Eco-Labelling and Green Procurement Schemes for IT Products: The German / European Approach

1. Introduction

The purpose of this paper is to provide information on the approach taken in Germany and on the EU level for Eco-Labelling and Green Procurement of IT products. The paper will first **describe the existing or planned Eco-labels and procurement initiatives** addressing products that belong to the core infrastructure of the internet, like computers (workstations, servers, desktop PC, laptops/notebooks) including monitors, keyboards, printers, mobile telephones and modems, as far as information is available.

The paper will then analyse **the ecological effectiveness and the economic efficiency** of the various instruments. Finally, the paper will **describe reasonable and desirable policy co-ordination** on an international level.

2. Description and Analysis of Eco-Labelling and Green Procurement Schemes for IT Products in Germany/ Europe

2.1 Possible Elements of the Policy Mix

A policy mix aiming at increased energy and environmental efficiency of IT products can contain various instruments, targeted at one or more of the three main types of market actors involved: manufacturers/importers; retail trade; and buyers/users of IT equipment.

Policy measures targeting **manufacturers and importers directly** include:

- voluntary commitments, e.g. voluntary industry standards,
- binding industry standards, e.g. defined by negotiated agreements,
- laws and guidelines, e.g. defining mandatory minimum efficiency standards.

Policy measures targeting **buyers and users** of IT equipment (and maybe the **retail trade** as an intermediary) usually indirectly have an impact on **manufacturers and importers** in the sense of market pull. These measures include:

- mandatory or voluntary energy labels, either as energy classification labels applied to all models (e.g., the EU label for domestic appliances), or as endorsement labels that are only applied to, e.g., the 25 % most efficient models on the market, or to those models that fulfil certain minimum efficiency criteria;

- mandatory or voluntary Eco-labels, which have energy efficiency criteria among other environmental criteria (e.g., toxic substances; recyclability);

- accompanying measures such as information campaigns, databases of models fulfilling the label criteria, software tools for life-cycle cost analysis or other supports for buyers, maybe financial incentive programmes for energy-efficient models;

- energy-efficient or green procurement programmes, including technology procurement.

This discussion paper will describe and analyse Eco-labels and their accompanying measures, as well as green procurement programmes. The policy measures targeting the manufacturers directly, as well as the energy labels and accompanying measures will be described and analysed in **another discussion paper** on "The German/European Approach Towards Higher Energy Efficiency of IT Products".

2.2 Guiding Questions for the Evaluation of Policies

For the **evaluation of the ecological effectiveness** of each of these measures, a simplified set of criteria shall be applied:

- Does the proposed measure offer sufficient incentives to the **producers** to reduce energy consumption to the level of the best available technology (or lower) during a) the "on" mode b) the "power save" mode c) the "stand by" mode and d) the "off" mode (as far as they exist for the product under consideration) as well as the yearly energy consumption?

- Are the criteria for labelling/ procurement of products ecologically sound?

- Does the label have the potential to change the decision of **buyers** to purchase more efficient products?
- Does the label/procurement help to bring about technology shifts towards energy efficient new technologies (e.g. LCD Monitors)?

For **evaluation of the economic efficiency** of the various measures, evaluation questions are:

- Is it cost-effective to reach the minimum or average energy efficiency target set by the policy (this question shall be answered as far as information exists)?
- Does the measure cover all market participants (e.g. producers, importers, traders)?
- Are there market distortions (e.g. unequal impacts on companies operating at different scales)?
- Does the proposed measure provide a clear framework for producers?
- Which administrative effort is necessary to achieve the stated environmental goals of the proposed measures?
- Do labelled products provide a good balance between the savings from reduced energy consumption and extra-costs for energy efficient technology components of the labelled product?
- Do the labels and procurement schemes significantly increase the market for green IT products?
- Are there measures (information campaigns, database, software or other supporting materials for decision-makers etc.) that support the label/procurement scheme?

2.3 Eco-Labelling Policies in Germany and on the EU Level

In the following, German or EU policies that are institutionalised and running for a number of years will be described and analysed according to the criteria provided in chapter 2.2.

The European Union Eco-Label

The European Eco-Label, symbolised by the EU Eco-Flower, has been created in 1992 (Council Regulation no. 880/92). It is a voluntary label for consumer goods,

except for food, drink and medicine and is used in the European Union, Norway, Liechtenstein and Iceland.

