



Full wwPDB X-ray Structure Validation Report ⓘ

Aug 6, 2023 – 05:53 PM EDT

PDB ID : 1KIY
Title : D100E trichodiene synthase
Authors : Rynkiewicz, M.J.; Cane, D.E.; Christianson, D.W.
Deposited on : 2001-12-03
Resolution : 2.40 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtrriage (Phenix) : **NOT EXECUTED**
EDS : **NOT EXECUTED**
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.35

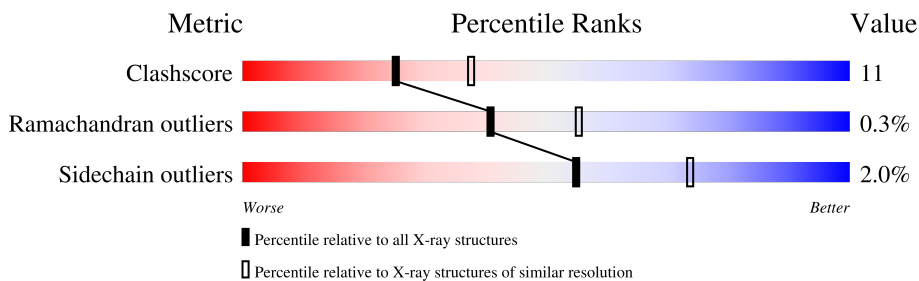
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
Clashscore	141614	4398 (2.40-2.40)
Ramachandran outliers	138981	4318 (2.40-2.40)
Sidechain outliers	138945	4319 (2.40-2.40)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	374	 75% 19% 5%
1	B	374	 73% 21% 5%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	EDO	A	752	-	X	-	-
2	EDO	A	754	-	X	-	-

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 6264 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called trichodiene synthase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	354	2941	1883	493	547	18	0	0	0
1	B	354	2941	1883	493	547	18	8	0	0

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	100	GLU	ASP	engineered mutation	UNP P13513
B	100	GLU	ASP	engineered mutation	UNP P13513

- Molecule 2 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: C₂H₆O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	4	2	2	0	0

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Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total C O 4 2 2	0	0
2	A	1	Total C O 4 2 2	0	0
2	A	1	Total C O 4 2 2	0	0
2	B	1	Total C O 4 2 2	0	0
2	B	1	Total C O 4 2 2	0	0

- Molecule 3 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	200	Total O 200 200	0	0
3	B	158	Total O 158 158	0	0

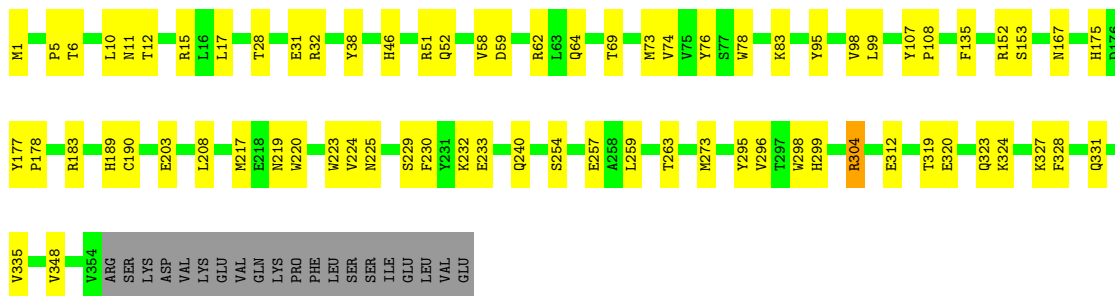
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

Note EDS was not executed.

