



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 7, 2026 – 03:20 AM UTC

PDB ID : 2IB9 / pdb_00002ib9
Title : Crystallographic and kinetic studies of human mitochondrial acetoacetyl-CoA thiolase (T2): the importance of potassium and chloride for its structure and function
Authors : Haapalainen, A.M.; Wierenga, R.K.
Deposited on : 2006-09-11
Resolution : 2.05 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 ⓘ 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	:	4-5-2 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

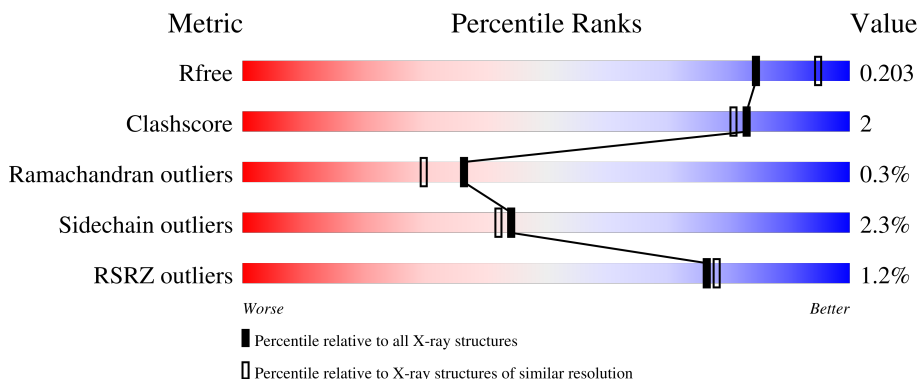
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.05 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	2260 (2.04-2.04)
Clashscore	190562	2333 (2.04-2.04)
Ramachandran outliers	187476	2318 (2.04-2.04)
Sidechain outliers	187428	2318 (2.04-2.04)
RSRZ outliers	180081	2260 (2.04-2.04)

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 $\leq 5\%$. 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	395	96% ..
1	B	395	% 89% 9% ..
1	C	395	% 91% 8% ..
1	D	395	3% 89% 10% .

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 12658 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 Acetyl-CoA acetyltransferase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	391	Total	C	N	O	S	0	11	0
			2910	1839	492	556	23			
1	B	391	Total	C	N	O	S	0	12	0
			2910	1840	492	555	23			
1	C	392	Total	C	N	O	S	0	10	0
			2915	1841	494	557	23			
1	D	393	Total	C	N	O	S	0	4	0
			2899	1829	493	554	23			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	33	MET	-	initiating methionine	UNP P24752
A	34	ALA	VAL	engineered mutation	UNP P24752
B	33	MET	-	initiating methionine	UNP P24752
B	34	ALA	VAL	engineered mutation	UNP P24752
C	33	MET	-	initiating methionine	UNP P24752
C	34	ALA	VAL	engineered mutation	UNP P24752
D	33	MET	-	initiating methionine	UNP P24752
D	34	ALA	VAL	engineered mutation	UNP P24752

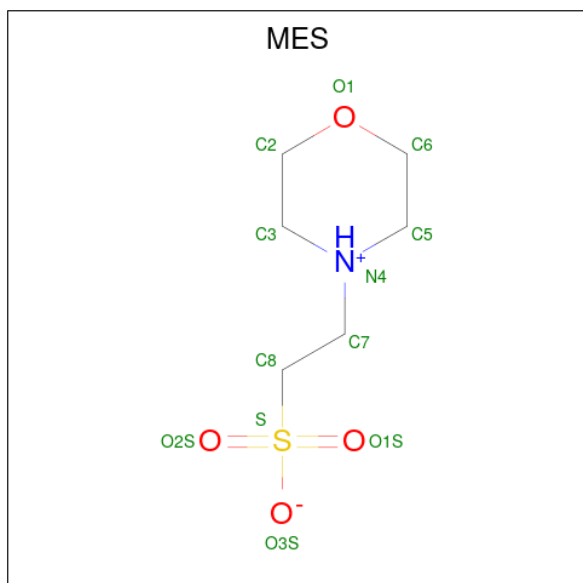
- Molecule 2 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Cl	0	0
			1	1		
2	B	1	Total	Cl	0	0
			1	1		
2	C	1	Total	Cl	0	0
			1	1		
2	D	1	Total	Cl	0	0
			1	1		

