wwPDB X-ray Structure Validation Summary Report (i)

Sep 23, 2023 – 04:40 PM EDT

PDB ID	:	5TDT
Title	:	Oxygenated toluene intermediate in toluene 4-monooxygenase (T4moHD) after reaction in the crystal
Authors	:	Acheson, J.F.; Fox, B.G.
Deposited on	:	2016-09-19
Resolution	:	1.82 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:

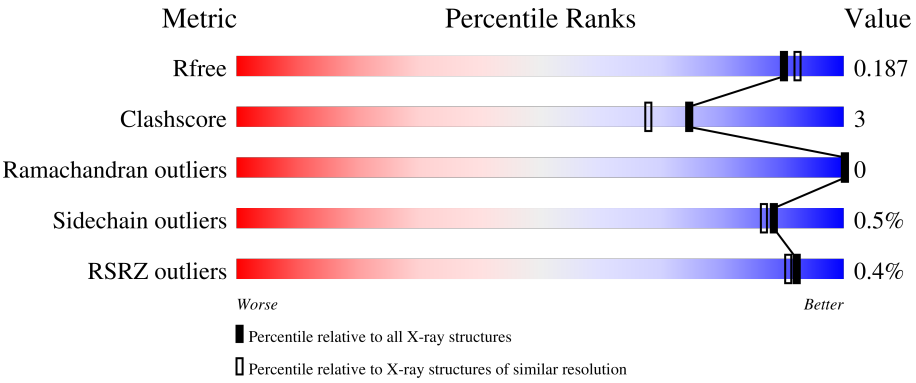
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.35.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35.1

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 1.82 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	7484 (1.84-1.80)
Clashscore	141614	8401 (1.84-1.80)
Ramachandran outliers	138981	8290 (1.84-1.80)
Sidechain outliers	138945	8290 (1.84-1.80)
RSRZ outliers	127900	7371 (1.84-1.80)

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	493	91% 8%
1	D	493	93% 6%
2	B	307	95% 5%
2	F	307	94% 6%
3	C	84	95%

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Mol	Chain	Length	Quality of chain
3	G	84	93% 5%
4	E	103	2% 95%
4	H	103	94%

2 Entry composition (i)

There are 8 unique types of molecules in this entry. The entry contains 18149 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 system protein A.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	489	Total	C	N	O	S	0	0	0
			4021	2578	679	742	22			
1	D	490	Total	C	N	O	S	0	3	0
			4041	2594	681	743	23			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	336	TRP	LEU	conflict	UNP Q00456
A	337	TYR	ASP	conflict	UNP Q00456
D	336	TRP	LEU	conflict	UNP Q00456
D	337	TYR	ASP	conflict	UNP Q00456

- Molecule 2 is a protein called Toluene-4-monooxygenase system protein E.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	306	Total	C	N	O	S	0	1	0
			2541	1609	440	477	15			
2	F	305	Total	C	N	O	S	0	2	0
			2542	1609	441	477	15			

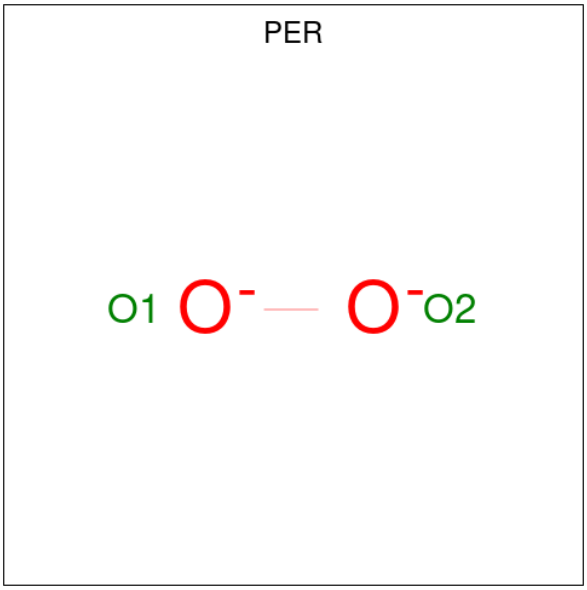
- Molecule 3 is a protein called Toluene-4-monooxygenase system protein B.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	82	Total	C	N	O	S	0	0	0
			654	412	117	121	4			
3	G	82	Total	C	N	O	S	0	0	0
			654	412	117	121	4			

