



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 9, 2026 – 10:29 AM UTC

PDB ID : 6THM / pdb\_00006thm  
Title : Linalool Dehydratase Isomerase M125A mutant  
Authors : Cuetos, A.; Zukic, E.; Danesh-Azari, H.R.; Grogan, G.  
Deposited on : 2019-11-20  
Resolution : 1.99 Å(reported)

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

We welcome your comments at [validation@mail.wwpdb.org](mailto: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>.

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

MolProbity : 4-5-2 with Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtriage (Phenix) : 2.0  
EDS : 3.0  
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)  
CCP4 : 9.0.010 (Gargrove)  
Density-Fitness : 1.0.12  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.49

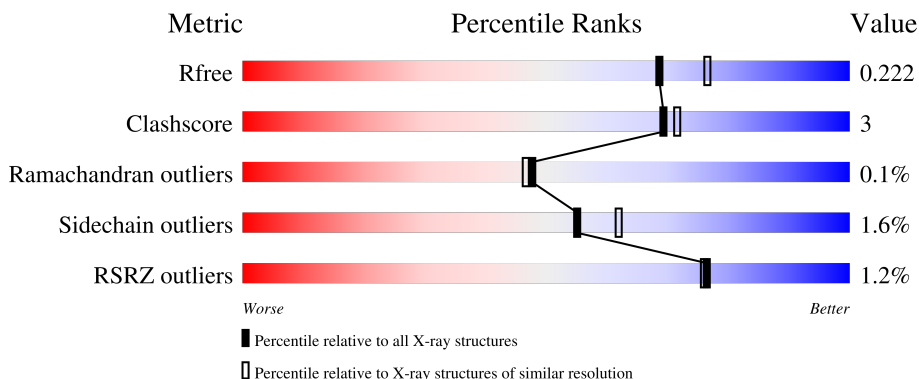
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.99 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))
$R_{free}$	180053	10052 (2.00-2.00)
Clashscore	190562	11152 (2.00-2.00)
Ramachandran outliers	187476	11031 (2.00-2.00)
Sidechain outliers	187428	11029 (2.00-2.00)
RSRZ outliers	180081	10067 (2.00-2.00)

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  $\geq 3$ , 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  $\leq 5\%$ . The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	372	 90% 8% .
1	B	372	 88% 9% ..
1	C	372	 90% 8% ..
1	D	372	 91% 8% .
1	E	372	 91% 6% ..

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 15330 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 Linalool dehydratase-isomerase protein LDI.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	364	2883	1869	479	523	12	0	1	0
1	B	364	2882	1864	485	521	12	0	0	0
1	C	365	2892	1873	482	524	13	0	1	0
1	D	368	2895	1877	478	528	12	0	0	0
1	E	364	2880	1865	481	522	12	0	0	0

There are 10 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MET	-	initiating methionine	UNP W8X534
A	125	ALA	MET	engineered mutation	UNP W8X534
B	1	MET	-	initiating methionine	UNP W8X534
B	125	ALA	MET	engineered mutation	UNP W8X534
C	1	MET	-	initiating methionine	UNP W8X534
C	125	ALA	MET	engineered mutation	UNP W8X534
D	1	MET	-	initiating methionine	UNP W8X534
D	125	ALA	MET	engineered mutation	UNP W8X534
E	1	MET	-	initiating methionine	UNP W8X534
E	125	ALA	MET	engineered mutation	UNP W8X534

- Molecule 2 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: C<sub>2</sub>H<sub>6</sub>O<sub>2</sub>).



