



Printers, Photocopiers and Multifunctional Devices Health, Safety and Environment



In Cooperation with
German Berufsgenossenschaft (VBG) and specialised
Expert Committee for the Administrative Sector





Printers, Photocopiers and Multifunctional Devices

Health, Safety and Environment



In Cooperation with
**German Berufsgenossenschaft (VBG) and specialised
Expert Committee for the Administrative Sector**

**BITKOM –
German Association for Information Technology,
Telecommunications, and New Media e.V.**

Headquarters Berlin
Albrechtstrasse 10
D-10117 Berlin
Telephone: +49 30 27 57 60
Telefax: +49 30 27 57 64 00
bitkom@bitkom.org

This brochure has been written in cooperation with Brother, Canon, EPSON, Hewlett-Packard, IBM, Lexmark, Konica, Kyocera-Mita, Minolta, NRG, Océ, Panasonic, RICOH, Siemens, Sharp, Tally, Toshiba and Xerox.

© Copyright 2002

Reprints and copies not without permission of the BITKOM German Association for Information Technology, Telecommunications, and New Media e.V.

Production:
Eggebrecht-Pressen GmbH & Co. Druck und Verlag KG, Mainz

Contents

1	Objectives and purpose	5
2	Printing/copying and safety	6
2.1	Electrical and mechanical safety	6
2.2	Occupational safety	6
2.3	Fire protection	6
2.4	Electromagnetic compatibility	7
3	Printing/copying and health	8
3.1	Toners, developers and inks	8
3.1.1	Evaluation of black toner powders	8
3.1.2	Evaluation of colored toner powders	10
3.1.3	Developer	10
3.1.4	Inks	10
3.2	Silicone oils	11
3.3	Photo semiconductors	11
3.4	Emissions	12
3.4.1	Light/laser beam	12
3.4.2	Odor emissions	12
3.4.3	Ozone	13
3.4.4	Volatile Organic Compounds (VOCs)	14
3.4.5	Styrene and benzene	15
3.4.6	Aerosols	15
3.4.7	Dust	15
3.4.8	Noise levels	16
3.4.9	Other emissions	16
3.5	Safety data sheets	17

4	Printing/copying and environment	18
4.1	Environmental labels	18
4.1.1	Blue Angel	19
4.1.2	BG-Pruefzert label	20
4.1.3	Product environmental declaration (according to ECMA TR/70)	20
4.2	Energy consumption	20
4.3	Print paper/copy paper	23
4.4	Take-back, recycling and/or disposal of consumables	25
4.4.1	Toner, toner containers and ink containers	25
4.4.2	Copying cartridges and print cartridges	26
4.4.3	Photo semiconductors	26
4.4.4	Silicone oil	26
4.5	Take-back, reuse and/or recycling of devices and accessories	27
	Final remarks	28
	Appendix	29
	Literature	32

1 Objectives and purpose

Modern information technology has changed the appearance of our offices. Due to enhanced performance as well as simultaneous miniaturization and cost reduction of office devices, tasks like print and copy jobs no longer have to be performed centrally but can be moved to the individual workplace directly. This has led to extensive independence and flexibility.

This brochure is supposed to convey basic safety, health and environmental aspects about the operation of modern printers and photocopiers to the users. All statements apply to intended use of devices, being operated according to the instructions given in the user manuals. They are valid for both, digital and analogous technique.

All statements on printers and photocopiers also apply to fax machines and multifunctional devices with corresponding print technology.

**Comprehensive
and objective
information
for the user**

2 Printing/copying and safety

Printers and photocopiers must comply with the Equipment Safety Law

2.1 Electrical and mechanical safety

In Germany, only devices, which correspond to the German Equipment Safety Law and thereby the generally recognized rules of technology, shall be put into circulation. Therefore, all printers/photocopiers should be developed and produced according to valid standards such as EN 60950 (DIN VDE 0805). The compliance of devices with the Equipment Safety Law is confirmed with the CE marking by the manufacturers. With the GS label manufacturers may document the agreement with these standards after a voluntary control by an authorized laboratory.

2.2 Occupational safety

All printers/photocopiers put into circulation according to EN 60950 must be developed and constructed in such a way, that users are not put at any risk if the products are used as intended and maintained according to the manufacturers' instructions. This applies to electrical safety in case of contact with conductive parts of the housings, for example.

Hazardous areas must be protected by covers, safety interlocks, or adequate distances.

2.3 Fire protection

According to EN 60950 (DIN VDE 0805), materials are tested for heat resistance, flammability, and for resistance to fire. Therefore, danger of fire does not have to be expected for printers/photocopiers, even if a single equipment failure occurs.

For example, in laser printers and photocopiers toner is generally fused onto the paper through heat and pressure. For this process, the exceeding of permissible temperatures is reliably prevented by automatic safety shutoffs.

2.4 Electromagnetic compatibility

All printers/photocopiers put into circulation must comply with the law on electromagnetic compatibility (EMC).

This ensures that electronic devices do not disturb other electronic devices through electromagnetic radiation in foreseen environments (as long as these other electronic devices also comply with the German EMC law).

By the way, compliance with the EMC law is, among other things, ensured by the CE marking.

3 Printing/copying and health

**Safety also means:
Consider the
manufacturer's
instructions!**

In their instruction manuals manufacturers give detailed information on installation and operation of printers and photocopiers. If these instructions are observed and if consumables approved by the manufacturers are used, no adverse health effects or dangers have to be expected.

