



Hytrel®

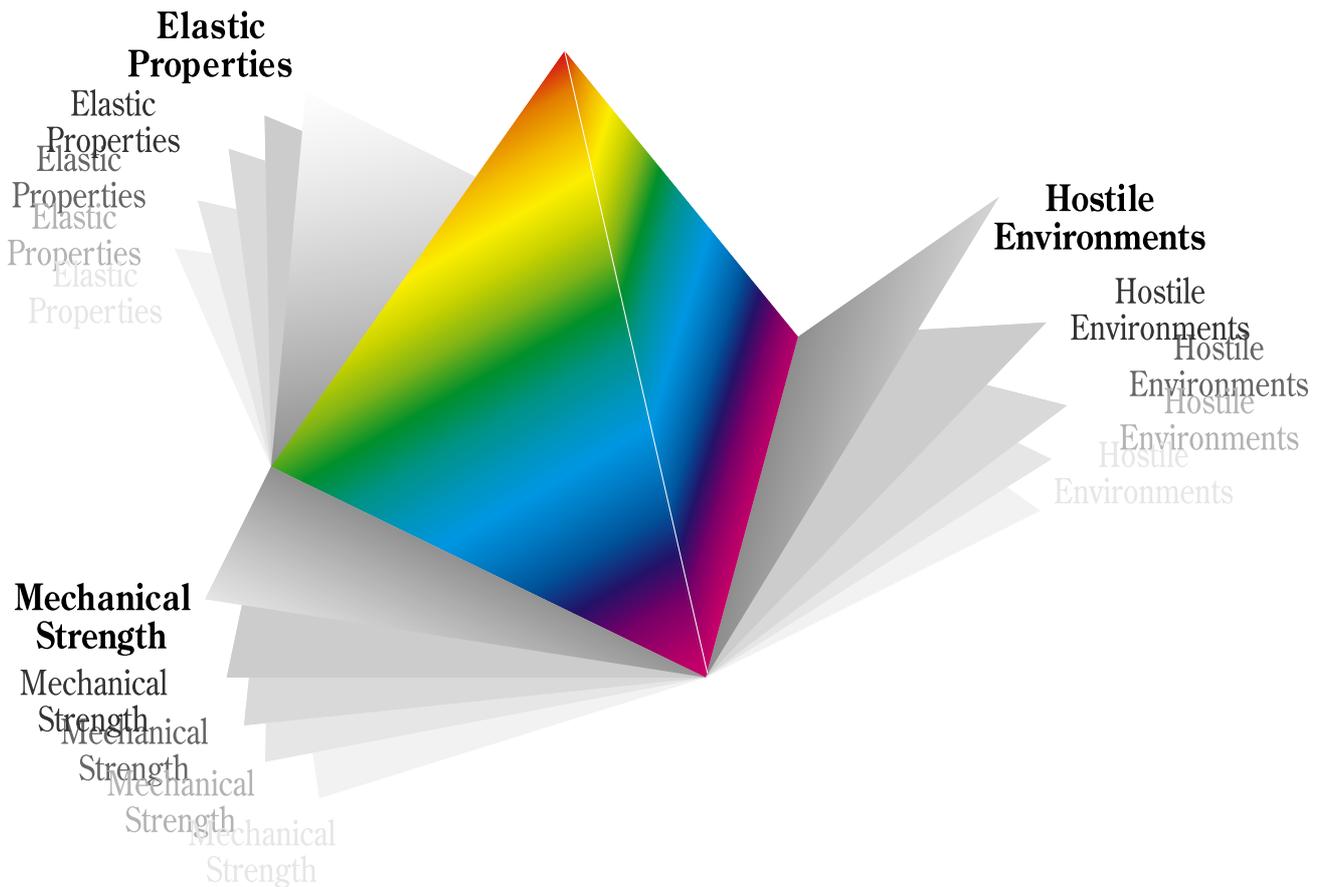
Thermoplastic Polyester Elastomer

Product guide and properties



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DuPont Engineering
Polymers

Design Flexibility



Illustrations of the cover page

- 1 – Gears
- 2 – SCOTT Sun glasses: bridge for lens, rear frame and arms HYTREL®, frame of lens DELRIN®
- 3 – Lens support for SONY CD-player
- 4 – Front strap for ski boot
- 5 – Air duct

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HYTREL® engineering thermoplastic elastomer

HYTREL® is DuPont's registered trademark for its family of engineering thermoplastic elastomers. HYTREL® engineering thermoplastic elastomers are block copolymers, consisting of a hard (crystalline) segment of polybutylene terephthalate and a soft (amorphous) segment based on long-chain polyether glycols. Properties are determined by the ratio of hard to soft segments and by the make-up of the segments.

