NANO*Verify* Functionality Properties Testing of Products Containing Nanomaterials

(Requirements)

(NVSB/PRO/02)

NANOVERIFY SDN. BHD.

NanoVerify Sdn Bhd (NVSB) is a wholly owned company under NanoMalaysia Berhad (NMB), an agency under the Ministry of Science, Technology and Innovation (MOSTI) mandated to monitor and facilitate nanotechnology development and commercialisation in Malaysia. NVSB has been designated by NMB to fully operate a nano certification programme owned by NMB known as NANO*Verify* Programme.

NANO*Verify* Programme is a voluntary certification programme for process and product with claims of nano-object in the range of 1 nm to 100 nm. ("nm" referring to nanometer), and performance enhancements related to the presence of such nano-elements. "NANO*Verified*" certification will be awarded to the processes and products upon successful completion of the NANO*Verify* Programme as determined by the relevant parties.

There are two scopes of certification under this programme which are characterization (size) and functionality (surface, mechanical and/or electrical). For both scopes, the characterization for size shall be done prior to determine the presence of nanomaterials. Functionality scope goes on to compare the performance of nanotechnology-based products against a control product without nano materials.

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Foreword

This document was developed with participation of technically competent representative of the professional groups on Nanomaterials established by NanoVerify Sdn. Bhd.

This document was developed with the following objectives:

a) to provide the quality requirements and test methods for products containing nanomaterials;

b) to provide assurance on the functionality of the products containing nanomaterials to ensure consumer protection and health; and

c) to support the implementation of certification programme for nanomaterials.

This document will be subjected to review to reflect current needs and conditions. Users and other interested parties may submit comments on the contents of this document for consideration into future versions.

Compliance with this document does not by itself grant immunity from legal obligations.

Functional properties testing of products containing nanomaterials- Requirements

0. Introduction

Due to the active R&D activities and emerging technology in nanomaterials and nano-enabled and nano-enhanced products, it is necessary for the relevant authorities to ensure that nanomaterials and nanoproducts distributed in the market comply with certain characteristics, functionality, safety and health requirements. A certification programme is formulated to ensure that manufacturers or producers of nanomaterials and nanoproducts abide to the necessary requirements to ensure product quality and consumer protection.

In Malaysia, NANO*Verify* Programme is a voluntary certification programme for product with claims of nano-enabled or nano-enhanced properties in the range of 1 nm to 100 nm. NANO*Verify* certification is awarded to the products upon successful completion of the NANO*Verify* Programme, as determined by the relevant parties.

In support of the NANO*Verify* Programme, this document was formulated to prescribe requirements for the industry to measure and verify the functional properties improvement of a product containing nanomaterials either/or process formulation to become nano based products. The requirements of this standard should be applied in tandem with other parameter limits or requirements for relevant products as stated in other relevant international standards, national standards and/or other related guidelines.

1. Scope

This document prescribes the requirements to measure and verify the functionality properties improvement of a product caused by nanomaterials. The functionality properties cover mechanical, surface and electrical aspect. This document is applicable for nanomaterials used in a product that are between the size of 1 nm to 100 nm for any one dimension.

2. Normative references

Refer to Annex A.

3. Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 80004 series and the following apply.

3.1 Nanomaterial

Material with any external dimension in the nanoscale or having an internal structure or surface structure in the nanoscale of 1 nm to 100 nm.

EXAMPLE Nanosilica, nano titanium dioxide, nanogold, nanosilver, nanoclay, carbon nanotube, nano calcium carbonate, nano cellulose, nano zeolite and graphene.

3.2 Mechanical properties

Those properties of material that associated with elastic and inelastic reaction when force is applied or that involve the relationship between stress and strain.

3.3 Surface properties

Those properties of a material which are defined by the physico-chemical and morphological structure of its surface.

3.4 Electrical properties

Properties of substance which determine its response to an electric field, such as its dielectric constant or conductivity. The electrical properties of a material define its behaviour when an electric field is applied. The two principals of electrical properties are the dielectric constant, which is a measure of the electrical polarisation that takes place when an electric field is applied and the conductivity, which is a measure of the conduction current developed by an electric field.

4. General requirements

4.1 The health and safety aspects of the products shall comply with the relevant regulatory and/or statutory requirements.

4.2 Fulfilment to the requirements of this document shall not compromise the product specification as prescribed in the existing product documents.

4.3 Health and safety practices during processing, production and handling of nanomaterials shall follow best practices of the relevant international or national standards such as ISO/TR 12885, ISO/TS 12901-1 and ISO/TS 12901-2.

4.4 The nanomaterials properties shall meet the requirements prescribed in relevant international or national standards or general industrial requirement.

5. Products containing nanomaterials

5.1 Products containing nanomaterials for functionality properties improvement include:

5.1.1 Mechanical Properties

(a) rubber (dry rubber and dipped rubber product);
(b) thermoplastic (examples of semicrystalline and amorphous thermoplastics as provided in Table 1);
(c) thermosetting plastic (examples vulcanized rubber, epoxy resins, polyimides etc);
(d) composite material (combination of two or more materials such as concrete, fibre, thermoset material, thermoplastic rubber, etc).

Table 1. Examples of thermoplastics

	Semicrystalline	**Amorphous**
Commodity plastics	Polythylene (PE-LD, PE-HD)	Polystyrene (PS)
	Polypropylene (PP)	Polyvinyl chloride (PVC)
		Styrene acrylonitrile (SAN)
Engineering plastics	Thermoplastics polyester (PBT, PET)	Polycarbonate (PC)
	Acetals (POM)	Acrylics (e.g PAN, PMMA)
		Acrylonitrile butadience styrene (ABS)
		Polyphenylene oxide PPO)
		Polyphenylene sulfide (PPS)
		Polyetherimide (PEI)
		Polysulfones (PSU)
Specialty polymers	Nylon	
	Polytetraflouroethylene (PTFE or Teflon)	
	Polyvinyl alcohols	

5.1.2 Surface Properties

(a) paint;
(b) textile;
(c) rubber products;
(d) coating;
(e) plastics;
(f) geotextile;
(g) metal and metal composites;
(h) ceramic;
(i) concrete;
(j) adhesive;
(k) lubricant (automotive sector in engine).

