wwPDB X-ray Structure Validation Summary Report (i)

Aug 22, 2020 – 06:53 PM BST

PDB ID	:	5UDQ
Title	:	LarE, a sulfur transferase involved in synthesis of the cofactor for lactate racemase, apo form
Authors	:	Fellner, M.; Desguin, B.; Hausinger, R.P.; Hu, J.
Deposited on	:	2016-12-28
Resolution	:	2.09 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 following versions of software and data (see references (1)) were used in the production of this report:

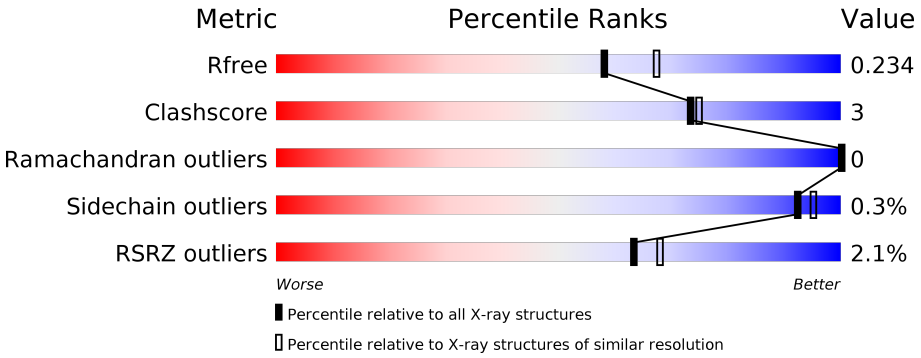
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.13.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.13.1

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 2.09 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	5197 (2.10-2.10)
Clashscore	141614	5710 (2.10-2.10)
Ramachandran outliers	138981	5647 (2.10-2.10)
Sidechain outliers	138945	5648 (2.10-2.10)
RSRZ outliers	127900	5083 (2.10-2.10)

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 >=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	286	82% 10% 8%
1	B	286	80% 6% 14%
1	C	286	80% 7% 13%
1	D	286	78% 6% 16%
1	E	286	85% 7% 8%
1	F	286	80% 8% 13%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 12338 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 Lactate racemization operon protein LarE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	263	Total	C	N	O	S	0	0	0
			2006	1262	349	388	7			
1	B	245	Total	C	N	O	S	0	0	0
			1876	1184	327	359	6			
1	C	249	Total	C	N	O	S	0	1	0
			1928	1215	339	368	6			
1	D	240	Total	C	N	O	S	0	2	0
			1849	1169	319	354	7			
1	E	262	Total	C	N	O	S	0	2	0
			2018	1275	349	387	7			
1	F	250	Total	C	N	O	S	0	3	0
			1958	1233	341	378	6			

There are 60 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	277	ALA	-	expression tag	UNP F9UST4
A	278	SER	-	expression tag	UNP F9UST4
A	279	TRP	-	expression tag	UNP F9UST4
A	280	SER	-	expression tag	UNP F9UST4
A	281	HIS	-	expression tag	UNP F9UST4
A	282	PRO	-	expression tag	UNP F9UST4
A	283	GLN	-	expression tag	UNP F9UST4
A	284	PHE	-	expression tag	UNP F9UST4
A	285	GLU	-	expression tag	UNP F9UST4
A	286	LYS	-	expression tag	UNP F9UST4
B	277	ALA	-	expression tag	UNP F9UST4
B	278	SER	-	expression tag	UNP F9UST4
B	279	TRP	-	expression tag	UNP F9UST4
B	280	SER	-	expression tag	UNP F9UST4
B	281	HIS	-	expression tag	UNP F9UST4
B	282	PRO	-	expression tag	UNP F9UST4
B	283	GLN	-	expression tag	UNP F9UST4

