WASC 2334

Compatability

Information Summary

All materials used in the design as part of the manufacturing system for propellant explosives must be shown to be compatible with the explosives used in the system.

Compatibility is necessary to ensure safety and reliability throughout the service life of the store. VF1

The weapon Design Authorities make the final decision on suitability following tests or reference to past experience.

For MoD use testing normally has to be carried out by DRA RARDE although RO can carry out many of the tests.

The requirements are laid out in various standards. VF2

The Project Office or the OB may ask RO to justify their use of particular materials. For other uses non-MoD RO can do their own testing.

The factors to be considered are given in VF3.

FACTORS CONSIDERED WHEN ASSESSING COMPATIBILITY

- Level of Proximity
- Amount of Material Present
- Degree of Sealing
- Reliability or Safety Consideration

ROYALORDNANCE

COMPATIBILITY REGULATIONS

DEF STAN 08-5	Design Requirements for Weapon Systems
DEF STAN 13-102	Testing of materials that are required to be compatible with propellant explosives
DEF STAN 08-3	OB safety guidelines for munitions
BR 8541	Navy design requirements for ordnance for naval use

ENSURE

- SAFETY IN MANUFACTURE
- SAFETY IN STORAGE
- RELIABILITY IN SERVICE
- ADEQUATE SERVICE LIFE

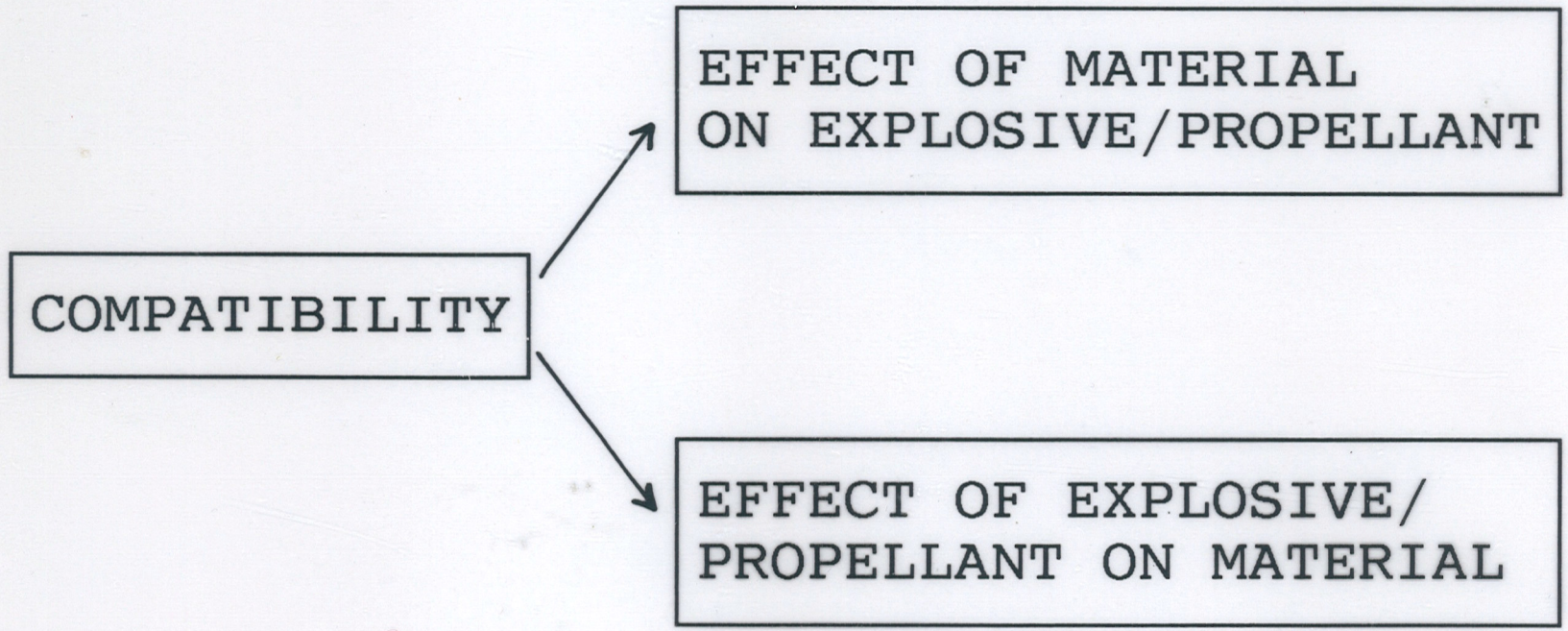
ROYALORDNANCE

What do we mean by compatibility?

