



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 15, 2020 – 08:38 pm BST

PDB ID : 5A4J  
Title : Crystal structure of FTHFS1 from T.acetoxydans Re1  
Authors : Bergdahl, R.; Jacobson, F.; Muller, B.; Mikkelsen, N.; Schurer, A.; Sandgren, M.  
Deposited on : 2015-06-10  
Resolution : 2.15 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.

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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)
Xtriage (Phenix)	:	1.13
EDS	:	2.11
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)	:	2.11

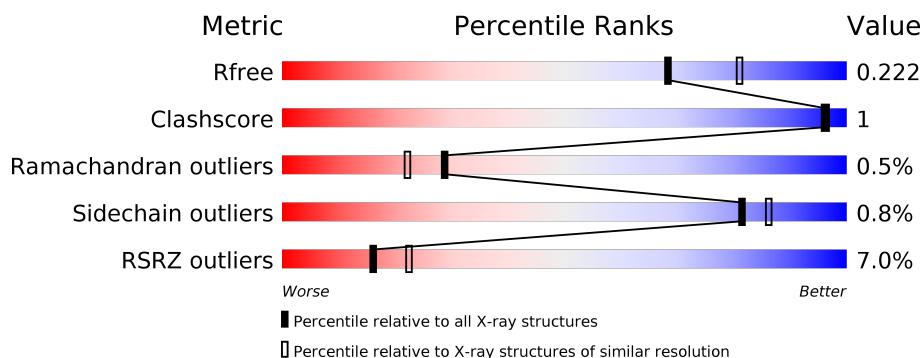
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.15 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	1479 (2.16-2.16)
Clashscore	141614	1585 (2.16-2.16)
Ramachandran outliers	138981	1560 (2.16-2.16)
Sidechain outliers	138945	1559 (2.16-2.16)
RSRZ outliers	127900	1456 (2.16-2.16)

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 on 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	559	<div> <div>2%</div> <div>98%</div> <div>.</div> </div>
1	B	559	<div> <div>2%</div> <div>96%</div> <div>..</div> </div>
1	C	559	<div> <div>12%</div> <div>96%</div> <div>...</div> </div>
1	D	559	<div> <div>12%</div> <div>96%</div> <div>..</div> </div>

## 2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 18075 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 FORMATE--TETRAHYDROFOLATE LIGASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	559	Total	C	N	O	S	0	7	0
			4295	2730	733	809	23			
1	B	556	Total	C	N	O	S	0	8	0
			4265	2710	728	806	21			
1	C	556	Total	C	N	O	S	0	1	0
			4228	2685	727	797	19			
1	D	556	Total	C	N	O	S	0	1	0
			4231	2686	728	798	19			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	377	THR	ALA	cloning artifact	UNP K7SWE7
B	377	THR	ALA	cloning artifact	UNP K7SWE7
C	377	THR	ALA	cloning artifact	UNP K7SWE7
D	377	THR	ALA	cloning artifact	UNP K7SWE7

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



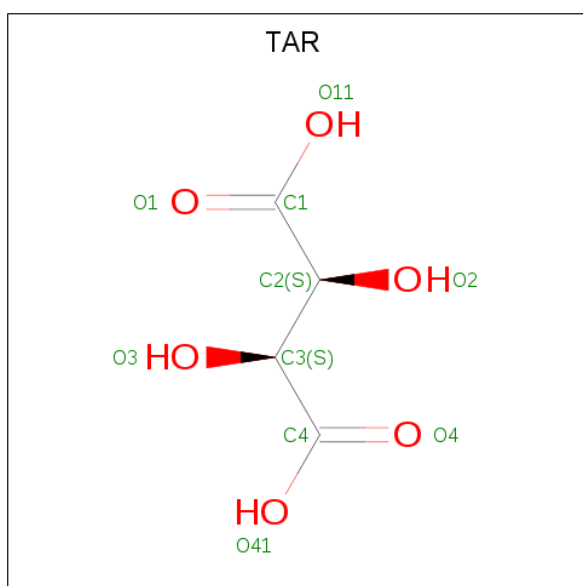
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			4	2	2		
2	A	1	Total	C	O	0	0
			4	2	2		
2	A	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		

- Molecule 3 is DI(HYDROXYETHYL)ETHER (three-letter code: PEG) (formula: C<sub>4</sub>H<sub>10</sub>O<sub>3</sub>).