- Molecule 3 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total K 1 1	0	0
3	B	1	Total K 1 1	0	0
3	C	1	Total K 1 1	0	0
3	D	1	Total K 1 1	0	0

- Molecule 4 is 2-(N-MORPHOLINO)-ETHANESULFONIC ACID (CCD ID: MES) (formula: C₆H₁₃NO₄S).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total C N O S 12 6 1 4 1	0	0
4	B	1	Total C N O S 12 6 1 4 1	0	0
4	C	1	Total C N O S 12 6 1 4 1	0	0
4	D	1	Total C N O S 12 6 1 4 1	0	0

- Molecule 5 is GLYCEROL (CCD ID: GOL) (formula: C₃H₈O₃).



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	A	1	Total	C	O	0	0
			6	3	3		
5	B	1	Total	C	O	0	0
			6	3	3		
5	C	1	Total	C	O	0	0
			6	3	3		

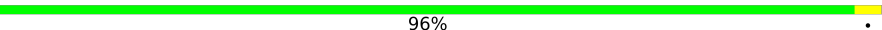
- Molecule 6 is water.

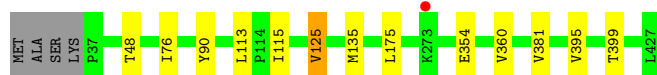
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	327	Total	O	0	0
			327	327		
6	B	279	Total	O	0	0
			279	279		
6	C	179	Total	O	0	0
			179	179		
6	D	153	Total	O	0	0
			153	153		

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.

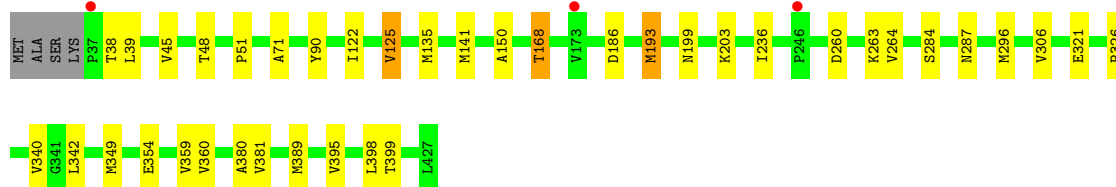
- Molecule 1: Acetyl-CoA acetyltransferase

Chain A:  96% ..

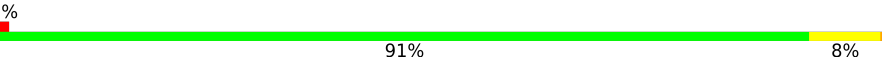


- Molecule 1: Acetyl-CoA acetyltransferase

Chain B:  89% 9% ..



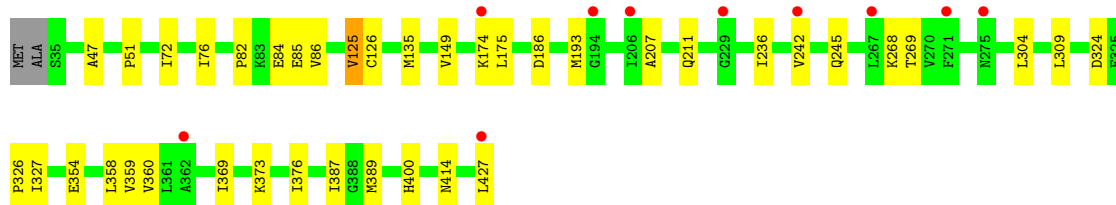
- Molecule 1: Acetyl-CoA acetyltransferase

Chain C:  91% 8% ..



- Molecule 1: Acetyl-CoA acetyltransferase

Chain D:  89% 10% 3% ..