VF4

IN OTHER WORDS

ABILITY OF 2 OR MORE MATERIALS TO REMAIN TOGETHER WITHOUT INTERACTING WITH EACH OTHER


COMPATIBILITY
EFFECT OF MATERIAL ON EXPLOSIVE/PROPELLANT
EFFECT OF EXPLOSIVE/ PROPELLANT ON MATERIAL

What effects do we see?

VF5

(propellant explosives)

EFFECTS ON EXPLOSIVE/PROPELLANT

1. Stabiliser Consumption/
   Loss of Activity

2. Production of Gas

3. Self-heating

What effects do we see?

(materials)

VF6

EFFECTS ON MATERIALS

1. Softening due to absorption

2. Softening due to breakdown

3. Embrittlement

How do we test?

The philosophy is to use cheap but severe tests to see quickly if any incompatibility exists.

VF8

STANDARD TESTS

1. VACUUM STABILITY

5g explosive/ propellant) 5g material)	40 hours at 100°C	1 week at 80°C

Subjective test
<5cc gas OK
5-10 marginal
>10cc reject

2. SILVER VESSEL

70g explosive/propellant) 600 hours at 80°C
3½g material) self heating test
If temperature rises by 2°C test is stopped.
Material fails if time < 80% of control.

3. ELEVATED TEMPERATURE STORAGE

5g explosive/propellant) 3 days at 80°C
5g material)
plus blank control.
Analyse for stabiliser depletion/loss of activity

4. pH OF AQUEOUS EXTRACT

Accept if >5 <9.

NEWER METHODS

Heat Flow Calorimetry

DSC TGA

Chromatographic methods HPLC GC etc.

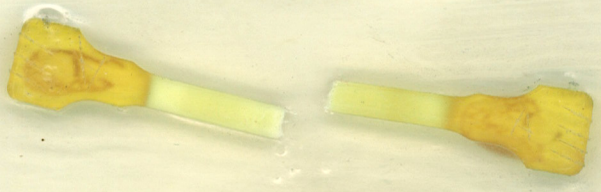
Generally 1 off tests no data base at present

TESTS ON MATERIALS

For polymers these are exposed to 2 standard explosives RDX/TNT and Cordite NQ for 3-12 months at 60°C and the change in properties measured. Few direct tests have been carried out on adhesives.

Show samples.

EXPOSURE TO CORDITE NQ



TPX

ARYLON

FLUORO ELASTOMER

POLYSULPHONE

RESULTS

A large database exists on proprietary materials. Much of the work done in the 1970's by Blay et all - show but DRA and ourselves do not always know what the materials were.

myself at ERDE

DEMONSTRATE RO RESULTS ON ADHESIVES

Some general guidelines are given in the next viewfoil.

VF9

Remember this is only a guide, you must test your own material combinations.

Blay & Pembridge	ERDE	Tech	Report 110	Compat of Epoxy Resins.
Blay & Pembridge	ERDE	Tech	Report 168	Compat of hardeners
"	ERDE	Tech	Report 184	" " Rubber/Resin Adhesives.
Blay, Maher & Rapley	PERME	"	" 121	Comp of lead & Silver Azide

ADHESIVES - GENERAL GUIDE ONLY

Material type	
Epoxy - amine cured	Generally incompatible especially part cured.
Epoxy - anhydride cured	OK
Phenolic	OK
Silicone	OK but may transmit vapour
2 part acrylic	OK but may be affected by NG
Anearobic	OK on limited results
Rubbery Adhesives Inc PU's	OK except for azides but often degraded by explosive/propellant

RO Summerfield can do many standard and non standard compatibility tests on materials including adhesives.

We have considerable experience of epoxies remember most of our rocket motors are 100% bonded together.

Manufacturers are helpful with both materials and surface preparation.

These days you have to pay the DRA but Fort Halstead has a wide experience of adhesives and compatibility. They provide both a testing and an advisory service.