Relevant subjects with regard to health-related questions about printers/photocopiers are emissions, toners and photo semiconductors. Thus, detailed information on these aspects is given in the following sections.

**Principle of
Paracelsus:
Poison is a ques-
tion of the dose**

Time and again, the media report on dangerous constituents in toners or emissions, without giving information on their dose, disregarding toxicological evaluations. However, such evaluations should follow the principle of Paracelsus: Poison is a question of the dose. This means that the sheer presence of a substance itself may not necessarily cause toxic effects. Only when a certain concentration of this substance is reached, it may pose a health risk.

To demonstrate this, the following chapters exemplarily compare concentrations of some repeatedly discussed substances in toners to the concentrations of these substances in nature and foods.

3.1 Toners, developers and inks

3.1.1 Evaluation of black toner powders

**Toners are not
dangerous
materials**

Standard black toners consist of resin particles, in which carbon and/or, in part, magnetizable metal oxides are imbedded. Original toners are not to be considered dangerous formulations in the sense of the Chemicals Act (see also chapter 4.1). If used properly, no danger to health has to be expected for the users. For toners distributed by printer and photocopier manufacturers, so-called safety data sheets are provided, which can be obtained from the manufacturers or authorized resellers.

**Toners are checked
according to EU
directives and the
Ordinance on
Hazardous
Substances**

Original toners are qualified according to the directives of the European Union (88/379/EWG, from 30. 7. 2002: 1999/45/EG, with amendments) and the Ordinance on Hazardous Substances. Furthermore, they are regularly checked for compliance with standards relevant for health and workplace safety. In addition, toners are submitted to toxicological tests according to the OECD (Organization for Economic Cooperation and Development) and are evaluated by independent institutions. Also,

manufacturers carry out numerous measurements within the framework of their quality controls.

Aside from unavoidable impurities of natural raw materials (geogene content or background values), heavy metals like lead, cadmium, cobalt and mercury – as well as their compounds and chrome(VI) compounds – are not part of toners.

For example, lead contents detectable in toners (traces of lead) are clearly below the normal values for cultivated arable land in Germany. This naturally occurring lead content is approximately 10 to 20 mg/kg.

Nickel, for instance, is contained in nuts and chocolate. As a comparison, a bar of nut chocolate of 100 g contains about as much nickel as approximately 25 grams of toner.

Nuts contain more nickel than toners

With respect to mercury, the following example can be provided: On average, people take up about as much mercury with their daily food as is contained in approximately 30 grams of toner.

In the past, toners have frequently been implicated to pose a risk for getting cancer. This concern was based on the use of impure carbon for the production of black toner and a positive Ames test for one charge of toner published more than 20 years ago.

The underlying test result was based on the existence of a biologically effective nitropyrene impurity. Nitropyrenes are listed in the TRGS 905 (technical rules for dangerous materials) as substances, which assumedly have a carcinogenic effect, according to confirmed scientific findings.

Today, improved manufacturing and test procedures exclude the existence of such bioactive impurities with mutagenic potential. However, printer and photocopier manufacturers can only ensure this for their own original toners.

Toners are not carcinogenic

For the use of printers and photocopiers, special health and safety precautions do not have to be taken, either during operation of the devices or when changing the consumables. When changing the consumables or after contact with toners, normal work-hygienic measures, like washing one's hands afterwards, are sufficient. Also, it is not necessary to wear gloves.

The change of toner cartridges and the replenishment with toners should be carried out according to instructions in the user manuals. Otherwise, fine seals can unintentionally be damaged, which can lead to the pollution of the surrounding area.

3.1.2 Evaluation of color toner powders

Color toners, as well, are not dangerous materials

Instead of iron oxide or carbon, other color pigments are added to color toners. However, the same statements as for black toners apply to the evaluation of color toners.

The German professional organizations' "Expert Committee for the Administrative Sector", in cooperation with the professional organizations' Institute for Occupational Safety (BG/BIA), has developed testing principles for color toners (see also chapter 4.1.2).

The measuring program, which the testing principles are based on, includes recognized testing procedures according to OECD (Organization for Economic Cooperation and Development). Additional new testing procedures are currently being developed.

3.1.3 Developer

Developers are not dangerous materials

Developer, also called starter, consists of a synthetic-coated carrier made of quartz, magnetizable iron or iron oxide, which is supplemented with small amounts of toner.

3.1.4 Inks

Inks are used in ink jet printers and modern digital color photocopiers. Main components of inks are water, watersoluble substances, color pigments and small quantities of solvents.

Inks are not dangerous materials

Inks are not considered dangerous formulations in the sense of the Chemicals Act (for ingredients and environmental aspects of inks see also chapter 4.1).

When used as intended, no health hazard has to be expected for the users. For health-relevant information on their distributed inks, manufacturers issue so-called safety data sheets.

3.2 Silicone oils

Silicone oils are used in photocopiers and printers as mould release agents during the fixing process. Silicone oils are not dangerous substances and they do not represent a health hazard. They are not on a mineral oil basis and therefore are not subjected to the regulations for used oils. Also, due to their high thermal stability, there is no thermal decomposition of silicone oils during the printing/copying process. Because of their high boiling points, only very little of the oils can evaporate from photocopiers even in case of continuous operation of the devices.

Silicone oils are not dangerous materials

3.3 Photo semiconductors

In laser printers and photocopiers the following different semi-conducting materials with photoconductive properties are used:

- Organic photo semiconductors (OPC)
- Silicon
- Selenium and selenium compounds

Image carriers (drums or belts) with organic photo semiconductors (OPC – Organic Photo Conductor) – which are the most common photo conductors today – are used in greater numbers since the middle of the 1980s. Their photosensitive coat is non-poisonous.

