Technical specification for green design evaluation of cooking appliances

Jianfang Zong, Xin Zhang, Xiuying Liang, Jianwei Tian, Han Yuan, Jinxin Guan
China National Institute of Standardization (No.4 Zhichun Road, Haidian District, Beijing)
zongjf@cnis.ac.cn

Abstract. This paper sets out the principle of green design of cooking appliances, and analyzes the general provisions on green design of cooking appliances, the green design process and key points, evaluation requirements, preparation methods for a life-cycle evaluation report, and evaluation methods. The Technical Specification for Green Design Evaluation of Cooking Appliances plays a practical supporting role in systematically supporting the establishment of China’s eco-design evaluation mechanism. The research on and formulation of standards will help improve and promote the green design capabilities of enterprises, improve comprehensive management and cleaner production, and thereby cultivate a batch of green design demonstration enterprises with green development awareness and brand influence. Meanwhile, it has positive guiding significance to guiding green production and promoting green consumption.

1. Introduction
In 2016, the Industrial Green Development Plan (2016-2020) (GXB G [2016] No. 225) issued by the Ministry of Industry and Information Technology proposes to actively promote the evaluation of green products and other key tasks, striving to promote the realization of the goals of creating one hundred green design demonstration enterprises and one hundred green design centers and developing and promoting ten thousand green products by 2020. In order to implement this important task, efforts should be made to solidly promote cleaner production, reduce the use of toxic and hazardous raw materials, and actively promote the evaluation of green products and other key tasks. Related key industries are actively developing green product design standards under the arrangement of the Ministry of Industry and Information Technology.

Cooking appliances are important consumer goods in the lives of Chinese residents. With the continuous advancement of urbanization and the increasing income level of residents, the cooking appliance manufacturing industry has made considerable progress and development in recent years, and played an active role in improving the living quality of residents and promoting economic development. The Chinese government and competent industry authorities pay great attention to the production and product quality of cooking appliances, and have issued a series of laws, regulations and policies that are conducive to the healthy and sustainable development of the industry. The demand direction of the cooking appliance market is the development direction of the cooking appliance market. Therefore, the development direction of the cooking appliance market is to meet the increasing potential demands of consumers, that is, to develop towards high efficiency, energy conservation, functionalization, intelligence, and ecology. Carrying out eco-design of cooking appliances is to meet the upgraded consumption demands, increase the supply of green products, and solve the problems of low thermal efficiency, low exhaust gas treatment level and material selection for cooking appliances, so that
consumers can choose and use green products, thereby alleviating the resource and energy pressure and reducing adverse effects on the environment and humans [1].

In addition, the Technical Specification for Green Design Evaluation of Cooking Appliances is to implement the requirements and key tasks of China's Guidelines for the Construction of the Green Manufacturing Standard System. The research content of such specification complies with the standardization focuses on "environmental protection" and "energy conservation and low carbon" in the key areas of "strengthening ecological civilization standardization and serving green development" under the Plan for the Construction and Development of the National Standardization System (2016-2020). Meanwhile, such specification is also the key task on solidly promoting cleaner production, reducing the use of toxic and hazardous raw materials, and actively promoting the evaluation of green products under the Industrial Green Development Plan (2016-2020).

The Technical Specification for Green Design Evaluation of Cooking Appliances plays a practical supporting role in systematically supporting the establishment of China's eco-design evaluation mechanism. The research on and formulation of standards will help improve and promote the green design capabilities of enterprises, improve comprehensive management and cleaner production, and thereby cultivate a batch of green design demonstration enterprises with green development awareness and brand influence. Meanwhile, it has positive guiding significance to guiding green production and promoting green consumption.

2. Basic principles of green design

The green design of cooking appliances aims at reducing environmental pollution and improving the recyclability rate of cooking appliances, to reduce the adverse environmental impact generated during the entire life cycle of cooking appliances, and develop a cooking appliance system that is more ecological, economical, and sustainable. The basic principles of green design of cooking appliances include: demand orientation, process orientation, and risk orientation.

2.1 Demand orientation

Green design follows the design principles under GB/T 24256[2] and is guided by comprehensive demands: considering the resource attributes and comprehensive resource utilization requirements of cooking appliances and their system in an integrated manner; fully considering the environmental attributes and requirements of cooking appliances at each stage of the life cycle, especially the environmental requirements in the use and scrapping of such appliances; adopting customized design to avoid functional waste, so that the functions of cooking appliances can properly reflect energy attributes and system requirements.