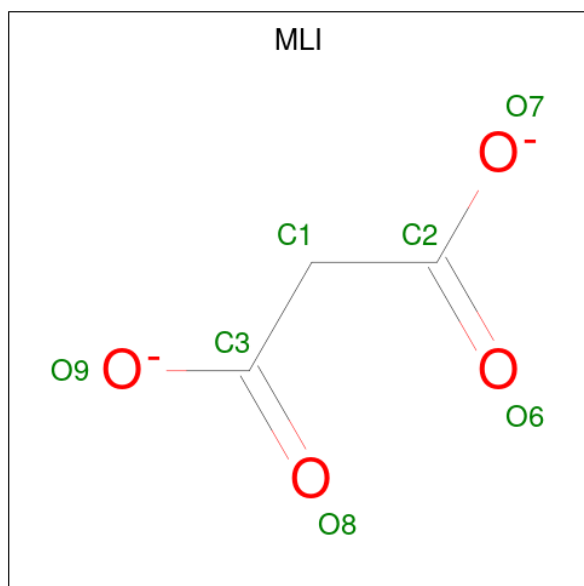
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total C O 4 2 2	0	0
2	A	1	Total C O 4 2 2	0	0
2	A	1	Total C O 4 2 2	0	0
2	B	1	Total C O 4 2 2	0	0
2	B	1	Total C O 4 2 2	0	0
2	B	1	Total C O 4 2 2	0	0
2	C	1	Total C O 4 2 2	0	0
2	C	1	Total C O 4 2 2	0	0
2	D	1	Total C O 4 2 2	0	0
2	D	1	Total C O 4 2 2	0	0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

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

- Molecule 3 is MALONATE ION (CCD ID: MLI) (formula:  $C_3H_2O_4$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	B	1	7	3	4	0	0
3	E	1	7	3	4	0	0

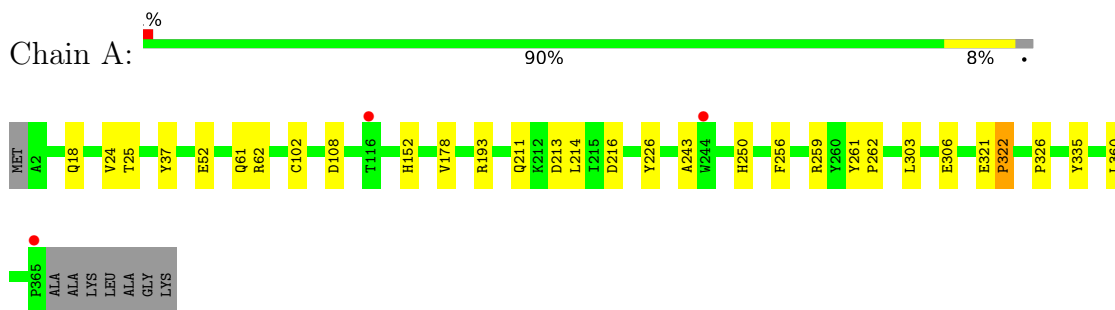
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	151	Total	O	0	0
			151	151		
4	B	185	Total	O	0	0
			185	185		
4	C	152	Total	O	0	0
			152	152		
4	D	174	Total	O	0	0
			174	174		
4	E	162	Total	O	0	0
			162	162		

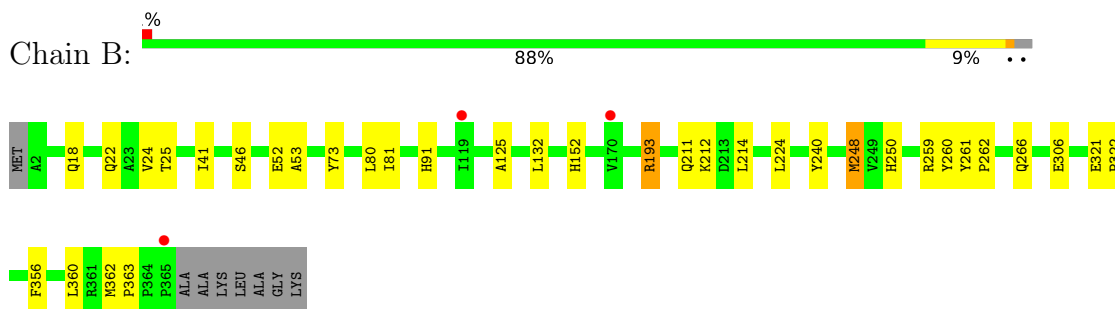
### 3 Residue-property plots [i](#)

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 and electron density. 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. A red dot above a residue indicates a poor fit to the electron density ( $RSRZ > 2$ ). 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.