OPC image carriers and silicon drums are harmless for one's health

Some years ago, also photo semiconductors made of silicon have been introduced onto the market. Silicon is a very stable element and not a dangerous substance.

In fact, selenium or selenium compounds have a toxic (poisonous) effect if they are inhaled as vapor or dust. However, the selenium coat of imaging drums is wear-resistant to such an extent, that an increase of the natural selenium content of the indoor air during printing or copying jobs is not detectable. Thus, the use of selenium drums in printers and photocopiers is harmless for one's health.

The use of selenium drums is harmless for one's health

By the way, selenium drums are no longer used in new product developments of printers and photocopiers. For return and disposal of selenium photo conductors, see section 4.4.3.

3.4 Emissions

Printers and photocopiers basically emit light, ozone, volatile organic compounds, dust and noises.

**Printers/
photocopiers are
to be set up in
sufficiently venti-
lated rooms of
appropriate size**

To avoid odor nuisance possibly developing through emissions, manufacturers and the Professional Associations recommend in their installation instructions to set up printers/photocopiers in sufficiently ventilated rooms of appropriate size. Additionally, users can further reduce concentrations of possible emissions. Relevant parameters are: Room size, ventilation, capacity utilization of devices and number of devices in the room.

3.4.1 Light/laser beam

**No danger
for the eyes**

During the printing/copying process the original document is scanned by visible rays of light produced by halogen lamps, fluorescent lamps or flash lamps. Possible ultraviolet radiation is filtered out by the glass plate of the printers/photocopiers and the housings of the devices, respectively. In case of proper use, there is no danger for the eyes.

The invisible laser beams used in “laser photocopiers and printers” are not used for scanning the originals. They are employed to generate the print image on the photo semiconductor. The laser is enclosed in the housing. If the devices are opened, the laser is turned off automatically.

3.4.2 Odor emissions

**Odor nuisance
often results from
evaporations of
the paper**

Frequently, odor nuisance through printers or photocopiers is attributed to ozone. It can be assumed, however, that emissions of the paper are largely responsible for this.

A simple check, everybody can easily perform at home, is to place about 50 pages of the paper to be tested in a microwave and heating it for 90 seconds at 600 Watts. After opening the device, one can at once smell the typical odor of the tested paper type. This odor normally is absolutely harmless. However, especially in case of preprinted, chemically pretreated or recycled paper, the resulting odor can irritate the respiratory tract of users, who are extremely sensitive to these particular odors anyway.

Further information on paper is given in chapter 4.3.

3.4.3 Ozone

Ozone is a natural component of the atmosphere. It is produced for example by the ultraviolet light of the sun and during thunderstorms. Furthermore, a comparably small amount is produced during all electrical discharges, for instance through electric motors. Examples from our daily life are household appliances like blenders, vacuum cleaners and drilling machines or artificial ultraviolet light from tanning lamps.

Ozone is a natural component of our atmosphere

In higher concentrations, the gas ozone can be harmful. Thus, a maximum concentration for workplaces has been established in accordance with the TRGS 900 ("Limit values in the air at the workplace – air limit values"). This maximum workplace concentration according to TRGS 900 is 0.1 ml/m^3 (ppm) ($= 0.2 \text{ mg/m}^3 = 200 \text{ } \mu\text{g/m}^3$). This concentration is calculated for an eight-hour exposure, assuming 40 weekly hours of work.

For comparison: At ozone concentrations of more than $180 \text{ } \mu\text{g/m}^3$ (average over one hour) the 22nd Federal Immission Control Ordinance recommends, that ozone-sensitive persons should abstain from unusual physical efforts in the open air to avoid temporary health effects.

Modern printers and photocopiers frequently work with transfer roller technology (or comparable technologies) instead of the older corona wire technology. This largely avoids a corona effect, which in conventional laser printers and photocopiers leads to the formation of ozone during the printing or copying process. Thus, virtually no ozone is released. So-called "ozone filters" are not necessary when this technology is used.

Through modern technology ozone formation is largely avoided

Still, there are laser printers and photocopiers that work with corona wire technology, thus producing a certain amount of ozone. In these cases, the release of ozone is reduced to a minimum by suitable constructive measures. Consequently, the concentrations remain considerably below the prescribed limit values. One of the most common measures for ozone reduction is the use of so-called "ozone filters", that have to be checked regularly and changed if necessary. These filters transform the released ozone into carbon dioxide and/or more quickly into oxygen.

In small rooms, or if several printers/photocopiers are in operation simultaneously, ozone odor may result. The reason for this is the low odor threshold of ozone: There can be a smell of ozone even though its concentrations are only about 1/10 of the MAK value (approx. 0.02 mg/m^3)

(see appendix). Consequently, ozone odor is not tantamount to the existence of health threatening concentrations. In addition, since ozone is not stable and does break down into oxygen by itself, any slight ozone concentration in indoor air will decrease even without ventilation after a print or copy job is completed.

Thus, measurements of released ozone concentrations from devices, which were installed and adjusted in accordance with respective requirements, never showed violations of the limit values.

3.4.4 Volatile Organic Compounds (VOCs)

Under certain conditions, emissions of (total) volatile organic compounds (TVOCs) may occur during printing/copying. Possibly resulting concentrations in workspaces are well (that is at least around the factor 100) below the current European limit values for workplaces.