Properties and Characteristics

HYTREL® is an engineering thermoplastic elastomer which combines many of the most desirable characteristics of high-performance elastomers and flexible plastics. It features: exceptional toughness and resilience; high resistance to creep, impact and flex fatigue; flexibility at low temperatures; and good retention of properties at elevated temperatures. In addition, it resists many industrial chemicals, oils and solvents.

Processing

HYTREL® can be readily formed into high-performance parts by a variety of thermoplastic processing techniques, including injection moulding, extrusion, blow moulding, rotational moulding and melt casting. For injection-moulding HYTREL® processes at temperatures between 175°C and 260°C depending on the polymer type. All grades have a sharp melting point and very good melt stability.

For additional information relating to processing of HYTREL®, see:

- Injection moulding guide, TRH 30.
- Extrusion of HYTREL®, HYT-403.

Recycling

For recycling purposes, the international acronym for DuPont's engineering thermoplastic elastomer HYTREL® is TEEE (thermoplastic elastomer ether ester).

Hardness of HYTREL®

Many HYTREL® grades are conveniently classified and named according to their nominal values of hardness on the Shore D scale.

However, Shore D Hardness is an imprecise parameter that may vary substantially according to the nature of the specimen measured. Therefore, only typical values are given in this brochure.

In general, Shore D Hardness relates to more precisely measurable and more directly useful parameters like flexural modulus, low and high temperature stress-strain and impact behaviour and solvents resistance.

CVJ boot

Blow moulded boots are very cost effective compared to their rubber counterparts, and offer superior toughness and resistance to greases, particularly at low temperatures.



Key pad

The change to HYTREL® from the traditional silicone rubber for keypads of remote control resulted in shorter production cycles, increased design flexibility and an agreeable 'touch'.

Head phone

Innovative design features the combination of high flexibility and mechanical strength.



Seal for perfume bottle

HYTREL® has good chemical and abrasion resistance; more important it is resistant to all chemicals and the odours from the content of the bottle.

Product line description

There are two main groups of products depending on the type of soft segment used.

These are:

1. Standard grades: The most economical grades offer the best balance of cost and performance. These grades range in Shore D hardness from 35 to 82.
2. High Performance grades: These grades provide an extra measure of performance and service life

in applications where properties such as abrasion resistance and tear strength are critical. They range in Shore D hardness from 40 to 72.

Within each of these groups a range of hardnesses or flexural modulus is obtained by varying the ratio of hard and soft segments.

Available grades in each group are:

Hardness	Flexural modulus, MPa	Standard	High performance
35D	35	G3548L	
40D	55-67	G4074/G4078W	4056/4068
45D	94		4556
47D	117	G4774	
55D	193-207	G5544	5526/5556/5586
63D	300	6358	6356
72D	570	7248	7246
104R*	1207	8238	

* Rockwell R

Specific properties of all these grades can be enhanced through the addition of any of the following concentrates:

Concentrate	Typical letdown ratio	Description
Carbon black 40CB and 41CB	2,5 to 6%	Provides protection against W light exposure.
UV light stabilizer 20UV	2,5 to 4%	Provides protection against UV light exposure or light-coloured parts.
Heat stabilizer 30HS	5%	Retards thermal oxidative degradation and extends useful life at elevated temperatures. Some discolouration, which has no effect on properties, will occur.
Hydrolytic stabilizer 10MS	10%	Improves long term performance in hot moist environments.
Flame retardants 51FR and 52FR	10–13%	Improves flame retardancy to attain UL-94 V-2 rating.

For more detailed information on the effects of these concentrates, refer to their individual data sheets.

