Cleaner Production Assessment in Meat Processing

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for

United Nations Environment Programme
Division of Technology, Industry and Economics

and

Danish Environmental Protection Agency
Danish Ministry of Environment and Energy

CONTENTS

PREFACE

The purpose of the Industrial Sector Guides for Cleaner Production Assessment is to raise awareness of the environmental impacts associated with industrial and manufacturing processes, and to highlight the approaches that industry and government can take to avoid or minimise these impacts by adopting a Cleaner Production approach.

This guide is designed for two principal audiences:

- People responsible for environmental issues at meat processing plants (environmental managers or technicians) who seek information on how to improve production processes and products. In many countries, managers are ultimately responsible for any environmental harm caused by their organisation's activities, irrespective of whether it is caused intentionally or unintentionally.
- Environmental consultants, Cleaner Production practitioners, employees of industry bodies, government officers or private consultants that provide advice to the meat processing industry on environmental issues.

This guide describes Cleaner Production opportunities for improving resource efficiency and preventing the release of contaminants to air, water and land. The Cleaner Production opportunities described in this guide will help improve production as well as environmental performance.

Chapter 1 provides a brief introduction to the concept of Cleaner Production and the benefits that it can provide.

Chapter 2 provides an overview of the meat processing industry including process descriptions, environmental impacts and key environmental indicators for the industry.

Chapter 3 describes Cleaner Production opportunities for each of the unit operations within the process and provides examples of their successful application. The processes discussed in most detail are the slaughtering of pigs and cattle, carcass dressing, casings and offal processing and rendering, as well as cleaning and ancillary operations. Quantitative data for the inputs and outputs associated with each unit operation are provided as an indication of typical levels of resource consumption and waste generation.

Chapter 4 provides a case study demonstrating the application of Cleaner Production at a meat processing plant.

Chapter 5 describes the Cleaner Production assessment methodology in detail. It can be used as a reference guide for carrying out a Cleaner Production assessment within an organisation.

Annex 1 contains a reference and bibliography list.

Annex 2 contains a glossary and list of abbreviations.

Annex 3 contains a list of literature and contacts for obtaining further information about the environmental aspects of the industry.

Annex 4 contains background information about the UNEP Division of Technology, Industry and Economics (UNEP DTIE).

Monetary figures quoted in this guide are based on 1995–98 figures and are presented as US dollars for consistency. As prices vary from country to country and from year to year, these figures should be used with care. They are provided as a guide to capital expenditure and savings only.

ACKNOWLEDGEMENTS

This guide has been published jointly by the UNEP Division of Technology, Industry and Economics (UNEP DTIE) and the Danish Environmental Protection Agency, and funded by the Danish Ministry of Foreign Affairs. The following people produced the guide:

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EXECUTIVE SUMMARY

This document is one in a series of Industrial Sector Guides published by the United Nations Environment Programme UNEP Division of Technology, Industry and Economics (UNEP DTIE) and the Danish Environmental Protection Agency. The documents in this series include:

- *Cleaner Production Assessment in Dairy Processing*;
- *Cleaner Production Assessment in Meat Processing*; and
- *Cleaner Production Assessment in Fish Processing*.

This document is a guide to the application of Cleaner Production to the meat processing industry, with a focus on the slaughtering of cattle and pigs at abattoirs. Its purpose is to raise awareness of the environmental impacts of meat processing, and to highlight approaches that industry and government can take to avoid or minimise these impacts by adopting a Cleaner Production approach.

The life cycle of meat products commences with the production of livestock. Beef cattle are raised on grazing properties or in intensive feedlots. Pigs are generally raised intensively at piggeries. At abattoirs, livestock are slaughtered and the carcasses dressed to produce sides of meat. The basic steps in this process are stunning and bleeding, hide removal or hide treatment, evisceration and carcass dressing. It is common for abattoirs to also undertake the boning of carcasses to produce smaller retail cuts of meat.

Even though meat is the most significant product from the abattoir, by-products such as hides, blood, fat, bone and offal are also produced. The profitability of an abattoir can often depend on the extent to which these materials are utilised. Edible by-products are further processed into saleable products and inedible by-products are converted into animal feed supplements by rendering.

From the abattoir, carcasses, boned meat and edible by-products are distributed on a wholesale basis to butchers or to other meat processing plants for further processing into specialty products and processed meats. Retail cuts of meat are packaged and then further distributed to retail outlets. Fresh meat products are highly perishable and refrigerated storage is required throughout their life to maintain eating appeal and prevent microbiological spoilage. The life cycle ends with consumption by the consumer and disposal or recycling of the packaging.

In this guide, the upstream process of livestock production, and the downstream processes of distribution and post-consumer packaging management are not covered. The manufacture of specialty meat products and processed meats is also not covered. The guide focuses on activities, which occur at abattoirs, namely, slaughter and its associated processes. The slaughtering of livestock is a significant contributor to the overall environmental load produced over the life cycle of meat production and consumption. Therefore, the application of Cleaner Production in this phase of the life cycle is important.

As with many food processing industries, the key environmental issues associated with abattoir operations are the high consumption of water, the generation of high-strength effluent streams, the consumption of energy and the generation of by-products. For some sites, noise and odour may also be concerns.

This guide contains background information about the industry and its environmental issues, including quantitative data on rates of resource consumption and waste generation, where available. It also describes examples of ways to improve the environmental performance of abattoir operations through the application of Cleaner Production. Case studies of successful Cleaner Production projects are also presented.