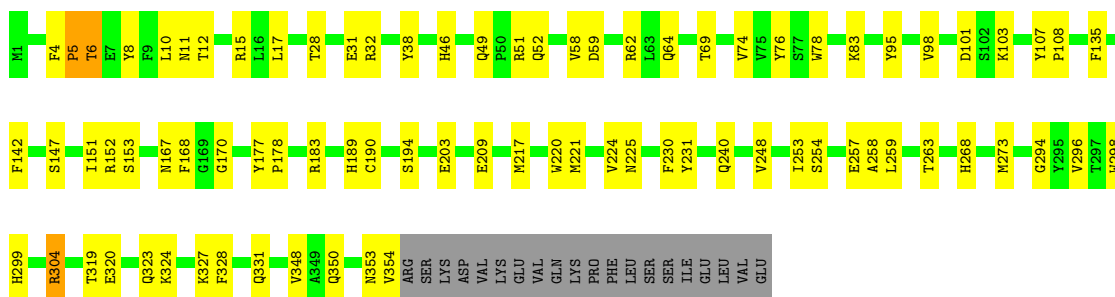
- Molecule 1: trichodiene synthase

Chain A: 



- Molecule 1: trichodiene synthase

Chain B: 



4 Data and refinement statistics

Xtrriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	122.67Å 122.67Å 151.50Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	24.57 – 2.40	Depositor
% Data completeness (in resolution range)	92.3 (24.57-2.40)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS	Depositor
R, R_{free}	0.212 , 0.244	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	6264	wwPDB-VP
Average B, all atoms (Å ²)	43.0	wwPDB-VP

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: EDO

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	# Z >5	RMSZ	# Z >5
1	A	0.38	0/3026	0.54	0/4107
1	B	0.38	0/3026	0.55	0/4107
All	All	0.38	0/6052	0.54	0/8214

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2941	0	2795	58	0
1	B	2941	0	2795	67	0
2	A	16	0	24	2	0
2	B	8	0	12	0	0
3	A	200	0	0	4	0
3	B	158	0	0	9	0
All	All	6264	0	5626	123	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 11.

All (123) close contacts within the same asymmetric unit are listed below, sorted by their clash

magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:304:ARG:HB2	1:B:304:ARG:HH11	1.31	0.93
1:B:64:GLN:HE22	1:B:348:VAL:H	1.17	0.90
1:B:258:ALA:HB2	3:B:903:HOH:O	1.73	0.89
1:A:64:GLN:HE22	1:A:348:VAL:H	1.17	0.88
1:A:304:ARG:HH11	1:A:304:ARG:HB2	1.37	0.86
1:A:167:ASN:HD21	1:A:240:GLN:HE21	1.23	0.85
1:B:217:MET:HE3	1:B:220:TRP:HB3	1.57	0.84
1:A:59:ASP:HB3	1:A:62:ARG:HG3	1.61	0.80
1:A:217:MET:HE1	1:A:220:TRP:HB3	1.63	0.80
1:A:167:ASN:HD21	1:A:240:GLN:NE2	1.82	0.77
1:A:254:SER:OG	1:A:257:GLU:HG3	1.87	0.75
1:B:59:ASP:HB3	1:B:62:ARG:HG3	1.69	0.74
1:B:304:ARG:HB2	1:B:304:ARG:NH1	2.04	0.72
1:B:254:SER:OG	1:B:257:GLU:HG3	1.91	0.69
1:A:304:ARG:HB2	1:A:304:ARG:NH1	2.08	0.66
1:B:69:THR:HG22	1:B:298:TRP:HZ2	1.62	0.65
1:B:320:GLU:O	1:B:324:LYS:HG2	1.97	0.64
1:A:320:GLU:O	1:A:324:LYS:HG2	1.98	0.64
1:B:304:ARG:HH11	1:B:304:ARG:CB	2.10	0.63
1:A:46:HIS:O	1:A:52:GLN:HG3	1.98	0.63
1:B:167:ASN:HD21	1:B:240:GLN:HE21	1.47	0.63
1:B:225:ASN:HD22	1:B:299:HIS:HE1	1.47	0.62
1:A:217:MET:CE	1:A:220:TRP:HE3	2.13	0.62
1:A:225:ASN:HD22	1:A:299:HIS:HE1	1.47	0.61
1:A:175:HIS:HD2	1:B:268:HIS:NE2	1.99	0.61
1:B:203:GLU:HB2	3:B:890:HOH:O	1.99	0.60
1:B:353:ASN:HA	3:B:892:HOH:O	2.02	0.60
1:B:217:MET:CE	1:B:220:TRP:HE3	2.15	0.59
1:A:69:THR:HG22	1:A:298:TRP:HZ2	1.68	0.59
1:A:28:THR:OG1	1:A:31:GLU:HG3	2.03	0.58
1:A:38:TYR:CD2	1:A:83:LYS:HB3	2.38	0.58
1:B:4:PHE:C	1:B:6:THR:H	2.07	0.58
1:A:323:GLN:O	1:A:327:LYS:HG3	2.04	0.58
1:A:217:MET:HE2	1:A:220:TRP:HE3	1.70	0.57
1:B:217:MET:HE1	1:B:220:TRP:HE3	1.70	0.57
1:B:323:GLN:O	1:B:327:LYS:HG3	2.04	0.56
1:A:1:MET:SD	1:A:5:PRO:HG3	2.45	0.56
1:B:46:HIS:O	1:B:52:GLN:HG3	2.05	0.55
1:B:225:ASN:HD22	1:B:299:HIS:CE1	2.24	0.55
1:A:107:TYR:HB3	1:A:108:PRO:HD3	1.89	0.55
1:A:225:ASN:HD22	1:A:299:HIS:CE1	2.24	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:59:ASP:HB3	1:B:62:ARG:CG	2.36	0.54
1:A:59:ASP:HB3	1:A:62:ARG:CG	2.34	0.54
1:A:58:VAL:HG21	1:A:98:VAL:HG11	1.89	0.54
1:B:167:ASN:HD21	1:B:240:GLN:NE2	2.06	0.53
1:A:203:GLU:HB2	3:A:849:HOH:O	2.08	0.52
1:B:38:TYR:CD2	1:B:83:LYS:HB3	2.45	0.52
1:A:217:MET:HE1	1:A:220:TRP:CE3	2.44	0.52
1:A:32:ARG:HD3	1:A:76:TYR:CE1	2.45	0.52
1:A:32:ARG:HH11	1:A:32:ARG:HG3	1.75	0.51
1:B:58:VAL:HG21	1:B:98:VAL:HG11	1.91	0.51
1:B:103:LYS:NZ	1:B:103:LYS:HB3	2.25	0.51
1:A:217:MET:CE	1:A:220:TRP:CE3	2.92	0.51
1:B:217:MET:CE	1:B:220:TRP:HB3	2.37	0.51
1:B:217:MET:CE	1:B:220:TRP:CE3	2.93	0.50
1:B:46:HIS:HE1	1:B:95:TYR:OH	1.95	0.50
1:B:183:ARG:NH2	3:B:887:HOH:O	2.39	0.49
1:A:167:ASN:ND2	1:A:240:GLN:NE2	2.56	0.49
1:A:304:ARG:HH11	1:A:304:ARG:CB	2.15	0.49
1:B:203:GLU:HG2	3:B:830:HOH:O	2.12	0.49
1:B:4:PHE:CE1	1:B:231:TYR:HA	2.49	0.48
1:A:6:THR:O	1:A:10:LEU:HG	2.12	0.48
1:B:217:MET:HE3	1:B:220:TRP:CE3	2.48	0.48