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	75.75Å 107.44Å 102.33Å 90.00° 103.06° 90.00°	Depositor
Resolution (Å)	73.72 – 2.05 73.72 – 2.05	Depositor EDS
% Data completeness (in resolution range)	100.0 (73.72-2.05) 100.0 (73.72-2.05)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	0.07	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.21 (at 2.05Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.156 , 0.199 0.160 , 0.203	Depositor DCC
R_{free} test set	4998 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	21.2	Xtriage
Anisotropy	0.075	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 54.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	12658	wwPDB-VP
Average B, all atoms (Å ²)	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.97% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: K, MES, GOL, CL

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	0.82	0/2998	0.85	0/4057
1	B	0.79	1/3005 (0.0%)	0.87	2/4068 (0.0%)
1	C	0.66	0/2999	0.86	3/4059 (0.1%)
1	D	0.66	0/2957	0.88	1/4001 (0.0%)
All	All	0.74	1/11959 (0.0%)	0.87	6/16185 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	264	VAL	CA-CB	7.13	1.57	1.54

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	387	ILE	N-CA-C	6.32	117.07	110.62
1	C	270	VAL	N-CA-C	6.11	116.89	110.72
1	B	380	ALA	N-CA-C	5.68	118.24	111.71
1	C	387	ILE	N-CA-C	5.62	117.03	110.62
1	B	287	ASN	N-CA-C	5.36	117.12	109.14

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	2910	0	3004	8	0
1	B	2910	0	3003	23	0
1	C	2915	0	3006	14	0
1	D	2899	0	2989	19	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
3	C	1	0	0	0	0
3	D	1	0	0	0	0
4	A	12	0	12	0	0
4	B	12	0	12	0	0
4	C	12	0	12	0	0
4	D	12	0	12	0	0
5	A	18	0	24	0	0
5	B	6	0	8	1	0
5	C	6	0	8	0	0
6	A	327	0	0	1	0
6	B	279	0	0	0	0
6	C	179	0	0	1	0
6	D	153	0	0	0	0
All	All	12658	0	12090	58	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 2.

The worst 5 of 58 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:168[B]:THR:HG21	1:C:163:MET:HE3	1.72	0.71
1:D:47:ALA:O	1:D:400:HIS:HE1	1.75	0.68
1:B:39:LEU:HD13	1:B:141:MET:HE2	1.77	0.66
1:A:48[A]:THR:HG22	6:A:5105:HOH:O	1.95	0.66
1:B:395:VAL:O	1:B:399[B]:THR:HG23	1.97	0.65

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone

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	400/395 (101%)	395 (99%)	4 (1%)	1 (0%)	36	30
1	B	401/395 (102%)	394 (98%)	6 (2%)	1 (0%)	43	37
1	C	400/395 (101%)	392 (98%)	7 (2%)	1 (0%)	36	30
1	D	395/395 (100%)	384 (97%)	10 (2%)	1 (0%)	36	30
All	All	1596/1580 (101%)	1565 (98%)	27 (2%)	4 (0%)	36	30

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	125	VAL
1	B	125	VAL
1	C	125	VAL
1	D	125	VAL

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	317/309 (103%)	315 (99%)	2 (1%)	78	83
1	B	318/309 (103%)	310 (98%)	8 (2%)	42	39
1	C	317/309 (103%)	306 (96%)	11 (4%)	32	27
1	D	312/309 (101%)	303 (97%)	9 (3%)	37	33
All	All	1264/1236 (102%)	1234 (98%)	30 (2%)	44	40

5 of 30 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	241	THR
1	D	369	ILE
1	C	267	LEU
1	D	427	LEU
1	D	175	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	164	ASN
1	D	400	HIS
1	B	209	ASN
1	B	377	ASN
1	C	93	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 17 ligands modelled in this entry, 8 are monoatomic - leaving 9 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
4	MES	C	5003	-	12,12,12	2.33	1 (8%)	15,16,16	2.35	4 (26%)
5	GOL	A	4001	-	5,5,5	0.42	0	5,5,5	0.31	0
4	MES	A	5001	-	12,12,12	2.30	1 (8%)	15,16,16	2.37	6 (40%)
5	GOL	C	4005	-	5,5,5	0.40	0	5,5,5	0.30	0
4	MES	B	5002	-	12,12,12	2.29	1 (8%)	15,16,16	2.30	5 (33%)
4	MES	D	5004	-	12,12,12	2.22	1 (8%)	15,16,16	2.34	6 (40%)
5	GOL	A	4003	-	5,5,5	0.35	0	5,5,5	0.31	0
5	GOL	B	4002	-	5,5,5	0.44	0	5,5,5	0.59	0
5	GOL	A	4004	-	5,5,5	0.38	0	5,5,5	0.31	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
4	MES	C	5003	-	-	1/6/14/14	0/1/1/1
5	GOL	A	4001	-	-	2/4/4/4	-
4	MES	A	5001	-	-	4/6/14/14	0/1/1/1
5	GOL	C	4005	-	-	2/4/4/4	-
4	MES	B	5002	-	-	2/6/14/14	0/1/1/1
4	MES	D	5004	-	-	4/6/14/14	0/1/1/1
5	GOL	A	4003	-	-	0/4/4/4	-
5	GOL	B	4002	-	-	0/4/4/4	-
5	GOL	A	4004	-	-	1/4/4/4	-