5.1.3 Electrical Properties

(a) antenna;
(b) battery;
(c) conductive ink;
(d) light-emitting diode (LED);
(e) display (electroluminescent display (ELD), LED display);
(f) energy harvester (solar photovoltaic (PV));
(g) fuel cell;
(h) radio-frequency identification (RFID);
(i) supercapacitor;
(j) sensor platform (tranducers, actuators).

5.2 The functionality properties performance of each product containing nanomaterials shall have improvement in properties than an equivalent product (used as a control product without nanomaterials) accepted by the companies, industries or professional bodies.

5.3 If the standard improvement value is not available, the producer shall provide the control material for testing or provide data on any improvement made as compared to the control material as evidence of compliance.

6. Test methods

6.1 Depending on relevant products, the test methods for each functionality properties shall apply as illustrate in Table 2, 3 and 4.

Table 2. Test methods for Mechanical Properties

Material	Test	Test method
Dry rubber	Hardness	MS ISO 48
	Fatigue	ISO 132
	Heat Build Up (HBU)	ISO 4666-3
	Brittleness and cold crack temperature	ISO 812 ASTM D746 ASTM D2137
	Tear strength	ISO 34-1
	Stress strain properties	MS ISO 37 MS 1155 ISO 7743 ISO 1827

	Adhesion/Peel strength	ISO 813
	Dynamic mechanical analysis	ISO 4664-1
Dipped rubber	Tear strength	ISO 34-1
	Tensile properties (Force and elongation at break)	ISO 11193-1 ISO 11193-2 ISO 10282 ISO 4074
Composite	Punch and interlaminar shear	ASTM D2344 (for parallel fiber reinforced plastics and composites)
Thermoplastic and/or thermosetting plastics composite	Hardness	ASTM D2240 ISO 868
	Thermal conductivity	ISO 22007-2 ISO 22007-4
	Brittleness and cold crack temperature	ASTM D746 ISO 974
	Tear strength	ASTM D1922 (Elmendorf tear) ASTM D1938 (Trouser tear) ASTM D624
	Stress strain properties	ASTM D638 ISO 527-1 ISO 527-2 ISO 527-4
	Drop test	BS EN 60068-2-31
	Impact test (Izod and Charpy)	Izod: ASTM D256 ISO 180 Charpy: ASTM D6110 ISO 179-1
	Adhesion/Peel strength	ASTM D6392 ASTM D4884

	Dynamic mechanical analysis	ASTM D4065 ASTM D4440 ASTM D5279
	Flexural test	ASTM D790 ISO 178
	Deflection temperature under load	ASTM D648 ISO 75-1 ISO 75-2 ISO 75-3
Concrete	Compressive strength	MS EN 12390-3
	Tensile splitting strength	MS EN 12390-6
	Flexural strength	MS EN 12390-5

Table 3. Test methods for Surface Properties

Properties	Products	Test method
Anti-bacterial	Paint/Coating	ASTM D2574 ASTM D5588 ASTM E2180
	Textile	AATCC 100 AATCC 147 CNS 14945 ISO 20645 ISO 20743 JIS L 1902
	Rubber products	ASTM D7907 ASTM E2180 ISO 4074
	Plastics	ASTM E2180 ISO 22196 JIS Z 2801
	Metal	JIS Z 2801
	Ceramic	ISO 27447 JIS Z 2801
	Concrete	NA

	Adhesive	ASTM D4783
	Lubricant (automotive sector in engine)	NA
Anti-fungal	Paint/Coating	ASTM D3273 ASTM D5590 ASTM D7855/D7855M MS 133:Part G6 MS 134:2007, Annex A
	Textile	ISO 13629-1 ISO 13629-2
	Lubricant (automotive sector)	NA
	Rubber products	ASTM E2180 ASTM STP1533 ASTM WK56940
	Plastics	ASTM G21
	Metal	ASTM F748 ISO 10993-5
	Ceramic	ISO 13125
	Concrete	NA
	Adhesive	ASTM D4300
Anti-rust/Anti-corrosion	Metals and metal composites	Exposure method: ASTM B117 ASTM B368 ASTM D5894 ASTM G85 ISO 11997-1 ISO 11997-2 ISO 12944-6 ISO 20340 ISO 9227
		Evaluation method: ASTM D1654 ASTM D2803 ASTM D4214 ASTM D610 ASTM D714 ISO 4628-2 ISO 4628-3

		ISO 4628-4 ISO 4628-5 ISO 4628-6 ISO 4628-7 ISO 4628-8
	Textile	NA
	Rubber products	NA
	Plastics	NA
	Ceramic	NA
Anti-rust/Anti-corrosion	Concrete	NA
	Adhesive	NA
	Lubricant (automotive sector in engine)	ASTM B117 ASTM D1743 ASTM D6557 ASTM D6594 ASTM D665 ASTM D942 ASTM D4310
Heat/Thermal resistance	Paint/Coating	ASTM D2485 ISO 3248
	Textile	ISO 5085-1
	Rubber products	Ageing (Specification for condom) ASTM D3492 BS EN ISO 4074 ISO 4074
		Ageing (Specification for gloves) AS/NZS 4011.1 AS/NZS 4011.2 AS/NZS 4179 ASTM D3577 ASTM D3578 ASTM D4679 ASTM D5250 ASTM D6319 BS EN 455-2 ISO 10282 ISO 11193-1 MS 1155 MS 1291

		SMG Type I SMG Type II
		Fatigue - Resistance to flex-cracking and crack growth ASTM D430 BS ISO 132 ISO 132
		Fatigue - Heat build-up ASTM D623 BS ISO 4666-3 ISO 4666-3 MS ISO 4666-3
	Plastics	ASTM D3045
	Metal	Fire resistance BS EN 1634-1 MS 1073:Part 3
	Ceramic	MS ISO 13006
	Concrete	NA
	Adhesive	ASTM D4502 BS 5131-1.1
	Lubricant (automotive sector in engine)	ASTM D2070 ASTM D6203-17 ASTM D5763-11 ASTM D189 ASTM D6375
	Ceramic	MS ISO 13006
Water and chemical resistance	Adhesive	ASTM D5570/D5570M
	Lubricant	DIN 51 807, part 1 ASTM D1401
Anti-scratch and/or abrasion	Paint/Coating	ASTM D3363 ASTM D4060 ASTM D7187 ASTM D968 ISO 1518-1 ISO 1518-2 MS 133:Part E2 MS 164:2007, Annex C

