wwPDB X-ray Structure Validation Summary Report (i)

Feb 11, 2024 – 08:30 PM EST

PDB ID	:	3DHH
Title	:	Crystal Structure of Resting State Toluene 4-Monoxygenase Hydroxylase Complexed with Effector Protein
Authors	:	Bailey, L.J.; Mccoy, J.G.; Phillips Jr., G.N.; Fox, B.G.
Deposited on	:	2008-06-17
Resolution	:	1.94 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) 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 (i)) were used in the production of this report:

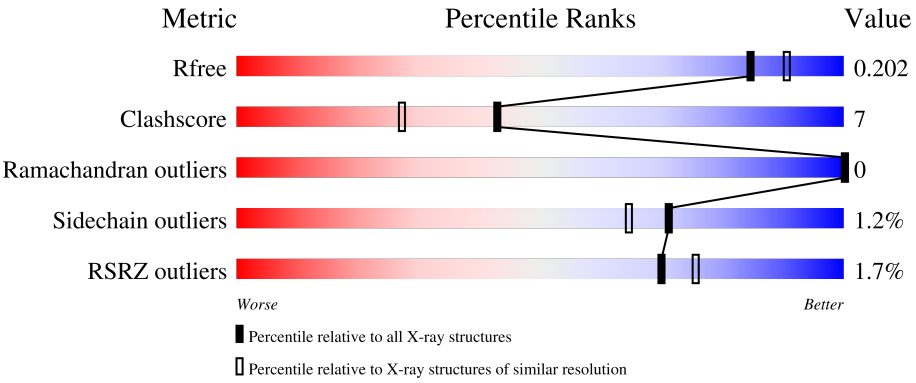
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.94 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}	130704	4310 (1.96-1.92)
Clashscore	141614	1023 (1.94-1.94)
Ramachandran outliers	138981	1007 (1.94-1.94)
Sidechain outliers	138945	1007 (1.94-1.94)
RSRZ outliers	127900	4250 (1.96-1.92)

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 <=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	500	88% 9% • •
2	B	327	2% 86% 7% 7%
3	C	84	5% 81% 18% •
4	E	103	6% 82% 17% •

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
6	BML	A	503	-	-	X	-
6	BML	A	507	-	-	X	-
6	BML	B	508	-	-	X	-

2 Entry composition (i)

There are 10 unique types of molecules in this entry. The entry contains 8972 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 toluene 4-monooxygenase hydroxylase alpha subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	491	Total	C	N	O	S	6	14	0
			4091	2630	683	754	24			

- Molecule 2 is a protein called toluene 4-monooxygenase hydroxylase beta subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	305	Total	C	N	O	S	0	9	0
			2564	1625	441	482	16			

- Molecule 3 is a protein called toluene 4-monooxygenase hydroxylase gamma subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	83	Total	C	N	O	S	5	2	0
			669	420	118	127	4			

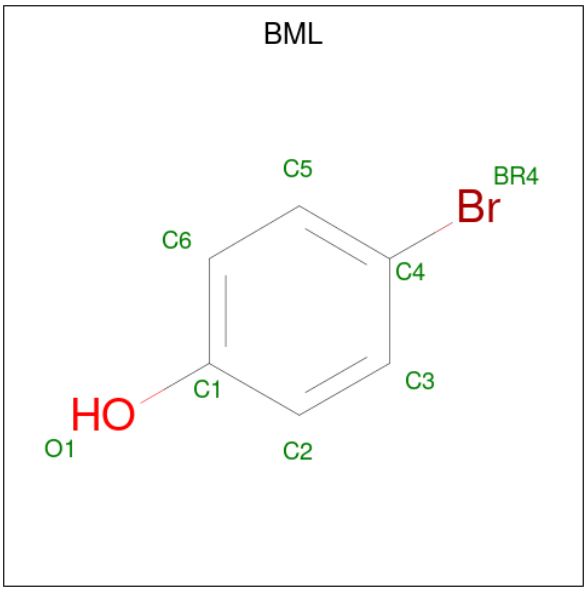
- Molecule 4 is a protein called Toluene-4-monooxygenase system effector protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	E	102	Total	C	N	O	S	0	2	0
			817	513	140	162	2			

- Molecule 5 is FE (III) ION (three-letter code: FE) (formula: Fe).

