

PAS 107:2012

Specification for the manufacture and storage of size reduced tyre materials



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Foreword

This revised Publicly Available Specification, PAS 107:2012, has been sponsored by the Tyre Recovery Association (TRA) in association with WRAP and its development was facilitated by the British Standards Institution (BSI).

The overall aim of this document is to provide a specification that can be adopted by suppliers for producing grades of size reduced tyre rubber such that potential customers will be assured that they are procuring a material of consistent and verifiable quality.

Here it is noted that, under current legislation, all size reduced materials covered by this PAS are classified as waste until incorporated into an end use application. It follows that handling and storage of these materials must comply with all regulations arising out of the *Waste Framework Directive* [1].

The Quality Protocol¹⁾ developed by WRAP and the Environment Agency in consultation with industry and other regulatory stakeholders is applicable in both England and Wales. The Quality Protocol sets out end of waste criteria for the production and use of tyre derived rubber materials from source aggregated waste tyres. If these criteria are met, tyre derived rubber materials will normally be regarded as having been fully recovered and to have ceased to be waste.

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- Bridgestone;
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- Charles Lawrence International Ltd;
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Wider comments from other interested parties were invited by BSI. The expert contributions made by the organizations and individuals consulted in the development of this Publicly Available Specification (PAS) are gratefully acknowledged.

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¹⁾ <http://www.environment-agency.gov.uk/business/topics/waste/114455.aspx>

Introduction

The use of recycled tyre materials in a wide range of civil engineering applications and industrial products is well established and has grown considerably in the last decade.

The introduction of legislation transposing European Directives, in particular regulations relating to landfill management²⁾, End of Life Vehicles (ELV) salvage³⁾ and waste incineration⁴⁾, eliminated the disposal option of landfill. Today, the UK is meeting its 100 % recovery target in its entirety through a combination of reuse, recycling and recovery activities.

In order to facilitate the growth of, and to strengthen the end markets for sustainable recovery options for used tyres, WRAP and industry introduced a range of initiatives to encourage expansion of existing processes and investment in new applications.

Information relating to the quality of materials can be an important requirement in the successful functioning of any free market. Such information is often absent for many waste material streams and, in the case of tyre-derived rubber, this Publicly Available Specification (PAS 107) harmonises the various independent specifications across the industry in the UK. It provides a standard, for use by processors and buyers, in defining the quality requirements for the collection and initial storage of used tyres and the processing and final storage of size-reduced, or graded, rubber material.

The production of size reduced or graded tyre rubber is currently a process, which is managed under the Environmental Permitting (England and Wales) Regulations 2010 [2].

All of the commercial size reduction of tyres in the UK is currently by means of cutting and grinding, at or above ambient temperature, into increasingly smaller rubber particles for a range of new end use applications. This process, known as ambient size reduction, is the subject of this PAS. Brief reference is made within the body of the PAS to emerging new technologies to produce size reduced rubber, such as cryogenic treatment and

water jetting, however these do not currently feature substantially in the UK marketplace. In the future, new technology facilities such as these could provide further capacity for the production of size reduced rubber for end use applications that will be similar to those for ambient ground rubber.