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	C	5003	MES	C8-S	-7.76	1.66	1.77
4	B	5002	MES	C8-S	-7.63	1.66	1.77
4	A	5001	MES	C8-S	-7.61	1.66	1.77
4	D	5004	MES	C8-S	-7.36	1.67	1.77

The worst 5 of 21 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	C	5003	MES	C5-N4-C3	5.96	121.68	108.84
4	B	5002	MES	C5-N4-C3	5.72	121.16	108.84
4	A	5001	MES	C5-N4-C3	5.44	120.55	108.84

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	D	5004	MES	C5-N4-C3	5.39	120.45	108.84
4	D	5004	MES	C7-N4-C5	3.44	120.40	111.24

There are no chirality outliers.

5 of 16 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	5001	MES	C7-C8-S-O2S
4	A	5001	MES	C7-C8-S-O3S
5	C	4005	GOL	C1-C2-C3-O3
5	C	4005	GOL	O2-C2-C3-O3
4	B	5002	MES	C8-C7-N4-C3

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	B	4002	GOL	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, 95th 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	391/395 (98%)	-0.63	1 (0%) 90 92	12, 21, 34, 65	23 (5%)
1	B	391/395 (98%)	-0.43	3 (0%) 82 84	14, 24, 40, 58	21 (5%)
1	C	392/395 (99%)	-0.07	5 (1%) 75 76	17, 32, 47, 70	18 (4%)
1	D	393/395 (99%)	0.44	10 (2%) 58 60	22, 37, 54, 73	17 (4%)
All	All	1567/1580 (99%)	-0.17	19 (1%) 76 78	12, 29, 49, 73	79 (5%)

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	194	GLY	2.9
1	B	173	VAL	2.7
1	B	246	PRO	2.6
1	C	173	VAL	2.6
1	D	242	VAL	2.5

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, 95th 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
4	MES	C	5003	12/12	0.73	0.26	86,87,88,88	5
4	MES	D	5004	12/12	0.80	0.23	88,89,90,90	5
4	MES	B	5002	12/12	0.81	0.26	97,97,98,98	5
5	GOL	A	4004	6/6	0.81	0.17	69,70,70,70	0
5	GOL	B	4002	6/6	0.84	0.19	41,43,43,43	6
5	GOL	C	4005	6/6	0.85	0.20	62,63,63,63	0
5	GOL	A	4001	6/6	0.87	0.17	52,54,54,55	0
4	MES	A	5001	12/12	0.88	0.16	55,57,58,58	5
5	GOL	A	4003	6/6	0.90	0.12	42,45,46,46	0
3	K	D	3004	1/1	0.98	0.06	36,36,36,36	0
2	CL	B	2001	1/1	0.99	0.03	22,22,22,22	0
2	CL	C	2004	1/1	0.99	0.03	34,34,34,34	0
2	CL	D	2003	1/1	0.99	0.03	29,29,29,29	0
3	K	B	3002	1/1	0.99	0.04	21,21,21,21	0
3	K	C	3003	1/1	0.99	0.03	27,27,27,27	0
2	CL	A	2002	1/1	1.00	0.02	23,23,23,23	0
3	K	A	3001	1/1	1.00	0.01	17,17,17,17	0

6.5 Other polymers

There are no such residues in this entry.