Likewise, the concentration values to be expected are well below the standard value RW I determined by the former Federal Health Department (today: Federal Institute for Health Protection of Consumers and Veterinary Medicine). This standard value represents a concentration that presumably does not cause any adverse health effects even in case of life-long exposure.

No adverse health effects through VOCs

Thus, adverse health effects by possibly emitted VOCs from printers/photocopiers are not to be expected for the users. Also, tests of a research project on emissions of color laser printers and color photocopiers, conducted by the Professional Associations' Expert Committee for the Administrative Sector, confirm these findings.

Emissions testings in dynamic environmental test chambers show that the released TVOC concentrations of printers and photocopiers are typically clearly lower than the normal concentrations of TVOCs in interiors.

Possible sources of VOCs in interiors are: Building materials, wall colors, floor coverings and office furniture.

3.4.5 Styrene and benzene

Due to the impact of heat and pressure during the fusing of styrene acrylate copolymer containing toners, very small amounts of styrene and possibly also benzene may be released into the surrounding air.

The resulting concentrations of styrene and benzene have been demonstrated to be far below recognized standard values (for example for the evaluation of indoor air quality).

This means that neither styrene nor benzene emissions reach any health-endangering concentrations.

Emissions of styrene and benzene of printers and photocopiers measured in test chambers are clearly lower than the normal concentrations of styrene and/or benzene in interiors.

Health-threatening styrene- and benzene concentrations are not reached

3.4.6 Aerosols

In order to prevent the formation of aerosols from ejected ink droplets (as is the case for the jet of a spray can, for example), the jet of ink jet printers or copiers leaves the nozzle with high speed immediately in front of the paper. Since the paper immediately absorbs the ink, it has no time to disperse into the air. This technique ensures optimal print quality and at the same times effectively prevents the formation of aerosols. So, if the printers/photocopiers are operated according to the instructions, health as well as environmental dangers are excluded.

3.4.7 Dust

Dust in printers and photocopiers consists mainly of ordinary house dust, paper particles and small amounts of toner particles. In order to prevent heat accumulation in the devices, accrued heat has to be lead away by ventilation through fans. Along with the hot, air dust particles circulate as well. In order to minimize the amount of dispersed dust, the manufacturers recommend

- to have regular maintenance of printers and photocopiers through the technical customer service,
- to use dust-free paper (for example paper conforming to the standards for printing and copying purposes according to DIN 19309).

Regular maintenance and dust-free paper reduce emission of dust

Dust emissions of modern printers and photocopiers are far below recognized standard values for inhalable dust and alveolar dust (alveoli: thin-walled vesicles, lined with tissue that allow gas exchange in the lung).

Until 1996, the inhalable dust fraction was called “total dust” and the alveolar fraction was termed “fine dust”.

Dust emissions of printers/ photocopiers by far lower than the dust concentration in urban areas

The average dust emissions of current devices are clearly lower than the average dust particle concentrations in urban areas and the European (and German) annual limit value for particles in outdoor air (with an aerodynamic diameter of 10 µm, PM10).

For a comparison: House dust has an irritating (sensitizing) potential, meaning that under specific circumstances increased contact with house dust can cause allergic rhinitis (inflammation of the mucous membrane) or asthma, for example. Currently, no sensitizing potential is known or expected for toner dust.

3.4.8 Noise levels

Noise levels of printers and photocopiers depend on the printer model and printer performance as well as on the mode of operation (for example stand-by or printing/copying operation with or without accessories). Depending on the desired printing/copying performance and device configuration as well as on the prevailing noise level at the workplace, the operator has to select a suitable location for the device that corresponds to the requirements of the Workplace Ordinance.

Printers and photocopiers that carry the environmental label Blue Angel or comply with its criteria, meet its strict regulations concerning acoustic emissions.

3.4.9 Other emissions

Emissions from ink

Vapors from solvents in inks for ink jet printers and copiers cannot reach any health threatening concentrations however unfavorable the conditions might be.

No health threatening emissions through inks

Since the consumption of ink and, going along with it, the vaporization of ink ingredients is so little, even the printing/copying of several hundred pages does not lead to a transgression of limit values in a normal-sized office.

Electromagnetic fields (EMF)

EMF is the shortcut for “electrical, magnetic and electromagnetic fields”. Internationally, EMF is usually used to describe the biological effect of such fields on man and the environment. Especially for these EMFs, there is quite a number of extensive international guidelines.

The existing limit values were developed by independent organizations due to regular and thorough evaluations of scientific studies. They include a considerable safety margin, which is supposed to provide for the safety of all people, independent of their age and state of health.

3.5 Safety data sheets

In general, so-called safety data sheets have to be provided for industrial users of dangerous substances and preparations.

This does not apply to consumables for printers and photocopiers, since they are not dangerous substances and hazardous materials, if used as intended. Nevertheless, manufacturers and importers voluntarily provide safety data sheets to the users, in case respective information should be requested.

Consumables for printers and photocopiers are no dangerous substances

These data sheets do not only give information on the substantial composition of the individual toners, but also contain references to possible risks through dealing with large amounts of unpacked material, to first aid and fire fighting measures or to measures in case of unintentional release.

Furthermore, information is given on handling and storage, exposure limitation and personal protective equipment, physical and chemical properties, stability and reactivity, toxicology and ecology, disposal, transport, rules to be considered and other topics.

4 Printing/copying and environment

Environmental legislation and the general conditions relating to environmental policy are important for office communication systems on the German and the European level.

The member companies of the BITKOM German Association for Information Technology, Telecommunications, and New Media e.V. deal with effects on the level of industries and refer necessary measures to the respective departments for research, development or production.