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

- Molecule 4 is D(-)-TARTARIC ACID (three-letter code: TAR) (formula:  $C_4H_6O_6$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			10	4	6		
4	B	1	Total	C	O	0	0
			10	4	6		

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	C	1	Total	C	O	0	0
			10	4	6		

- Molecule 5 is GLYCEROL (three-letter code: GOL) (formula:  $C_3H_8O_3$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	0
			6	3	3		
5	A	1	Total	C	O	0	0
			6	3	3		
5	C	1	Total	C	O	0	0
			6	3	3		
5	D	1	Total	C	O	0	0
			6	3	3		

- Molecule 6 is POTASSIUM ION (three-letter code: K) (formula: K).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	2	Total	K	0	0
			2	2		
6	A	2	Total	K	0	0
			2	2		
6	D	2	Total	K	0	0
			2	2		
6	C	2	Total	K	0	0
			2	2		

- Molecule 7 is ACETATE ION (three-letter code: ACT) (formula:  $C_2H_3O_2$ ).



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

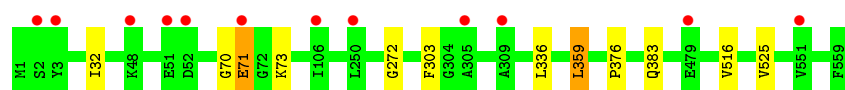
- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	377	Total	O	0	0
			377	377		
8	B	303	Total	O	0	1
			304	304		
8	C	151	Total	O	0	0
			151	151		
8	D	120	Total	O	0	0
			120	120		

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

These plots are drawn for all protein, RNA and DNA 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.

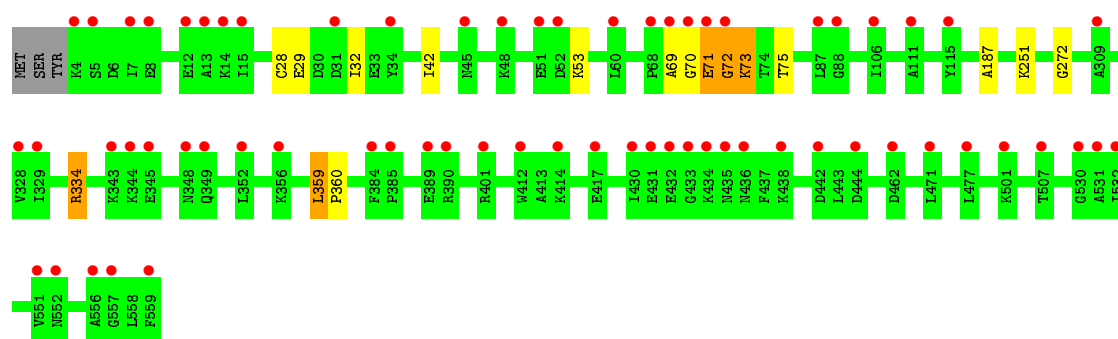
- Molecule 1: FORMATE--TETRAHYDROFOLATE LIGASE



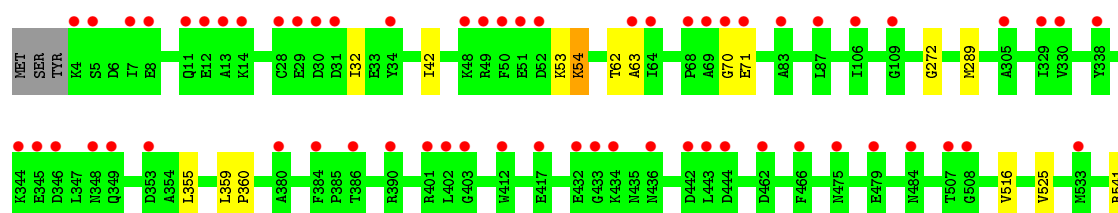
- Molecule 1: FORMATE--TETRAHYDROFOLATE LIGASE



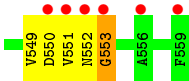
- Molecule 1: FORMATE--TETRAHYDROFOLATE LIGASE



- Molecule 1: FORMATE--TETRAHYDROFOLATE LIGASE







## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	90.04Å 100.98Å 258.05Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.62 – 2.15 29.60 – 2.15	Depositor EDS
% Data completeness (in resolution range)	98.7 (29.62-2.15) 98.7 (29.60-2.15)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.19 (at 2.16Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, $R_{free}$	0.184 , 0.220 0.189 , 0.222	Depositor DCC
$R_{free}$ test set	6356 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	27.9	Xtriage
Anisotropy	0.279	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 45.7	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	18075	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	34.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.25% 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: GOL, TAR, K, EDO, ACT, PEG