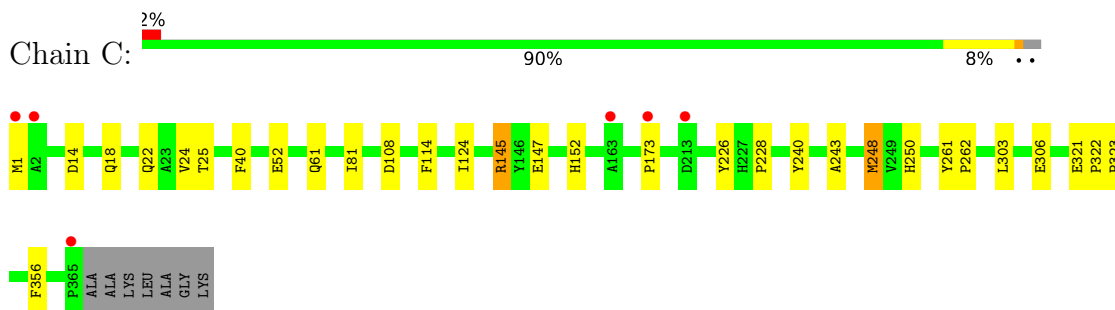
- Molecule 1: Linalool dehydratase-isomerase protein LDI



- Molecule 1: Linalool dehydratase-isomerase protein LDI

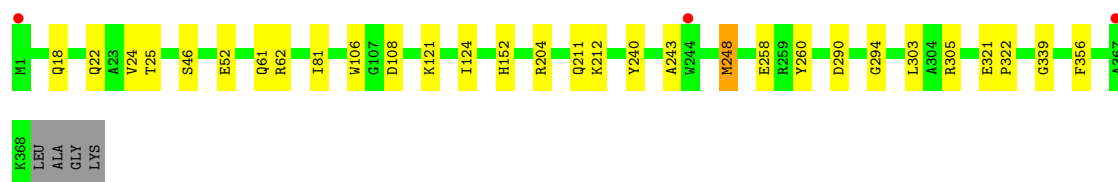


- Molecule 1: Linalool dehydratase-isomerase protein LDI

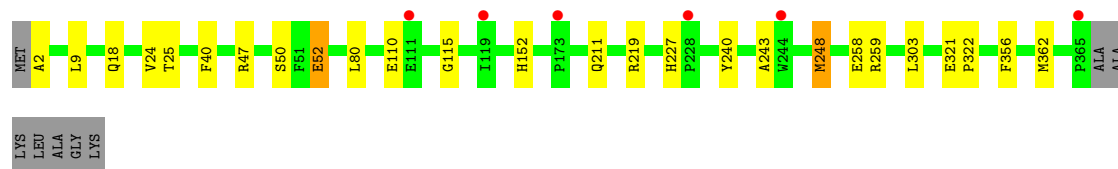
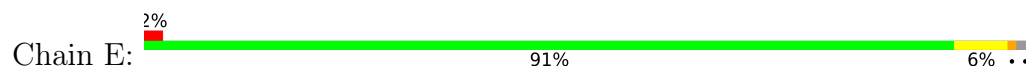


- Molecule 1: Linalool dehydratase-isomerase protein LDI





- Molecule 1: Linalool dehydratase-isomerase protein LDI



## 4 Data and refinement statistics

Property	Value	Source
Space group	I 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	108.67Å 110.69Å 196.72Å 90.00° 91.26° 90.00°	Depositor
Resolution (Å)	96.18 – 1.99 96.18 – 1.99	Depositor EDS
% Data completeness (in resolution range)	98.2 (96.18-1.99) 98.2 (96.18-1.99)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.01 (at 1.98Å)	Xtriage
Refinement program	REFMAC 5.8.0258	Depositor
R, $R_{free}$	0.178 , 0.215 0.186 , 0.222	Depositor DCC
$R_{free}$ test set	7886 reflections (4.81%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	31.1	Xtriage
Anisotropy	0.653	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.36 , 31.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.009 for k,h,-l 0.005 for -k,-h,-l 0.019 for h,-k,-l	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	15330	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	36.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.72% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

## 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, MLI

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	1.07	0/2972	1.36	3/4045 (0.1%)
1	B	1.08	0/2968	1.36	1/4041 (0.0%)
1	C	1.09	0/2981	1.36	2/4057 (0.0%)
1	D	1.08	0/2981	1.35	2/4058 (0.0%)
1	E	1.06	0/2966	1.30	0/4036
All	All	1.08	0/14868	1.34	8/20237 (0.0%)

There are no bond length outliers.