This platform links the industry to the current developments in environmental policy and makes their expertise available for the formation of appropriate regulations.

Consequently, manufacturers and importers of office communication systems design their products according to these regulations and, in addition, offer forward-looking solutions for an environmentally sound product design.

The following sections deal more closely with selected topics.

4.1 Environmental labels

Environmental labels are protected logos, which are issued by interest groups in order to identify environmentally sound products for the consumer. In association with these labels, the products to be labeled have to meet defined requirements. These have to be either confirmed by the manufacturer in a declaration, verified by a test report or tested by the awarding authority.

For the manufacturer, the use of the label is always coupled with a license and a fee for usage. Consequently, customers pay for the labels, too.

Below, important environmental labels for printers and photocopiers are described.

4.1.1 Blue Angel

The fundamental criteria for awarding the environmental label Blue Angel are prepared and suggested by the German Federal Environmental Agency and RAL – German Institute for Quality Assurance and Labeling e.V. – with the support of an expert hearing. These criteria are subsequently adopted by the German Jury Umweltzeichen (RAL) and published by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Interested manufacturers can apply to the RAL for a license with a determined term (for example three years).

The Blue Angel environmental labels for printers and photocopiers include numerous groups of criteria (with defined requirements) that are listed in the appendix. An environmental label for multifunctional devices is currently being developed.

Office printers (electro photographic [e. g. laser-] printers, ink jet printers and matrix printers), i. e. with a print rate of up to 25 pages per minute, can be labeled with the Blue Angel for “low emissions and a recycling-friendly product design”, if they meet the defined requirements. Office photocopiers with a copying capacity of up to 70 copies per minute may receive the eco label “for low emissions and a waste-reducing product design” for the indirect electrostatic copying process, if they meet the defined requirements.

Inks as well as toners for printers/photocopiers that meet the requirements for the environmental label Blue Angel may not contain heavy metals like mercury-, lead-, cadmium- or chrome(VI)-compounds as essential constituents. Azo dyes with cancer-suspicious or carcinogenic amine components may not be used as well as poisonous, cancer-suspicious, genetically damaging, reproduction-endangering or sensitizing substances. Consequently, the final product also has to be composed in a way that it is not subject to the labeling duty of the Ordinance on Hazardous Substances. Also, the packaging may not carry danger symbols, risk sentences, or safety advice.

There are devices that meet all criteria of the Blue Angel but, however, the manufacturer did not apply for the eco label. This is also the case with regard to original toners and original inks.

4.1.2 BG Pruefzert label

With the BG Pruefzert label, the Expert Committee for the Administrative Sector of the Federal Professional Associations offers further testing of toner emissions. All work equipment that carries this label complies with the recommendations of the Professional Associations and meets the protective objectives of the labour protection laws when used as intended.

There are devices that meet all the criteria of the BG Pruefzert label but, however, the manufacturer did not apply for this labor protection label.

4.1.3 Product environmental declaration (according to ECMA TR/70)

ECMA (Standardizing Information and Communication Systems) is an international industry association that develops recognized standards for the IT industry. The Technical Report 70 describes structure and content of a manufacturer's statement on environmentally oriented product specifications.

Many companies release environmental product declarations to provide their customers with precise environmentally relevant data (for example energy consumption, emissions etc.).

The environmental product declarations are also part of the "European Environmental Label for Computers" and represent an alternative to national environmental labels for many customers.

4.2 Energy consumption

The energy consumption of electric appliances is an essential factor for their eco-efficiency. During the last years, considerable progress has been achieved in minimizing the energy consumption of printers, fax machines and photocopiers.

**Considerable
progress in mini-
mizing energy
consumption**

Definition of consumption modes

A simplified description of the energy consumption modes is supposed to suffice here in order to understand the essential concepts and saving-tips.

In 1992, the US-American environmental protection agency started a program to induce customers of information processing devices for homes and offices, to buy only energy-efficient devices. The program is recognized worldwide (Japan, New Zealand, Australia, Taiwan) and, in 2001, it was also officially introduced in the European Union by a contract with the USA.

The requirements (www.energystar.gov) concern energy consumption in the so-called sleep state, into which the devices automatically switch after some time of inactivity. Devices that meet these requirements can carry the “Energy Star” label. The requirements are regularly adapted to the state of the art and tightened accordingly.

The Energy Star energy saving program

Mode	Description
in operation	average consumption under full utilization, for example during printing or copying
idle/stand-by	consumption in print-free times before the device switches into the energy-saving mode. The device reacts immediately to actions of the user
sleep	consumption in the energy-saving mode, which is often reached after a fixed period of time. The device needs a short (heat-up) time to reach the operation mode
off	consumption, when the user has switched off the device with the “normal” on/off switch

Requirements for the Energy Star

Devices (A4, A3) (for market launch after 1. 11. 2001)	Performance (pages per minute)	Consumption on in sleep mode (Watts)	Default time to sleep mode (minutes)
fax machines (stand alone)	10	10	5
	>10	15	5
printers, printer-fax combinations (b/w laser-, b/w thermo transfer-, b/w and color ink jet-)	10	10	5
	20	20	15
	30	30	30
	44	40	60
>44	75	60	
color printers (laser-, thermo transfer-) color printers	10	35	30
	20	45	60
	>20	75	60
photocopiers* (off mode)	40	10	30
	>40	20	90

* For photocopiers with a print rate of 40 pages per minute (ppm) and up, a sleep state with $3,85 \cdot \text{ppm} + 5$ Watts must be activated after no more than 15 minutes (photocopier requirements as of July 1999).