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Chain	Residue	Modelled	Actual	Comment	Reference
B	284	PHE	-	expression tag	UNP F9UST4
B	285	GLU	-	expression tag	UNP F9UST4
B	286	LYS	-	expression tag	UNP F9UST4
C	277	ALA	-	expression tag	UNP F9UST4
C	278	SER	-	expression tag	UNP F9UST4
C	279	TRP	-	expression tag	UNP F9UST4
C	280	SER	-	expression tag	UNP F9UST4
C	281	HIS	-	expression tag	UNP F9UST4
C	282	PRO	-	expression tag	UNP F9UST4
C	283	GLN	-	expression tag	UNP F9UST4
C	284	PHE	-	expression tag	UNP F9UST4
C	285	GLU	-	expression tag	UNP F9UST4
C	286	LYS	-	expression tag	UNP F9UST4
D	277	ALA	-	expression tag	UNP F9UST4
D	278	SER	-	expression tag	UNP F9UST4
D	279	TRP	-	expression tag	UNP F9UST4
D	280	SER	-	expression tag	UNP F9UST4
D	281	HIS	-	expression tag	UNP F9UST4
D	282	PRO	-	expression tag	UNP F9UST4
D	283	GLN	-	expression tag	UNP F9UST4
D	284	PHE	-	expression tag	UNP F9UST4
D	285	GLU	-	expression tag	UNP F9UST4
D	286	LYS	-	expression tag	UNP F9UST4
E	277	ALA	-	expression tag	UNP F9UST4
E	278	SER	-	expression tag	UNP F9UST4
E	279	TRP	-	expression tag	UNP F9UST4
E	280	SER	-	expression tag	UNP F9UST4
E	281	HIS	-	expression tag	UNP F9UST4
E	282	PRO	-	expression tag	UNP F9UST4
E	283	GLN	-	expression tag	UNP F9UST4
E	284	PHE	-	expression tag	UNP F9UST4
E	285	GLU	-	expression tag	UNP F9UST4
E	286	LYS	-	expression tag	UNP F9UST4
F	277	ALA	-	expression tag	UNP F9UST4
F	278	SER	-	expression tag	UNP F9UST4
F	279	TRP	-	expression tag	UNP F9UST4
F	280	SER	-	expression tag	UNP F9UST4
F	281	HIS	-	expression tag	UNP F9UST4
F	282	PRO	-	expression tag	UNP F9UST4
F	283	GLN	-	expression tag	UNP F9UST4
F	284	PHE	-	expression tag	UNP F9UST4
F	285	GLU	-	expression tag	UNP F9UST4

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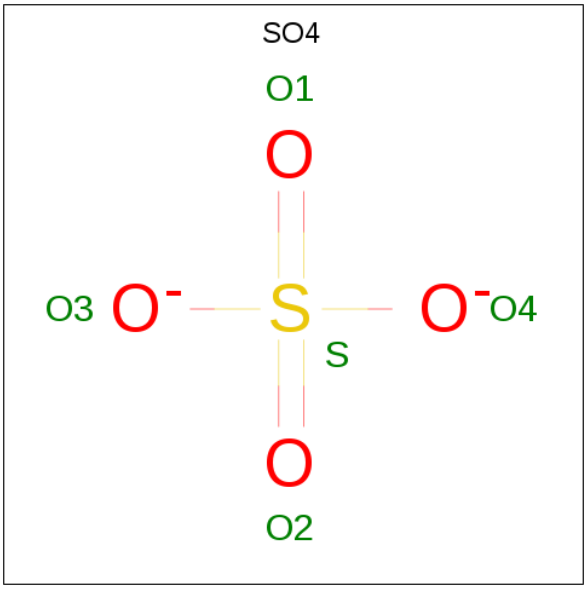
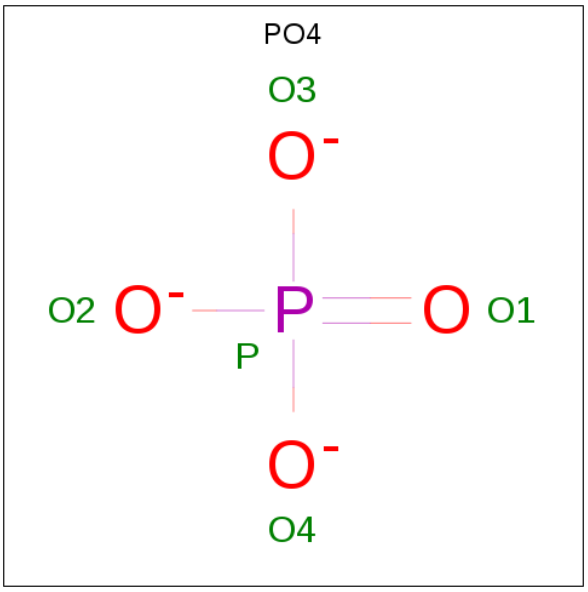
Chain	Residue	Modelled	Actual	Comment	Reference
F	286	LYS	-	expression tag	UNP F9UST4

- Molecule 2 is SULFATE ION (three-letter code: SO4) (formula: O_4S).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total O S 5 4 1	0	0
2	A	1	Total O S 5 4 1	0	0
2	B	1	Total O S 5 4 1	0	0
2	C	1	Total O S 5 4 1	0	0
2	D	1	Total O S 5 4 1	0	0
2	E	1	Total O S 5 4 1	0	0
2	F	1	Total O S 5 4 1	0	0
2	F	1	Total O S 5 4 1	0	0

- Molecule 3 is PHOSPHATE ION (three-letter code: PO4) (formula: O_4P).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total O P 5 4 1	0	0
3	B	1	Total O P 5 4 1	0	0
3	C	1	Total O P 5 4 1	0	0
3	D	1	Total O P 5 4 1	0	0
3	E	1	Total O P 5 4 1	0	0
3	F	1	Total O P 5 4 1	0	0

- Molecule 4 is water.