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	0.30	0/4374	0.52	0/5908
1	B	0.30	0/4352	0.52	0/5881
1	C	0.27	0/4297	0.47	0/5807
1	D	0.28	0/4297	0.47	0/5807
All	All	0.29	0/17320	0.50	0/23403

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	4295	0	4404	6	0
1	B	4265	0	4376	11	0
1	C	4228	0	4331	8	0
1	D	4231	0	4330	10	0
2	A	12	0	18	0	0
2	B	12	0	18	0	0
3	A	7	0	10	1	0
3	B	7	0	10	0	0
4	A	10	0	4	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	B	10	0	4	0	0
4	C	10	0	4	1	0
5	A	12	0	16	0	0
5	C	6	0	8	0	0
5	D	6	0	8	0	0
6	A	2	0	0	0	0
6	B	2	0	0	0	0
6	C	2	0	0	0	0
6	D	2	0	0	0	0
7	B	4	0	3	0	0
8	A	377	0	0	0	0
8	B	304	0	0	1	0
8	C	151	0	0	1	0
8	D	120	0	0	0	0
All	All	18075	0	17544	34	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 1.

The worst 5 of 34 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:162[A]:ARG:NH1	8:B:2120:HOH:O	2.07	0.81
1:A:70:GLY:O	1:A:71[B]:GLU:HB2	1.85	0.76
1:B:442[A]:ASP:OD2	1:B:444[A]:ASP:CG	2.33	0.67
1:B:442[A]:ASP:OD2	1:B:444[A]:ASP:OD1	2.16	0.63
1:A:70:GLY:O	1:A:71[A]:GLU:HB2	2.02	0.58

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	564/559 (101%)	545 (97%)	16 (3%)	3 (0%)	29	22
1	B	562/559 (100%)	545 (97%)	17 (3%)	0	100	100
1	C	555/559 (99%)	529 (95%)	21 (4%)	5 (1%)	17	11
1	D	555/559 (99%)	528 (95%)	23 (4%)	4 (1%)	22	15
All	All	2236/2236 (100%)	2147 (96%)	77 (3%)	12 (0%)	29	22

5 of 12 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	72	GLY
1	D	550	ASP
1	A	71[A]	GLU
1	A	71[B]	GLU
1	C	69	ALA

### 5.3.2 Protein sidechains ⓘ

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	449/442 (102%)	446 (99%)	3 (1%)	84	89
1	B	447/442 (101%)	444 (99%)	3 (1%)	84	89
1	C	440/442 (100%)	433 (98%)	7 (2%)	62	67
1	D	440/442 (100%)	438 (100%)	2 (0%)	88	92
All	All	1776/1768 (100%)	1761 (99%)	15 (1%)	81	86