Assessment Scheme for the Chemical Compatibility of Materials with Cast Double Base Propellants

G. M. Keeton and D. Facer

Royal Ordnance plc, Rocket Motors Division, Summerfield, Kidderminster, Worcs DY11 7RZ (United Kingdom)

Planschema für chemische Verträglichkeitsprüfungen von Materialien mit gegossenen Doublebase-Treibstoffen

Ein Schema für chemische Verträglichkeitsprüfungen von Materialien mit gegossenen Doublebase-Treibstoffen wird beschrieben, wie diese bei Royal Ordnance Summerfield durchgeführt werden. Wichtigster Punkt ist die Erkenntnis, daß es im Grunde genommen zwei Sicherheitsbereiche gibt für die Bewertung der Materialverträglichkeit. Diese sind die Anforderungen an die Sicherheit in der Fabrik und die Lebensdauer des Raketenmotors unter Einbeziehung der chemischen Stabilität, der Langzeitfunktion und der Betriebssicherheit eines Lagers. Zur Rationalisierung der Untersuchungen wird ein systematisches Prüfverfahren entwickelt nach definierten Kategorien, die im Hinblick auf Anwendung und Gebrauch eines Materials aufgestellt wurden.

Summary

The scheme for the chemical compatibility assessment of materials with cast double base propellants as operated at Royal Ordnance Summerfield is described. Central to the scheme is the recognition that evaluation of the compatibility of materials must consider two areas of safety. These are on-site process safety requirements, and rocket motor service life which includes safe chemical stability and the long term functioning and reliability of a store. To rationalize testing, a system of compatibility testing to defined categories classified by the application and usage of a material is followed.

1. Introduction

It has long been recognized that as part of ensuring the safety and long term reliability of a store containing explosive(s) the compatibility of materials and explosive(s) which make up the store must be ascertained. This paper is concerned with compatibility aspects associated with cast double base (CDB) rocket motor technology.

Compatibility testing and specification control includes materials such as paints, lacquers, adhesives, insulants, as well as the ingredients which make up the actual propellant.

In addition to the obvious need to identify the compatibility of materials in intimate contact, adverse reactions may also occur due to vapour contact. Physical aspects of compatibility, though not under consideration here, are equally important to determine, for example any deterioration in the properties of polymeric and adhesives which may feature in a design, must be established.

Questions of compatibility are not only important for project motor applications, the materials and process aids employed during the manufacturing process must also be assessed. Materials used in the process building may also have to be tested since articles can be affected by contact with surfaces of a building or fittings during storage for example.

2. Compatibility Requirements

The requirements for obtaining clearance for use of materials by designers, researchers and engineers are detailed in formally controlled documentation. Satisfying the relevant specification is a prerequisite to the introduction of any novel substance/material.

3. Chemical Compatibility: The Formal Scheme

All materials contained in explosives and explosive compositions have to be compatible, both chemically and physically, with each other and with explosives constituents. The requirement for materials to be compatible applies also to materials which are in contact with, or could come in contact with, explosives during production, processing and transport.

The sentencing of materials in respect of compatibility requires to take into account the nature of the material application. In particular whether the contact with explosives involves propellant, casting liquid or casting powder; whether the contact is intimate; whether the material is intended to be a reactant to form a finished material, and if so the maximum time of contact with explosives in the intermediate reactant state e.g. an additive to casting liquid involving magazine storage of the liquid requires different considerations to an inhibitor material or a rocket case external paint application etc.