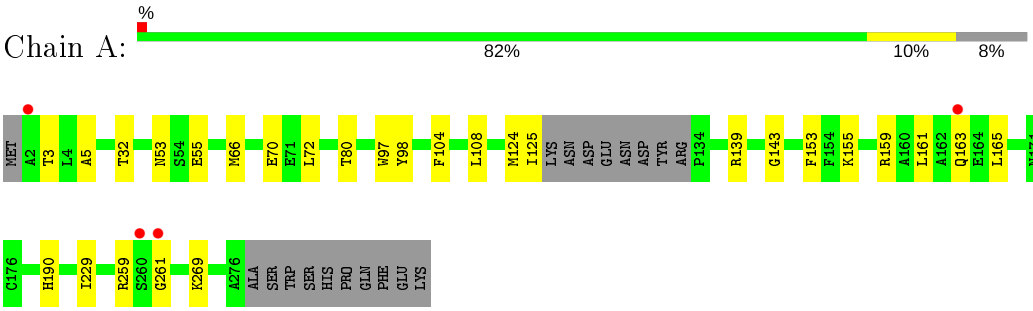
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	85	Total O 85 85	0	0
4	B	115	Total O 115 115	0	0
4	C	125	Total O 125 125	0	0
4	D	92	Total O 92 92	0	0
4	E	97	Total O 97 97	0	0
4	F	119	Total O 119 119	0	0

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.

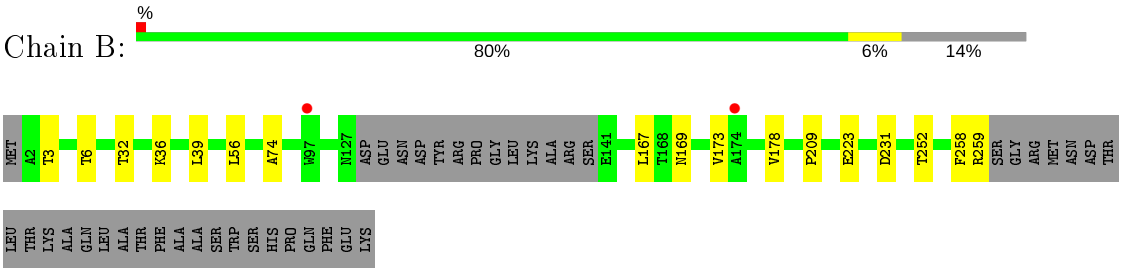
- Molecule 1: Lactate racemization operon protein LarE

Chain A:



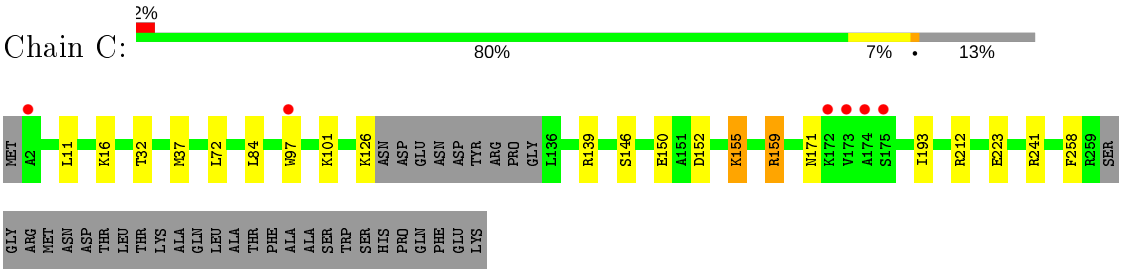
- Molecule 1: Lactate racemization operon protein LarE

Chain B:



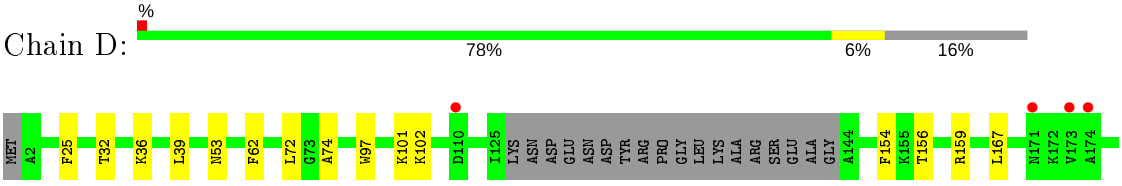
- Molecule 1: Lactate racemization operon protein LarE

