Technical Report No. 48 (2)

Eye Irritation: Reference Chemicals Data Bank (Second Edition)

June 1998

ISSN-0773-8072-48(2)

Brussels, June 1998

ECETOC Technical Report No. 48 (2)

PREFACE TO THE SECOND EDITION

ECETOC Technical Report No. 48, Eye Irritation Reference Chemicals Data Bank, published in 1992, presented comprehensive rabbit eye irritation data obtained on 55 chemicals assessed in 72 *in vivo* tests. Since that publication, the ECETOC Task Force became aware of other studies, not then published, and of other sources of unpublished data. This second edition contains 77 additional chemicals which, together with their *in vivo* data, meet the ECETOC selection criteria.

Most of the text from the original report is repeated in this second edition, but with minor changes necessitated by the increased number (132) of chemicals. The main changes are in the updated indexes (Tables 3 and 4) and data sheets (Appendix), in which the additional chemicals are identified by an asterisk (*).

Note: This is a compilation of existing data, much of which has never been published in detail. No testing was undertaken in relation to the preparation and updating of this data bank.

Eye Irritation: Reference Chemicals Data Bank
(Second Edition)

CONTENTS

SUMMARY

For several years industry has been engaged in modifying the existing *in vivo* techniques for the assessment of ocular irritancy in order to minimise distress and the number of animals used. This has been seen as an interim measure until alternative non-sentient methods, acceptable to regulatory authorities have been developed. Acceptance of alternative techniques has been hampered in the past by the use of unspecified chemicals in validation exercises. Establishment of a reference chemicals data bank of freely available chemicals of known purity and ocular irritation response would allow the chemicals and their associated data to be used in the various stages of validation without recourse to *in vivo* testing.

The original list of 55 chemicals for which comprehensive *in vivo* rabbit eye irritation data were available has now been extended to 132 chemicals, assessed in 149 *in vivo* studies; 28 of the test materials were tested as solids, 24 as aqueous solutions. Stringent criteria regarding purity of the chemicals and quality of the *in vivo* data were applied in selecting the chemicals. No new *in vivo* testing was carried out in order to qualify a chemical for inclusion in the data bank. The 132 chemicals selected are available at high and consistent purity and are expected to be stable in storage. They have been tested undiluted in *in vivo* studies, excepting those chemicals where high concentrations of the substance could be expected to cause severe effects. The *in vivo* data have been generated since 1981 in studies carried out according to OECD Test Guideline 405 and following the principles of Good Laboratory Practice. The data presented were obtained from tests normally using at least 3 rabbits evaluated at the same time. Dosing was by instillation of 0.1 ml (or equivalent weight) into the conjunctival sac and observations were made at least at 24, 48 and 72 hours after instillation.

The extended list of chemicals now represents a full range of chemical types (acetates, acids, acrylates/methacrylates, acyl halides, alcohols, aldehydes, alkalis, aromatics, brominated derivatives, esters, fatty acids, heterocyclics, hydrocarbons, inorganics, ketones, nitriles, organophosphates, pesticides, soaps/surfactants, sulphur-containing compounds, triglycerides) and different degrees of irritancy. These chemicals are ranked for eye irritation potential on the basis of a Modified Maximum Average Score (MMAS). They should be of use in validation tests for promising alternatives to the *in vivo* rabbit eye irritation test. This is an essential step in the progression to regulatory acceptance.

1. INTRODUCTION

Historically, toxicological data used in assessing the safety of chemicals to man have been generated by testing the materials on animals. Regulations now require extensive testing of new chemicals and there are increasing demands for the testing of many chemicals which may have been in use for a number of years. The net result of these developments is that the number of animals used in toxicological tests may be expected to increase. These trends are taking place whilst there is criticism over the use of animals in such testing.

Many companies and regulatory authorities share the published concern of the animal welfare organisations. For several years industry has been modifying the existing *in vivo* techniques in order to minimise distress, and the number of animals used, as an interim measure until alternative non-sentient methods acceptable to regulatory authorities have been developed.

The *in vivo* rabbit eye irritation test, in particular, has frequently been criticised on animal welfare grounds. In recent years many laboratories have been working to develop *in vitro* alternatives to this test, and a number of validation exercises have been carried out to assess the reliability and relevance of some of the more promising methods.

Initially, this work was conducted without the benefit of a data bank of reference chemicals for which good quality *in* vivo data were available, although proposals had been made that a bank should be established (US Joint Government-Industry Workshop, 1989; Balls *et al*, 1990; EEC, 1990; Purchase, 1990).