0721-3115/92/0??? $3.50+.25/0

COMPATIBILITY REGULATIONS

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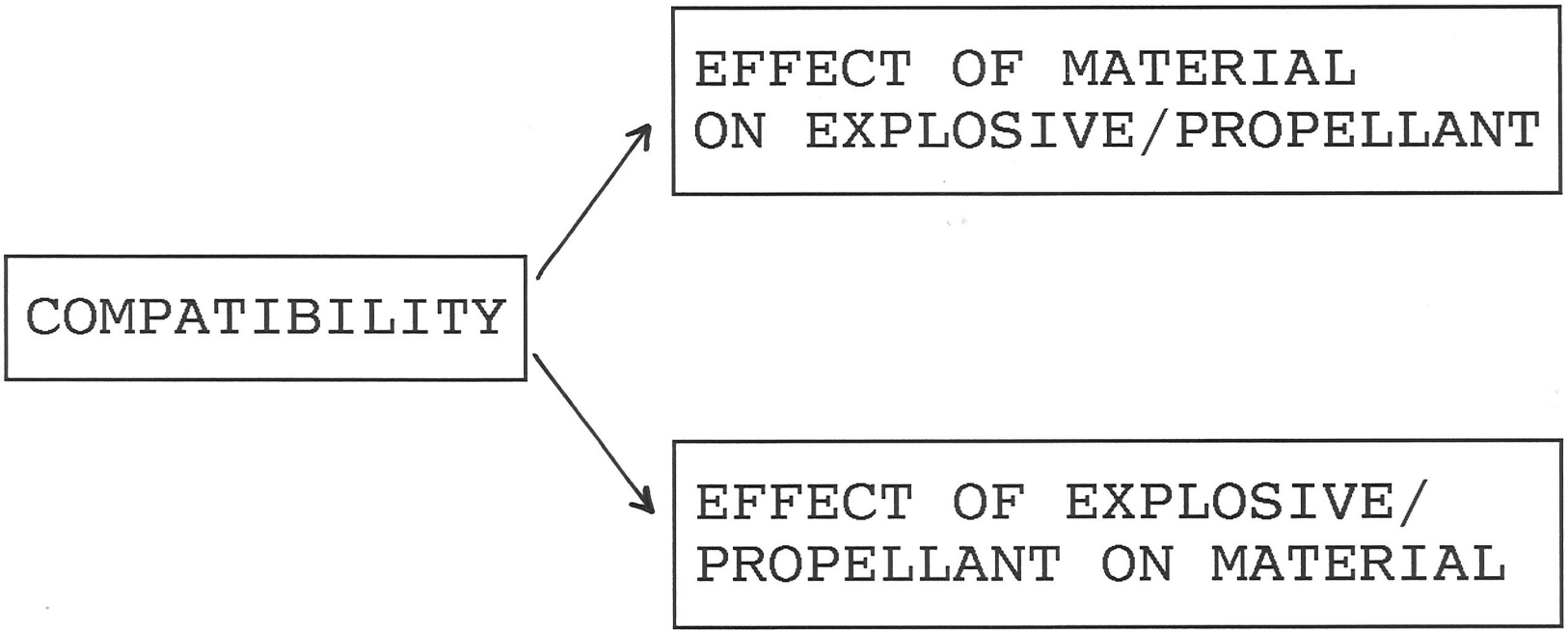
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ADHESIVE COMPOSITION PDE101 RMD	3041	2241
ADHESIVE FILM REDUX BSL319, BAT	3324	711
ADHESIVE FILM REDUX BSL319,BATC	3323	710
ADHESIVE LOCTITE LO 783 ANAEROB	4237/1	1993/1
ADHESIVE LOCTITE LO 783 ANAEROB	4237/2	1993/2
ADHESIVE NP 50.	3491	1025
ADHESIVE PLIOBOND TYPE 20 BATCH	4565	364
ADHESIVE, CHEMLOK 236 A RUBBER\	4435	2180
ADHESIVE, EVOSTIK,RESIN W,WOODW	4160	1539
ADHESIVE, LOCTITE SUPER GLUE XT	4406	786
ADHESIVE, LOCTITE SUPER GLUE XT	4405	785
ADHESIVE,736RTV,DOW CORNING,AS	4158	1987
ADHESIVE,736RTV,DOW CORNING,CUR	4159	1988
ADHESIVE,ARALDITE 2001 (CURED).	4274/1	2237/1
ADHESIVE,ARALDIT		
ADHESIVE,ARALDITE 2002 (CURED)	4274/2	2237/2
ADHESIVE,ARALDITE 2005 (CURED)	4274/3	2237/3
ADHESIVE,EMBOND NO 26 ANTISTATI	4029	263
ADHESIVE,EPOXY,025/35/4,(WITH I	4292/1	2241/1
ADHESIVE,EPOXY,025/35/4,(WITHOU	4292/2	2241/2
ADHESIVE,FRAME SEALANT (MASTIC)	4265	1703
ADHESIVE,HEAT SHRINK PLATAMID,0	4294/2	2243/2
ADHESIVE,HOT MELT ,MODIFIED POL	4163/2	1575/2
ADHESIVE,HOT MELT KUROPLAST CV2	4268	2157
ADHESIVE,HOT MELT S1030,(FILLED	4267	2156
ADHESIVE,HOT MELT,003/22/3,RAYC	4035/4	1945/4
ADHESIVE,HOT MELT,003/22/4,RAYC	4035/3	1945/3
ADHESIVE,HOT MELT,EVA BASED,BAM	4269/1	2158/1
ADHESIVE,HOT MELT,EVA BASED,BAM	4269/2	2158/2
ADHESIVE,HOT MELT,EVA BASED,BAM	4269/3	2158/3
ADHESIVE,HOT MELT,MODIFIED POLY	4163/1	1575/1
ADHESIVE,HOT MELT,RAYCHEM S1181	4035/1	1945/1
ADHESIVE,HOT MELT,S1182,RAYCHEM	4035/2	1945/2
ADHESIVE,LOCTITE SUPER GLUE XTR	4407	787
ADHESIVE,MS8008 A&B,2 PART COLD	4252	1994
ADHESIVE,PERMABOND (A) A113 ANA	4390	1732
ADHESIVE,PERMABOND ESP 110,(AS	4283	1706
ADHESIVE,PERMABOND ESP 110,(CUR	4302	2101
ADHESIVE,PLATAMID HEAT SHRINK,0	4294/1	2243
ADHESIVE,PLATAMID HEAT SHRINK,0	4294/1	2243/1
ADHESIVE,PVA HOT MELT,S1181(NEW	4272	2159
ADHESIVE,REDUX 120 TS 642,CIBA	4279	2162
ADHESIVE,SILVERLOK 1701,RUBBER\	4439	2182
ARALDITE 2001 ADHESIVE SOLVENT	5093	4251
BLUE SELF ADHESIVE DISCS (FOR U	3843	1914
CASCOPHEN ADHESIVE MIX (CURED F	4275	1997
CATALYST F FOR USE WITH E1958M	4240/2	1598/2
CHLORINATED RUBBER ADHESIVE, PR	3827	1906
CLOTH,POLYCOTTON,WHITE,FOR BAG	4121	1220
CYNOACRYLATE ADHESIVE RS STOCK	3482	1017
DOUBLE SIDED ADHESIVE TAPE 312,	4476/2	272/2
DOUBLE SIDED ADHESIVE TAPE 317,	4476/3	272/3
DOUBLE SIDED ADHESIVE TAPE 318,	4476/4	272/4
DOUBLE SIDED ADHESIVE TAPE 970,	4476/1	272/1
EPOXY PHENOLIC HT 432. HIGH TEM	4621	2407
EVOSTICK IMPACT ADHESIVE TYPE 5	3604	1301
EVOSTICK RESIN W WOODWORK ADHES	3356/1	687/1
EVOSTICK RESIN W WOODWORK ADHES	3356/2	687/2
EVOSTIK UNIVERSAL BUILDING ADHE	3756	1407
HEAT SHRINK ADHESIVE S1182+ 33%	4339	2066
HOT MELT ADHESIVE.S1090 & S1083	3836	1910
HOT MELT ADHESIVES MODIFIED POL	4190/2	1579/2
HOT MELT ADHESIVES. MODIFIED PO	4190/3	1579/3
HOT MELT ADHESIVES. MODIFIED PO	4190/4	1579/4
HOT MELT ADHESIVES. MODIFIED PO	4190/5	1579/5