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

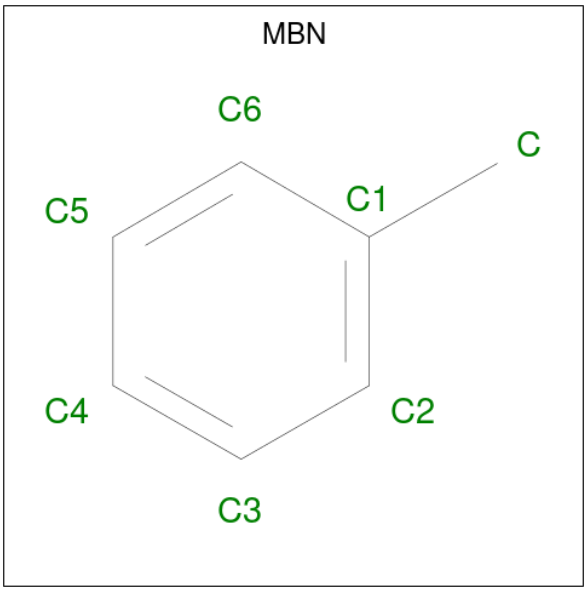
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	E	102	Total	C	N	O	S	0	0	0
			806	503	140	161	2			
4	H	101	Total	C	N	O	S	0	0	0
			801	500	139	160	2			

- Molecule 5 is PEROXIDE ION (three-letter code: PER) (formula: O_2).



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

- Molecule 6 is TOLUENE (three-letter code: MBN) (formula: C_7H_8).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	1	Total C 7 7	0	0
6	A	1	Total C 7 7	0	0
6	A	1	Total C 7 7	0	0
6	D	1	Total C 7 7	0	0
6	D	1	Total C 7 7	0	0

- Molecule 7 is FE (III) ION (three-letter code: FE) (formula: Fe).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	2	Total Fe 2 2	0	0
7	D	2	Total Fe 2 2	0	0

- Molecule 8 is water.

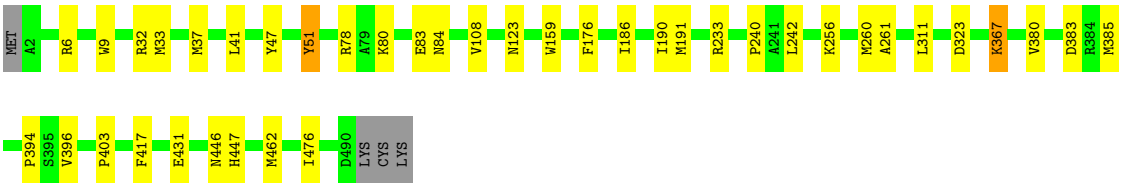
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	A	450	Total O 450 450	0	0
8	B	284	Total O 284 284	0	0
8	C	90	Total O 90 90	0	0
8	D	510	Total O 510 510	0	0
8	E	137	Total O 137 137	0	0
8	F	333	Total O 333 333	0	0
8	G	97	Total O 97 97	0	0
8	H	147	Total O 147 147	0	0

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.

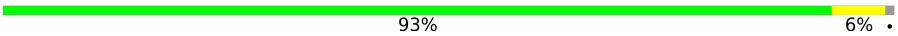
• Molecule 1: Toluene-4-monooxygenase system protein A

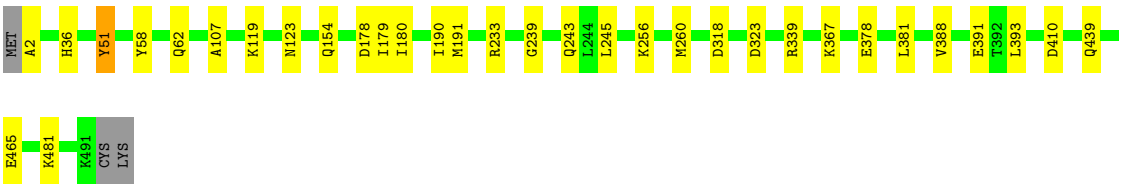
Chain A:



• Molecule 1: Toluene-4-monooxygenase system protein A

Chain D:



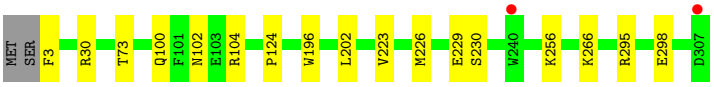


• Molecule 2: Toluene-4-monooxygenase system protein E

Chain B:

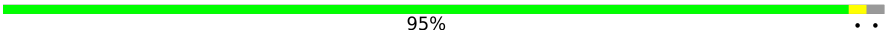
• Molecule 2: Toluene-4-monooxygenase system protein E

Chain F:



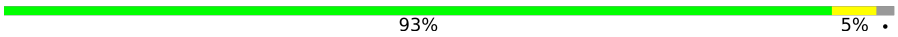
• Molecule 3: Toluene-4-monooxygenase system protein B

Chain C:



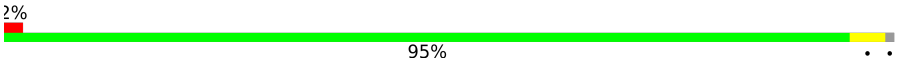
• Molecule 3: Toluene-4-monooxygenase system protein B

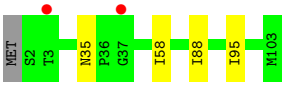
Chain G:



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

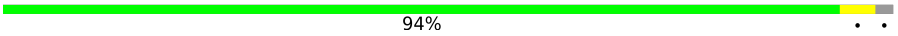
Chain E:





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

Chain H:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	99.90Å 116.25Å 181.61Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.48 – 1.82 29.47 – 1.82	Depositor EDS
% Data completeness (in resolution range)	89.4 (29.48-1.82) 89.4 (29.47-1.82)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.81 (at 1.82Å)	Xtriage
Refinement program	PHENIX (1.10pre_2124)	Depositor
R, R_{free}	0.153 , 0.187 0.152 , 0.187	Depositor DCC
R_{free} test set	1998 reflections (1.18%)	wwPDB-VP
Wilson B-factor (Å^2)	18.1	Xtriage
Anisotropy	0.242	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 54.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	18149	wwPDB-VP
Average B, all atoms (Å^2)	21.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 47.66 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 9.6087e-05. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[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: PER, FE, MBN

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	0.42	0/4150	0.54	0/5637
1	D	0.46	0/4179	0.56	0/5675
2	B	0.39	0/2616	0.53	0/3555
2	F	0.42	0/2621	0.52	0/3563
3	C	0.37	0/666	0.55	0/902
3	G	0.40	0/666	0.58	0/902
4	E	0.41	0/816	0.62	0/1104
4	H	0.40	0/811	0.62	0/1097
All	All	0.42	0/16525	0.55	0/22435

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

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	4021	0	3773	38	0
1	D	4041	0	3806	28	0
2	B	2541	0	2412	13	0
2	F	2542	0	2410	16	0
3	C	654	0	649	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	G	654	0	649	2	0
4	E	806	0	791	2	0
4	H	801	0	789	7	0
5	A	2	0	0	0	0
6	A	21	0	23	1	0
6	D	14	0	16	3	0
7	A	2	0	0	0	0
7	D	2	0	0	0	0
8	A	450	0	0	7	0
8	B	284	0	0	4	1
8	C	90	0	0	0	0
8	D	510	0	0	8	0
8	E	137	0	0	0	0
8	F	333	0	0	8	1
8	G	97	0	0	0	0
8	H	147	0	0	2	0
All	All	18149	0	15318	99	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 3.

The worst 5 of 99 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)
2:F:100[B]:GLN:OE1	8:F:401:HOH:O	1.95	0.84
1:D:378:GLU:OE2	8:D:601:HOH:O	1.95	0.84
1:D:481:LYS:NZ	8:D:604:HOH:O	2.10	0.83
1:A:80:LYS:CE	4:H:46:ARG:HH12	1.92	0.82
1:A:80:LYS:HE3	4:H:46:ARG:HH12	1.46	0.79

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)
8:B:570:HOH:O	8:F:404:HOH:O[4_545]	2.12	0.08