These proposals led the ECETOC Scientific Committee to convene the original Task Force, the objective of which was the development of a list of chemicals which would serve as a reference data bank to be used in assessing the potential of alternative techniques as a replacement for the *in vivo* eye irritation test (often referred to as the "Draize test"). The terms of reference of the original Task Force were as follows.

1. To prepare a list of chemicals suitable for use in the validation of alternative methods for the assessment of eye irritation; the list should contain chemicals covering different chemical classes and different degrees of irritancy;

2. to derive from the literature the *in vivo* eye irritancy of chemicals in this list;

3. to rank the eye irritancy potential of the chemicals on the basis of the individual *in vivo* data available;

4. to recommend, if appropriate, the need for chemicals so selected to be tested in a single laboratory in order to provide adequate information suitable for validation studies.

The data contained within the report and publication of the original Task Force (ECETOC, 1992; Bagley *et al*, 1992) were considered to be of great value to the EC/HO international validation study on alternatives to the Draize test (Balls *et al*, 1995).

In 1996, the ECETOC Scientific Committee approved the updating and expansion of the data bank using the same terms of reference and closely similar criteria.

Potential sources of *in vivo* eye irritation data were identified from the literature. From these (and other) sources, information relating to eye responses of individual rabbits, and the specification of the chemicals selected, was assessed against selection criteria (Chapter 2).

2. PROCESS FOR THE SELECTION OF CHEMICALS

A review of the literature revealed a number of publications containing references to *in vivo* eye irritation tests of identified chemicals. In virtually all cases data were presented in summary form (and interpreted against different standards or indices) and consequently were inappropriate for the ECETOC exercise. Due to these limitations, the authors and other sources were contacted to establish the availability of individual rabbit eye data, the *in vivo* test method and the specification of the chemicals used.

The chemicals and the eye irritation data given in the Appendix meet the following criteria.

- Reference chemicals are single chemical entities available at known and consistent high purity and are expected to be stable in storage.
- There are *in vivo* rabbit eye irritation data which have been generated since 1981 in studies carried out according to OECD Test Guideline 405[a], following the principles of Good Laboratory Practice and have been obtained in tests:
  - normally using at least 3 New Zealand White rabbits tested at the same time,
  - involving instillation of 0.1 ml or the equivalent weight into the conjunctival sac,
  - in which anaesthesia was not used,
  - in which observations were made at least at 1, 2, and 3 days after instillation, and
    - include individual scores (using the Draize scale) for each time point assessed in each rabbit,
    - enable reversibility/irreversibility to be assessed,
  - in which chemicals were tested undiluted (except that data from studies using dilutions of the chemical were acceptable when higher concentrations of the chemical could be expected to cause severe effects).

For the compilation of this Second Edition, the first criterion for reference chemicals ("single chemical entities available at known, high, consistent purity and expected to be stable in storage") has been slightly relaxed. This has been done so that some commercial chemicals, manufactured and supplied to a specification which ensures a consistent composition, can be included in the data bank. An example is fatty acids where composition is guaranteed by analytical parameters such as saponification value rather than % purity (saponification is used as a qualitative measurement since analytical quantitation is expensive and would take too much time). If appropriate, this is indicated on the data sheets in the Appendix.

---

[a] OECD Test Guideline 405 was adopted on 12 May 1981. A revised Test Guideline 405 was adopted on 24 February 1987 but the revisions did not amend the essentials of the procedure for the *in vivo* test (OECD, 1987).

3. CHEMICALS DATA BANK

3.1 CHEMICALS SELECTED

From the sources of data available 55 chemicals met the criteria defined above (Section 2) for inclusion in the original samples bank; a further 77 chemicals have now been included. Eye irritation data for individual rabbits tested with these chemicals are presented in the Appendix.

3.2. GRADING OF OCULAR EFFECTS

The EC and US regulatory agencies use the OECD grading scale for the effects on the eye as shown in Table 1.