PLASTIC,HOT MELT ADHESIVE,ESTAN	4239	1597
PLASTIC,HOT MELT ADHESIVE,MODIF	4190/1	1579/1
PLASTIC,POLYAMIDE HOT MELT ADHE	4282/1	2163/1
PLASTIC,POLYAMIDE HOT MELT ADHE	4282/2	2163/2
PLASTIC.HEAT SHRINK ADHESIVE.RA	4082/1	1557/1
PLASTIC.HEAT SHRINK ADHESIVE.RA	4082/2	1557/2
PLASTIC.HEAT SHRINK ADHESIVE.RA	4082/3	1557/3
PLATAMID MODIFIED HEAT SHRINK A	4325	2059
PLIOBOND 20 TYPE QX GRADE 52 (N	3668	256
POLY COTTON (WHITE) FOR USE WIT	3648	1206
POLYIMIDE BR 34 B 18. HIGH TEMP	4620	2406
POLYIMIDE FM 34B 18 u. HIGH TEM	4624	2410
POLYIMIDE FM 34B 18. HIGH TEMP.	4623	2409
RESIN, M BOND ADHESIVE TYPE AE	4417	1737
RS 554-850 QUICK SET EPOXY ADHE	3612/2	1303/2
RS 555-847 LOCTITE MULTI BOND A	3612/1	1303/1
S 1030 POLYOLEFIN BASED ADHESIV	4495	2312
S.S.L. END RING ADHESIVE CURED	5104/2	4052/2
S		
S.S.L. END RING ADHESIVE CURED	5104/2	4052/2
S.S.L. END RING ADHESIVE CURED	5104/1	4052/1
S.S.L. END RING ADHESIVE CURED	5109/1	4053/1
S.S.L. END RING ADHESIVE CURED	5109/2	4053/2
SELF ADHESIVE LABEL AL FOIL /AC	5230/3	4404/3
SELF ADHESIVE LABEL AL FOIL/ACR	5230/4	4404/4
SELF ADHESIVE LABEL AL FOIL/ACR	5230/5	4404/5
SELF ADHESIVE LABEL+PROTECTIVE	5203	4149
SELF ADHESIVE LABELS AL FOIL TA	5230/1	4404/1
SELF ADHESIVE LABELS AL FOIL/AC	5230/2	4404/2
SELF ADHESIVE LABELS FOR EGYPTI	3896	1857
SELF ADHESIVE LABELS MATAPAN IG	5151	4134
SELF ADHESIVE LABELS [BRADY LTH	5152	4133
SELF ADHESIVE LABLES. SUPPLIED	3283	884
SELF ADHESIVE PTFE SHEET 0.2mm	4427	1740
SELF-ADHESIVE LABELS,S22,25*51m	4857	2617
SILASTIC 732 RTV ADHESIVE/SELAN	5112	3867
SILBOND 22 ADHESIVE, RUBBER/MET	4437	2181
SILVER GREY THIXOTROPIC PASTE (	5096	4254
SUPER GLUE (FARWELL) 146-537 SU	4942/2	3001/2
TOUGHENED ARCYLIC ADHESIVE+PERM	5210	4304
TRETOBOND 844 CONDUCTIVE CONTAC	4937	1650
UNCLASSIFIED,PHOTOSENSITIVE ADH	4019/2	1894/2