2.2 Process orientation

Guided by appropriate process design, green design meets the requirements for advanced technology and scientific methods: improve environmental indicators of cooking appliances without reducing their technical performance indicators; product reducing and lightweight design; for selection of raw materials, process flow, and product testing methods, the optimal integration scheme should be selected; based on more suitable manufacturing technology.

2.3 Risk orientation

Green design is guided by risk avoidance, aims at environmental protection, and is subject to economic suitability: in the green design of cooking appliances, priority is given to environmentally friendly advanced design technologies; ensure the safety of cooking appliances during processing and manufacturing, use and maintenance, and final disposal; while realizing the functions of cooking appliances, pursue reduction in quantity and reuse and recycling, and improve the environmental impact of equipment during the life cycle, especially the environmental impact during the use and scrapping; place emphasis on the processing methods of refrigerants during the scrapping of cooking appliances, to avoid and reduce their pollution to the environment; attach importance to the improvement in the
comprehensive utilization of resources for cooking appliances, to reduce secondary pollution; comprehensively consider the environmental benefits of cooking appliances, including environmental effects and costs; take into account the environmental benefits of enterprises, customers, and society.

3. Green design process and key points

3.1 Overview
The design stage of cooking appliances includes demand analysis, conceptual design, structural design, and detailed design. The key points of green design at each design phase are shown in Figure 1.

3.2 Essentials of green design in demand analysis
Increase green demand analysis for products and formulate product green design goals. Green demand analysis for products includes but is not limited to: green-related laws, regulations, policies, standards, and patents; industry-related advanced green design and/or manufacturing technology; product demander's demand and requirements in green-related aspects; fully considering the environmental pollution at each stage of the life cycle of cooking appliances and the system boundaries of cooking appliances.

3.3 Essentials of green design in conceptual analysis
Predict and analyze the green design indicators in the full life cycle of products, comprehensively evaluate technical, economic, and green design indicators of products, and determine essentials of green design. The essentials of green design considered at each stage of the life cycle of products include but are not limited to: selection and use of raw materials; structural design; manufacturing; packaging process; product transportation; product use; recycling; other design requirements.

3.4 Essentials of green design in structural design
The essentials of green design in structural design include but are not limited to: fully considering green design indicators, such as improving thermal efficiency, lightweight, packaging and transportation convenience, and recycling convenience; improving the thermal efficiency rating of products, reducing product weight, and facilitating the emission and use by optimizing the product structure; simplifying the product structure to make it easy to process and produce products, and improve production efficiency and qualified rate; the material selection and structural design of parts and components are designed for their service lives; improving the convenience in product installation, use, recycling, and disassembly.

3.5 Essentials of green design in detailed design
3.5.1. Selection and use of raw materials. When raw materials are selected, consider the following: not use banned substances and use less restricted substances; give priority to standard and serialized raw materials; give priority to renewable raw materials from abundant sources, and try not to use or use less rare materials as much as possible; the materials can withstand temperature under normal use; metal parts (except for corrosion-resistant materials) are electroplated, painted, enameled or otherwise processed as appropriate for anti-corrosion surface treatment; parts that are or may be in direct contact with food shall be made from materials that cause no harmful chemical changes to human body or materials with appropriate surface treatment, and will not produce harmful substances; give priority to materials with good heat resistance, corrosion resistance, gas resistance, impact resistance, heat preservation and heat insulation, flame retardancy, and oil resistance; reduce the use of thermosetting plastics; give preference to materials that are easy to decomposable or recycle, and recyclable; give preference to suppliers with environmental management system capabilities or meet the requirements of the green supply chain; carefully select artificial chemical substances whose side effects are not known; when necessary, suppliers are required to provide a material safety data sheet (SDS).
When raw materials are used, consider the following: reduce the types of materials used in similar products; reduce the amount of materials used; improve the utilization rate of materials; reduce waste generation and discharge; achieve a high utilization rate of materials and reduce material waste through structural optimization of parts and components and standard and universal design; use recyclable raw materials, whose utilization rate can reach more than 85%; when mixed materials must be used, select materials with good compatibility; encourage the use of pollution-free green new materials.