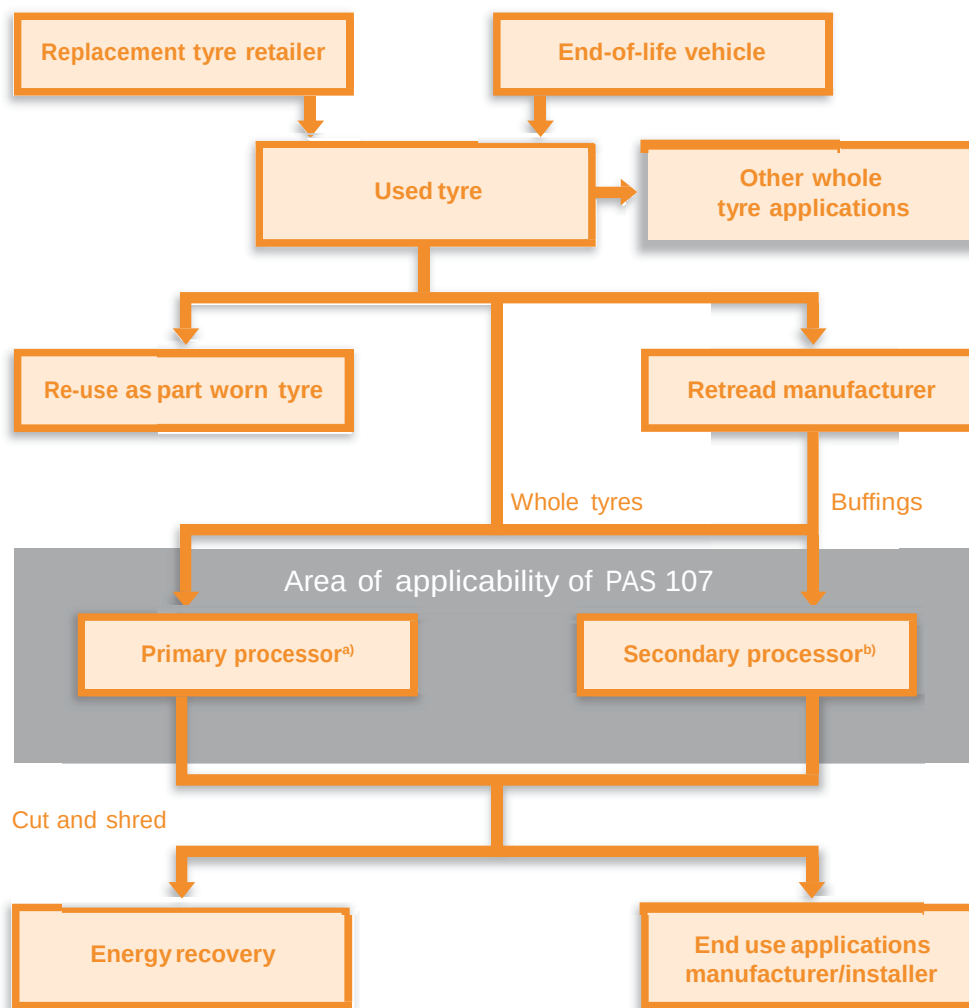
The source material covered by this PAS is end-of-life tyres; specifically tyres that have been removed from road vehicles and off-road vehicles such as agricultural and earthmoving equipment. Used aircraft tyres, due to their unique processing and relatively low level of arisings in the UK, are not included in the PAS. In addition, this PAS excludes the use of whole or baled tyres in end use applications. In conjunction with this document, PAS 108 has been introduced to cover the manufacture and storage of baled tyres.



²⁾ Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste [3]

³⁾ Council Directive 2000/53/EC of 18 September 2000 on end-of-life vehicles [4]

⁴⁾ Council Directive 2000/76/EC of 4 December 2000 on the incineration of waste [5]

Figure 1 – Applicability of PAS 107 in the used tyre collection and recycling supply chain.

^{a)} Carries out primary processing of converting whole tyres to material categories, as listed in Table 1.

^{b)} Carries out secondary processing on shred/other tyre rubber size-reduced materials, such as playground surface materials.

Tyre recycling by means of alternative technologies such as pyrolysis or microwave treatment, which reduce the tyre to steel, carbon black and energy products, or devulcanisation, are also excluded as these technologies are yet to be commercially proven across the UK. Consideration will be given to extending the scope of this PAS at the time that the new processing technologies become commercially available in the UK.

Size reduced rubber materials are defined primarily by their size. They range from large cuts of greater than 300 mm, which include all of the steel and textile components of the original tyre casings, down to fine rubber powders, which can be virtually free of those components. Size reduced rubber materials are used in an increasingly diverse range of end use applications and markets.

Since this PAS is primarily for use by processors and buyers in defining quality requirements for size reduced rubber materials, it is applicable only to those activities, carried out by the processor, that are appropriate to achieving the required standards. This is shown schematically in Figure 1.

It is noted that PAS 107 would apply where a used tyre collector also carries out primary processing of whole tyres into cuts or shred. In this instance, the collection and processing activities shall be treated as separate entities and the PAS will apply from the receipt of whole tyres at the first stage processing facility to the shipment of material to either the end user or to a second stage processor.

1 Scope

This Publicly Available Specification (PAS) specifies minimum requirements for the manufacture and storage of size-reduced, tyre derived rubber materials intended for a range of applications in existing and emerging secondary end markets. Tyre sources include those from land-based vehicles, i.e. bicycles, motorcycles, cars, light commercial vehicles, trucks, buses, as well as industrial and agricultural vehicles.

This PAS does not cover the processing of aircraft tyres, the use of whole or baled tyres in end use applications or the end use applications. It does not cover the by-products of the process, namely steel and textile fibre, or tyre recycling by means of alternative technologies such as pyrolysis or microwave treatment.

The secondary end markets to which this PAS applies include, but are not limited to, the applications set out in Table 1.

In order to accommodate the widening range of end user requirements for size reduced tyre materials, variations or additions to an end use specification may be required. This is referenced in the PAS as being subject to agreement between the producer and user. However, in all instances, the standard set by this PAS will be the minimum requirement.