Table 1: Grading Scale for Eye Irritation Effects
(OECD, 1987)

	Grade
Cornea: Opacity, degree of density (area most dense taken for reading)	
No opacity	0
Scattered or diffuse area, details of iris slightly obscured	1
Easily discernible translucent areas, details of iris slightly obscured	2
Opalescent areas, no details of iris visible, size of pupil barely discernible	3
Opaque, iris not visible	4
Iris: Values	
Normal	0
Folds above normal, congestion, swelling, circumcorneal injection (any or all of these or combinations of any thereof), iris still reacting to light (sluggish reaction is positive)	1
No reaction to light, haemorrhage, gross destruction (any or all of these)	2
Conjunctivae: Redness (refers to palpebral conjunctivae only):	
Vessels normal	0
Vessels definitely injected above normal	1
More diffuse, deeper crimson red, individual vessels not easily discernible	2
Diffuse beefy red	3
Conjunctivae: Chemosis (Oedema)	
No swelling	0
Any swelling above normal (includes nictating membrane)	1
Obvious swelling with partial eversion of lids	2
Swelling with lids about half closed	3
Swelling with lids about half closed to completely closed	4

Friedenwald *et al* (1944) published “a numerical estimation of the severity of lesions produced in the cornea of rabbit's eyes by action of corrosive agents.” In addition to the factors listed in Table 1, the scheme assigned grades, each with a maximum of 4, for the area of cornea affected and conjunctival discharge, and also rated four other parameters related to corneal effects. The maximum score (intensity of corneal opacity rating a maximum of 8), calculated by simple addition, was 40 with maximal corneal effects contributing 70 % of the maximum. Draize *et al* (1944) modified this scheme to make it more generally applicable by using a weighted scoring system involving multiplication factors as shown in Table 2. The contribution of maximal corneal effects contributes 73 % to the total score.

Table 2: Grading Scale and Multiplication Factors

(Draize *et al*, 1944)

		Grade
I.	**Cornea**	
	A. Opacity - degree of density (area most dense taken for reading):	
	No opacity	0
	Scattered or diffuse area, details of iris slightly obscured	1
	Easily discernible translucent areas, details of iris slightly obscured	2
	Opalescent areas, no details of iris visible, size of pupil barely discernible	3
	Opaque, iris invisible	4
	B. Area of cornea involved:	
	One quarter (or less) but not zero	1
	Greater than one quarter but less than half	2
	Greater than half but less than three quarters	3
	Greater than three quarters, up to whole area	4
	Score (A x B) x 5 ***Total Maximum = 80***	
II.	**Iris**	
	C. Values:	
	Normal	0
	Folds above normal, congestion, swelling, circumcorneal injection (any or all of these or combinations of any thereof), iris still reacting to light (sluggish reaction is positive)	1
	No reaction to light, haemorrhage, gross destruction (any or all of these)	2
	Score C x 5 ***Total Maximum = 10***	
III.	**Conjunctivae**	
	D. Redness (refers to palpebral conjunctivae only):	
	Vessels normal	0
	Vessels definitively injected above normal	1
	More diffuse, deeper crimson red, individual vessels not easily discernible	2
	Diffuse beefy red	3
	E. Chemosis (Oedema):	
	No swelling	0
	Any swelling above normal (includes nictating membrane)	1
	Obvious swelling with partial eversion of lids	2
	Swelling with lids about half closed	3
	Swelling with lids about lids about half closed to completely closed	4
	F. Discharge:	
	No discharge	0
	Any amount of difference from normal (does not include small amounts observed in inner canthus of normal animals)	1
	Discharge with moistening of the lids and hairs just adjacent to lids	2
	Discharge with moistening of the lids and hairs, and considerable area around the eye	3
	Score (D + E + F) x 2 ***Total Maximum = 20***	
	Maximum possible score = 80 + 10 + 20 = 110	

3.3. RANKING OF CHEMICALS SELECTED

The eye irritation potential of chemicals is often summarised as the Maximum Average Score (MAS). The MAS is obtained by averaging the individual animal weighted scores at each time of observation (e.g. 1 day, 2 days) and then selecting the highest (maximum) of these averages.

Not all the *in vivo* assays which qualified chemicals for inclusion in this report included readings made less than 24 hours after instillation. Consequently, for consistency, the scores given in Table 3 and 4, and in the Appendix are by "Modified Maximum Average Score" (MMAS) in that they represent maxima calculated at 24 hours (or more) following instillation. Selected chemicals are ranked by increasing MMAS in Table 3, and by chemical type and increasing MMAS in Table 4 and the Appendix.

All scores, including (where available) observations made within 24 hours following instillation are given in the data sheets which comprise the Appendix. Tables 3 and 4 refer the reader to these data sheets.