3.5.2. Structural design of products. Lightweight design includes but is not limited to the following: optimize the structure to reduce product weight; reduce the number of product parts and components and try to modularize and standardize the internal structure of the same type of products, and model parts can be shared to achieve weight reduction; use new materials to reduce product weight.

The design to improve the airtightness of cooking appliances includes but is not limited to the following: optimize the application and research of sealing materials, reduce the types of sealing materials, achieve standardization, and improve sealability; optimize the rational design of the sealing structure, reduce processing procedures, and improve sealability.

The design to improve the heat load and thermal efficiency of cooking appliances includes but is not limited to the following: optimize the design of the burner structure to increase the ejection capacity; optimize the design of the size of burner head to make the fire more concentrated and improve the thermal efficiency; the thermal efficiency and the thermal load deviation indicator meet Class-A requirements for the quality grade characteristic indicator of household gas cooking appliances under GB/T 36503 [3].

The design to improve the combustion conditions of cooking appliances includes but is not limited to the following: optimize the structural design of the burner to make the fire burn more completely; optimize the layout of the burner fire holes to improve the flame combustion state; optimize the nozzle design to ensure stable ejection flow and achieve full burning; optimize the stainless steel combustion system; the carbon monoxide concentration indicator meets the Class-A requirements for the quality grade characteristic indicator of household gas cooking appliances under GB/T 36503.

Packaging and transportation convenience design includes but is not limited to the following: adopt a compact structure to reduce packaging and transportation volume; large products adopt a split structure with a stable center of gravity, which is convenient for packaging, loading and unloading, and transportation.

Recycling convenience design fully considers the difficulty in product scrapping, optimizes the product structure, and makes products easy to install and disassemble, and products are reused after being scrapped.

3.5.3. Manufacturing. Fully consider the difficulty and economy in product manufacturing, as well as factors such as pollutant emissions, resource use, human health and safety in the manufacturing process: analyze and confirm the rationality of design requirements such as the performance, accuracy and surface structure of parts, and reduce processing procedures and capacity; mark and classify toxic and hazardous materials, and give safety protection requirements for the production process; give priority to the use of clean energy; give priority to the use of advanced manufacturing technology and equipment; adopt advanced green manufacturing techniques to reduce energy consumption and pollutant emissions in the production process; reduce energy consumption in manufacturing process; reduce energy consumption and dust pollution; use advanced green materials to reduce the use of toxic and hazardous substances.
Figure 1. Brief design process and key points of green design
3.5.4. Packaging Process. The following should be considered for packaging materials: give priority to non-toxic, harmless, easy-to-decompose or biodegradable packaging materials; give priority to recyclable packaging materials; the same product should use the same packaging materials; packaging waste can be treated in a harmless manner.

The following should be considered for packaging design: on the premise of meeting packaging requirements, it is advisable to reduce the amount of packaging materials used; avoid excessive packaging and reduce the packaging volume; give priority to reusable packaging design; ensure the convenience and safety of lifting, handling and disassembly.

3.5.5. Product Transportation. The following should be considered for product transportation: choose the most economical, reasonable, and green transportation method after comprehensive consideration of transportation distance, cargo weight and volume; optimize the loading and unloading process to enhance the loading and unloading speed.

3.5.6. Use. The following should be considered when products are used: enhance the service life of the products, for example, analyzing the failure mode of parts and components and the service life of products, and adopting corresponding improvement measures; improve combustion efficiency and reduce energy consumption; for products with technological updates and rapid market changes, retain room for product upgrades or transformations, and achieve functional expansion or enhancement through partial replacement.

3.5.7. Recycle and Re-use. The following should be considered when products are recycled: analyze the state of products at the end of their service life and the impact of their recycling on the environment, and propose a treatment plan when the products are discarded; improve the recyclability rate and reuse rate of products; achieve harmless disposal of non-recyclable materials as much as possible to avoid the generation of hazardous waste after the products are scrapped; avoid injury to operators during product recycling and disassembly.

4. Technical Requirements

4.1 Basic Requirements
The pollutant discharge of manufacturers should meet the requirements of national or local pollutant discharge standards, and the total pollutant control should meet the national and local total pollutant discharge control indicators; the relevant national standards for energy conservation and environmental protection should be strictly implemented and a standard list should be provided. There were no major quality, safety or environmental accidents in recent three years.