The ecological criteria require scientific assessment studies of the environmental impacts of the product for each part of its life cycle. One criterion is energy consumption. The criteria are valid for a period of three years. They are subject to revision and may be tightened, depending on the market and advances in science and technology, in order to improve the environmental performance of the Eco-labelled product.

National Competent Bodies have been designated in every Member State. In Germany, this is the Federal Environmental Agency (UBA) and the German Institute for Quality Assurance and Labelling (RAL).

Everyone, including industry, trade and retailers or consumer organisations, may suggest new products to the National Competent Bodies. These are checked by the UBA and the Jury Umweltzeichen – Environmental Label Jury – and then passed on to the European Commission. Studies are made on the behalf of the Commission to develop a criteria proposal.

This proposal is discussed with several participants, e.g. other EU countries, non-EU countries, commerce, industry, producers outside the EU. Their views are taken into consideration and afterwards criteria are set. These proposed criteria are forwarded to the Consultation Forum. This forum is composed of European representations of interests.

The product group criteria must be approved by a qualified majority of Member States and the European Commission before being published in the Official Journal of the European Communities.

Award process

Any producer or an importer who wants to apply for the EU Eco-Label must contact the National Competent Body (in Germany, the RAL). He completes an application form, submits a non-returnable fee (500 Euro) and provides all the

necessary details and tests to prove that this product complies with the ecological and performance criteria.

The RAL assesses the application, using information provided by the producer and test results provided by independent laboratories. Afterwards the RAL informs the European Commission and the other member states. If no objections are raised within 30 days, the National Competent Body awards the Eco-Label. Once approved and awarded the Eco-Label, the company must pay an annual fee, which is fixed at 0,15 % of the annual sales volume of the product.

In September 1999, about 250 products had been awarded the Eco-label, including zero portable computers and one personal computer (from Sweden). Until now, no German products have been awarded.

The requirements of the EU Eco-label for portable computers and PCs are presented in **Annex 1** of the paper "The German/European Approach Towards Higher Energy Efficiency of IT-Products" in this report.

Analysis of ecological effectiveness

Looking at the criteria outlined above, the EU Eco-Label would give sufficient incentives to manufacturers to reduce the consumption of desktop and portable PCs in the "power save" and "off" modes towards the limits that are regarded feasible at present. However, some requirements could be tightened: the new "power save" requirements of the "Energy Star" label for desktop PC processing units are stricter, and the 10 W requirement for the "sleep mode" of monitors is not too ambitious. The high number of monitors fulfilling the GEA label criteria shows that restricting the consumption of a monitor in "sleep mode" to 3 W does not pose a problem to manufacturers nowadays.

Furthermore, as with all other labels, no requirements are given for energy consumption in the "on" mode.

Overall the criteria, including the requirements for recyclability, hazardous substances, guarantee and availability of spare parts, user instructions on energy **(Annex 1)** can be regarded as comprehensive and ecologically sound.

However, given the lack of products that have received the EU Eco-label for PCs so far, the label is not able to change the decisions of buyers. Furthermore, it neither has sufficiently strict criteria as to trigger the development of new, more energy-efficient products.

All in all, therefore, the environmental effectiveness of the EU Eco-label for PCs is so far rather limited.

Analysis of economic efficiency

No information about the cost-effectiveness (for society and for the final customers) of reaching the electricity consumption requirements for the EU Eco-Label is available. However, since the criteria are similar to those of the "Energy Star" label, which are subject to cost-effectiveness assessments, it can be assumed that the requirements can be met in a cost-effective manner.

The EU Eco-Label does provide a clear framework for producers, and it is not expected to lead to market distortions. However, the measure does not cover all market participants – in fact, it is a single manufacturer to date; and a reason for this seems to be high administrative costs for the manufacturers, but also a lack of large information and marketing campaigns associated with the label.

Therefore, the market transformation effect of the EU Eco-label for PCs so far is very small. A database of the licensed products is available on the website http://europa.eu.int/ecolabel, but no other support measures (e.g., life-cycle cost software) are known to us.

In sum, the economic efficiency of the EU Eco-label for PCs should be improved.

The "Blue Angel"

The German environmental label is based on the environmental sign used by the United Nations Environment Program. The "Blue Eco Angel" has been introduced in 1977. The criteria for the product groups are created as follows.