3.4. CLASSIFICATION SCHEMES

Data obtained from the *in vivo* rabbit eye test are used to assess ocular hazard of materials to man, and in many cases to meet regulatory requirements for classification of a material for its potential irritancy to the eye. Different national and international schemes, to which the reader is referred, are in current use to classify the ocular hazard from the results obtained, e.g. in the USA and EU (NAS,1977; FIFRA and US-EPA, 1990; EEC, 1993). Additional guidance in the application of such classification schemes has also been developed, see for example ECETOC (1997).

Table 3: Chemicals Ranked by MMAS[a]

MMAS range (No. of test materials)		Chemical[b]	MMAS	Page No. (Appendix)
Zero (19)	*	Bromo-2-butane	0	107
	*	1-Bromo-4-chlorobutane	0	108
	*	Dichlorotoluenes	0	83
	*	3,3-Dimethylpentane	0	125
	*	2-(*n*-Dodecylthio)ethanol (solid)	0	215
	*	2-Ethoxyethyl methacrylate	0	37
	*	Ethyleneglycol diethylether	0	119
	*	2-Ethylhexylthioglycolate	0	216
	*	Ethylthioethyl methacrylate	0	38
	*	Ethyltriglycol methacrylate	0	39
	*	3-Methoxy-1,2-propanediol	0	52
		4,4-Methylene *bis*-(2,6-di-*tert*-butylphenol)	0	84
	*	*p*-Methylthiobenzaldehyde	0	217
	*	Nonyl acrylate	0	40
	*	Nonyl methacrylate	0	41
	*	*n*-Octyl bromide	0	109
		Polyethylene glycol 400	0	195

Table 3: Chemicals Ranked by MMAS[a]

MMAS range (No. of test materials)	Chemical[b]	MMAS	Page No. (Appendix)
	* Potassium tetrafluoroborate (solid)	0	142
	* *iso*-Stearyl alcohol	0	51
0.1-10 (54)	* Di-*iso*-butyl ketone[c]	0.7	148
	3-Methylhexane	0.7	126
	* *iso*-Octyl acrylate	0.7	42
	* *iso*-Octylthioglycolate	0.7	218
	4-Bromophenetole	1.3	86
	* Di-*n*-propyl disulphide	1.3	219
	* Heptyl methacrylate	1.3	43
	* *n*-Hexyl bromide	1.3	110
	* Myristyl myristate (solid)	1.3	117
	* 2,4-Pentanediol	1.3	53
	Propylene glycol	1.3	54
	* *iso*-Propyl *iso*-stearate	1.3	118
	* Trifluoroethyl methacrylate	1.3	44
	Xylene [1 x][d]	1.5	87
	3-Chloro-4-fluoronitrobenzene	1.7	89
	Glycerol	1.7	56
	Triton X-100[e] (1 %)	1.7	197
	* *n*-Amyl bromide	2.0	111
	1,9-Decadiene	2.0	130
	* 1,6-Dibromohexane	2.0	112
	1,3-Di-*iso*-propyl benzene	2.0	91
	Dodecane	2.0	132
	* Glycerol tri-*iso*-stearate	2.0	226
	2-Methylpentane	2.0	128
	1-Methylpropyl benzene	2.0	93
	Polyethylene glycol 600	2.0	199
	3-Ethyltoluene	2.3	95
	Cetylpyridinium bromide (0.1 %)	2.7	187
	Methyl trimethyl acetate	2.7	16
	* *iso*-Propyl bromide	2.7	113
	1,5-Dimethyl cyclo-octadiene	2.8	134
	cis-Cyclo-octene	3.3	136
	* *iso*-Stearic acid	3.3	120
	Igepon AC-78[f] (0.5 %)	3.7	209
	Methyl cyclopentane	3.7	138
	Ethyl trimethyl acetate	3.8	18
	* 1,4-Dibromobutane	4.0	114
	* 1,5-Dibromopentane	4.0	115
	* 1,3-Dibromopropane	4.0	116
	* *iso*-Myristyl alcohol	4.0	58
	Tween 20[g]	4.0	201
	2,4-Difluoronitrobenzene	4.7	97
	1,5-Hexadiene	4.7	140
	Methyl *iso*-butyl ketone	4.8	149
	* Thiodiglycol	5.3	220
	* Allyl methacrylate	5.8	45
	N,N-Dimethyl guanidine sulphate (solid)	6.7	227
	Trichloroacetic acid (3 %)	6.7	30
	Styrene	6.8	99
	n-Butyl acetate	7.5	20
	* 2,2-Dimethyl-3-pentanol	8.3	59
	* 1,2,3-Trimercaptopropane	8.7	221
	Toluene	9.0	101
	Xylene [2 x][d]	9.0	103