	Textile	ISO 5470-1 ISO 5470-2
	Rubber products	ISO 5470-1 ISO 5470-2 ISO 4649
	Plastics	ASTM D1044 ISO 5470-1 ASTM D1044 (Haze) ASTM D4060 (Weight loss)
	Metal	ASTM G65
	Ceramic	ISO 20502
	Concrete	NA
	Adhesive	NA
	Lubricant	ASTM C1624 ISO 20502
Weathering	Paint/Coating	ASTM D5894 ASTM G154 ASTM G155 ISO 15110 ISO 16474-1 ISO 2810 ISO 4892-2 ISO 4892-3 MS 133: Part F6 MS 133: Part F8
	Textile	AATCC 16.3 ASTM G155 BS EN IS0 105-B02 BS EN ISO 105-B04 BS EN ISO 105-B06 ISO 105-B03
	Rubber products	Ozone resistance AS 1683.24 AS 1683.25 ASTM D1149 ASTM D1171 BS ISO 1431-1 DIN ISO 1431-1 ISO 1431-1 JIS K 6259-1 JIS K 6259-2

		MS ISO 1431-1
	Plastics	ASTM D1435 ASTM G154 ASTM G155 ISO 4892-2 ISO 4892-3
	Ceramic	NA
	Concrete	NA
	Adhesive	ASTM D1828
	Lubricant	NA
Fire retardant	Paint	ASTM D3806
	Textile	ASTM D1230 ISO 10047 ISO 17881-1 ISO 17881-2 ISO 6940 ISO 6941
	Rubber products	ISO 3582
	Coating	ASTM E1317
	Plastics	ASTM D635
	Ceramic	NA
	Concrete	NA
	Adhesive	NA
	Lubricant	NA
Scrub resistance	Paint/Coating	ASTM D2486 ASTM D4213 CNS 6928 ISO 11998
	Textile	AATCC 165 AATCC 8 BS EN ISO 105-D02 ISO 105-D02
	Rubber products	ISO 5473
	Plastics	ASTM D4060

	Metal	NA
	Ceramic	NA
	Concrete	NA
	Adhesive	NA
	Lubricant	ASTM D4172
Area/Wider coverage	Paint	MS 125 MS 132 MS 134 MS 903
	Textile	NA
	Rubber products	NA
	Coating	NA
	Plastics	NA
	Metal	NA
	Ceramic	NA
	Concrete	NA
	Adhesive	NA
	Lubricant	NA
Insect repellent	Paint/Coating	NA
	Textile	ISO 3998
	Rubber products	NA
	Plastics	NA
	Metal	NA
	Ceramic	NA
	Concrete	NA
	Adhesive	NA

	Lubricant	NA
NA = Not applicable		

Table 4. Test methods for Electrical Properties

Products	Properties	Test method
Antenna	Radiation patterns	IEEE 149-1979
Battery	Primary battery	MS IEC 60086-1 MS IEC 60086-2 MS IEC 60086-3
	Secondary battery	MS IEC 62133
Conductive ink	Physical properties Electrical properties Optical properties Materials	IEC 62899-202
Light-emitting diode (LED)	Minimum energy performance standards (MEPS)	MS 2598
	Moisture resistance and insulation Electric strength Thermal endurance test for windings of ballasts	MS IEC 61347-1
Display [electroluminescent display (ELD), LED display]	Total flux light measurement	CIE 127
Energy harvester [solar photovoltaic (PV)]	Calibration traceability	MS IEC 60904-4
	Measurement principles for terrestrial PV solar devices with reference spectral irradiance data	MS 60904-3
	Current-voltage characteristics measurement	MS IEC 60904-1
	Characteristic parameters of stand-alone PV systems	MS IEC 61194
	Electrical and thermal characteristics of crystalline silicon terrestrial PV modules	MS IEC 61215
Fuel cell	Fuel cell modules	IEC 62282-2

	Stationary fuel cell power systems	IEC 62282-3-100 IEC 62282-3-200
	Fuel cell power systems	IEC 62282-4-101 IEC 62282-4-102
	Portable fuel cell power systems	IEC 62282-5-100
	Micro fuel cell power systems	IEC 62282-6-100 IEC PAS 62282-6-150 IEC 62282-6-200 IEC 62282-6-300
	Single cell performance for polymer electrolyte fuel cells (PEFC)	IEC TS 62282-7-1
	Single cell and stack performance for solid oxide fuel cells (SOFC)	IEC TS 62282-7-2
Radio-frequency identification (RFID)	System performance	ISO/IEC 18046-1
	Interrogator performance	ISO/IEC 18046-2
	Tag performance	ISO/IEC 18046-3
	Performance of RFID gates in libraries	ISO/IEC 18046-4
	Air interface communications	ISO/IEC 18047-2 ISO/IEC TR 18047-3 ISO/IEC TR 18047-4 ISO/IEC 18047-6
Supercapacitor	Capacitance Internal resistance Leakage current Maintain voltage Endurance Characteristics at high and low temperature	IEC 62391-1
Sensor platform (transducers, actuators)	Electrical resistance Capacitance Impedance	IEC 62908-13-10

6.2 Upon agreement between the producer and the certification body, test methods other than those specified in Table 1, Table 2 and Table 3 may be used, provided that the test methods could be verified against accepted standard test methods. This shall be

accompanied with supporting documents provided by the independent testing laboratory together with all testing results previously conducted by the producer.

7. Test report

7.1 The results of each test or series of tests carried out by the laboratory shall be reported accurately, clearly, unambiguously and objectively, and in accordance with any specific instructions in the test methods.