You can find the current requirements for the Energy Star under:
<http://yosemite1.epa.gov/estar/consumers.nsf/content/officeequipment.htm>

Energy consumption: ink jet printers versus laser printers

Consumption (Watt) (as of September 2001)	Off	Sleep	Stand- by	In Operation	In operation per page* (Wmin)
ink jet printers	0–10	3–10	3–15	10– 30	4–30
laser printers (b/w)	0–10	5–15	5–20	400–800	20–80

* for standard letter ("Grauert letter", b/w) in normal to high quality at max. print performance in Watts*min

The table shows typical consumption values for workplace printers (for photocopiers similar values apply). The consumption per printed page calculates from the print performance and the energy consumption during printing.

The comparison shows:

- Efficient ink jet printers – particularly at normal quality and low throughput – have a lower energy consumption.
- Efficient laser printers – particularly at high throughput – also achieve good consumption values.

Saving-tips for energy, money and environment

Turning off during nights, on weekends, during breaks	Switch off devices that are not in use. Some devices still use energy even after they are switched off. A comfortable way to achieve 0 Watts consumption is the use of a switchable multiple socket outlet to safely separate several devices from the mains supply.
Buy energy-efficient devices	When buying a device, also pay attention to the energy consumption. One indicator is the Energy Star. Activate all energy-saving functions of the devices.
Share devices and save	Share the use of devices, for example network printers and fax machines. Then, the consumption is reduced during the sleep and stand-by modes.
Normal quality is often satisfactory	Many devices are set to optimal quality. Change the pre-setting to normal quality – less energy, less toner or ink and faster printing are the reward.
Double-sided printing and copying	Buy devices with good functions for double-sided printing or copying and use the devices accordingly. There was a lot of energy put in paper – more than the printing process needs – and you save paper costs and space in the files.
Reuse paper	For drafts and fax reception you can use the back of paper with print on one side. Devices with 2 paper trays are especially well suited for that.
Avoiding paper consumption	You have many possibilities: E-Mail instead of fax, print preview instead of draft printout, 2-4 page views on one printed page, no separate fax cover sheets etc.

4.3 Print paper/copy paper

The quality of copy paper is defined in the standard DIN 19 309 “paper for copying purposes”. This standard considers both normal and recycled paper. Types of paper that correspond to this standard can be used unhesitatingly for copying and printing purposes.

Standardized copy paper can be used without problems

Paper manufacturers divide papers basically into 3 classes: A- (the best quality), B-, and C-class.

A-class paper has the following properties:

- best operating characteristics on all printers/photocopiers
- excellent dimensional stability of the sheet
- best possible suitability for ink jet printers
- high degree of whiteness
- low filling material content, optimal cutting quality, thus least possible amounts of dust released into the air.

Consequently, the device has to be cleaned less, it saves service costs and the device has a longer service life.

Unfortunately, there are also many types of paper (papers of the C-class) that do not meet the DIN-standard nor the recommendations of the printer-/photocopier manufacturers, but they

- have extremely short fibrous materials,
- contain a high portion of resin,
- contain a lot of dust, or
- contain filling materials that assist wear-out.

Paper quality influences reliability of the devices, wearout, and quality of the printouts and copies

Poor paper quality can affect the wearing parts of printers/photocopiers. Paper jams occur more frequently and shorter maintenance intervals become necessary. When special materials (for example transparencies, labels) are used, the recommendations of the manufacturers have to be considered.

Some manufacturers indicate the paper class by the allocation of stars. In general, 1–5 stars are assigned, 5 stars indicating the best paper quality.

If there is no information on the paper class on the packaging of the paper, it can be requested at the paper manufacturer through the reseller.

The suitability and quality of the paper is expressed often through pictograms or corresponding formulations (for the A-class for example see further above).

4.4 Take-back, recycling and/or disposal of consumables

As a result of a strengthened environmental awareness of customers and manufacturers, special emphasis is put on reuse and recycling.

4.4.1 Toner, toner containers and ink containers

The toner, which passed through the imaging process and was removed from the imaging drum afterwards by a cleaning unit, is called residual toner. In some devices, this toner is mixed with new toner and then brought back into the printing or copying process again. In other printers/photocopiers, the residual toner is caught in special reservoirs for residual toner since possible impurities can cause malfunctions during printing or copying with residual toner.

Only pure transport containers that provide the toner reservoir of the copier or printer with toner are called toner containers. These containers are usually made of plastic or cardboard.

Some manufacturers take back toners and containers for toner residues/ink containers (where applicable, including the print head) for reuse or recycling or they feed it into a system (in accordance with the regulation on the packaging) for the recycling of plastics.

**Toner/toner
containers can be
reused or recycled**

With regard to environmental aspects and hygiene at the workplace, the German Federal Environmental Agency recommends bringing residual toners, sealed in a dust-proof way, to a recycling location or a waste incineration plant. Valid from 2002, the waste code for residual toners and containers for toner residues is 08 03 18.

Manufacturers of laser printers and photocopiers recommend using only original toner containers for printers and photocopiers. As a rule, manufacturers guarantee smooth and low-emission operation as well as good printing and copying results only for original toner containers.

4.4.2 Copying cartridges and print cartridges

The copying cartridge/print cartridge is a constructive unit, consisting of a photosensitive drum, a toner container with toner, a developing unit, a corona or charging roller, and a cleaning blade or cleaning mechanism. Copying cartridges or print cartridges from photocopiers/printers with corona technology consist of the same units. Modern printers/photocopiers frequently work with transfer roller technology and have no corona, but a transfer roller.

