The Committee for Conformity Assessment of Accreditation and Certification on Functional and Technical Textiles

Specified Requirements of Energy-saving Clothing

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Specified Requirements Enactment and Implementation Team	Convener: Mr. XING, WEN-HAO	Commissioner: Mr. LIN, NENG-JONG

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Document Revision History

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1.0	New release		09/25/ 2015

1. Scope

This Standard applies to formal shirts and garments worn in the office during summertime, and the test methods and quality requirements to assess whether such clothing has the properties of feeling cool and comfortable so as to achieve the purpose of saving air-conditioning energy.

Remarks: According to the analysis results of Thermal Comfort in the Air Conditioned Environment Study executed by ITRI, commissioned by Bureau of Energy, M.O.E.A., when air-conditioner's setting temperature rises 1℃, it will save 6% of power consumption, saving 0.4 kWh a day while using air-conditioner, which brought forth the optimal air-conditioning setting is 26~28℃, with relative humidity (RH)of about 50 ~ 70% (Source: Energy Forum in July 2007). According to the analysis results regarding energy consumption of office buildings from Taiwan Green Productivity Foundation, of the annual electricity consumption of major energy-consuming appliances, air-conditioning accounted for over 40%. Without wearing suits and ties, wearing light energy-saving clothing not only saves the energy of air-conditioning but brings comfort. This Standard was formulated for the indoor environment with A/C settings at 28℃ and 60% RH in summer.

2. Terminology

2.1 Total thermal insulation of the clothing ensemble with the manikin stationary, I_{cl}: It is the total thermal insulation from skin to ambient atmosphere, including clothing and boundary air layer. In accordance with ISO 15831, the measurement of thermal insulation is performed by means of a thermal manikin under a defined setting and designated in 1Clo=0.155m^2. K/W.

2.2 Predicted mean vote, PMV: It is a seven-point thermal sensation scale, developed by the thermal sensation results involving many people and through heat balance principles.

2.3 Predicted percentage dissatisfied, PPD: Statistical methodologies such as field research are used to express PMV with percentage to show the occupants' dissatisfaction with the given thermal condition.

3. Performance specification

3.1 Clothing's PPD: Below 20%, to meet the energy-saving requirement

3. Test methods

4.1 I_{cl} test: In accordance with the standards of ISO 15831 Clothing - Physiological effects - Measurement of thermal insulation by means of a thermal manikin

4.1.1 Test settings:

(1) Surface temperature of the manikin is set at (34.$\pm$ 0.2)℃

(2) The difference between the air temperature within the climatic chamber (T_a) and the skin surface temperature of the manikin shall be over 12℃, with a minimum heat flux of 20 W/m^2 at each segment of the manikin.

(3) The relative humidity in the climatic chamber is set between 30 % and 70 %, preferably 50 %.

(4) The air speed (V_a) in the climatic chamber is set to (0.4 ± 0.1) m/s.

(5) To reach steady-state conditions: The skin surface temperature of the manikin remains constant within ± 0.2 ℃, or ± 2 % during a time period of 10 min

4.1.2 Test procedure: Dress the manikin with the garments tested, record the manikin's skin surface temperature in steady-state conditions and the heat flux value entered by the heater, and integrate the temperature, the relative humidity, and I_{cl} of the garments tested in the climatic chamber.

4.2. Assess garments' PPD under a certain environment: In accordance with the standards of ISO 7730, Ergonomics of the thermal environment- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

4.2.1 Test procedure: PMV is derived from ISO 7730 Equations by setting in I_{cl} with other six environment-physical parameters, that is, the summer indoor air-conditioned environment and office activity level set by the Standard.

4.2.2 Parameters of ISO 7730 Equations:

(1) Clothing insulation ($I_{cl)}$: Based on the result of 4.1

(2) Metabolic rate: 1.2 MET (sedentary activities in the office and the lab, 1 MET= 58.15 W^2/m)

(3) External work: 0

(4) Air temperature(T_a): 28℃

(5) Relative air velocity (V_a): 0.25 m/s

(6) RH: 60%

4.2.3 Convert the PMV values on a 7-point thermal sensation scale through Equation to calculate PPD

5. Report

Test results and test reports shall be recorded in accordance with each Standard applied and note down the washing conditions and times of water-washing

6. Reference standards

CNS 15140 Textiles - Domestic washing and drying procedures for textile testing(紡織品試驗之家庭洗滌及乾燥程序)

ISO 15831: 204 Clothing -- Physiological effects -- Measurement of thermal insulation by means of a thermal manikin

ISO7730: 2006 Ergonomics of the thermal environment- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

7. Supplementary:

The Standard has been reviewed by the Convener of the Specified Requirements Enactment and Implementation Team and submitted to the Commissioner of the Committee for approval before the release, and so has the revision.

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Appendix A. ISO 7730 references

A.1 The seven-point thermal sensation scale of predicted mean vote, PMV

Table A-1 7-point thermal sensation scale

+3	hot
+2	warm
+1	slightly warm
0	neutral
-1	slightly cool
-2	cold
-3	freezing

A.2 Intervals of application

Table A-2 ISO 7730 Intervals of application

Parameters	Intervals
Metabolic rate (M)	46 W/M^2 to 232 W/M^2 (0-4 MET)
Clothing insulation (I_{cl})	0 $m^2K.W$ to 0.31 $m^2K.W$ (0-2 clo)
Air temperature(T_a)	10℃ to 30℃
Mean radiant temperature (T_r)	10℃ to 40℃
Relative air velocity (V_a)	0 m/s to 1 m/s
Water vapor partial pressure (P_a)	0 Pa to 2700 Pa

A.3 Metabolic rates for various activities

The Metabolic rates used in the Standard are related to sedentary light activities in the office and the lab: 1.2 MET (70 $W/M^{2)}$

Table A-3 Metabolic rates for various activities

Activity	Metabolic rates W/M^2	met
Reclining	46	0.8
Seated relaxed	58	1.0
Sedentary activity (office, dwelling, school, laboratory)	70	1.2
Standing, light activity (shopping, laboratory, light industry)	93	1.6
Standing, medium activity (shop assistant, domestic work, medicine work)	116	2.0
Walking on level ground: 2 km/h 3 km/h 4 km/h 5 km/h	 110 140 165 200	 1.9 2.4 2.6 3.4

A. 4 The Equation to calculate the PPD from the PMV values

With the PMV determined, calculate the PPD using Equation:

$$PPD= 100 -95 \exp (-0.03353\ PMV^4 – 0.2179\ PMV^2)$$

Distribution of PMV and PPD is shown as follows:

Table A-4 Distribution of PMV and PPD

Thermal sensation	hot	warm	slightly warm	neutral	slightly cool	cold	freezing
PMV	3	2	1	0	-1	-2	-3
PPD	99.1	76.8	26.1	5	26.1	76.8	99.1

The Standard used several formal shirts and garments worn in the office during summertime for the experiment. The calculated PMV and PPD values are shown in the Table B-1.

Table B-1 Summer shirts Trials

No.	**Clothing insulation** (clo)	**PMV**	**PPD (%)**
1	0.468	0.817	19.09
2	0.461	0.806	18.70
3	0.469	0.817	19.09
4	0.460	0.805	18.65
5	0.496	0.860	**20.64**
6	0.471	0.822	19.25
7	0.569	0.971	**24.90**
8	0.561	0.960	**24.46**
9	0.513	0.888	**21.60**
10	0.494	0.858	**20.54**
11	0.473	0.825	19.36
12	0.454	0.795	18.31
13	0.456	0.799	18.44
14	0.504	0.874	**21.10**