7.2 Each test report shall include at least the following information, unless the laboratory has valid reasons for not doing so:

a) a title (e.g. “Test Report”);

b) the name and address of the laboratory, and the location where the tests were carried out, if different from the address of the laboratory;

c) unique identification of the test report (such as serial number), and on each page an identification in order to ensure that the page is recognised as a part of the test report, and a clear identification of the end of the test report;

d) the name and address of the customer;

e) identification of the method used;

f) a description of, the condition of, and unambiguous identification of the item(s) tested;

g) the category of nanomaterials used;

h) the date of sampling and the receipt of the test item(s) where this is critical to the validity and application of the results, and the date(s) of performance of the test;

i) reference to the sampling plan and procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results;

j) the test results with, where appropriate, the units of measurement;

k) the name(s), function(s) and signature(s) or equivalent identification of person(s) authorising the test report;

l) where relevant, a statement to the effect that the results relate only to the items tested;

m) where applicable, deviations from, additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions;

n) where relevant, a statement of compliance or non-compliance with requirements and/or specifications;

o) where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit;

p) where appropriate and needed, opinions and interpretations;

q) where necessary, the location of sampling, including any diagrams, sketches or photographs;

r) details of any environmental conditions during sampling that may affect the interpretation of the test results;

s) any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned; and

t) additional information which may be required by specific methods, customers or groups of customers. (For example, statement of traceability/reference).

8. Certification mark

Each product may, by arrangement with the relevant certification body, be marked with its certification mark, provided the product conforms to the requirements of this document.

Certification mark may be affixed to the product, packaging or report, where appropriate.

The flow chart of the certification process is given in Annex B.

Annex A
(normative)

Normative references

The following normative references are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the normative reference (including any amendments) applies.

AATCC 100	*Antibacterial finishes on textile materials:*
AATCC 147	*Antibacterial activity of fabrics, assessment of textile materials: Parallel streak method*
AATCC 16.3	*Colorfastness to light: Xenon-arc*
AATCC 165	*Colorfastness to crocking: Textile floor coverings - Crockmeter method*
AATCC 8	*Colorfastness to crocking: Crockmeter method*
AS 1683.24	*Methods of test for rubber - Determination of the resistance of vulcanized or thermoplastic rubbers to ozone cracking - Static strain test*
AS 1683.25	*Methods of test for rubber - Determination of the resistance of vulcanized or thermoplastic rubbers to ozone cracking - Dynamic strain test*
AS/NZS 4011.1	*Single-use medical examination gloves - Specification for gloves made from rubber latex or rubber solution*
AS/NZS 4011.2	*Single-use medical examination gloves - Specification for gloves made from poly(vinyl chloride)*
AS/NZS 4179	*Single-use sterile rubber surgical gloves - Specification*
ASTM B117	*Standard practice for operating salt spray (fog) apparatus*
ASTM B368	*Standard test method for copper-accelerated acetic acid-salt spray (fog) testing (CASS Test)*
ASTM C650	*Standard test method for resistance of ceramic tile to chemical substances*
ASTM C1624	Standard Test Method for Adhesion Strength and Mechanical Failure Modes of Ceramic Coatings by Quantitative Single Point Scratch Testing

ASTM D638	*Standard test method for tensile properties of plastics*
ASTM D648	*Standard test method for deflection temperature of plastics under flexural load in the edgewise position*
ASTM D746	*Standard test method for brittleness temperature of plastics and elastomers by impact*
ASTM D790	*Standard test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials*
ASTM D1044	*Standard test method for resistance of transparent plastics to surface abrasion*
ASTM D1922	*Standard test method for propagation tear resistance of plastic film and thin sheeting by Pendulum method*
ASTM D1938	*Standard test method for tear-propagation resistance (Trouser tear) of plastic film and thin sheeting by a single-tear method*
ASTM D2137	*Standard test methods for rubber property - Brittleness point of flexible polymers and coated fabrics*
ASTM D2240	*Standard test method for rubber property - Durometer hardness*
ASTM D2344	*Standard test method for short-beam strength of polymer matrix composite materials and their laminates*
ASTM D4060	*Standard test method for abrasion resistance of organic coatings by the Taber abraser*
ASTM D4065	*Standard practice for plastics: Dynamic mechanical properties: Determination and report of procedures*
ASTM D4440	*Standard test method for plastics: Dynamic mechanical properties: Melt rheology*
ASTM D4884/D4884M	*Standard test method for strength of sewn or bonded seams of geotextiles*
ASTM D5279	*Standard test method for plastics: Dynamic mechanical properties: In torsion*
ASTM D6110	*Standard test method for determining the Charpy impact resistance of notched specimens of plastics*
ASTM D6392	*Standard test method for determining the integrity of nonreinforced geomembrane seams produced using thermo-fusion methods*
ASTM D5963	*Standard Test Method for Rubber Property—Abrasion Resistance (Rotary Drum*

	Abrader)
ASTM D1149	*Standard test methods for rubber deterioration - Cracking in an ozone controlled environment*
ASTM D1171	*Standard test method for rubber deterioration - Surface ozone cracking outdoors (Triangular specimens)*
ASTM D1230	*Standard test method for flammability of apparel textiles*
ASTM D1435	*Standard practice for outdoor weathering of plastics*
ASTM D1653	*Standard test methods for water vapor transmission of organic coating films*
ASTM D1654	*Standard test method for evaluation of painted or coated specimens subjected to corrosive environments*
ASTM D1735	*Standard practice for testing water resistance of coatings using water fog apparatus*
ASTM D1828	*Standard practice for atmospheric exposure of adhesive-bonded joints and structures*
ASTM D2247	*Standard practice for testing water resistance of coatings in 100 % relative humidity*
ASTM D2485	*Standard test methods for evaluating coatings for high temperature service*
ASTM D2486	*Standard test methods for scrub resistance of wall paints*
ASTM D2574	*Standard test method for resistance of emulsion paints in the container to attack by microorganisms*
ASTM D2803	*Standard guide for testing filiform corrosion resistance of organic coatings on metal*
ASTM D3045	*Standard practice for heat aging of plastics without load*
ASTM D3273	*Standard test method for resistance to growth of mold on the surface of interior coatings in an environmental chamber*
ASTM D3363	*Standard test method for film hardness by pencil test*
ASTM D3492	*Standard specification for rubber contraceptives (Male condoms)*
ASTM D3577	*Standard specification for rubber surgical gloves*
ASTM D3578	*Standard specification for rubber examination gloves*
ASTM D3806	*Standard test method of small-scale evaluation of fire-retardant paints (2-foot*