Manufacturers should establish, implement, maintain and continuously improve the quality and environment management systems respectively in accordance with GB/T 19001[4] and GB/T 24001[5]. Manufacturers should carry out green design of products in accordance with GB/T 24256 and Part 5 hereof. In addition to environmental requirements, the design work should also give due consideration to the durability, reliability, maintainability, reusability, remanufacturing, modularization, and intelligence of products, and easy-to-disassemble (separate) and easy-to-recycle components that have a negative impact on the environment, and a product green design scheme should be formed.

Manufacturers should adopt advanced technologies and techniques encouraged by the State, and may not use eliminated or prohibited technologies, techniques, equipment and related substances issued by the State or relevant departments; requirements should be formulated based on the principle of saving materials during design and production. Manufacturers should carry out green supply chain management, establish green supply chain management performance evaluation mechanisms and procedures, and determine evaluation indicators and methods. Manufacturers should put forward management requirements related to quality, environment, energy, and safety for main raw material suppliers, production partners, and related service providers.
The main energy-consuming equipment of manufacturers should meet the relevant national energy efficiency standards of level 2 or above. The product quality should meet the corresponding product quality standards and the compulsory product certification requirements. The product manual should contain the relevant instructions on the use of hazardous substances, materials that require special treatment, and related recycling after the products are scrapped. Manufacturers should publish technical guidance information on product dismantling through appropriate methods, and the information should be easy for relevant organizations to obtain. Product packaging should meet the relevant requirements of GB/T 191[6], GB/T 1019[7] and GB/T 31268[8].

4.2 Evaluation Indicator Requirements

The evaluation indicators of cooking appliances are selected from the perspectives of resource and energy consumption and the impact on the environment and human health. They usually include resource, energy, environmental, and product attribute indicators. Requirements such as the names, reference value, and judgment basis (pollutant monitoring method, product inspection method, and calculation method of each indicator) of evaluation indicators of cooking appliances are shown in Table 1.

| Indicator name                  | Unit | Indicator direction | Reference value                                                                 | Judgment basis                                                                 |
|--------------------------------|------|---------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Content of harmful substances in products | -    | -                   | Products should meet the requirements of GB/T 26572[9]                        | Provide a content table of hazardous substances in raw materials, perform a test according to GB/T 26125 [10], and provide a test report, or provide an exemption statement |
| Recyclable logo                | -    | -                   | Recyclable labels for products and parts meet the requirements of GB/T 23384[11] | Provide logo usage instructions and related management documents                |
| Packaging and packaging materials | -    | -                   | If the packaging materials are cartons (bags), it is recommended to use recycled paper mixed mode first to meet the relevant requirements of GB/T 31268 [12] | Provide a description of packaging paper materials                              |
| -                              | -    | -                   | Do not use HFCs as blowing agents                                              | Provide evidentiary materials                                                   |
| -                              | -    | -                   | The total amount of heavy metals such as lead, cadmium, mercury and hexavalent chromium in packaging and packaging materials should not exceed 100mg/kg | Provide evidentiary materials                                                   |
| Thermal efficiency            | %    | ≥                   | Level 1 indicator in GB 30720[13]                                               | Perform a test according to GB30720, and provide a test report                  |
| Standby power                 | W    | ≤                   | Level 1 indicator in GB 30720                                                   | Perform a test according to GB30720, and provide a test report                  |
| Power deviation               | %/W  | ≤                   | Negative deviation: -10% or -                                                  | Perform a test according to                                                   |
Positive deviation: 5% or 20W (The larger absolute value shall prevail)

| Electromagnetic field radiation | % ≤ 30 | GB/T16410[14] and GB 4706.1[15], and provide a test report |
|-------------------------------|--------|-------------------------------------------------------------|
| Electromagnetic compatibility  | - - | Products should comply with relevant requirements of GB 4343.1[18] and GB 4343.2[19] |
| Noise pressure level            | dB(A) ≤ The limit in GB/T 23128[20] | Perform a test according to GB 4824[16] and IEC 62233[17], and provide a test report |
| Electrical safety              | - - | Products should comply with relevant requirements of GB 4706.1[21], GB 4706.14[22], GB 4706.22[23] and GB 4706.29[24] |
| Continuous working hours       | h ≥ 1.5 | Provide a mandatory product certification report or a qualified test report meeting requirements of GB4706.1, GB 4706.14, GB 4706.22 and GB 4706.29 |
|                               |         | Perform a test according to GB/T 16410, and provide a test report |

5. Preparation Methods of Product Life Cycle Assessment Report

5.1 Methods
Prepare a life cycle evaluation report of cooking appliances according to the life cycle evaluation methodology framework and general requirements given in GB/T 24040[25], GB/T 24044[26] and GB/T 32161[27].