New proposals are collected and commented on by the Federal Environment Agency (UBA). The Jury Environmental Label will then decide on further examinations. The UBA will draft a criteria proposal and the RAL will organise hearings. These expert hearings are organised with the chair of the RAL, UBA, industry (BDI), consumers (AgV, Stiftung Warentest), environmental associations, unions and other experts.

The criteria are set by the "Jury Environmental Label" and published by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Any producer who wants to use the sign must contact the RAL. The RAL will check the conditions of the product and the fulfilment of the criteria. The (sub-federal) State, where the producer is situated, and some other institutions have the possibility to comment. Finally, the importer or producer will sign a contract on the use of the Environmental Label.

In 1998, 4300 products were awarded with the Blue Angel including computers, portable computers and printers. The requirements of the Blue Angel for portable computers and PCs are given in **Annex 1** of the paper "The German/European Approach Towards Higher Energy Efficiency of IT-Products" in this report. As of September 2000, the Blue Angel was awarded to

- 18 PC processing units without monitor, from 6 manufacturers;
- 4 monitors from 2 manufacturers;
- 23 keyboards from 5 manufacturers;
- 0 portable computers;
- 44 printers from 8 manufacturers.

Analysis of ecological effectiveness

For the PC "sleep" mode, and for the "stand-by" mode of printers, the requirements on energy efficiency of the Blue Angel are similar to those of the "Energy Star" label (cf. Annex 1 of the paper "The German/European Approach Towards Higher Energy Efficiency of IT-Products" in this report). This does limit the ecological effectiveness of the Blue Angel with respect to energy efficiency. However, an interesting feature of the Blue Angel are the requirements for the

"off" mode of PCs. These are relatively strict, but allow 5 W if the PC or portable is able to communicate while in the "off" mode. This provides an incentive for manufacturers to develop PCs with such a feature, which would significantly reduce the annual consumption of PCs able to communicate with the net 24 hours, compared to the "Energy Star" sleep mode requirements.

Since the "on" mode is not subject to the criteria of the Blue Angel as well as of the other labels, they are not sufficient to bring about technology shifts to LCD monitors or notebook CPU technology. The criteria, including the requirements for recyclability, hazardous substances, noise, batteries, and packaging materials **(Annex 1)**, can be regarded as comprehensive and ecologically sound.

In general, the Blue Angel receives high recognition and awareness with customers and purchasers in Germany. For IT equipment, the Umweltbundesamt considers it an important decision criterion in public procurement, due to the green purchasing guidelines and handbook published by the Umweltbundesamt (personal communication by Mrs. Jakobs, 27 October 2000; cf. Chapter 2.4). Not many products are licensed with the Blue Angel, but the requirements are used also to judge other products, not only by public purchasers, but also by private companies. However, for private consumers, the effect is more limited, since the retail trade does not widely use the Blue Angel for IT products in marketing.

All in all, the Blue Angel has a high potential of environmental effectiveness, but the factual effectiveness could be improved by better awareness raising, particularly for private consumers, and stricter requirements on the energy consumption for the PC "sleep" mode, and for the "stand-by" mode of printers.

Analysis of economic efficiency

As is the case with the other labels, the "Blue Angel" does not provide information about the cost-effectiveness (for society and for the final customers) of reaching the electricity consumption requirements. However, since most criteria are similar to those of the "Energy Star" label, it may be assumed that the requirements can be reached in a cost-effective way.

As a voluntary label, the Blue Angel does not cover all market participants, but neither leads to market distortions. It provides a clear framework for producers. The administrative effort is moderate for both the institutions running the scheme and the appliance producers.

The Blue Angel seems to increase the market for "green" IT products at least with public/commercial buyers. There is a database of products on the website, but the effectiveness of the label for IT products, particularly with private consumers, could be improved by additional information campaigns, while for professional buyers an easy tool for life-cycle cost assessments would be helpful.

In summary, the economic efficiency of the Blue Angel is potentially good, but could be improved in practice through higher participation rates of producers and higher awareness among users.

The TCO Label

The Swedish TCO Label has been designed to improve the working conditions of employees who work with computers and other electronic equipment.

The TCO is the Swedish Confederation of professional Employees and consists of 1,3 million Swedish employees, organised in 19 organisations that work together to improve their members' working. Therefore, the TCO standard for monitors is well known.