	tunnel method)
ASTM D4213	*Standard test method for scrub resistance of paints by abrasion weight loss*
ASTM D4214	*Standard test methods for evaluating the degree of chalking of exterior paint films*
ASTM D430	*Standard test methods for rubber deterioration - Dynamic fatigue*
ASTM D4300	*Standard test methods for ability of adhesive films to support or resist the growth of fungi*
ASTM D4502	*Standard test method for heat and moisture resistance of wood-adhesive joints*
ASTM D4679	*Standard specification for rubber general purpose, household or beautician gloves*
ASTM D4783	*Standard test methods for resistance of adhesive preparations in container to attack by bacteria, yeast, and fungi*
ASTM D5250	*Standard specification for poly(vinyl chloride) gloves for medical application*
ASTM D5570/D5570M	*Standard test method for water resistance of tape and adhesives used as box closure*
ASTM D5588	*Standard test method for determination of the microbial condition of paint, paint raw materials, and plant areas*
ASTM D5590	*Standard test method for determining the resistance of paint films and related coatings to fungal defacement by accelerated four-week agar plate assay*
ASTM D570	*Standard test method for water absorption of plastics*
ASTM D5894	*Standard practice for cyclic salt fog/UV exposure of painted metal, (Alternating exposures in a fog/dry cabinet and a UV/condensation cabinet)*
ASTM D610	*Standard practice for evaluating degree of rusting on painted steel surfaces*
ASTM D623	*Standard test methods for rubber property - Heat generation and flexing fatigue in compression*
ASTM D6319	*Standard specification for nitrile examination gloves for medical application*
ASTM 635	*Standard test method for rate of burning and/or extent and time of burning of plastics in a horizontal position*
ASTM D6943	*Standard practice for immersion testing of industrial protective coatings and linings*
ASTM D714	*Standard test method for evaluating degree of blistering of paints*

ASTM D7187	*Standard test method for measuring mechanistic aspects of scratch/mar behavior of paint coatings by nanoscratching*
ASTM D7198	*Standard specification for disposable embalming gloves for single-use applications*
ASTM D7334	*Standard practice for surface wettability of coatings, substrates and pigments by advancing contact angle measurement*
ASTM D7855/D7855M	*Standard test method for determination of mold growth on coated building products designed for interior applications using an environmental chamber and indirect inoculation*
ASTM D7907	*Standard test methods for determination bactericidal efficacy on the surface of medical examination gloves*
ASTM D870	*Standard practice for testing water resistance of coatings using water immersion*
ASTM D968	*Standard test methods for abrasion resistance of organic coatings by falling abrasive*
ASTM D6557	Standard Test Method for Evaluation of Rust Preventive Characteristics of Automotive Engine Oils
ASTM D6594	*Standard Test Method for Evaluation of Corrosiveness of Diesel Engine Oil at 135 °C*
ASTM D665	*Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water*
ASTM D942	*Oxidation Stability of Lubricating Greases by the Oxygen Pressure Vessel Method Significance and Use*
ASTM D4310	*Standard Test Method for Determination of Sludging and Corrosion Tendencies of Inhibited Mineral Oils*
ASTM D189	*Standard Test Method for Conradson Carbon Residue of Petroleum Products*
ASTM D6375	*NOACK Volatility by TGA (thermogravimetric analysis)*
ASTM D4172	*Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)*
ASTM D5185	*Standard Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)*
ASTM D482	*Standard Test Method for Ash from Petroleum Products*

ASTM D874	*Standard Test Method for Sulfated Ash from Lubricating Oils and Additives*
ASTM D2896	*Standard Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration*
ASTM D1500	*Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)*
ASTM D4172	*Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)*
ASTM D1401	*Standard Test Method for Water Separability of Petroleum Oils and Synthetic Fluids*
ASTM D2070	*Standard Test Method for Thermal Stability of Hydraulic Oils*
ASTM D6203-17	*Standard Test Method for Thermal Stability of Way Lubricants*
ASTM D5763-11	*Standard Test Method for Oxidation and Thermal Stability Characteristics of Gear Oils Using Universal Glassware*
ASTM E1317	*Standard test method for flammability of marine surface finishes*
ASTM E2180	*Standard test method for determining the activity of incorporated antimicrobial agent(s) in polymeric or hydrophobic materials*
ASTM F748	*Standard practice for selecting generic biological test methods for materials & devices*
ASTM G154	*Standard practice for operating fluorescent ultraviolet (UV) lamp apparatus for exposure of nonmetallic materials*
ASTM G155	*Standard practice for operating xenon arc light apparatus for exposure of non-metallic materials*
ASTM G21	*Standard practice for determining resistance of synthetic polymeric materials to fungi*
ASTM G65	*Standard test method for measuring abrasion using the dry sand/rubber wheel apparatus*
ASTM G85	*Standard practice for modified salt spray (fog) testing*
ASTM STP1533	*Surface and dermal sampling*
ASTM WK56940	*New guide for standard guide to standard test methods and practices for determining antifungal activity on natural or synthetic substrates treated with antimicrobial agents*
BS 1881-122	*Testing concrete. Method for determination of water absorption*