1:A:17:LEU:CD2	1:A:296:VAL:HG11	2.43	0.48
1:B:32:ARG:HG3	1:B:32:ARG:HH11	1.79	0.48
1:B:225:ASN:ND2	1:B:299:HIS:HE1	2.12	0.48
1:A:46:HIS:HE1	1:A:95:TYR:OH	1.97	0.48
1:A:217:MET:CE	1:A:220:TRP:HB3	2.37	0.48
1:B:74:VAL:HA	1:B:78:TRP:CE3	2.49	0.47
1:A:335:VAL:HB	3:A:910:HOH:O	2.14	0.47
1:A:295:TYR:O	1:A:299:HIS:HD2	1.97	0.47
1:B:152:ARG:NH2	1:B:189:HIS:ND1	2.62	0.47
1:B:101:ASP:HB3	3:B:881:HOH:O	2.14	0.46
1:A:220:TRP:CZ2	1:A:224:VAL:HG21	2.50	0.46
1:A:208:LEU:HD22	1:B:168:PHE:CG	2.50	0.46
1:A:99:LEU:HA	2:A:754:EDO:H22	1.98	0.46
1:A:17:LEU:HD21	1:A:296:VAL:HG11	1.97	0.45
1:B:231:TYR:HB3	3:B:866:HOH:O	2.15	0.45
1:A:217:MET:O	1:A:217:MET:HE3	2.17	0.45
1:B:32:ARG:HD3	1:B:76:TYR:CE1	2.52	0.45
1:A:183:ARG:NH1	3:A:769:HOH:O	2.49	0.45
1:B:217:MET:HE1	1:B:220:TRP:CE3	2.51	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:253:ILE:HG13	3:B:903:HOH:O	2.16	0.45
1:A:152:ARG:NH2	1:A:189:HIS:ND1	2.63	0.44
1:B:32:ARG:HD3	1:B:76:TYR:CZ	2.52	0.44
1:B:46:HIS:O	1:B:49:GLN:HG3	2.17	0.44
1:A:232:LYS:NZ	3:A:844:HOH:O	2.50	0.44
1:B:230:PHE:CE2	1:B:259:LEU:HD22	2.53	0.44
1:A:12:THR:HG23	1:A:263:THR:HG23	1.99	0.44
1:A:298:TRP:HH2	2:A:755:EDO:H11	1.82	0.44
1:B:168:PHE:CE2	1:B:170:GLY:HA2	2.52	0.44
1:A:177:TYR:HB3	1:A:178:PRO:HD3	1.99	0.44
1:B:248:VAL:N	3:B:903:HOH:O	2.49	0.44
1:B:64:GLN:NE2	1:B:348:VAL:H	1.98	0.43
1:A:153:SER:HB3	1:A:190:CYS:HB2	1.99	0.43
1:B:11:ASN:O	1:B:15:ARG:HG3	2.18	0.43
1:B:107:TYR:HB3	1:B:108:PRO:CD	2.48	0.43
1:B:6:THR:O	1:B:10:LEU:HG	2.17	0.43
1:B:76:TYR:O	1:B:294:GLY:HA3	2.18	0.43
1:B:217:MET:O	1:B:217:MET:HE2	2.19	0.43
1:A:11:ASN:O	1:A:15:ARG:HG3	2.18	0.43
1:A:74:VAL:HA	1:A:78:TRP:CE3	2.54	0.43
1:A:219:ASN:HB3	1:A:223:TRP:CZ3	2.54	0.43
1:B:350:GLN:O	1:B:354:VAL:HG23	2.19	0.43
1:B:12:THR:HG23	1:B:263:THR:HG23	2.02	0.42
1:B:328:PHE:O	1:B:331:GLN:HB2	2.20	0.42
1:A:229:SER:O	1:A:233:GLU:HG3	2.19	0.42
1:B:4:PHE:HE1	1:B:231:TYR:HA	1.83	0.42
1:B:17:LEU:CD2	1:B:296:VAL:HG11	2.49	0.42
1:B:28:THR:OG1	1:B:31:GLU:HG3	2.18	0.42
1:B:4:PHE:O	1:B:6:THR:N	2.51	0.42
1:A:225:ASN:ND2	1:A:299:HIS:HE1	2.14	0.41
1:B:5:PRO:O	1:B:8:TYR:N	2.49	0.41
1:B:153:SER:HB3	1:B:190:CYS:HB2	2.02	0.41
1:A:69:THR:CG2	1:A:298:TRP:HZ2	2.32	0.41
1:B:142:PHE:CE2	1:B:194:SER:HA	2.55	0.41
1:B:220:TRP:CZ2	1:B:224:VAL:HG21	2.56	0.41
1:A:230:PHE:CE2	1:A:259:LEU:HD22	2.56	0.41
1:A:73:MET:HB2	1:A:298:TRP:CE2	2.56	0.41
1:A:32:ARG:HD3	1:A:76:TYR:CZ	2.56	0.40
1:B:177:TYR:HB3	1:B:178:PRO:HD3	2.02	0.40
1:B:147:SER:O	1:B:151:ILE:HG13	2.21	0.40
1:A:328:PHE:O	1:A:331:GLN:HB2	2.21	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	352/374 (94%)	346 (98%)	6 (2%)	0	100	100
1	B	352/374 (94%)	339 (96%)	11 (3%)	2 (1%)	25	36
All	All	704/748 (94%)	685 (97%)	17 (2%)	2 (0%)	41	55