In addition, the following special grades are available:

Specialities			
Description	Grades	Hardness (Shore D)	Flexural modulus (MPa)
Flame retardant UL-94 V-0 at 1,57 mm thickness	HTR8068	46	131
Blow moulding	HTR5612 BK	50	124
Blow moulding	HTR4275 BK316	55	160
Improved heat ageing performance	5555HS	55	207

Product form and packaging

HYTREL® engineering thermoplastic elastomers are supplied as cylindrical pellets (approximately 3 mm in diameter by 3 mm long), having a bulk density of about 700 kg/m³. They are packaged in 25 kg multiwall paper bags with a moisture barrier inner wall. Palletized units contain 40 bags, or 1000 kg net weight, wrapped in polyolefin film on disposable wooden pallets.

Most HYTREL® grades are also available in 1000 kg bulk boxes with a moisture resistant liner. Check with your local DuPont representative for details regarding which packages are available for the specific grade you need.

Product literature

This “General guide to products and properties” contains information on the complete line of HYTREL® products. Additional handling, processing and product information is available in a variety of other technical literature. Also, tips on designing parts with HYTREL® are available in the “HYTREL® Design Handbook” (H-38344). Further information and copies of the above mentioned literature can be obtained from your local DuPont representative.

Applications

The excellent properties of HYTREL® engineering thermoplastic elastomer qualify it for a number of demanding applications where mechanical strength and durability are required in a flexible component.

Examples include seals, belts, bushings, pump diaphragms, gears, protective boots, hose and tubing, springs and couplings, hinges, impact and sound absorbing devices. In many of these applications, HYTREL® allows a multipiece rubber, or even metal composite assembly to be replaced with a single part. Some of the industries where HYTREL® is used include: automotive, fluid power, electrical/electronic, appliance and power tool, sporting goods, furniture and off-road transportation/equipment. The potential for using HYTREL® in other industries is limited only by your imagination.

Product selection

The following tables offer some general guidelines to assist you in selecting the most suitable grade of HYTREL® for your specific application. More detailed product data is available and should be consulted prior to making your final material selection.

For simplicity, the HYTREL® products have been grouped into three hardness ranges. Their ability to meet end-use requirements is indicated by the following codes:

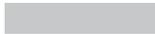
	very suitable
	generally suitable
	not suitable

Often, the starting point in selecting the right material is to consider the end-use environment, to what the application will be exposed to (i.e. – temperature, chemicals, etc.).

The best heat and chemical resistance is typically provided by the hardest, stiffest HYTREL® grades; whereas the softer, more flexible HYTREL® grades, usually provide better performance in low temperature environments.

It is important to keep in mind that the part design must accommodate the mechanical behaviour of the material selected based on the environmental conditions. In addition physical properties, methods of assembly and other criteria all play a part in making the best material selection for your application.

1. End-use environment:

	Hardness		
	35D to 40D	45D to 55D	63D to 82D/104R
Temperature:			
• High temperature mechanical properties			
• Standard grades			
• High performance grades			
• Low temperature flexibility			63D  82D/104R 
• Heat ageing (with 30 HS concentrate)			
Chemicals: See footnote below			
Weathering:			
• With 20 UV and/or 40CB/41CB			

Note: For more detailed information see page 9 of this brochure or the individual data sheets for the relevant concentrates.

2. Assembly

	Hardness		
	35D to 40D	45D to 55D	63D to 82D/104R
Heat welding			
High frequency welding			
Ultrasonic welding			
Solvent welding			
Bonding with adhesives			
Spin welding			
Snap fit			
Overmoulding (specific grades + process recommendations)	Contact DuPont representative for grades and process recommendations		

3. Physical properties

	Hardness		
	35D to 40D	45D to 55D	63D to 82D/104R
Impact strength (from -20 to +60°C)			 
Abrasion resistance			
• Standard grades			
• High performance grades			
Tear strength			
• Standard grades			
• High performance grades			
Flexural fatigue			
Creep			

4. Fluid resistance

	Hardness		
	35D to 40D	45D to 55D	63D to 82D/104R
Mineral oils and greases, other non-aromatic hydrocarbons	■	■	■
Benzene, toluene, other aromatic hydrocarbons, chemicals and solvents	□	■	■
Water, alcohols, glycols			
• at ambient temperature	■	■	■
• >50°C with 10MS	■	■	■
without 10MS	□	□	□
Acids and bases			
• diluted	■	■	■
• concentrated	□	□	□

Grade of HYTREL®

STANDARD GRADES

These grades offer the best balance of properties and cost.