The worst 5 of 8 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
1	A	322	PRO	N-CA-C	6.10	118.14	110.70
1	B	363	PRO	CB-CA-C	-5.96	105.56	111.17
1	A	216	ASP	CB-CA-C	5.88	115.74	110.44
1	D	106	TRP	CA-C-N	5.53	127.10	120.13
1	D	106	TRP	C-N-CA	5.53	127.10	120.13

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	2883	0	2763	21	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	2882	0	2767	23	0
1	C	2892	0	2774	24	0
1	D	2895	0	2767	17	0
1	E	2880	0	2763	16	0
2	A	12	0	18	0	0
2	B	12	0	18	0	0
2	C	8	0	12	0	0
2	D	12	0	18	2	0
2	E	16	0	24	1	0
3	B	7	0	2	0	0
3	E	7	0	2	0	0
4	A	151	0	0	3	0
4	B	185	0	0	5	0
4	C	152	0	0	5	0
4	D	174	0	0	4	0
4	E	162	0	0	4	0
All	All	15330	0	13928	98	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 3.

The worst 5 of 98 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:A:211:GLN:HE22	1:A:259:ARG:HH21	1.14	0.89
1:A:211:GLN:NE2	1:A:259:ARG:HH21	1.81	0.79
1:B:250:HIS:HD2	1:B:306:GLU:OE2	1.69	0.75
1:C:250:HIS:HD2	1:C:306:GLU:OE2	1.76	0.69
1:C:14:ASP:OD2	4:C:501:HOH:O	2.11	0.67

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	363/372 (98%)	352 (97%)	11 (3%)	0	100	100
1	B	362/372 (97%)	353 (98%)	8 (2%)	1 (0%)	36	35
1	C	364/372 (98%)	353 (97%)	11 (3%)	0	100	100
1	D	366/372 (98%)	356 (97%)	9 (2%)	1 (0%)	36	35
1	E	362/372 (97%)	353 (98%)	9 (2%)	0	100	100
All	All	1817/1860 (98%)	1767 (97%)	48 (3%)	2 (0%)	48	46

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	212	LYS
1	D	212	LYS

### 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	287/302 (95%)	286 (100%)	1 (0%)	86	91
1	B	289/302 (96%)	283 (98%)	6 (2%)	47	52
1	C	290/302 (96%)	286 (99%)	4 (1%)	59	66
1	D	287/302 (95%)	281 (98%)	6 (2%)	47	52
1	E	289/302 (96%)	283 (98%)	6 (2%)	47	52
All	All	1442/1510 (96%)	1419 (98%)	23 (2%)	55	62

5 of 23 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	240	TYR
1	E	47	ARG
1	D	258	GLU

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Mol	Chain	Res	Type
1	E	52	GLU
1	B	266	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 35 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	310	GLN
1	D	337	HIS
1	E	152	HIS
1	B	211	GLN
1	B	91	HIS

### 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 oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

17 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	403	-	3,3,3	0.15	0	2,2,2	0.03	0
2	EDO	D	403	-	3,3,3	0.19	0	2,2,2	0.23	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
2	EDO	A	402	-	3,3,3	0.08	0	2,2,2	0.08	0
2	EDO	C	402	-	3,3,3	0.19	0	2,2,2	0.18	0
2	EDO	C	401	-	3,3,3	0.18	0	2,2,2	0.26	0
2	EDO	D	402	-	3,3,3	0.24	0	2,2,2	0.19	0
2	EDO	E	403	-	3,3,3	0.10	0	2,2,2	0.10	0
2	EDO	D	401	-	3,3,3	0.27	0	2,2,2	0.11	0
2	EDO	E	404	-	3,3,3	0.06	0	2,2,2	0.15	0
2	EDO	B	402	-	3,3,3	0.08	0	2,2,2	0.14	0
2	EDO	A	403	-	3,3,3	0.09	0	2,2,2	0.20	0
3	MLI	B	404	-	6,6,6	1.46	1 (16%)	7,7,7	1.03	0
2	EDO	B	401	-	3,3,3	0.23	0	2,2,2	0.33	0
3	MLI	E	405	-	6,6,6	1.48	1 (16%)	7,7,7	1.14	0
2	EDO	E	402	-	3,3,3	0.31	0	2,2,2	0.36	0
2	EDO	A	401	-	3,3,3	0.12	0	2,2,2	0.40	0
2	EDO	E	401	-	3,3,3	0.15	0	2,2,2	0.19	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	403	-	-	1/1/1/1	-
2	EDO	D	403	-	-	1/1/1/1	-
2	EDO	A	402	-	-	1/1/1/1	-
2	EDO	C	402	-	-	1/1/1/1	-
2	EDO	C	401	-	-	0/1/1/1	-
2	EDO	D	402	-	-	1/1/1/1	-
2	EDO	E	403	-	-	1/1/1/1	-
2	EDO	D	401	-	-	1/1/1/1	-
2	EDO	E	404	-	-	0/1/1/1	-
2	EDO	B	402	-	-	1/1/1/1	-
2	EDO	A	403	-	-	0/1/1/1	-
3	MLI	B	404	-	-	4/4/4/4	-
2	EDO	B	401	-	-	1/1/1/1	-
3	MLI	E	405	-	-	4/4/4/4	-
2	EDO	E	402	-	-	0/1/1/1	-
2	EDO	A	401	-	-	1/1/1/1	-
2	EDO	E	401	-	-	1/1/1/1	-