BS 5131-1.1	*Methods of test for footwear and footwear materials. Adhesives. Resistance of adhesive joints to heat (Creep test)*
BS EN 1634-1	*Fire resistance and smoke control tests for door, shutter and, openable window assemblies and elements of building hardware. Fire resistance tests for doors, shutters and openable windows*
BS EN 455-2	*Medical gloves for single use. Requirements and testing for physical properties*
BS EN 60068-2-31:2008,	*Environmental testing. Tests. Test Ec. Rough handling shocks, primarily for equipment-type specimens*
BS EN IS0 105-B02	*Textiles. Tests for colour fastness. Colour fastness to artificial light: Xenon arc fading lamp test*
BS EN ISO 105-B04	*Textiles. Tests for colour fastness. Colour fastness to artificial weathering. Xenon arc fading lamp test*
BS EN ISO 105-B06,	*Textiles. Tests for colour fastness. Colour fastness and ageing to artificial light at high temperatures: Xenon arc fading lamp test*
BS EN ISO 105-D02,	*Textiles. Tests for colour fastness. Colour fastness to rubbing: Organic solvents*
BS EN ISO 4074	*Natural rubber latex male condoms. Requirements and test methods*
BS ISO 132	*Rubber, vulcanized or thermoplastic. Determination of flex cracking and crack growth (De Mattia)*
BS ISO 1431-1	*Rubber, vulcanized or thermoplastic. Resistance to ozone cracking. Static and dynamic strain testing*
BS ISO 4666-3	*Rubber, vulcanized. Determination of temperature rise and resistance to fatigue in flexometer testing. Compression flexometer (Constant-strain type)*
CIE 127	*Measurement of LEDs*
CNS 14945	*Assessment of general-purpose antibacterial textiles*
CNS 3299-10	*Methods of test for ceramic tiles - Part 10: Determination of chemical resistance*
CNS 6928	*Method of test for scrub resistance of interior latex flat wall paints*
DIN ISO 1431-1	*Rubber, vulcanized or thermoplastic - Resistance to ozone cracking - Part 1: Static and dynamic strain testing*
IEC 62282-2	*Fuel cell technologies - Part 2: Fuel cell modules*
IEC 62282-3-100	*Fuel cell technologies - Part 3-100: Stationary fuel cell power systems - Safety*

IEC 62282-3-200	*Fuel cell technologies - Part 3-200: Stationary fuel cell power systems - Performance test methods*
IEC 62282-4-101	*Fuel cell technologies - Part 4-101: Fuel cell power systems for propulsion other than road vehicles and auxiliary power units (APU) - Safety of electrically powered industrial trucks*
IEC 62282-4-102	*Fuel cell technologies - Part 4-102: Fuel cell power systems for industrial electric trucks - Performance test methods*
IEC 62282-5-100	*Fuel cell technologies - Part 5-100: Portable fuel cell power systems - Safety*
IEC 62282-6-100	*Fuel cell technologies - Part 6-100: Micro fuel cell power systems - Safety*
IEC 62282-6-200	*Fuel cell technologies - Part 6-200: Micro fuel cell power systems - Performance test methods*
IEC 62282-6-300	*Fuel cell technologies - Part 6-300: Micro fuel cell power systems - Fuel cartridge interchangeability*
IEC 62391-1	*Fixed electric double-layer capacitors for use in electric and electronic equipment - Part 1: Generic specification*
IEC 62899-202	*Printed electronics - Part 202: Materials - Conductive ink*
IEC 62908-13-10	*Touch and interactive displays - Part 13-10: Reliability test methods of touch displays - Environmental durability test methods*
IEC PAS 62282-6-150	*Fuel cell technologies - Part 6-150: Micro fuel cell power systems - Safety - Water reactive (UN Devision 4.3) compounds in indirect PEM fuel cells*
IEC TS 62282-7-1	*Fuel cell technologies - Part 7-1: Test methods - Single cell performance tests for polymer electrolyte fuel cells (PEFC)*
IEC TS 62282-7-2	*Fuel cell technologies - Part 7-2: Test methods - Single cell and stack performance tests for solid oxide fuel cells (SOFC)*
IEEE 149-1979	*Standard test procedures for antennas*
ISO/TS 80004-1	*Nanotechnologies - Vocabulary - Part 1: Core terms*
ISO/TS 80004-2	*Nanotechnologies - Vocabulary - Part 2: Nano-objects*
ISO/TS 80004-3	*Nanotechnologies - Vocabulary - Part 3: Carbon nano-objects*
ISO/TS 80004-4	*Nanotechnologies - Vocabulary - Part 4: Nanostructured materials*
ISO/TS 80004-5	*Nanotechnologies - Vocabulary - Part 5: Nano/bio interface*
ISO/TS 80004-6	*Nanotechnologies - Vocabulary - Part 6: Nano-object characterization*

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ISO/TS 80004-8	*Nanotechnologies - Vocabulary - Part 8: Nanomanufacturing processes*
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ISO/TS 80004-13	*Nanotechnologies - Vocabulary - Part 13: Graphene and related two-dimensional (2D) materials*
ISO 34-1	*Rubber, vulcanized or thermoplastic - Determination of tear strength - Part 1: Trouser, angle and crescent test pieces*
ISO 75-1	*Plastics - Determination of temperature of deflection under load - Part 1: General test method*
ISO 75-2	*Plastics - Determination of temperature of deflection under load - Part 2: Plastics and ebonite*
ISO 75-3	*Plastics - Determination of temperature of deflection under load - Part 3: High-strength thermosetting laminates and long-fibre-reinforced plastics*
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ISO 178	*Plastics - Determination of flexural properties*
ISO 179-1	*Plastics - Determination of Charpy impact properties - Part 1: Non-instrumented impact test*
ISO 180	*Plastics - Determination of Izod impact strength*
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ISO 527-2	*Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics*
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ISO 813	*Rubber, vulcanized or thermoplastic - Determination of adhesion to a rigid substrate - 90 degree peel method*

