a matter of low cost and convenience at the job site. It is done due to sanitary needs, the cost of removal, inconvenience of on-site burial or unavailability of alternatives. While it is a poor practice, and should be avoided under any but the worst circumstances regarding public health, intentional combustion of post-disaster debris is known due to unavailability of alternatives, desire to avoid massive use of landfill space or for convenience in clearing areas after earthquake.[11] The issue, nominally, is cost whether expressed as direct cost or the cost of development or use of other disposal means.

3.2.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste

Clean, uncontaminated construction waste can be collected, sorted and usable materials diverted to other construction, shredding for mulch and material recycling. Demolition, when done as disassembly can yield many fixtures suitable for resale and reuse. Materials which cannot be reused or reprocessed can be separated and disposed, much as construction waste.

While in theory the strategies used for treatment of construction and demolition waste can also be used for post-disaster debris, the scale can be enormously different. After a disaster there may be no choice but to move material to a landfill site, allow scavenging as usual or conduct recovery operations there. Landfilling without scavenging or BAT incineration may be the best option in emergency, depending on exact circumstances.

Governments can--and some do--prohibit open burning of construction and demolition debris. Where there is poor waste management infrastructure, many of the same

instruments used in recovery of household waste may be useful for construction and demolition materials.

3.2.4 Alternatives, Barriers to Use and Policy Instruments to Remove Barriers

As outlined above, the alternatives for waste disposal on construction and demolition sites are collection, separation, disassembly, resale, reuse and recycling. These processes can be economically viable or can be made economically viable by changes in laws or regulations governing disposal of these materials. Such instruments include bans on open burning, taxes on landfill disposal of construction and demolition material or economic instruments promoting recycling. In many cases, the resale of building fixtures is already economically viable; this is particularly true in developing countries.

Additionally, contracts for construction can be written to specify removal of debris as a responsibility of the contractor. Acceptable means of disposal can also be specified by contract.

3.2.5 Burning Techniques and Attributes, and Means of Improvement

For these materials the same general guidance holds as outlined elsewhere in the document. Burning should be a last resort and should actively exclude materials that do not burn well or at all.

4.0 Open Burning of Specific Materials and Miscellaneous

4.1 Agricultural plastic

4.1.1 Material Composition

Agricultural film is usually made from polyethylene due to cost but EVA is also offered for sale. PVC has been used previously, but appears not to be common today. Among other uses, agricultural film is used for covering fields in early season to warm the ground; as bale wrap, as silage, fertilizer or agricultural chemical bags and as greenhouse film. Some specialty suppliers offer material specified to be degradable.

Rigid plastic containers of pesticides or other agricultural chemicals may be found as well. Bags are usually low density polyethylene; bottles, drums and tubs are usually high density polyethylene, a multilayer polyethylene, or a polyethylene container whose interior surface has been treated to reduce interaction with the product contents. One report[12] discusses experiments burning bags containing residual pesticide but finds PCDD/F “at very low levels” versus blanks for both air emissions and solid residual. Following published procedures for rinsing containers and treating the rinse water properly will reduce this low possibility significantly.

4.1.2 Barriers to Elimination; Remedies or Policy to Remove Barriers

Material located far from normal waste collection will be discarded in the lowest cost and most convenient method. Burning could be reduced by institution of a collection scheme for the material, particularly if many farmers in an area use the same material. Governments can also institute education programs and laws prohibiting burning.

4.1.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste

Agricultural film is recycled extensively in some countries. This is facilitated when material is collected explicitly. Where there is no opportunity for recycle, other forms of disposal are utilized, including landfill. Use of additives such as UV-inhibitors can extend the life of greenhouse films and reduce the need for disposal. Absent specific programs, material used for wrapping bales or bagging compost is discarded in the same was as any packaging in a particular area. In some areas, film can be recycled explicitly, compounded into wood-plastic composites or processed into refuse-derived fuel for combustion in a BAT incinerator. For bottles, WHO recommends triple-rinsing, then puncturing and burying them[13].

4.1.4 Alternatives, Barriers to Use and Policy Instruments to Remove Barriers

Strategies for waste reduction and available alternatives to open burning are largely congruent.