The TCO standard 1999 does not provide much guidance in the field of energy efficiency. It merely points out that the "energy saving mode" must be equal to or less than 30 watt. These standards mostly refer to working conditions, e.g. emissions, noise, electrical safety.

2.4   "Green procurement policy", particularly energy-efficient IT

In the field of public procurement, environmental protection is becoming more and more important. In the international context, the Green Procurement Agreement (GPA) has been created within the framework of GATT. The **European Union** has enacted a Directive for public procurement. Non-

discrimination of suppliers coming from other member countries is one of the main issues of this guideline. Therefore, calls for tenders up from a specified amount of money have to be advertised European-wide.

However, this EU Directive does not include energy efficiency as a positive criterion for the selection of bids; it thus can even be used to inhibit the use of energy efficiency as a positive criterion for the selection of bids. Therefore, the European Commission is now planning a specific initiative, and considering a specific Directive, on making public procurement more energy-efficient.

In **Germany**, guidelines for public procurement are based on the EU Directive. According to these guidelines, environmental aspects should be taken into consideration. Furthermore, ecologically friendly procurement is generally mentioned in § 37 Kreislaufwirtschafts- und Abfallgesetz (a law concerning waste treatment in Germany). In this context, however, this means mainly avoiding waste and not energy efficiency as an aim for public procurement.

Within the framework of a public call for tenders, environmental aspects should be mentioned as criteria. It is also possible to refer to the criteria of the environmental label „Blauer Engel". On the other hand, the possession of the label by a manufacturer/product cannot be made a precondition to get the contract, because this would be an indirect obligation to apply for the label.

The energy consumption of the public sector (without the military) is about 478,1 Petajoule (Umweltbundesamt, 1999a), which is equivalent to 5 to 6 % of the German energy consumption. There are large energy efficiency potentials in the administration sector. Around 30 % of the electricity and heat used in administration buildings could be saved cost-effectively.

The **Federal Environmental Agency** has published a **handbook** called „Environment-friendly procurement – a guide to take into account environmental aspects in public administration and in purchasing" (Umweltbundesamt, 1999b). This book contains a description of the most important environmental aspects required to be taken into account for the majority of the orders made by government authorities.

- Essential product information is listed and suggestions are made for the choice of products and services.
- Recommendations are made for more than 11 product classes and services listed in 12 chapters. This includes computers and office equipment.
- The existing Eco-labels are described to inform the employees.

Furthermore, the International Council for Local Environmental Initiatives (**ICLEI**) has taken several initiatives on Green Procurement. One initiative is the series of Conferences called EcoProcura®, which started in 1998. This conference series is supported by the European Commission.

Another initiative is the **European Green Purchasing Network (EGPN)**, founded in 1997 by ICLEI and the European Partners for the Environment (EPE) with support from the European Commission (http://www.epe.be). The main task of EGPN is to organise workshops and conferences for the exchange of experiences and information. Its is planning to issue a workbook on green purchasing in Europe. Their programme for the next 18 months is as follows:

- "To bring together procurement officers of (i) Governments -Swedish Presidency - and (ii) Regional Authorities – Belgium Presidency -to address the integration of green procurement policies in their "Sustainable Development Strategies"
- To develop a partnership with the European Eco-efficiency Initiative and the WBCSD to promote the greening of the "value chain" and to reach 1.000.000 corporations, mainly SMEs, as well as public authorities
- To promote as our contribution to the Rio+10 process - initiatives to implement existing environmental conventions and regulations, as the climate change convention and the biodiversity convention, through green purchasing. A pilot initiative will be done in the field of water by launching the EGPN Water Equipments, Materials and Services Clearing House."

The International Academy of ICLEI also offers a training course "economic and ecological purchasing and procurement in Europe" in this framework.

Analysis of ecological effectiveness

As the "green procurement" policy of the German government is based on the criteria of the Blue Angel" label, the judgement of the ecological effectiveness is

the same. In practice, both policies are mutually enforcing the effectiveness of each other.

Analysis of economic efficiency

Like with ecological effectiveness, in practice both policies are mutually enforcing the effectiveness of each other. However, no statistical or empirical material is known about the extent to which the policy of voluntary guidelines and handbooks in fact changes the purchasing behaviour of public or private entities in Germany.