Cleaner Production

Cleaner Production is defined as *the continuous application of an integrated, preventive, environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment*. It is different to the traditional 'pollution control' approach to environmental management. Where pollution control is an after-the-event, 'react and treat' approach, Cleaner Production is a proactive, 'anticipate and prevent' philosophy.

Cleaner Production has most commonly been applied to production processes, by bringing about the conservation of resources, the elimination of toxic raw materials, and the reduction of wastes and emissions. However it can also be applied throughout the life cycle of a product, from the initial design phase, through to the consumption and disposal phase. Techniques for implementing Cleaner Production include improved housekeeping practices, process optimisation, raw material substitution, new technology or new product design.

The other important feature of Cleaner Production is that by preventing inefficient use of resources and avoiding unnecessary generation of waste, an organisation can benefit from reduced operating costs, reduced waste treatment and disposal costs and reduced liability. Investing in Cleaner Production, to prevent pollution and reduce resource consumption is more cost effective than relying on increasingly expensive 'end-of-pipe' solutions. There have been many examples that demonstrate the financial benefits of the Cleaner Production approach as well as the environmental benefits.

Water consumption

Water is used for the watering and washing of livestock, the washing of trucks, washing of carcasses and by-products, and for cleaning and sterilising equipment and process areas.

Rates of water consumption can vary considerably depending on the scale of the plant, the age and type of processing, the level of automation, and cleaning practices. Typical figures for fresh water consumption are 2–15 m^3 per tonne of live carcass weight.

In most parts of the world, the cost of water is increasing as supplies of fresh water become scarcer and as the true environmental costs of its supply are taken into consideration. Water is therefore becoming an increasingly valuable commodity and its efficient use is becoming more important.

Strategies for reducing water consumption can involve technological solutions or equipment upgrade. However reviewing cleaning procedures and operator practices can make some of the most significant gains.

Some key strategies for reducing water consumption are listed below, and the use of these techniques would represent best practice for the industry:

- undertaking dry cleaning of trucks prior to washing with water;
- using automatically operated scalding chambers rather than scalding tanks for the de-hairing of pigs;
- using offal transport systems that avoid or minimise the use of water;
- using dry dumping techniques for the processing of cattle paunches and pig stomachs that avoid or minimise the use of water, instead of wet dumping techniques;
- reusing relatively clean wastewaters from cooling systems, vacuum pumps etc. for washing livestock if possible;
- reusing final rinse waters from paunch and casings washing for other non-critical cleaning steps in the casings department;
- reusing wastewaters from the slaughter floor, carcass washing, viscera tables and hand-wash basins for the washing of inedible products if possible;
- reusing cooling water from the singeing process for other application in the pig de-hairing area;
- reusing the final rinse from cleaning operations for the initial rinse on the following day;
- using dry cleaning techniques to pre-clean process areas and floors before washing with water;
- using high pressure rather than high volume for cleaning surfaces;
- using automatic control systems to operate the flow of water in hand-wash stations and knife sterilisers.

Effluent discharge

Most water consumed at abattoirs ultimately becomes effluent. Abattoir effluent contains high levels of organic matter due to the presence of manure, blood and fat. It can also contain high levels of salt, phosphates and nitrates. The most significant contributor to the organic load is blood, followed by fat. Blood is also the major contributor to the nitrogen content of the effluent stream. Salt and phosphorus originate from the presence of manure and stomach contents in the effluent. At those plants where rendering occurs, the effluent from rendering typically represents the single most significant source of pollutant load in abattoir effluent.

It follows therefore that effluent quality depends on the extent to which blood, fat, manure and stomach contents are excluded from the effluent stream, and whether or not rendering occurs at the site. Typical values for the organic loads discharged in abattoir effluent are 4–18 kg COD per tonne of live carcass weight.

Strategies for reducing the pollutant load of abattoir effluent principally focus on excluding blood, fat, manure and scraps of meat from the effluent stream. This means capturing materials before they enter drains and using dry cleaning methods.

Some key strategies are listed below:

- maximising the segregation of blood by designing suitable blood collection facilities and allowing sufficient time for bleeding, typically seven minutes;
- sweeping up solid materials for use as by-products, instead of washing them down the drain;
- fitting drains with screens and/or traps to prevent solid materials from entering the effluent system;
- using offal transport systems that avoid or minimise the use of water;
- using water sprays with a pressure of less than 10 bar for carcass washing to avoid removing fat from the surface;
- using dry cleaning techniques to pre-clean process areas and floors before washing with water;
- segregating high-strength effluent streams, such as rendering effluent and wastewaters from paunch washing, and treating them separately.

Energy consumption

Approximately 80–85% of total energy consumed by abattoirs is provided by thermal energy from the combustion of fuels in on-site boilers. Thermal energy is used to heat water for cleaning, pig scalding, rendering, blood coagulation and blood drying. The remaining 15–20% of energy is provided by electricity, which is used for operating equipment in the slaughter and boning areas, for by-product processing, and for refrigeration and compressed air. Typical ranges for the energy consumption are 1200–4800 MJ per tonne of hot standard carcass weight.

Energy is an area where substantial savings can be made almost immediately with no capital investment, through simple housekeeping efforts. Additional savings can be made through the use of more energy-efficient equipment and heat recovery systems. Some key strategies are listed below:

- implementing switch-off programs and installing sensors to turn-off or power-down lights and equipment when not in use;
- improving insulation on heating or cooling systems and pipework etc.;
- insulating and covering scald tanks to prevent heat loss;
- recovering waste heat from effluent streams, vents, exhausts and

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