	Description	Characteristics ¹⁾	Typical uses
HYTREL® G3548L	Low modulus moulding and extrusion grade. Contains improved colour-stable antioxidants and some UV stabilizer.	Very flexible grade of HYTREL®. Excellent flex-resistance, especially at low temperatures. Mouldable even in thin sections. Can be used in light-coloured products.	Applications requiring flex life coupled with good flexibility at low temperatures. Thin, flexible membranes. Good for high original colour retention.
HYTREL® G4074	Low modulus moulding and extrusion grade. Contains a discolouring antioxidant.	Excellent heat-ageing resistance and resistance to oils at high temperatures. Best low modulus moulding and extrusion grade.	Tubing. Hose Jackets. Wire and cable jackets. Film sheeting. Moulded products.
HYTREL® G4078W	Low modulus moulding and extrusion grade. Contains improved colour-stable antioxidants and some UV stabilizer.	Like HYTREL® G4074, except that heat-ageing resistance is reduced. Can be used in light-coloured products.	Applications requiring high original colour retention. Moulded and extruded products for consumer use.
HYTREL® G4774	Medium-low modulus moulding and extrusion grade. Contains a discolouring antioxidant.	Excellent heat-ageing resistance and resistance to oils at high temperatures. Good resistance to oils, fuels and solvents.	Tubing. Hose jackets. Wire and cable jackets. Profiles. Moulded products.
HYTREL® G5544	Medium modulus moulding and extrusion grade. Contains a discolouring antioxidant.	Excellent heat-ageing resistance and resistance to oils at high temperatures.	Same as HYTREL® G4774.
HYTREL® 6358	Medium modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Excellent heat-ageing resistance and resistance to oils at high temperatures.	Applications requiring high original colour retention. Moulded and extruded products for consumer use.
HYTREL® 7248	Medium modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Excellent heat-ageing resistance and resistance to oils at high temperatures.	Applications requiring high original colour retention. Moulded and extruded products for consumer use.
HYTREL® 8238	Highest modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Highest service temperature. Best resistance to oils, fuels, and solvents. Lowest fuels permeability.	Tubing. Wire and cable jackets. Gears and sprockets. Oil field parts. Electrical connectors.

HIGH-PERFORMANCE GRADES

These grades provide an extra measure of strength or performance in the most demanding applications, can be used in light-coloured products (except HYTREL® 5555HS).

	Description	Characteristics ¹⁾	Typical uses
HYTREL® 4056	Low modulus extrusion grade. Contains colour-stable anti-oxidants.	Excellent low-temperature properties. Excellent flex-fatigue resistance. Excellent creep resistance.	Hose jackets. Wire and cable jackets. Film and sheeting. Belting. Seals.
HYTREL® 4068	Low modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Low modulus grade similar to HYTREL® 4056, with a higher melting point.	Same as HYTREL® 4056 + Moulded products.
HYTREL® 4556	Medium-low modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Same as HYTREL® 4068.	Same as HYTREL® 4056 + Moulded products.
HYTREL® 5526	Medium modulus moulding grade. Contains colour-stable antioxidants.	Combines the best balance of properties of the product line.	Seals, packing and gaskets. Gears and bearings.
HYTREL® 5556	Medium modulus extrusion grade. Contains colour-stable antioxidants.	Combines the best balance of properties of the product line.	Tubing and hose. Wire and cable jackets. Film and sheeting. Belting.
HYTREL® 6356	Medium-high modulus moulding and extrusion grade. Contains colour-stable antioxidants.	Very good resistance to oils, hydraulic fluids and fuels. Very good resistance to permeation by gases and liquids.	Tubing and hose. Film. Profiles. Seals. Gears and sprockets. Fuel tanks.
HYTREL® 7246	High modulus moulding an extrusion grade. Contains colour-stable antioxidants.	High service temperature. Retains good low-temperature flexibility. Excellent resistance to oils, fuels and solvents. Low fuel permeability.	Tubing. Wire and cable jackets. Gears and sprockets. Oil field parts.