4.1.5 Burning Techniques and Attributes, and Means of Improvement

Agricultural film, while combustible, because of the way it has been manufactured will tend to melt and shrink. Good burning could depend on shredding to increase surface-to-volume ratio or relatively slow feeding of material. High temperature, well-ventilated combustion is possible, but may be challenging on a large scale if film is the only material burned.

Bottles may not burn well due to their surface-to-mass ratio even if dry and combustible. Alternative fuel may be required and should be material consistent with good open burning as described in the general guidance.

4.2 Tires

4.2.1 Material Composition

Tires are a composite of styrene-butadiene copolymer or natural rubber, polyamide, steel wire, carbon black and numerous other organic and inorganic additives. Tires are relatively high in sulfur as a result of vulcanization. Sulfur inhibits POPs formation in combustion; the probability for generation of chlorinated POPs in this waste is probably lower than for mixed waste; however, poor combustion of large volumes of tires in open burning situations may be a prodigious generator of other hazardous organic pollutants including SO_2 and PAHs.

4.2.2 Barriers to Elimination; Remedies or Policy to Remove Barriers

Ignition of tire fires can be natural (lightning) or anthropogenic. Tire dumps present a number of hazards including culture of insect disease vectors. Additionally, they occupy large spaces. Anthropogenic burning of tires can and has been undertaken to alleviate either of these problems.

4.2.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste

Worn tires can be retreaded and reused in many cases. Modern technology has extended the life of the average tire by a factor of ten. Utilizing tires with longest life minimizes need for disposal. Alternatively they may be recycled to various uses, either whole or as shredded material. Whole, or preferably, shredded tires can be landfilled. However, whole tires and similar articles like uncrushed bottles may tend to "float" to the surface of a dump. Collection of tires in above-ground dumps constitutes an eyesore and a hazard for insect control and potential for uncontrolled combustion.

4.2.4 Alternatives, Barriers to Use and Policy Instruments to Remove Barriers

Efficient combustion of shredded tires has been demonstrated in cement kilns; coal and waste wood combustors can also burn shredded tires efficiently under good combustion conditions. Additionally, tires may be pressed into service for fencing, reef creation or soil erosion control. Use of tires above ground, however, must take into consideration and mitigate their ability to collect water and harbor insect infestation.

4.2.5 Burning Techniques and Attributes, and Means of Improvement

Open burning of tires is modulated by scale. An individual tire can be used to assist in combustion of wet brush. As a mass or in dumps, however, there is virtually no way in which open burning of tires can be improved; extinguishment of large-scale fires is almost impossible and they may burn for years.

4.3 Crude Oil/Oil Well/Oil Spills

4.3.1 Material Composition

Crude oil consists largely of carbon and hydrogen with smaller constituent amounts of oxygen, sulfur and chlorine. As found in nature, it may be contaminated with salt or salt water from drilling or if spilled on salty ground or on an ocean. Spilled oil from pipeline breaks has been burned to mitigate potential contamination of a frozen river.[14]

4.3.2 Barriers to Elimination; Remedies or Policy to Remove Barriers

Cost, convenience and lack of alternative recovery or disposal methods.

4.3.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste

To the extent this is a waste issue and not one of recovery from accident, better procedures for handling materials may improve normal performance. In addition, biological remediation methods may be useful in some circumstances

4.4 Military Ordnance/Munitions

4.4.1 Material Composition

Among other materials, explosives such as trinitrotoluene (TNT), ammonium picrate (Explosive D), 1,3,5-triamino-2,4,6-trinitrobenzene (TATB), 1,1-dimethylhydrazine (UDMH). In specialized situations chemical and biological weapons may also be found.

4.4.2 Barriers to Elimination; Remedies or Policy to Remove Barriers

The actual extent of this practice is not well characterized, but it may be a matter of convenience or exigency, depending on whether the destruction is done in the midst of battle or in the disposal of obsolete materials.

4.4.3 Strategies and Policy Instruments to Avoid, Reduce or Divert Waste

Various controlled forms of combustion and chemical destruction [15,16,17] have been designed and tested. Explosives and propellants can be removed from weapons with subsequent reformulation or destruction.[18] Simple detonation in a closed chamber with flue gas cleaning may be sufficient; on the other hand, sophisticated combustion or non-combustion chemical techniques may be either useful or necessary. Technology for chemical weapons destruction under the Chemical Weapons Convention has been reviewed in detail.[19]

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