5.2 Content framework of the report
The report should provide basic information such as report information, applicant information, evaluation target information, and adopted standard information. Specifically, the report information includes report number, preparer, reviewer, and release date, and applicant information includes full company name, organization code, address, contact person, and contact information.

The report should indicate main technical parameters and functions of products, including: physical state, manufacturer, and scope of use. Product weight, packaging size and materials should also be stated in the life cycle evaluation report. The report should provide the compliance with the basic requirements and the evaluation indicator requirements, and provide an explanation of the improvement in all the evaluation indicator reporting periods compared with the base period, or an explanation of the comparison of products with equivalent functions.

The report should describe in detail the evaluation objects, functional units and main functions of the products, provide a table of material composition and main technical parameters of the products, draw and explain the system boundaries of the products, and disclose the software tools used based on the Chinese life cycle database. The report should provide the life cycle stages to be considered, explain the inventory factors considered at each stage and the collected field data or background data, and explain the distribution methods and results when data distribution is involved. The report should provide the characteristic value of different impact types at each stage of the life cycle of the products, and make a comparative analysis of the distribution of different impact types at each life cycle stage. Based on the
analysis of the conformity evaluation results of the indicators and the life cycle evaluation results, a specific plan for improvement in product green design is proposed.

The conclusion of products' conformity with evaluation indicators, the life cycle evaluation results, and the proposed improvement plan should be explained, and whether the products are green design products shall be preliminary judged based on the evaluation conclusion. The report should be provided in the appendix: original packaging drawing of products; list of production materials of products; process sheet of products (schematic diagram of production process of products, etc.); data collection sheet for each unit process; others.

6. Evaluation Methods
Self-evaluation or third-party evaluation may be carried out in accordance with 3.1 basic requirements and 3.2 evaluation indicator requirements, provided that the following conditions should be met, and after publicity on www.green-label.org according to relevant procedures and requirements, if no objection is lodged, the cooking appliances can be called green design products may be labeled according to the requirements of GB/T 32162.

a) Meet the basic requirements (see 3.1) and evaluation indicator requirements (see 3.2);
b) Provide a life cycle evaluation report of cooking appliances according to 4.

When a self-declaration is made on relevant information in various forms for the products labeled in accordance with the requirements of GB/T 32162, the content of the declaration should include but be not limited to the requirements of 3.1 and 3.2, but certain verification materials proving compliance with relevant requirements must be provided.

7. Conclusion
The ecological design and evaluation of cooking appliances are the important driving force to promote cooking appliance enterprises to reduce resources, energy consumption, pollutants, and greenhouse gas emissions from the source, and to upgrade the development from process technology to energy conservation, low carbon, and green technology, thereby promoting industrial transformation and upgrading. This paper has analyzed the general principles of green design of cooking appliances, the green design process and main points, evaluation requirements, preparation methods of life cycle evaluation reports and evaluation methods. People should directly face the ecological damage caused by the development and application of modern science and technology, and users may make more wise and ecological decisions through ecological products.

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[4] GB/T 19001 Quality Management Systems – Requirements.
[5] GB/T 24001 Environmental Management Systems - Requirements with Guidance for Use (GB/T 24001-2016, ISO 14001: 2015, IDT).
[6] GB/T 191 Packaging - Pictorial Marking for Handling of Goods.
[7] GB/T 1019 General Requirements for the Package of Household and Similar Electrical Appliances.
[8] GB/T 31268 Restricting Excessive Packaging for Commodity.
[9] GB/T 26572 Requirements for Concentration Limits for Certain Restricted Substances in
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[10] GB/T 26125 Electrical and Electronic Products - Determination of Six Regulated Substances (IEC 62321:2008, IDT).
[11] GB/T 23384 The Recovery Marking of Products and Components.
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[13] GB 30720 Minimum Allowable Values of Energy Efficiency and Energy Efficiency Grades for Domestic Gas Cooking Appliances.
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