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ISO 1827	*Rubber, vulcanized or thermoplastic - Determination of shear modulus and adhesion to rigid plates - Quadruple-shear methods*
ISO 4074	*Natural rubber latex male condoms - Requirements and test methods*
ISO 4649	*Rubber, vulcanized or thermoplastic - Determination of abrasion resistance using a rotating cylindrical drum device*
ISO 4664-1	*Rubber, vulcanized or thermoplastic - Determination of dynamic properties - Part 1: General guidance*
ISO 4666-3	*Rubber, vulcanized - Determination of temperature rise and resistance to fatigue in flexometer testing - Part 3: Compression flexometer (constant-strain type)*
ISO 7743	*Rubber, vulcanized or thermoplastic - Determination of compression stress-strain properties*
ISO 10282	*Single-use sterile rubber surgical gloves - Specification*
ISO 11193-1	*Single-use medical examination gloves - Part 1: Specification for gloves made from rubber latex or rubber solution*
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ISO/TS 12901-1	*Nanotechnologies - Occupational risk management applied to engineered nanomaterials - Part 1: Principles and approaches*
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ISO 22007-2	*Plastics - Determination of thermal conductivity and thermal diffusivity - Part 2: Transient plane heat source (hot disc) method*
ISO 22007-4	*Plastics - Determination of thermal conductivity and thermal diffusivity - Part 4: Laser flash method*
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ISO 105-B03	*Textiles - Tests for colour fastness - Part B03: Colour fastness to weathering: Outdoor exposure*

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ISO 11998	*Paints and varnishes - Determination of wet-scrub resistance and cleanability of coatings*
ISO 12944-6	*Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 6: Laboratory performance test methods*
ISO 13125	*Fine ceramics (advanced ceramics, advanced technical ceramics) - Test method for antifungal activity of semiconducting photocatalytic materials*
ISO 13629-1	*Textiles - Determination of antifungal activity of textile products - Part 1: Luminescence method*
ISO 13629-2	*Textiles - Determination of antifungal activity of textile products - Part 2: Plate count method*
ISO 1420	*Rubber- or plastics-coated fabrics - Determination of resistance to penetration by water*
ISO 1431-1	*Rubber, vulcanized or thermoplastic - Resistance to ozone cracking - Part 1: Static and dynamic strain testing*
ISO 14419	*Textiles - Oil repellency - Hydrocarbon resistance test*
ISO 15110	*Paints and varnishes - Artificial weathering including acidic deposition*
ISO 1518-1	*Paints and varnishes - Determination of scratch resistance - Part 1: Constant-loading method*
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ISO 16474-1	*Paints and varnishes - Methods of exposure to laboratory light sources -*

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ISO 20743	*Textiles - Determination of antibacterial activity of textile products*
ISO 22196	*Measurement of antibacterial activity on plastics and other non-porous surfaces*
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ISO 2812-1	*Paints and varnishes - Determination of resistance to liquids - Part 1: Immersion in liquids other than water*
ISO 2812-2	*Paints and varnishes - Determination of resistance to liquids - Part 2: Water immersion method*
ISO 2812-3	*Paints and varnishes - Determination of resistance to liquids - Part 3: Method using an absorbent medium*
ISO 2812-3	*Paints and varnishes - Determination of resistance to liquids - Part 3: Method using an absorbent medium*
ISO 2812-4	*Paints and varnishes - Determination of resistance to liquids - Part 4: Spotting methods*
ISO 2812-5	*Paints and varnishes - Determination of resistance to liquids - Part 5: Temperature-gradient oven method*
ISO 3248	*Paints and varnishes - Determination of the effect of heat*

ISO 3582	*Flexible cellular polymeric materials - Laboratory assessment of horizontal burning characteristics of small specimens subjected to a small flame*
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ISO 4628-3	*Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 3: Assessment of degree of rusting*
ISO 4628-4	*Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 4: Assessment of degree of cracking*
ISO 4628-5	*Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 5: Assessment of degree of flaking*
ISO 4628-6	*Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 6: Assessment of degree of chalking by tape method*
ISO 4628-7	*Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 7: Assessment of degree of chalking by velvet method*
ISO 4628-8	*Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 8: Assessment of degree of delamination and corrosion around a scribe or other artificial defect*
ISO 4892-2	*Plastics - Methods of exposure to laboratory light sources- Part 2: Xenon-arc lamps*
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ISO 4920	*Textile fabrics - Determination of resistance to surface wetting (Spray test)*
ISO 5085-1	*Textiles - Determination of thermal resistance - Part 1: Low thermal resistance*
ISO 5470-1	*Rubber- or plastics-coated fabrics - Determination of abrasion resistance - Part 1: Taber abrader*
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ISO 5473	*Rubber- or plastics-coated fabrics - Determination of crush resistance*
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ISO 6941	*Textile fabrics - Burning behaviour - Measurement of flame spread properties of vertically oriented specimens*
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ISO/IEC 18046-3	*Information technology - Radio frequency identification device performance test methods - Part 3: Test methods for tag performance*
ISO/IEC 18046-4	*Information technology - Radio frequency identification device performance test methods - Part 4: Test methods for performance of RFID gates in libraries*
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JIS K 6259-2	*Rubber, vulcanized or thermoplastic - Determination of ozone resistance - Part 2: Determination of the ozone concentration*
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MS 1291	*Single-use sterile rubber surgical gloves- specification*
MS 132	*Specification for under coating paint for use under gloss enamel*
MS 133 Part E2	*Paints and varnishes- Determination of scratch resistance- Part E2: Constant-loading method*
MS 133:Part F6	*Paints and varnishes - Natural weathering of coatings - Part F6: Exposure and assessment*
MS 133:Part F8	*Paints and varnishes - Part F8: Determination of resistance to humid atmospheres containing sulfur dioxide*
MS 133: Part G6	*Methods of test for paints - Part G6: Resistance to fungal growth*
MS 134:2007	*Latex emulsion paint for exterior and interior use - Specification*
MS 164:2007	*Road marking paints - Specification*
MS 903	*Specification for latex emulsion paint for interior use*
MS 1073: Part 3	*Specification for fire resistance doorsets: Part 3: Methods for determination of fire resistance-type of doorsets*
MS 1155	*Single-use medical examination gloves- Specification*
MS 2598	*Minimum energy performance standards (MEPS) for lamps*
MS 60904-3	*Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*
MS EN 12390-3	*Testing hardened concrete - Part 3: Compressive strength of test specimens*
MS EN 12390-5	*Testing hardened concrete - Part 5: Flexural strength of test specimens*
MS EN 12390-6	*Testing hardened concrete - Part 6: Tensile splitting strength of test specimens*
MS IEC 60086-1	*Primary batteries - Part 1: General*
MS IEC 60086-2	*Primary batteries - Part 2: Physical and electrical specifications*