Table 1 – Examples of material categories and applications

Material category	Application
Cuts, Shred and Chips	Co-combustion with other fuels in the manufacture of cement and lime products
Cuts, Shred and Chips	Generation of energy by incineration
Shred and Chips	As the leachate drainage layer in the construction of landfill cells
Chips	Clean cut, as the surface for equestrian ménages and pathways
Chips, Granulate and Powder	Resin-bound as a shock absorbing layer for sports tracks and children's playgrounds
Granulate and Powder	Moulded products such as tiles, street furniture and level crossing platforms
Granulate and Powder	In rubber modified bitumen for road surfacing and repair
Granulate and Powder	Carpet underlay and floor tiles
Granulate	Various horticultural applications such as mulching and soil amelioration
Granulate	As a filler, with sand, in artificial turf for sports pitches
Granulate	As aggregate replacement in construction products such as building blocks
Powder	In industrial adhesives and sealants and in new and retreaded tyres

2 Normative references

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

NOTE See Bibliography for other referenced standards which may apply for specific usages if a particular characteristic of the material is required, as decided between producer and user.

BS ISO 1126, *Rubber compounding ingredients – Carbon black – Determination of loss on heating*

BS 5293-2, *Sampling and testing carbon black for use in the rubber industry – Part 2: Method for determination of pour density (ISO 1306)*

ISO 3310-1, *Test sieves – Technical requirements and testing - Part 1: Test sieves of metal wire cloth*

BS SO 6101-5, *Rubber – Determination of metal content by atomic absorption spectrometry – Part 5: Determination of iron content*

PPG 29: Safe Storage – Combustible materials, prevent and control fire.⁵⁾



⁵⁾ Available from www.environment-agency.gov.uk

3 Terms and definitions

For the purpose of this PAS the following terms and definitions apply.

3.1 ambient size reduction

processing of used tyres into smaller particles by mechanical means at or above ambient or room temperature

3.2 bead wire

steel strand, or strands, in the form of a hoop, built into the tyre casing to anchor and strengthen the tyre edge where it fits to the wheel rim

3.3 buffings

rubber particles of varying sizes obtained from abrading an end of life tyre to remove the tread or part of the sidewalls prior to retreading or remoulding

3.4 butyl rubber

synthetic rubber, which is virtually impermeable to air, used in the manufacture of tyres and tyre inner tubes

3.5 casing

structural body of a tyre on which the tread and sidewalls are laid and which forms the major part of a used tyre

3.6 chips

fragmented pieces of used tyres, including embedded wire or textile material, whose maximum dimension, of the rubber portion, is between approximately 10 mm and 50 mm in size

3.7 civil engineering applications

use of tyre derived materials in any construction project, either above or below ground

3.8 cord

elements comprising textile or steel plies forming the basic structure of the tyre

3.9 crosslink

chemical bond between polymer chains, such as rubber, which influence the physical properties of the material

3.10 crossply tyre

type of tyre construction in which the cord plies run at angles to the direction of travel and cross each other diagonally

3.11 cryogenic process

process occurring at extremely low temperatures which facilitates the fragmentation of tyres into very small, smooth surfaced particles

3.12 cuts

size reduced pieces of used tyres, including embedded wire or textile material

3.13 devulcanisation

process of breaking the chemical cross links of vulcanized rubber which may enable the material to be re-used as a compounding ingredient and again vulcanized

3.14 duty of care

a provision of the Environmental Protection Act 1990 [6], which applies to anyone who imports, produces, carries, keeps, treats or disposes of waste, requiring that waste can only be carried by registered waste carriers and that all movements of waste are fully auditable

3.15 end of life tyre

tyre which has been permanently discarded following normal use

3.16 energy recovery

use of tyres as a means to generate energy through direct incineration with or without other waste but with the generation of heat and/or electrical power

3.17 feedstock

stock of whole tyres, or tyre derived rubber material, which has been partially size reduced, awaiting further size reduction

3.18 fine powder

particles of rubber below 500 µm in size

3.19 fluff

fine textile materials that are separated from the rubber during the process of cutting and grinding tyres

3.20 granulate

particles of rubber whose maximum dimension is between 0.5 mm and 10 mm in size

3.21 lower defined limit

lower limit of size for the majority of rubber particles in a batch of material

3.22 particle size

<of a batch of granulate or powder is> the range of dimensions between the upper defined limit and the lower defined limit

NOTE The particle size of a batch of cuts, shred or chips is more commonly determined by the average or nominal particle size within the batch.

3.23 powder

particles of rubber below 1 mm in size

3.24 pyrolysis

process by which tyres are heated in the absence of oxygen in order to break down the structure of the tyres into steel, oil, gas and char

3.25 radial tyre

type of tyre construction in which the cord plies run at right angles to the direction of travel

3.26 recovery

any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, in the plant or in the wider economy

NOTE Definition taken from Waste Framework Directive [1].