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UNCLASSIFIED,PHOTOSENSITIVE ADH	4019/3	1894/3
UNCLASSIFIED,PHOTOSENSITIVE ADH	4019/4	1894/4
UNCLASSIFIED,PHOTOSENSITIVE ADH	4019/5	1984/5
UNCLASSIFIED,PHOTOSENSITIVE ADH	4019/6	1894/6
UNCLASSIFIED,PHOTOSENSITIVE ADH	4019/1	1894/1
UNCLASSIFIED,POLYCELL ALL PURPO	4226	1548
UNCLASSIFIED,RED SELF-ADHESIVE	4050	1946
VINYL FILM ADHESIVE FASCAL 400	4990	3057
YELLOW FABRIC ADHESIVE TAPE. VI	3800	555
ZIRCONIUM DIOXIDE,4.5% LIME STA	3373	755

END OF FILE

(TO CONTINUE ENTER ANY KEY)

CHLORINATED RUBBER ADHESIVE, PR	3827	1906
CLOTH,POLYCOTTON,WHITE,FOR BAG	4121	1220
CYNOACRYLATE ADHESIVE RS STOCK	3482	1017
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HOT MELT ADHESIVES. MODIFIED PO	4190/5	1579/5
J25/318.5 ADHESIVE. CURED FOR 1	3747	1344
LIQUID ADHESIVE 4753C. CPC (UK.	4504	2315
LOCTITE ADHESIVE "TEMPFLEX 544"	4653	2412
LOCTITE ADHESIVE GRADE 638 CURE	4590	2401
LOCTITE ADHESIVE STEELBONDER 34	4674/1	2413/1
LOCTITE ADHESIVE SUPERFLEX SEAL	4674/2	2413/2
MODIFIED EPOXY FILM ADHESIVE DL	5110	4054
MOSTAR STAR LINER PERMANENT SEL	5197	3636
OSMAN POLYESTER COTTON SHEET. B	3594	1047
OXYIMIDE FM 32. HIGH TEMP.ADHES	4622	2408
P-2 ADHESIVE.	3619	1305
PERMABOND A ANAEROBIC ADHESIVE	4587	1669
PLAIN SELF ADHESIVE LABELS. A&G	3842	1913
PLASTIC,ADHESIVE,HEAT SHRINK, C	4298	2246
PLASTIC,ADHESIVE,HOT MELT,B.A.M	4228/1	1592/1
PLASTIC,ADHESIVE,HOT MELT,B.A.M	4228/2	1592/2
PLASTIC,HOT MELT ADHESIVE 020/4	4229	1593
PLASTIC,HOT MELT ADHESIVE XIRO/	4236	1596
PLASTIC,HOT MELT ADHESIVE,020/	4227	1591
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