SPECIALITY GRADES

	Description	Characteristics¹⁾	Typical uses
HYTREL® 5555HS	Heat-stabilized grade of HYTREL® 5556. Contains a discolouring antioxidant.	Combine the best balance of properties of the product line.	Used where increased heat-ageing stability is required.
HTR4275 BK316	Medium modulus, high viscosity grades. Contains a discolouring antioxidant. HTR4275 BK is pigmented black. Particularly suitable for extrusion blow moulding and extrusion.	Good balance of properties combined with high viscosity for extrusion and blow moulding applications.	Hollow thin-walled parts. Blown film and sheeting. Large diameter tubing. Profiles. Automotive boots, air ducts and covers.
HTR5612 BK	Medium modulus, high-viscosity grades. Particularly suitable for blow moulding and extrusion.	Good balance of properties combined with high viscosity for extrusion and blow moulding applications.	Blown thin-walled parts. Blown film and sheeting. Large diameter tubing. Profiles. Automotive boots and covers.
HTR8068	Medium-low modulus moulding and extrusion grade, flame retarded antidrip compound.	Meets requirements of UL-94 class V-0 at 1,6 mm thickness.	Tubing and hose. Wire and cable jackets. Film and sheeting.

CONCENTRATES²⁾

These concentrates are in a base of HYTREL® 4056.

	Description	Characteristics ¹⁾ and typical uses
HYTREL® 10MS	Hydrolytic stabilizer concentrate.	For blending with other grades of HYTREL® to improve long term performance in hot, moist environments. Recommended letdown ration is 9:1.
HYTREL® 20UV	Ultraviolet (UV) light stabilizer concentrate.	HYTREL® 20UV is used for protection of lightcoloured parts against UV degradation. Recommended letdown ratio is 25:1 or less.
HYTREL® 30HS	Heat stabilizer concentrate.	For blending with other grades of HYTREL® to retard thermal oxidative degradation and extend useful life at elevated temperatures. Recommended letdown ratio is between 16:1 and 40:1, usually about 20:1.
HYTREL® 40CB HYTREL® 41CB	Concentrates of a fine particle size carbon black.	HYTREL® must be protected against degradation from exposure to UV light when used outdoors or when exposed to sunlight. HYTREL® 41CB provides the most effective protection. Recommended letdown ratio for direct outdoor exposure is from 20:1 to 9:1.
HYTREL® 51FR HYTREL® 52FR	Flame retardant concentrate.	For blending with soft (up to 47D: HYTREL® 51FR) and hard (from 55D: HYTREL® 52FR) grades of HYTREL® to improve the flame retardancy as measured by the time to flame extinction of the burn rate. Recommended letdown ratio is 10:1.)

Fluid resistance

HYTREL® has excellent resistance to non-polar materials, even at elevated temperatures. Polar materials at elevated temperatures may have severe effects on HYTREL®. In general, fluid resistance of HYTREL® improves as the stiffness of the grade increases.

Footnotes:

- 1) The characteristics shown are those of the unmodified standard composition. Special stabilizers and additives can be mixed into HYTREL® to improve its resistance to ultraviolet light, heat-ageing and moisture.
- 2) All concentrates are supplied in pellet form. They can be dry-blended with pellets of unmodified grades, then melt-mixed in the screw of an extruder or injection moulding machine.
- 3) All properties were measured on injection-moulded specimens at 23°C, unless specified otherwise.
The values shown are for unmodified grades. Colourants or additives of any kind may alter some or all of these properties. The data listed here fall within the normal range of product properties, but they should not be used to establish specification limits or used alone as the basis of design.
- 4) The Standard and High-Performance grades of HYTREL® are named according to the following product key:

First two digits	Hardness durometer D (in general, the greater the hardness, the stiffer the polymer)
Third digit	No significance
Fourth digit	Type of antioxidant: 0-5 Discolouring 6-9 Non-discolouring
Two-letter suffix	Special functions or colours
- 5) ASTM Type IV dumbbells diecut from injection moulded slab 2 mm thick. Head speed 50 mm/min.
- 6) Specimens 6,35mm thick.
- 7) Specimens 2 mm thick.