The manufacturer recycles copying cartridges and print cartridges

Due to the high-quality materials used, some manufacturers take back the copying cartridges and print cartridges, reuse them partly and otherwise recycle them.

4.4.3 Photo semiconductors

The disposal of photo semiconductors must be carried out according to their composition. The local disposal system or the suppliers feed photo semiconductors into the reusable materials cycle.

Suppliers take back selenium drums

It must be guaranteed during the disposal of used selenium drums, that they do not reach the local disposal system or smelting-/waste incineration plants. The supplier takes back the selenium drums and provides for compliance with the legal waste disposal regulations through materials recovery or disposal.

OPC photo semiconductors/silicon drums can be recycled

Organic photo semiconductors (OPC belts) can be disposed of locally. The base material of OPC drums (for example aluminum) can be recycled.

Also, the base material of silicon drums (for example aluminum) can be recycled.

4.4.4 Silicone oils

Silicone oils are to be disposed of according to local regulations

Silicone oils, that are used for fusing (see chapter 3.2), are not mineral oils. Silicone oils are classified as slightly hazardous to water in the water pollution class I and have to be disposed of according to local regulations with the waste code no. 120110. In most cases, the service technician takes back used silicone oils.

4.5 Take-back, reuse and/or recycling of devices and accessories

Printers and photocopiers predominantly consist of reusable/recyclable parts and materials. In order to return these parts and materials to the production cycle, the devices are first disassembled and then reused or recycled depending on the components. Meanwhile, there are suitable recycling methods for almost all fractions. Numerous test disassemblies and recycling tests that were carried out by different manufacturers were able to show this.

In the meantime, both systems established by manufacturers and manufacturer-spanning initiatives exist for the take-back and recycling of old devices.

At the moment, the so-called WEEE directive is being discussed in the European Union (Directive on Waste Electrical and Electronic Equipment, German: Richtlinie über Elektro- und Elektronikaltgeräte). Presumably in two years, it will come into force Europe-wide. Subsequently, it has to be transposed into national legislation so that, to a later date, all used electrical and electronic appliances in private households will have to be disposed of adequately. Then, used devices will have to be collected separately from other kinds of waste and, being in the responsibility of the manufacturers, should be reused, recycled and utilized in an environmentally compatible way.

At the moment the WEEE directive is being discussed

The reuse of components as well as the reprocessing of complete devices has been carried out for some time already by both, authorized resellers and some manufacturers themselves. These processes are continuously developed further.

Experiences won with the recycling of devices are used for an environmentally sound design of new products and consequently contribute to the implementation of the Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal. This also accommodates the thought of the closed loop recycling management.

Final remarks

This information is based on the present state of the legislation and technology.

Further information – like the German and English version of this brochure – is available in electronic form on the web sites of the BITKOM (www.bitkom.org) and the Professional Association for the Administrative Sector (www.vbg.de).

Appendix

Aerosols

Aerosols are micro particles that are both able to act as carriers for air pollution, and for the purification of the air.

Ames test

The Ames test is a bacterial test method for mutagenic properties of substances (test for mutagenicity). This test was developed at the beginning of the 70s and named after its inventor, Prof. Ames.

The Ames test is able to prove potential mutagenic effects of substances or their impurities since they cause typical changes in the genetic make-up of bacteria. This circumstance is then called mutagenic in the Ames test (Ames-positive).

Workplace Ordinance

The regulation issued by the Federal Minister for Labor and Social Affairs on the design of workspaces, workplaces etc.

BG Pruefzert label

Professional Associations' label for devices with low emissions in accordance with the labor protection laws.

Blue Angel

The environmental label is designed for products and services that distinguish themselves from other products used for the same purposes by their particular environmental compatibility.

The following exemplarily lists the groups of criteria for printers/photocopiers:

- Durability
- Construction suitable for recycling
- Product take-back
- Acoustic emissions
- Energy consumption
- Suitability for recycling paper
- Avoidance of dangerous constituents in products and consumables
- Emissions

The criteria are regularly adjusted to state-of-the-art technology. You can find the current criteria (in English) under: www.blauer-engel.de

EN 60950 (DIN VDE 0805)

European standard that defines requirements with regard to the safety of equipment of the information technology, including electrical office appliances.

Equipment Safety Law

The Equipment Safety Law is applicable to technical work materials which the manufacturer or importer puts in circulation or exhibits professionally or independently within the framework of an economical enterprise. According to the Act on Safety of Devices, only products that meet its requirements may be brought into circulation.

Noise levels

According to the Workplace Ordinance, sound levels in workspaces have to be kept as low as possible, according to the mode of operation. The assessment level at the workplace, even when taking outside noises into consideration, may only reach:

- 55 dB(A) in the case of mainly intellectual activities
- 70 dB(A) in the case of simple or mainly mechanized office work and comparable activities

VDI 2058, Page 3 contains further information.

GS label

The GS label documents that the product was tested by an authorized (independent from the manufacturer) testing authority for compliance with the Act on Safety of Devices. It states that the product corresponds to its requirements.

Declaration of conformity by the manufacturer or supplier

Self-declaration by the manufacturer or supplier, explaining the guidelines/regulations that the product brought into circulation meets.