Table 3: Chemicals Ranked by MMAS[a]

MMAS range (No. of test materials)		Chemical[b]	MMAS	Page No. (Appendix)
10 - 20	*	Tetra-aminopyrimidine sulphate (solid)	10.3	122
(12)		Methyl amyl ketone [1 x][d]	10.5	151
	*	2-Methyl-1-pentanol	13.0	60
	*	Fomesafen, acid form (solid)	13.5	163
	*	3-Chloropropionitrile	13.7	159
	*	Maneb (solid)	14.3	164
		Cellosolve acetate[h]	15.0	22
		Ethyl acetate	15.0	24
		Sodium lauryl sulphate (3 %)	16.0	174
		Methyl amyl ketone [2 x][d]	16.3	153
		Ethyl-2-methyl acetoacetate	18.0	26
		Ammonium nitrate (solid)	18.3	143
20 - 30	*	Cyclopentanol	21.7	61
(9)	*	Soap from 80/20 tallow/coconut oil (solid)	23.3	171
		2,6-Dichlorobenzoyl chloride	23.8	49
	*	Ethanol	24.0	62
	*	Ethyl Thioglycolate	24.7	222
		Sodium hydroxide (1 %)	25.8	80
	*	Methyl cyanoacetate	27.7	27
	*	Glycidyl methacrylate	28.0	47
	*	2,5-Dimethylhexanediol (solid)	28.3	63
30 - 40	*	Dibenzyl phosphate (solid)	30.0	161
(14)		*iso*-Propanol	30.5	64
		Sodium perborate tetrahydrate (solid)	30.5	144
	*	Potassium cyanate (solid)	31.3	146
	*	Soap from 80/20-Palm oil/coconut oil	31.3	172
	*	3,3'-Dithiopropionic acid (solid)	31.7	223
		Triton X-100[e] (5 %) [1 x][d]	32.3	203
		Triton X-100[e] (5 %) [2 x][d]	33.8	205
		Benzalkonium chloride (1 %) [1 x][d]	34.3	180
		Cetylpyridinium bromide (1 %)	36.0	189
	*	Dibenzoyl-L-tartaric acid (solid)	36.7	32
		Igepon AC-78[f] (10 %)	36.8	211
	*	L-Aspartic acid (solid)	37.3	33
	*	Lauric acid (solid)	38.0	121
		Methyl acetate	39.5	28
40 - 50	*	*n*-Octanol	41.0	66
(8)	*	γ-Butyrolactone	43.0	228
	*	Furfuryl alcohol	44	67
		2,2-Dimethyl butanoic acid	44.7	34
	*	Methoxyethyl acrylate	45.0	48
	*	Sodium undecylenate (33.2 %)	45	173
	*	1-Naphthalene acetic acid (solid)	46.7	166
	*	Pyridine	48.0	123
50 - 60		Methyl ethyl ketone	50.0	155
(9)		4-Carboxybenzaldehyde (solid)	50.3	79
		2-Ethyl-1-hexanol	51.3	68
		Igepon AC-78[f] (5 %)	51.7	213
	*	Methyl thioglycolate	53.0	224
	*	Calcium sulphhydrate solution (20.0 %)	55	225
		Benzalkonium chloride (1 %) [2 x][d]	56.3	182
		Sodium lauryl sulphate (15 %)	59.2	176
	*	Imidazole (solid)	59.3	124

Table 3: Chemicals Ranked by MMAS[a]

MMAS range (No. of test materials)	Chemical[b]	MMAS	Page No. (Appendix)
60 - 70	*iso*-Butanol	60.3	70
(11)	Sodium lauryl sulphate (30 %)	60.5	178
	n-Butanol	60.8	72
	* Sodium oxalate (solid)	61.3	147
	* Diethyl aminopropionitrile	62.3	160
	* 1-Naphthalene acetic acid, sodium salt (solid)	64.5	168
	n-Hexanol	64.8	74
	Acetone	65.8	157
	Butyl cellosolve[i]	68.7	76
	Triton X-100[e] (10 %)	68.7	207
	p-Fluoroaniline	69.8	105
70 - 80	* Promethazine hydrochloride (solid)	71.7	229
(2)	Cyclohexanol	79.8	77
80 - 90	* Quinacrine (solid)	82.0	230
(6)	* Chlorhexidine (solid)	82.3	231
	* Captan 90-concentrate (solid)	83.0	170
	Benzalkonium chloride (5 %)	83.8	184
	Cetylpyridinium bromide (6 %)	85.8	191
	Cetylpyridinium bromide (10 %)	89.7	193
> 100	* 1,2,4-Triazole, sodium salt (solid)	104	232
(4)	Trichloroacetic acid (30 %)	106	36
	Benzalkonium chloride (10 %)	108	186
	Sodium hydroxide (10 %)	108	82