	Test method				Standard grades ⁴⁾					
	ASTM	ISO	DIN	Units	G3548L	G4074	G4078W	G4774	G5544	G358
MECHANICAL										
Property ³⁾										
Tensile stress at break ⁵⁾	D638	527	53455	MPa	10,3	13,8	17	20,7	31,0	41
Elongation at break ⁵⁾	D638	527	53455	%	200	230	310	275	375	420
Tensile stress at 5% strain	D638	527	53455	MPa	1,7	2,4	3,0	3,8	6,0	9
Tensile stress at 10% strain	D638	527	53455	MPa	2,6	3,8	4,5	6,0	10,5	13,1
Flexural modulus, at -40 °C 23 °C 100 °C	D790	178	53457	MPa	62 32,4 7	207 65,5 33	166 65,5 16	320 117 69	850 193 125	1850 290 -
Impact strength, Izod ⁶⁾ notched at -40 °C 23 °C	D256 Method A	-	-	J/m	No break No break	27 No break	27 No break	144 No break	133 No break	30 No break
Abrasion resistance Taber, CS-17 wheel Taber, H1-18 wheel	D1044	-	-	mg/1000 rev.	30 310	9 193	20 260	13 168	9 116	-
Initial tear resistance ⁷⁾ , die C	D1004	34	-	kN/m	51	81	88	94	123	-
Resistance to flex cut growth, Ross [pierced]	D1052	-	-	Cycles to 5×cut	>1×10 ⁶	>1×10 ⁶	>1×10 ⁶	>1×10 ⁶	8×10 ⁵	-
THERMAL										
Melting temperature	D3418 C	3146	53736	°C	156	170	170	208	215	213
Deflection temperature under flexural load at 0,5 MPa at 1,8 MPa	D648	75	53461	°C °C	N/A N/A	50 N/A	50 N/A	72 45	111 51	115 51
Vicat softening point	D1525 Method A	306	53460	°C	77	112	119	174	196	195
MISCELLANEOUS										
Density	D792	1183	53479	g/cm ³	1,15	1,18	1,18	1,20	1,22	1,22
Water absorption, 24 h immersion	D570	62	53495	%	5,0	2,1	3	2,5	1,5	-
Hardness, durometer D (max. reading)	D2240	868		points	35	40	40	47	55	63
Melt flow rate Test conditions: Temperature, °C / load, kg	D1238	1133	53735	g/10 min	10 190/2,16	5,2 190/2,16	5,3 190/2,16	11 230/2,16	10 230/2,16	9 230/2,16

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Standard grades		High-performance grades ⁴⁾							Specialty grades			
7248	8238	4056	4068	4556	5526	5556	6356	7246	5555HS	HTR4275 BK316	HTR5612	HTR8068
46	48,3	28,0	27,6	31,0	40,0	40,0	41,0	45,8	40,0	30,0	36,0	12,4
350	350	550	600	600	500	500	420	360	500	350	530	340
14	27,6	2,4	2,4	4,1	6,9	6,9	12,0	14,0	6,9	7,6	5,5	3,9
20	30,3	3,6	3,5	5,7	10,3	10,3	16,0	20,0	10,3	10,3	8,3	5,2
2390 544 -	3030 1210 255	155 62 27	172 55 28	230 94 44	760 207 110	760 207 110	1800 330 150	2410 570 207	760 207 110	910 160 59	510 124 46	650 174 50
40 210	30 40	No break No break	No break No break	No break No break	128 No break	170 No break	48 No break	40 210	43 No break	70 No break	110 No break	90 No break
- -	9 20	3 100	15 80	3 72	7 70	6 64	7 77	13 47	- 112	20 227	38 186	25 -
-	253	101	95	116	158	158	175	200	158	163	145	75
-	N/A	>1×10 ⁶	>1×10 ⁶	>1×10 ⁶	5×10 ⁵	5×10 ⁵	5×10 ⁵	3×10 ⁴	1×10 ⁵	5×10 ⁴	6×10 ⁵	-
219	223	150	193	193	203	203	211	218	203	196	196	169
130 52	140 55	54 N/A	55 N/A	60 43	90 49	90 49	115 51	130 52	90 49	68 45	62 44	- -
207	212	108	134	158	180	180	195	207	180	174	155	110
1,25	1,28	1,17	1,11	1,14	1,20	1,20	1,22	1,25	1,20	1,16	1,16	1,43
0,3	0,3	0,6	0,7	0,6	0,5	0,5	0,3	0,3	0,7	0,5	0,4	1,9
72	82 (104R)	40	40	45	55	55	63	72	55	55	50	46
13 240/2,16	12,5 240/2,16	5,3 190/2,16	8,5 220/2,16	8,5 220/2,16	18 220/2,16	7,5 220/2,16	8,5 230/2,16	12,5 240/2,16	8,5 220/2,16	2,0 230/5,0	3,0 230/2,16	4,6 190/2,16

N/A = not applicable

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