5 of 15 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	53	LYS
1	C	71	GLU
1	C	359	LEU
1	B	438	LYS
1	C	334[B]	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 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 carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 24 ligands modelled in this entry, 8 are monoatomic - leaving 16 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	$\# Z  > 2$
2	EDO	B	1560	-	3,3,3	0.49	0	2,2,2	0.24	0
2	EDO	A	1560	-	3,3,3	0.47	0	2,2,2	0.28	0
4	TAR	A	1564	-	3,9,9	0.47	0	6,12,12	1.06	0
2	EDO	B	1561	-	3,3,3	0.49	0	2,2,2	0.24	0
5	GOL	D	1560	-	5,5,5	0.36	0	5,5,5	0.11	0
7	ACT	B	1564	-	1,3,3	1.60	0	0,3,3	0.00	-
2	EDO	A	1562	-	3,3,3	0.52	0	2,2,2	0.06	0
4	TAR	C	1560	-	3,9,9	0.51	0	6,12,12	0.40	0
2	EDO	B	1562	-	3,3,3	0.47	0	2,2,2	0.18	0
5	GOL	A	1566	-	5,5,5	0.39	0	5,5,5	0.22	0
5	GOL	A	1565	-	5,5,5	0.36	0	5,5,5	0.16	0
2	EDO	A	1561	-	3,3,3	0.55	0	2,2,2	0.19	0
4	TAR	B	1565	-	3,9,9	0.38	0	6,12,12	0.86	0
5	GOL	C	1561	-	5,5,5	0.29	0	5,5,5	0.30	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
3	PEG	B	1563	-	6,6,6	0.49	0	5,5,5	0.19	0
3	PEG	A	1563	-	6,6,6	0.55	0	5,5,5	0.41	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	1560	-	-	1/1/1/1	-
2	EDO	A	1560	-	-	1/1/1/1	-
4	TAR	A	1564	-	-	4/4/12/12	-
2	EDO	B	1561	-	-	0/1/1/1	-
5	GOL	D	1560	-	-	4/4/4/4	-
3	PEG	A	1563	-	-	1/4/4/4	-
2	EDO	A	1562	-	-	0/1/1/1	-
4	TAR	C	1560	-	-	0/4/12/12	-
2	EDO	B	1562	-	-	0/1/1/1	-
5	GOL	A	1566	-	-	4/4/4/4	-
5	GOL	A	1565	-	-	2/4/4/4	-
2	EDO	A	1561	-	-	0/1/1/1	-
4	TAR	B	1565	-	-	0/4/12/12	-
5	GOL	C	1561	-	-	0/4/4/4	-
3	PEG	B	1563	-	-	1/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 18 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	1566	GOL	O1-C1-C2-C3
5	A	1566	GOL	C1-C2-C3-O3
5	D	1560	GOL	O1-C1-C2-C3
5	A	1565	GOL	C1-C2-C3-O3
5	D	1560	GOL	C1-C2-C3-O3

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	C	1560	TAR	1	0
3	A	1563	PEG	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	559/559 (100%)	-0.02	12 (2%) 63 71	13, 22, 37, 65	8 (1%)
1	B	556/559 (99%)	0.05	10 (1%) 68 75	13, 24, 40, 60	0
1	C	556/559 (99%)	0.64	66 (11%) 4 6	19, 46, 66, 85	0
1	D	556/559 (99%)	0.70	68 (12%) 4 6	17, 45, 66, 85	0
All	All	2227/2236 (99%)	0.34	156 (7%) 16 22	13, 31, 61, 85	8 (0%)

The worst 5 of 156 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	69	ALA	8.7
1	D	551	VAL	8.3
1	D	28	CYS	6.6
1	D	550	ASP	6.6
1	C	551	VAL	5.9

### 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 carbohydrates 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( $\text{\AA}^2$ )	Q<0.9
5	GOL	D	1560	6/6	0.58	0.23	54,55,57,58	0
3	PEG	A	1563	7/7	0.59	0.25	36,38,39,41	0
4	TAR	C	1560	10/10	0.62	0.32	56,57,61,63	0
4	TAR	B	1565	10/10	0.70	0.31	61,63,67,68	0
2	EDO	B	1560	4/4	0.74	0.20	45,45,46,46	0
5	GOL	A	1566	6/6	0.76	0.14	48,48,48,48	0
5	GOL	C	1561	6/6	0.76	0.27	42,43,44,45	0
4	TAR	A	1564	10/10	0.78	0.37	39,45,46,48	0
5	GOL	A	1565	6/6	0.81	0.17	38,39,39,40	0
3	PEG	B	1563	7/7	0.87	0.11	43,44,46,46	0
2	EDO	A	1562	4/4	0.88	0.12	37,37,37,37	0
2	EDO	B	1561	4/4	0.89	0.11	34,35,35,35	0
2	EDO	A	1561	4/4	0.92	0.11	29,30,31,31	0
2	EDO	B	1562	4/4	0.94	0.16	30,31,32,34	0
2	EDO	A	1560	4/4	0.95	0.11	40,41,41,41	0
7	ACT	B	1564	4/4	0.95	0.14	42,43,44,44	0
6	K	D	1562	1/1	0.96	0.11	33,33,33,33	0
6	K	C	1563	1/1	0.97	0.14	35,35,35,35	0
6	K	A	1568	1/1	0.98	0.06	31,31,31,31	0
6	K	A	1567	1/1	0.99	0.10	14,14,14,14	0
6	K	D	1561	1/1	0.99	0.06	31,31,31,31	0
6	K	B	1567	1/1	0.99	0.03	34,34,34,34	0
6	K	C	1562	1/1	0.99	0.08	36,36,36,36	0
6	K	B	1566	1/1	1.00	0.09	18,18,18,18	0

## 6.5 Other polymers

There are no such residues in this entry.