3.   Conclusions and International Policy Co-ordination

The discussion paper on "The German/European Approach Towards Higher Energy Efficiency of IT Products" concluded that the "Energy Star" label has taken the role of a world-wide minimum efficiency standard for IT products, particularly for PCs. However, some national governments would prefer lower power values for the requirements of the EU Energy Star scheme. Therefore, it seems appropriate to use **international policy co-ordination** in order to reach agreement on **stricter requirements** for an **international "Energy Star" label** used at least by the EU, Japan, and the USA. Such a label could combine the requirements of the "Blue Angel" for the "off" mode, the requirements of the GEA label for monitors and printers, and the new requirements of the "Energy Star" label for the processing unit of a desktop PC (cf. Annex 1 of the paper "The German/European Approach Towards Higher Energy Efficiency of IT-Products" in this report). Such strengthened and harmonised minimum efficiency requirements could also be the basis for the energy efficiency requirements of more comprehensive Eco-labels. However, there may still be room for more ambitious energy labels to endorse the most energy-efficient products, e.g., a dynamic GEA label, in those EU Member States who wish to proceed faster.

Any **Eco-Labels** should either harmonise their energy efficiency requirements with the Energy Star or the GEA label, to send clear signals to consumers. The effectiveness of all labels for IT products, particularly with private consumers, could be improved by additional information campaigns, while for professional buyers an easy tool for life-cycle cost assessments would be helpful.

Furthermore, international co-ordination should try to reach an agreement on a measurement standard and an energy efficiency index for the **"on" mode** of PCs and printers. At least for the monitors, an energy efficiency index could be used as a basis, as has recently been proposed for TVs (Siderius and Harrison, 2000). This energy efficiency index targets the annual consumption, based on a mix of the "on" and "stand-by" modes.

For the **other environmental criteria**, at least the EU Eco-label and the "Blue Angel" could harmonise their requirements to improve their acceptability for manufacturers. The EU Eco-label could, for example, include the requirements on batteries and packaging materials of the "Blue Angel", while the latter might adopt the requirements for user instructions on energy of the former. International Co-ordination with, e.g., the Japanese Eco-Label would certainly be useful as well.

International co-ordination and co-operation between the EU and Japan could furthermore be helpful in the field of **Green Procurement**. This could include exchange of information and materials as well as the adoption of common criteria. The latter would, of course, benefit from an international co-ordination of the Eco-Label criteria.

Finally, the German federal **government** (as well as the regional and local governments) should render **mandatory** for all their IT appliance purchases the efficiency criteria of the "Blue Angel" or the GEA label (or a combination of both) and the new "sleep mode" for processing units of PCs by the "Energy Star", as well as the other environmental criteria of the "Blue Angel" and/or the EU Eco-label.

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Annex 1: Ecological Requirements other than Energy Efficiency of the EU Eco-Label and the "Blue Angel"

Table A2-1: Non-Energy Requirements for the EU Eco-Label for Desktop PCs (1999/205/EG)

Longevity of the appliances	3 years guarantee for central unit, 1 year for monitor
	5 years availability of spare parts and service
	modular construction of the unit
	the processor, the graphics card, the HDD, and a CD ROM must be upgradable
	one or more free docking places must be available
Recycling-oriented construction	must be able to be disassembled by one skilled person alone
	manufacturer must proof the easy-to-disassemble construction in a report
	incompatible or hazardous substances must be able to separate
	labels must be easy to remove
	plastics must consist of one polymer or compatible polymers
Avoidance of toxic or harmful substances in the unit	polymers and other materials must not contain lead or cadmium
	plastic parts must be free from organic bromine or chlorine and be labelled according to ISO 11469.
Take back of units	the manufacturer must take back appliances with the EU Eco-label, unless contaminated by the user (e.g., through medical or nuclear applications)
Information for the user	on energy use in the "on", "sleep" and "off" modes, and the consequences of pulling the plug/inactivating the "sleep" mode;
	on guarantee, recycling and take-back;
	and an environmental declaration

Table A2-2:

Non-Energy Requirements for the EU Eco-Label for portable PCs (1999/698/EG)