[a] Modified Maximum Average Score
[b] An asterisk (*) denotes additional chemicals with respect to the 1992 edition
[c] 2,6-Dimethyl-4-heptanone
[d] The same sample of the chemical was retested [1 x, 2 x] in the same laboratory
[e] Polyoxyethylene octylphenol
[f] CN-oil acid ester of sodium isethionate
[g] Sorbitanpolyoxyethylene monolaurate
[h] Ethyleneglycol monoethyl ether acetate
[i] Ethyleneglycol monobutyl ether

Table 4: Eye Irritation Data Scores Ranked by Chemical Type and Increasing MMAS[a]

	Chemical[b]	Purity (%)	N[c]	MMAS	Page (Appendix)
	Acetates (8 chemicals)				
	Methyl trimethyl acetate	99	6	2.7	16
	Ethyl trimethyl acetate	99	6	3.8	18
	n-Butyl acetate	99	4	7.5	20
	Cellosolve acetate[d]	99	4	15.0	22
	Ethyl acetate	99	4	15.0	24
	Ethyl-2-methyl acetoacetate	97[e]	3	18.0	26
*	Methyl cyanoacetate	99	3	27.7	27
	Methyl acetate	98	4	39.5	28
	Acids (4 chemicals, 5 tests)				
	Trichloroacetic acid (3 %)	RG[f]	6	6.7	30
*	Dibenzoyl-L-tartaric acid (solid)	98	3	36.7	32
*	L-Aspartic acid (solid)	100	3	37.3	33
	2,2-Dimethyl butanoic acid	96	6	44.7	34
	Trichloroacetic acid (30 %)	RG[f]	1	106	36
	Acrylates and Methacrylates (11 chemicals)				
*	2-Ethoxyethyl methacrylate	99.8	3	0	37
*	Ethylthioethyl methacrylate	99.7	3	0	38
*	Ethyltriglycol methacrylate	96.1	3	0	39
*	Nonyl acrylate	99	3	0	40
*	Nonyl methacrylate	99.0	3	0	41
*	*iso*-Octyl acrylate	> 99	3	0.7	42
*	Heptyl methacrylate	> 99	3	1.3	43
*	Trifluoroethyl methacrylate	99.9	3	1.3	44
*	Allyl methacrylate	99.6	6	5.8	45
*	Glycidyl methacrylate	> 99	3	28.0	47
*	Methoxyethyl acrylate	99.6	3	45.0	48
	Acyl halides (1 chemical)				
	2,6-Dichlorobenzoyl chloride	99	6	23.8	49
	Alcohols (20 chemicals)				
*	*iso*-Stearyl alcohol	-	3	0	51
*	3-Methoxy-1,2-propanediol	98	3	0	52
*	2,4-Pentanediol	98	3	1.3	53
	Propylene glycol	-	6	1.3	54
	Glycerol	> 99.5	6	1.7	56
*	*iso*-Myristyl alcohol	92.6	3	4.0	58
*	2,2-Dimethyl-3-pentanol	97	3	8.3	59
*	2-Methyl-1-pentanol	99	3	13.0	60
*	Cyclopentanol	99	3	21.7	61
*	Ethanol	100	3	24.0	62
*	2,5-Dimethylhexanediol (solid)	99.5	3	28.3	63
	iso-Propanol	99.9	4	30.5	64
*	*n*-Octanol	> 99	3	41.0	66
*	Furfuryl alcohol	99	1	44	67
	2-Ethyl-1-hexanol	99	4	51.3	68
	iso-Butanol	99.9	4	60.3	70
	n-Butanol	99.8	4	60.8	72
	n-Hexanol	98	4	64.8	74
	Butyl cellosolve[g]	99	3	68.7	76
	Cyclohexanol	97	4	79.8	77
	Aldehydes (1 chemical)				
	4-Carboxybenzaldehyde (solid)	> 95	3	50.3	79