MS IEC 60086-3	*Primary batteries - Part 3: Watch batteries*
MS IEC 60904-1	*Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics*
MS IEC 60904-4	*Photovoltaic devices - Part 4: Reference solar devices - Procedures for establishing calibration traceability*
MS IEC 61194	*Characteristic parameters of stand-alone photovoltaic (PV) systems*
MS IEC 61215	*Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval*
MS IEC 61347-1	*Lamp controlgear - Part 1: General and safety requirements*
MS IEC 62133	*Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications*
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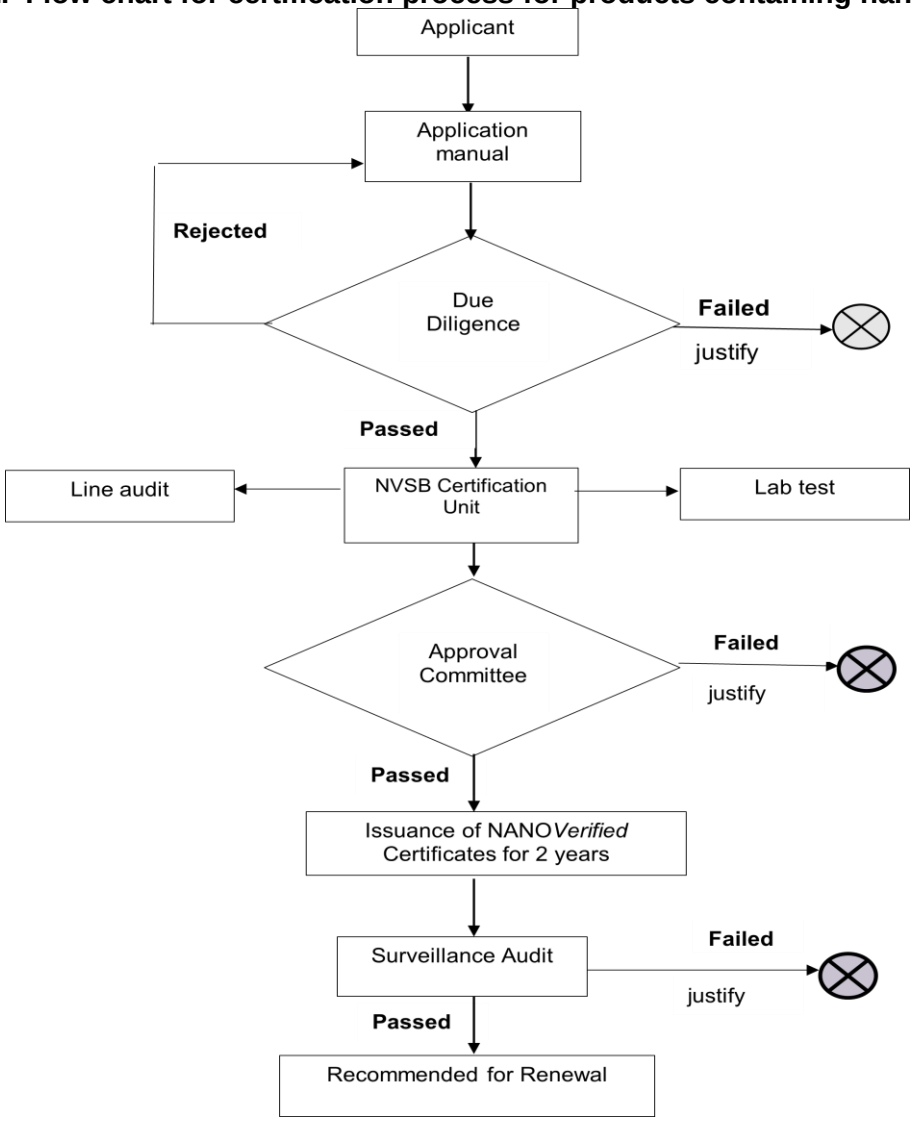
MS ISO 13006	*Ceramic tiles- Definitions, classification, characteristics and marking*
MS ISO 1431-1	*Rubber, vulcanized or thermoplastic- Resistance to ozone cracking- Part 1: Static and dynamic strain testing*
MS ISO 4666-3	*Rubber, vulcanized - Determination of temperature rise and resistance to fatigue in flexometer testing - Part 3: Compression flexometer (Constant-strain type)*

Annex B
(informative)

Certification process to certify products containing nanomaterials

Figure B.1 illustrates the flow chart for certification process that provides general guidelines for the industry to ensure that proper action, evaluation, supplementation and/or documentation are in order for every application to a certification programme for products containing nanomaterials.

Figure B.1. Flow chart for certification process for products containing nanomaterials



Annex C
List of nanomaterial used in a product

No	Nanomaterial
1	Boron based materials
2	Carbon nanomaterials such as Graphene, carbon nanotube, reduced graphene oxide, graphene oxide, MXenes
2	Metal chalcogenides such as Molybdenum disulfide, tungsten disulfide, tungsten diselenide, niobium selenide, molybdenum diselenide, tantalum sulfide, copper sulfide
3	Metal oxides such as Silica, titania, alumina, iron oxide, copper oxide, cerium oxide, zirconia, zinc oxide, magnesium oxide, molybdenum oxide, yttrium oxide, tin oxide, vanadium pentoxide
4	Metallic nanoparticles such as silver, tungsten, copper, nickel, titanium
4	Minerals such as diamond, quartz
5	Organic nanoparticles such as nanosilica/ nanofibre from biomass
6	Polymeric nanomaterials such as Polytetrafuoroethylene, guanidine carbonate, polymethyl methacylate, polyethylene
7	Soft metals
8	Other nanomaterials such as fluoride, silicon nitride, calcium borate, serpentine, lanthanum borate, titanium carbide, zinc borate, lanthanum borate, magnesium

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[4] ISO/TS 12901-2, *Nanotechnologies - Occupational risk management applied to engineered nanomaterials - Part 2: Use of the control banding approach*

[5] *Standard operating procedures for NANOVerify Programme*

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