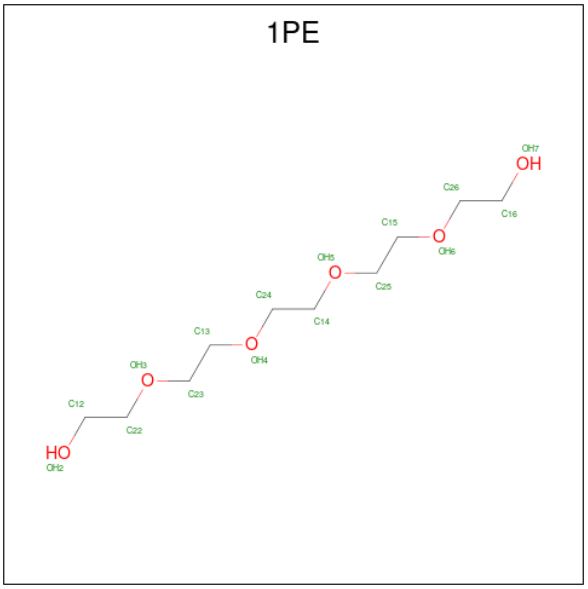
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	2	Total	Fe	0	0
			2	2		

- Molecule 6 is 4-BROMOPHENOL (three-letter code: BML) (formula: C_6H_5BrO).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	1	Total Br C O 8 1 6 1	0	0
6	A	1	Total Br C O 8 1 6 1	0	0
6	A	1	Total Br C O 8 1 6 1	0	0
6	B	1	Total Br C O 8 1 6 1	0	0
6	E	1	Total Br C O 8 1 6 1	0	0

- Molecule 7 is PENTAETHYLENE GLYCOL (three-letter code: 1PE) (formula: $C_{10}H_{22}O_6$).

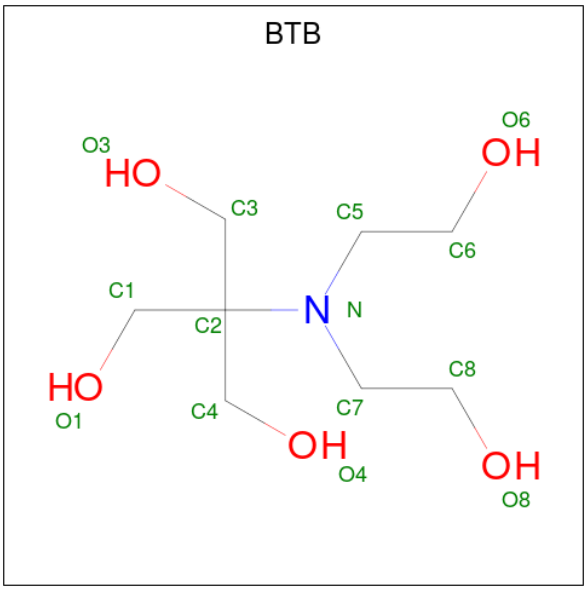


Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	1	Total C O 8 5 3	0	0

- Molecule 8 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	A	1	Total Cl 1 1	0	0

- Molecule 9 is 2-[BIS-(2-HYDROXY-ETHYL)-AMINO]-2-HYDROXYMETHYL-PROPANE-1,3-DIOL (three-letter code: BTB) (formula: $C_8H_{19}NO_5$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
9	A	1	Total C N O 14 8 1 5	0	0

- Molecule 10 is water.

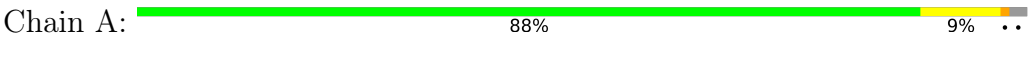
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
10	A	385	Total O 385 385	0	0
10	B	228	Total O 228 228	0	0
10	C	49	Total O 49 49	0	0
10	E	104	Total O 104 104	0	0

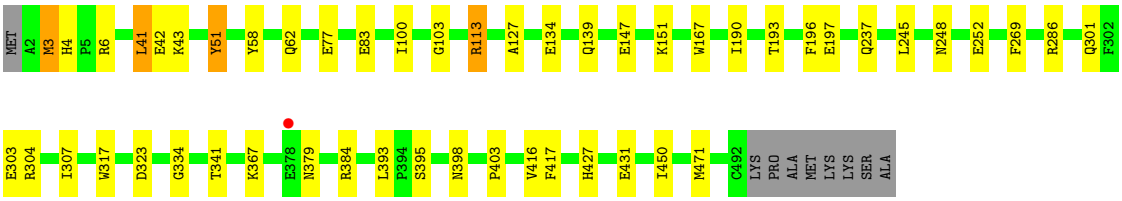
3 Residue-property plots (i)

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 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: toluene 4-monooxygenase hydroxylase alpha subunit

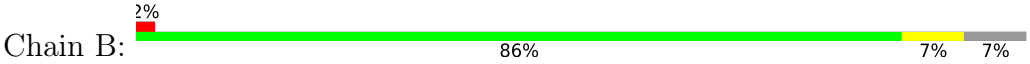
Chain A:

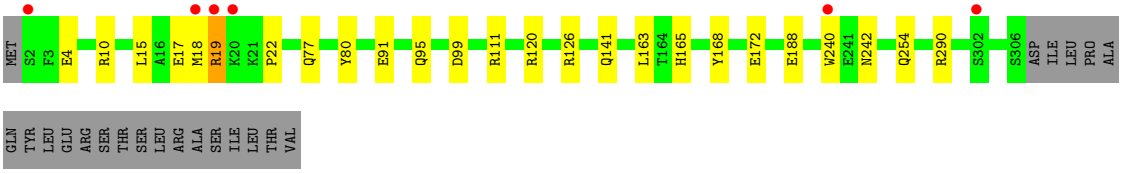




• Molecule 2: toluene 4-monooxygenase hydroxylase beta subunit

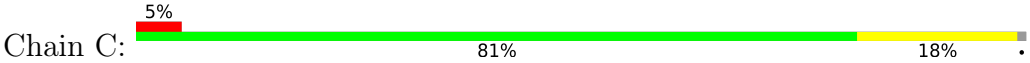
Chain B:

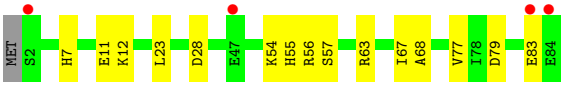




• Molecule 3: toluene 4-monooxygenase hydroxylase gamma subunit

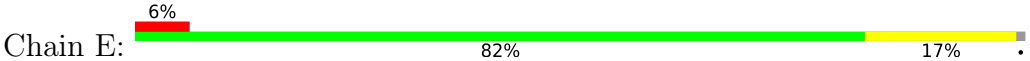
Chain C:

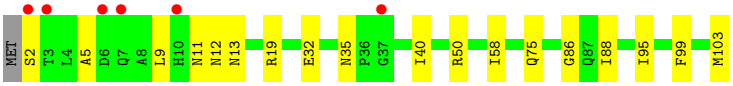




• Molecule 4: Toluene-4-monooxygenase system effector protein

Chain E:





4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	100.42Å 115.61Å 182.40Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	91.29 – 1.94 38.71 – 1.94	Depositor EDS
% Data completeness (in resolution range)	99.4 (91.29-1.94) 99.5 (38.71-1.94)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	5.70 (at 1.94Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.157 , 0.202 0.158 , 0.202	Depositor DCC
R_{free} test set	3889 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å^2)	24.2	Xtriage
Anisotropy	0.064	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.34 , 48.4	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	8972	wwPDB-VP
Average B, all atoms (Å^2)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.23% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: 1PE, BTB, CL, FE, BML

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	0.79	2/4256 (0.0%)	0.69	4/5780 (0.1%)
2	B	0.71	0/2655	0.67	0/3606
3	C	0.67	0/684	0.67	0/925
4	E	0.83	0/833	0.73	1/1127 (0.1%)
All	All	0.76	2/8428 (0.0%)	0.69	5/11438 (0.0%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	134	GLU	CD-OE2	-7.35	1.17	1.25
1	A	134	GLU	CD-OE1	-5.89	1.19	1.25

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	41	LEU	CA-CB-CG	5.59	128.16	115.30
1	A	286	ARG	NE-CZ-NH2	-5.31	117.64	120.30
1	A	113	ARG	NE-CZ-NH1	5.22	122.91	120.30
1	A	3	MET	CG-SD-CE	-5.14	91.97	100.20
4	E	19	ARG	NE-CZ-NH2	-5.03	117.79	120.30

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

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	4091	0	3879	61	0
2	B	2564	0	2446	38	0
3	C	669	0	659	13	0
4	E	817	0	816	18	0
5	A	2	0	0	0	0
6	A	24	0	13	15	0
6	B	8	0	4	5	0
6	E	8	0	4	2	0
7	A	8	0	8	2	0
8	A	1	0	0	0	0
9	A	14	0	19	1	0
10	A	385	0	0	4	1
10	B	228	0	0	3	0
10	C	49	0	0	0	0
10	E	104	0	0	0	0
All	All	8972	0	7848	109	1

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 7.

The worst 5 of 109 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:3:MET:SD	6:B:508:BML:BR4	2.76	0.99
1:A:450:ILE:HG21	6:A:507:BML:H5	1.49	0.94
4:E:12:ASN:HD21	4:E:103:MET:H	1.11	0.91
4:E:88:ILE:HD11	4:E:95[A]:ILE:HD11	1.56	0.88
4:E:35:ASN:HD21	4:E:58:ILE:H	1.22	0.88

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
10:A:817:HOH:O	10:A:817:HOH:O[4_545]	2.16	0.04