Longevity of the appliances	3 years guarantee
	5 years availability of spare parts and service
	modular construction of the unit
	the direct memory must be upgradable, i.e. at least the CPU, the HDD, and a CD-ROM if installed
	one or more free docking places must be available
Recycling-oriented construction	must be able to be disassembled by one skilled person alone
	manufacturer must proof the easy-to-disassemble construction in a report
	incompatible or hazardous substances must be able to separate
	labels must be easy to remove
	plastics must consist of one polymer or compatible polymers
Avoidance of toxic or harmful substances in the unit	polymers and other materials must not contain lead or cadmium
	plastic parts over 25 g, cables, and plastic coatings of cables, batteries etc. must be free from a list of hazardous substances and be labelled according to ISO 11469.
	batteries must not contain more than 0.001 % cadmium, 0.01 % lead or 0.0001 % quicksilver
	the display background lighting must not contain more than 5 mg quicksilver (up to 12") or 10 mg (for larger screens)
Take back of units	the manufacturer must take back appliances with the EU Eco-label, unless contaminated by the user (e.g., through medical or nuclear applications)
Information for the user	on energy use in the "on", "sleep" and "off" modes, and the consequences of pulling the plug/inactivating the "sleep" mode;
	on guarantee, recycling and take-back;
	and an environmental declaration

Table A2-3:

Non-Energy Requirements for the Blue Angel for Desktop PCs (RAL-UZ 78)

Longevity of the appliances	3 years guarantee 5 years availability of spare parts modular construction of the processing units
Recycling-oriented construction	fewer material types use of recyclable materials labelling of materials easy-to-disassemble construction
Avoidance of toxic or harmful substances in the unit	polymers and plastic case of the PC must not contain halogens/ halogen organic compounds additives to plastics must not be classified as cancerogeneous or possibly damaging genes or reproduction batteries must not contain cadmium the monitor screen must not contain cadmium
Take back of units	the manufacturer must take back appliances with the Blue Angel
Avoidance of non-material emissions	the monitors must fulfil the requirements of the Swedish "MPR II" standard on electric and magnetic fields
Noise	The processing units must not exceed the following values: - in stand-by L_{WAd} 48 dB(A) – in operation L_{WAd} 55 dB(A)

Table A2-4:

Non-Energy Requirements for the Blue Angel for portable PCs (RAL-UZ 93)

Longevity of the appliances	3 years guarantee
	5 years availability of spare parts
	modular construction of the processing units
Recycling-oriented construction	fewer material types
	use of recyclable materials
	labelling of materials
	easy-to-disassemble construction
Avoidance of toxic or harmful substances in the unit	polymers and other materials must not contain halogens/ halogen organic compounds
	additives to plastics must not be classified as cancerogeneous or possibly damaging genes or reproduction
	batteries must not contain cadmium, lead or quicksilver
	the display must not contain any substances classified as cancerogeneous or possibly damaging genes or reproduction
Take back of units	the manufacturer must take back appliances with the Blue Angel
Noise	The units must not exceed the following values: - in stand-by L_{WAd} 48 dB(A) - in operation L_{WAd} 55 dB(A)

Table A2-5:

Non-Energy Requirements for the Blue Angel for printers (RAL-UZ 85)

Longevity of the appliances	3 years guarantee 5 years availability of spare parts 5 years availability of ink cartridges etc.
Recycling-oriented construction	fewer material types use of recyclable materials labelling of materials easy-to-disassemble construction
Avoidance of toxic or harmful substances in the unit	polymers and plastic case of the PC must not contain halogens/ halogen organic compounds fire inhibitor substances must not be classified as cancerogeneous batteries must not contain cadmium, lead or quicksilver toner, ink or colours must not contain: - azo colours - substances possibly damaging genes or reproduction
Take back of units and cartridges	the manufacturer must take back appliances with the Blue Angel the manufacturer must take back original toner cartridges/containers
Avoidance of harmful emissions	laser printers must not exceed the following values: - dust emissions $\quad$ 150 mg/m^3 - ozone emissions $\quad$ 0.02 mg/m^3 - styrol emissions $\quad$ 0,07 mg/m^3
Noise	laser and ink jet printers must not exceed the following values: - speed $\quad$ 7 pages/minute: $\quad$ L_{WAd} $\quad$ 58 dB(A) - speed 8 to 14 pages/minute: $\quad$ L_{WAd} $\quad$ 62 dB(A) – speed > 14 pages/minute: $\quad$ L_{WAd} $\quad$ 67 dB(A) for matrix printers: $\quad$ L_{WAd} $\quad$ 72 dB(A)