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	6	THR
1	B	5	PRO

5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	320/340 (94%)	314 (98%)	6 (2%)	57	75
1	B	320/340 (94%)	313 (98%)	7 (2%)	52	71
All	All	640/680 (94%)	627 (98%)	13 (2%)	55	74

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	51	ARG

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Mol	Chain	Res	Type
1	A	135	PHE
1	A	273	MET
1	A	304	ARG
1	A	312	GLU
1	A	319	THR
1	B	51	ARG
1	B	135	PHE
1	B	209	GLU
1	B	221	MET
1	B	273	MET
1	B	304	ARG
1	B	319	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (20) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	46	HIS
1	A	64	GLN
1	A	68	GLN
1	A	137	ASN
1	A	175	HIS
1	A	216	GLN
1	A	219	ASN
1	A	240	GLN
1	A	264	GLN
1	A	299	HIS
1	A	353	ASN
1	B	3	ASN
1	B	46	HIS
1	B	64	GLN
1	B	68	GLN
1	B	137	ASN
1	B	216	GLN
1	B	240	GLN
1	B	299	HIS
1	B	353	ASN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

6 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
2	EDO	B	753	-	3,3,3	2.26	2 (66%)	2,2,2	0.46	0
2	EDO	B	751	-	3,3,3	2.22	2 (66%)	2,2,2	0.47	0
2	EDO	A	754	-	3,3,3	2.38	2 (66%)	2,2,2	0.43	0
2	EDO	A	752	-	3,3,3	2.32	2 (66%)	2,2,2	0.41	0
2	EDO	A	755	-	3,3,3	2.22	2 (66%)	2,2,2	0.48	0
2	EDO	A	750	-	3,3,3	2.28	2 (66%)	2,2,2	0.46	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	EDO	B	753	-	-	0/1/1/1	-
2	EDO	B	751	-	-	0/1/1/1	-
2	EDO	A	754	-	-	1/1/1/1	-
2	EDO	A	752	-	-	1/1/1/1	-
2	EDO	A	755	-	-	0/1/1/1	-
2	EDO	A	750	-	-	0/1/1/1	-

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	752	EDO	O2-C2	3.06	1.57	1.42
2	B	753	EDO	O2-C2	3.04	1.57	1.42
2	A	754	EDO	O2-C2	3.03	1.57	1.42
2	A	750	EDO	O2-C2	2.94	1.57	1.42
2	B	751	EDO	O2-C2	2.93	1.57	1.42
2	A	755	EDO	O2-C2	2.88	1.57	1.42
2	A	754	EDO	O1-C1	2.60	1.55	1.42
2	A	750	EDO	O1-C1	2.46	1.54	1.42
2	A	752	EDO	O1-C1	2.42	1.54	1.42
2	A	755	EDO	O1-C1	2.36	1.54	1.42
2	B	753	EDO	O1-C1	2.33	1.54	1.42
2	B	751	EDO	O1-C1	2.33	1.54	1.42

There are no bond angle outliers.

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	754	EDO	O1-C1-C2-O2
2	A	752	EDO	O1-C1-C2-O2

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	754	EDO	1	0
2	A	755	EDO	1	0

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

6 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates [i](#)

EDS was not executed - this section is therefore empty.

6.4 Ligands [i](#)

EDS was not executed - this section is therefore empty.

6.5 Other polymers [i](#)

EDS was not executed - this section is therefore empty.