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	501/500 (100%)	483 (96%)	18 (4%)	0	100	100
2	B	309/327 (94%)	307 (99%)	2 (1%)	0	100	100
3	C	82/84 (98%)	79 (96%)	3 (4%)	0	100	100
4	E	102/103 (99%)	100 (98%)	2 (2%)	0	100	100
All	All	994/1014 (98%)	969 (98%)	25 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	428/423 (101%)	424 (99%)	4 (1%)	78	75
2	B	282/296 (95%)	278 (99%)	4 (1%)	67	58
3	C	75/75 (100%)	73 (97%)	2 (3%)	44	31
4	E	88/87 (101%)	88 (100%)	0	100	100
All	All	873/881 (99%)	863 (99%)	10 (1%)	71	67

5 of 10 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	290	ARG
3	C	56	ARG
3	C	83	GLU

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	323	ASP
2	B	10	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 26 such sidechains are listed below:

Mol	Chain	Res	Type
2	B	141	GLN
2	B	242	ASN
4	E	75	GLN
2	B	165	HIS
3	C	7	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 monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 10 ligands modelled in this entry, 3 are monoatomic - leaving 7 for Mogul analysis.

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	$\#\|Z\| > 2$
6	BML	A	507	-	8,8,8	0.71	0	10,10,10	1.02	0
6	BML	A	504	-	8,8,8	0.48	0	10,10,10	0.61	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
9	BTB	A	509	-	13,13,13	0.69	0	7,16,16	0.34	0
7	1PE	A	505	5	7,7,15	0.49	0	6,6,14	0.65	0
6	BML	B	508	-	8,8,8	0.99	0	10,10,10	1.84	3 (30%)
6	BML	A	503	-	8,8,8	0.69	0	10,10,10	0.48	0
6	BML	E	507	-	8,8,8	0.61	0	10,10,10	0.95	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
6	BML	A	507	-	-	-	0/1/1/1
6	BML	A	504	-	-	-	0/1/1/1
9	BTB	A	509	-	-	5/21/21/21	-
7	1PE	A	505	5	-	5/5/5/13	-
6	BML	B	508	-	-	-	0/1/1/1
6	BML	A	503	-	-	-	0/1/1/1
6	BML	E	507	-	-	-	0/1/1/1

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
6	B	508	BML	BR4-C4-C3	4.08	125.23	119.30
6	B	508	BML	C6-C5-C4	2.22	122.08	119.19
6	B	508	BML	BR4-C4-C5	-2.06	116.31	119.30

There are no chirality outliers.

5 of 10 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
9	A	509	BTB	C1-C2-N-C5
9	A	509	BTB	C3-C2-N-C5
9	A	509	BTB	C4-C2-N-C5
9	A	509	BTB	N-C7-C8-O8
7	A	505	1PE	OH6-C15-C25-OH5

There are no ring outliers.

7 monomers are involved in 25 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	A	507	BML	8	0
6	A	504	BML	1	0
9	A	509	BTB	1	0
7	A	505	1PE	2	0
6	B	508	BML	5	0
6	A	503	BML	7	0
6	E	507	BML	2	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

6.1 Protein, DNA and RNA chains

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^{th} 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^2)	Q<0.9
1	A	491/500 (98%)	-0.15	1 (0%)	95	97	12, 21, 31, 45	0
2	B	305/327 (93%)	-0.11	6 (1%)	65	71	14, 25, 39, 48	0
3	C	83/84 (98%)	0.19	4 (4%)	30	38	22, 33, 46, 60	1 (1%)
4	E	102/103 (99%)	-0.19	6 (5%)	22	28	15, 23, 38, 48	0
All	All	981/1014 (96%)	-0.12	17 (1%)	70	75	12, 23, 40, 60	1 (0%)

The worst 5 of 17 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	C	84	GLU	4.3
2	B	240	TRP	3.8
4	E	7	GLN	3.2
4	E	3	THR	3.1
4	E	6	ASP	2.8

6.2 Non-standard residues in protein, DNA, RNA chains

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

6.3 Carbohydrates

There are no monosaccharides in this entry.

6.4 Ligands

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^{th} 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^2)	Q<0.9
6	BML	B	508	8/8	0.76	0.33	59,61,61,62	0
9	BTB	A	509	14/14	0.84	0.25	32,41,44,50	0
7	1PE	A	505	8/16	0.87	0.28	31,35,38,40	0
6	BML	A	504	8/8	0.92	0.17	49,49,50,51	8
6	BML	A	507	8/8	0.94	0.29	36,37,37,39	7
6	BML	A	503	8/8	0.96	0.24	22,23,23,25	8
6	BML	E	507	8/8	0.97	0.14	33,35,37,37	8
8	CL	A	506	1/1	0.99	0.16	26,26,26,26	1
5	FE	A	502	1/1	0.99	0.06	18,18,18,18	0
5	FE	A	501	1/1	1.00	0.09	17,17,17,17	0

6.5 Other polymers (i)

There are no such residues in this entry.