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	E	405	MLI	C1-C2	2.20	1.54	1.51
3	B	404	MLI	C1-C3	2.11	1.54	1.51

There are no bond angle outliers.

There are no chirality outliers.

5 of 19 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	403	EDO	O1-C1-C2-O2
2	C	402	EDO	O1-C1-C2-O2
2	B	401	EDO	O1-C1-C2-O2
2	B	402	EDO	O1-C1-C2-O2
2	E	401	EDO	O1-C1-C2-O2

There are no ring outliers.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	D	401	EDO	2	0
2	E	402	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](#)

In the following table, the column labelled ‘#RSRZ > 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95<sup>th</sup> percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q < 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å <sup>2</sup> )	Q<0.9
1	A	364/372 (97%)	0.05	3 (0%) 82 82	20, 33, 50, 65	1 (0%)
1	B	364/372 (97%)	0.09	3 (0%) 82 82	23, 33, 50, 63	0
1	C	365/372 (98%)	0.09	6 (1%) 70 70	23, 34, 52, 75	1 (0%)
1	D	368/372 (98%)	0.06	3 (0%) 82 82	24, 34, 52, 75	0
1	E	364/372 (97%)	0.09	6 (1%) 70 70	24, 33, 51, 64	0
All	All	1825/1860 (98%)	0.08	21 (1%) 76 76	20, 33, 51, 75	2 (0%)

The worst 5 of 21 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	1	MET	3.5
1	A	365	PRO	3.2
1	D	1	MET	3.0
1	B	365	PRO	3.0
1	D	367	ALA	2.8

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

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

### 6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

### 6.4 Ligands [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum,

median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
2	EDO	C	401	4/4	0.73	0.16	62,62,64,64	0
2	EDO	E	404	4/4	0.75	0.17	67,68,69,69	0
2	EDO	B	402	4/4	0.76	0.20	62,65,68,73	0
2	EDO	A	402	4/4	0.82	0.18	66,68,69,73	0
2	EDO	B	403	4/4	0.83	0.16	50,59,61,61	0
2	EDO	C	402	4/4	0.84	0.18	58,60,62,63	0
2	EDO	B	401	4/4	0.85	0.15	57,60,61,65	0
2	EDO	A	401	4/4	0.85	0.21	62,62,66,66	0
2	EDO	D	403	4/4	0.87	0.12	46,50,50,52	0
2	EDO	D	402	4/4	0.88	0.15	57,59,59,59	0
2	EDO	E	402	4/4	0.89	0.14	60,61,63,66	0
2	EDO	E	403	4/4	0.90	0.16	62,64,67,67	0
2	EDO	A	403	4/4	0.91	0.13	56,62,63,64	0
2	EDO	E	401	4/4	0.92	0.13	58,58,60,63	0
2	EDO	D	401	4/4	0.92	0.13	45,56,57,65	0
3	MLI	E	405	7/7	0.95	0.07	33,35,37,40	0
3	MLI	B	404	7/7	0.97	0.07	31,34,35,38	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.