3.27 recyclate

re-usable material from any recycling process

3.28 recycling

reprocessing, in a production process, of tyres for their original purpose or for other purposes but excluding energy recovery

3.29 retread

re-manufactured tyre where the remaining original tread has been replaced with new (with/without) sidewall

NOTE Retreading is a process to re-use structurally sound worn tyres, known as casings, by removing and replacing the remaining tyre tread, with the new tread being vulcanized to the body (casing). The process is described as “hot” (moulding a new tread pattern usually together with new sidewalls) or “cold” (application of a precured tread only).

3.30 re-use

recovery operation by which tyres that have become waste are used again for their original purpose

3.31 sample (of material)

portion of material intended for testing, selected at random from a batch making, of sufficient quantity to carry out the required test

3.32 secondary raw material

recycled material that is no longer a waste having quantifiable chemical and physical properties, that can be used as a replacement for alternative materials

3.33 shred

fragmented pieces of used tyres, including embedded wire or textile material, whose maximum dimension, the rubber portion, is between 50 mm and 300 mm in size

3.34 sidewall

outer side portion of tyre casing between the bead and the tread

3.35 source material

end-of-life tyres, buffings and tyre inner tubes used as material input to the size reduction process

3.36 transfer point

address of the location of the transfer of a waste material

3.37 tread

portion of the tyre around its circumference, contoured for optimum traction, that is in rolling contact with the ground when in use

3.38 upper defined limit

upper limit of size for the majority of rubber particles in a batch of material

3.39 visual inspection

naked eye examination of a material or product for quality assurance eye

3.40 vulcanization

process that produces crosslinks between rubber polymer strands to improve the physical properties of the rubber for automotive purposes

3.41 whole tyre

complete tyre comprising mainly casing, including cord and wire bead, sidewall and tread

4 Characterization of source materials

4.1 Categories of source materials

The principal material inputs for size reduction under this PAS consist of pneumatic tyres for use on motor cycles, passenger cars, commercial vehicles (ranging from light vans to heavy goods vehicles) and public service vehicles. Pneumatic tyres from these vehicles represent the great majority of the available end-of-life tyres in the UK but small quantities of tyres from bicycles, agricultural, industrial and earthmover vehicles, all inner tubes and solid tyres are also available for size reduction and are therefore covered by this PAS.

The raw material composition of individual tyres varies considerably between different manufacturers and types of tyre. However, this PAS relates to the collection and processing of mixed used tyres from multiple sources, and the average composition of these can be more closely defined. The principal constituents by weight of the tyre are shown in Table 2.⁶⁾

The major sources of tyres for size reduction are divided into two categories, namely car and truck, due to their different physical and chemical make-ups. These result in some differences in the nature and application of the materials derived from each. A further, minor category, namely “agricultural and earthmover”, is added due to the significantly larger size of these tyres, requiring different storage and handling facilities. The categories are summarized in Table 3.

Table 2 – Indicative composition of a tyre

Ingredient	Passenger car tyre (%)	Lorry tyre (%)	OTR (off-the-road) tyre (%)
Rubber / Elastomers ¹⁾	47	45	47
Carbon black ²⁾	21.5	22	22
Metal	16.5	25	12
Textile	5.5	-	10
Zinc oxide	1	2	2
Sulphur	1	1	1
Additives ³⁾	7.5	5	6
Carbon-based materials ⁴⁾	74	67	76

¹⁾ Lorry and OTR tyres contain higher proportions of natural rubber than passenger car tyres.
²⁾ Silica replaces part of the carbon black in certain types of tyres.
³⁾ Some of the additives include clays, which may be replaced in part in some tyres with recycled rubber crumb from waste tyres.
⁴⁾ These approximate totals would be slightly higher if clays were replaced by recycled crumb rubber from waste tyres.

⁶⁾ www.etra-eu.org: *The Composition of Tyres in the European Union*.

Table 3 – Material source details

Source	Description	Notes
Car tyre	Motorcycle, two-and four-wheeled drive passenger cars, light commercial vehicles, small agricultural and industrial vehicles	Predominantly radial tyres, containing more synthetic rubber than natural and proportionately more textile than steel
Truck tyre	Medium and heavy commercial vehicles, buses and other public service vehicles	These contain proportionately more natural than synthetic rubber. Tyres can be radial or cross ply. Cross ply tyres contain more textile than steel
Agricultural and Earthmover Tyre	Large agricultural and industrial vehicles	Agricultural tyres tend to be cross ply. Earthmover tyres can be cross ply or radial
Other tyres	Mixed categories, including inner tubes and solid tyres made of rubber	Industrial solid tyres tend to contain natural rubber and textile but no steel