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	487/493 (99%)	473 (97%)	14 (3%)	0	100	100
1	D	491/493 (100%)	475 (97%)	16 (3%)	0	100	100
2	B	305/307 (99%)	302 (99%)	3 (1%)	0	100	100
2	F	305/307 (99%)	303 (99%)	2 (1%)	0	100	100
3	C	80/84 (95%)	77 (96%)	3 (4%)	0	100	100
3	G	80/84 (95%)	77 (96%)	3 (4%)	0	100	100
4	E	100/103 (97%)	99 (99%)	1 (1%)	0	100	100
4	H	99/103 (96%)	98 (99%)	1 (1%)	0	100	100
All	All	1947/1974 (99%)	1904 (98%)	43 (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	414/418 (99%)	409 (99%)	5 (1%)	71	64
1	D	417/418 (100%)	413 (99%)	4 (1%)	76	70
2	B	276/278 (99%)	276 (100%)	0	100	100
2	F	277/278 (100%)	277 (100%)	0	100	100
3	C	73/75 (97%)	73 (100%)	0	100	100
3	G	73/75 (97%)	73 (100%)	0	100	100

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
4	E	85/87 (98%)	85 (100%)	0	100 100
4	H	85/87 (98%)	85 (100%)	0	100 100
All	All	1700/1716 (99%)	1691 (100%)	9 (0%)	88 87

5 of 9 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	323	ASP
1	D	381	LEU
1	A	323	ASP
1	A	367	LYS
1	D	51	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
4	E	35	ASN
4	E	67	GLN
4	H	13	ASN
3	G	7	HIS
1	D	62	GLN

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, 4 are monoatomic - leaving 6 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	$\#\|Z\| > 2$
5	PER	A	501	7,6	0,1,1	-	-	-		
6	MBN	A	504	-	7,7,7	0.31	0	8,8,8	0.37	0
6	MBN	D	501	-	7,7,7	0.25	0	8,8,8	0.40	0
6	MBN	A	502	5	7,7,7	0.38	0	8,8,8	0.50	0
6	MBN	A	503	-	7,7,7	0.47	0	8,8,8	0.41	0
6	MBN	D	502	-	7,7,7	0.50	0	8,8,8	0.36	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	MBN	A	504	-	-	-	0/1/1/1
6	MBN	D	501	-	-	-	0/1/1/1
6	MBN	A	502	5	-	-	0/1/1/1
6	MBN	A	503	-	-	-	0/1/1/1
6	MBN	D	502	-	-	-	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

3 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	D	501	MBN	3	0
6	A	502	MBN	1	0
6	D	502	MBN	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

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	489/493 (99%)	-0.57	0 100 100	11, 18, 32, 67	0
1	D	490/493 (99%)	-0.67	0 100 100	9, 15, 26, 56	0
2	B	306/307 (99%)	-0.39	3 (0%) 82 80	12, 22, 40, 97	1 (0%)
2	F	305/307 (99%)	-0.48	2 (0%) 87 86	10, 17, 35, 111	0
3	C	82/84 (97%)	-0.32	0 100 100	14, 24, 44, 61	0
3	G	82/84 (97%)	-0.42	0 100 100	13, 20, 33, 54	0
4	E	102/103 (99%)	-0.54	2 (1%) 65 61	10, 16, 33, 52	0
4	H	101/103 (98%)	-0.58	0 100 100	10, 18, 35, 50	0
All	All	1957/1974 (99%)	-0.53	7 (0%) 92 91	9, 18, 34, 111	1 (0%)

The worst 5 of 7 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	F	307	ASP	11.3
2	B	307	ASP	4.5
4	E	3	THR	3.8
4	E	37	GLY	3.5
2	B	276	PRO	2.6

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 (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^{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	MBN	A	502	7/7	0.94	0.13	17,22,28,29	7
6	MBN	A	504	7/7	0.94	0.12	25,28,30,31	0
5	PER	A	501	2/2	0.95	0.13	20,20,20,29	2
6	MBN	D	501	7/7	0.95	0.11	25,26,30,33	0
6	MBN	A	503	7/7	0.96	0.11	13,18,21,22	0
6	MBN	D	502	7/7	0.97	0.08	12,14,16,17	0
7	FE	A	505	1/1	1.00	0.04	15,15,15,15	0
7	FE	A	506	1/1	1.00	0.02	21,21,21,21	0
7	FE	D	503	1/1	1.00	0.04	13,13,13,13	0
7	FE	D	504	1/1	1.00	0.01	18,18,18,18	0

6.5 Other polymers (i)

There are no such residues in this entry.