MAK values

MAK values, maximum workplace concentrations, define the maximum permissible concentration of a working material as gas, vapor or airborne matter in the air at the workplace. According to current knowledge, the maximum workplace concentration does generally not affect the health of employees nor disturb them inappropriately even in the case of repeated and long-term exposure, normally eight hours daily, up to 40 average working hours per week.

The MAK values of the Deutsche Forschungsgemeinschaft (German Research Society, DFG) are, unlike the limit values listed in the TRGS, not legally binding. MAK values are recommendations for a possible later admission to the TRGS 900.

The MAK values are listed in the regularly up-dated version of the TRGS 900: Limit values in the air at the workplace – “Air limit values” (TRGS: Technical rules for dangerous substances).

mg/m³

Mass-related unit for a concentration: milligram per cubic meter.

OECD

Organization for Economic Cooperation and Development. The OECD protocol mentioned in this brochure describes recognized test methods and their precise execution.

ppm

parts per million, 1 part addition or impurity on 1 million parts substance.

ppm is dimensionless. For comparison: 1 ppm = 10⁻⁴ % = 1 mg/kg = 1 g/t = ...

Technical rules for dangerous substances (TRGS)

The TRGS reflect the requirements for hazardous materials in terms of safety engineering, occupational medicine, hygiene as well as industrial science with regard to their introduction and handling. The TRGS defines more closely those regulations and findings in particular that are mentioned in the Ordinance on Hazardous Substances, and directly establishes duties of the employer as far as relevant statutory regulations are missing.

Limit values specified in the TRGS are legally binding.

TRGS 900

Technical rules for hazardous materials: Limit values in the air at the workplace – “Air limit values”.

TRGS 905

Technical rules for hazardous materials: List of carcinogenic, mutagenic or reproduction endangering materials.

(Total) Volatile organic compounds, (T)VOCs

VOCs are volatile organic compounds; the entirety of volatile organic compounds is called TVOCs.

Of course, measuring methods can register only a limited number of VOCs. Thus, it is important to choose test conditions for the recording of VOCs (absorbents, extracting agents, analytical test methods ...) in a way that allows to register those VOCs important for the corresponding question. Furthermore, sources of emissions and emission processes (combustion, production processes ...) should be considered here.

Literature

Bundesanstalt für Arbeitsschutz: Gefahrstoffe beim Drucken und Kopieren im Büro. Eine Handlungsanleitung. Schriftenreihe der Bundesanstalt für Arbeitsschutz. Gefährliche Arbeitsstoffe. GA 44, 4. Auflage, 1996.

Deutsche Forschungsgemeinschaft: MAK- und BAT-Werte Liste 2001.

Europäische Luftqualitätsrichtlinie. Neue EU-Richtlinie über Grenzwerte für Schwefeldioxid, Stickstoffdioxid und Stickstoffoxide, Partikel und Blei in der Luft in Kraft getreten. Umwelt 9, 1999.

Hohensee, H., Flowerday, U., Oberdick, J.: Zum Emissionsverhalten von Farbfotokopiergeräten und Farblaserdruckern. Die BG 11/2000, Erich Schmid Verlag, Bielefeld.

Krause, C., Chutsch, M., Henke, M., Huber, M., Kliem, C., Leiske, M., Mailahn, W., Schulz, C., Schwarz, E., Seifert, B., Ulrich, D.; Umweltsurvey. Band IIIc. Wohn-Innenraum: Raumluft. WaBoLu-Hefte 4/1991, Institut für Wasser-, Boden- und Lufthygiene, Berlin, 1991.

Nies, E., Blome, H., Brüggemann-Prieshoff, H.: Charakterisierung von Farbtonern und Emissionen aus Farbfotokopierern/Farblaserdruckern. Gefahrstoffe – Reinhaltung der Luft, Nov./Dez. 2000.

Oppl, R., Höder, B., Lange, A.: Innenraumluft und TVOC: Messung, Referenz- und Zielwerte, Bewertung. Ein Diskussionsbeitrag zum TVOC-Konzept. Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz, 43, 2000, S. 513–518.

Sagunski, H.: Richtwerte für die Innenraumluft: Styrol. Bundesgesundheitsblatt, 41, 1998, S. 392–398.

Scheffer, F., Schachtschabel, P.: Lehrbuch der Bodenkunde, Thieme Verlag, Stuttgart, 1998.

Seifert, F.: Richtwerte für die Innenraumluft. Die Beurteilung der Innenraumluftqualität mit Hilfe der Summe der flüchtigen organischen Verbindungen (TVOC-Wert). Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz, 42, 1999, S. 270–278.

Technische Regeln für Gefahrstoffe

Thüringer Ministerium für Soziales, Familie und Gesundheit, Dr. Jörg Otto, Helmut Schenk: Gefahrstoffinformation Büro. 3. aktualisierte Auflage, Juni 2001.

The German Association for Information Technology, Telecommunications, and New Media, BITKOM, represents 1,250 companies, 670 of which are direct members. They realize a turnover of about 120 Billion Euro and employ more than 700,000 people. Members are producers of ITC hardware, office machinery and terminal equipment, telecommunications network infrastructure as well as suppliers of software, services, new media and content. The majority are small and medium sized enterprises. BITKOM members generate several tens of thousands of additional jobs each year.

BITKOM's political priorities are the improvement of the regulatory framework in Germany, the reform of the educational system, and the development and establishment of the information society.



German Association for Information Technology,
Telecommunications, and New Media e.V.

Headquarters Berlin
Albrechtstrasse 10
D-10117 Berlin

Tel.: +49 30 27 57 60
Fax: +49 30 27 57 64 00
bitkom@bitkom.org

www.bitkom.org