Chain C:



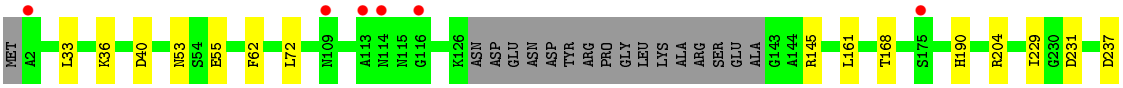
- Molecule 1: Lactate racemization operon protein LarE

Chain D:



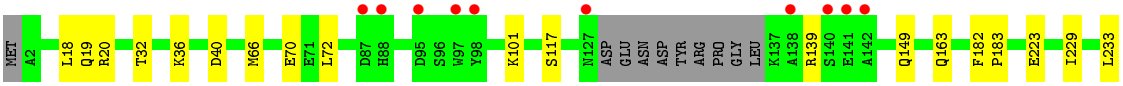
• Molecule 1: Lactate racemization operon protein LarE

Chain E:



• Molecule 1: Lactate racemization operon protein LarE

Chain F:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 41 2 2	Depositor
Cell constants a, b, c, α, β, γ	107.40Å 107.40Å 317.04Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.49 – 2.09 47.49 – 2.09	Depositor EDS
% Data completeness (in resolution range)	98.5 (47.49-2.09) 99.1 (47.49-2.09)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.92 (at 2.08Å)	Xtriage
Refinement program	PHENIX 1.11.1-2575	Depositor
R, R_{free}	0.187 , 0.231 0.190 , 0.234	Depositor DCC
R_{free} test set	5324 reflections (4.84%)	wwPDB-VP
Wilson B-factor (Å^2)	35.9	Xtriage
Anisotropy	0.122	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 56.7	EDS
L-test for twinning[2]	$< \|L\| > = 0.44$, $< L^2 > = 0.27$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	12338	wwPDB-VP
Average B, all atoms (Å^2)	45.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 1.95% 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: PO4, SO4

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	0.40	0/2036	0.55	0/2758
1	B	0.42	0/1905	0.58	0/2583
1	C	0.40	0/1957	0.60	0/2649
1	D	0.36	0/1878	0.54	0/2548
1	E	0.40	0/2050	0.55	0/2779
1	F	0.43	0/1989	0.57	0/2694
All	All	0.40	0/11815	0.56	0/16011

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand.A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	E	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	E	145	ARG	Sidechain

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	2006	0	1959	16	0
1	B	1876	0	1838	13	0
1	C	1928	0	1910	17	0
1	D	1849	0	1801	10	0
1	E	2018	0	1977	14	0
1	F	1958	0	1918	14	0
2	A	10	0	0	0	0
2	B	5	0	0	0	0
2	C	5	0	0	0	0
2	D	5	0	0	0	0
2	E	5	0	0	0	0
2	F	10	0	0	0	0
3	A	5	0	0	1	0
3	B	5	0	0	0	0
3	C	5	0	0	0	0
3	D	5	0	0	0	0
3	E	5	0	0	0	0
3	F	5	0	0	1	0
4	A	85	0	0	0	0
4	B	115	0	0	2	0
4	C	125	0	0	2	0
4	D	92	0	0	0	0
4	E	97	0	0	3	0
4	F	119	0	0	1	0
All	All	12338	0	11403	76	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 76 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:169:ASN:HB2	1:C:159:ARG:NH1	2.02	0.74
1:A:53:ASN:HB3	1:A:80:THR:HG22	1.72	0.72
1:B:3:THR:HG23	1:B:6:THR:H	1.55	0.71
1:B:173:VAL:HG11	1:B:209:PRO:HB2	1.78	0.65
1:D:39:LEU:HD11	1:D:74:ALA:HB2	1.80	0.64

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	257/286 (90%)	253 (98%)	4 (2%)	0	100	100
1	B	241/286 (84%)	235 (98%)	6 (2%)	0	100	100
1	C	246/286 (86%)	241 (98%)	5 (2%)	0	100	100
1	D	238/286 (83%)	235 (99%)	3 (1%)	0	100	100
1	E	260/286 (91%)	253 (97%)	7 (3%)	0	100	100
1	F	249/286 (87%)	242 (97%)	7 (3%)	0	100	100
All	All	1491/1716 (87%)	1459 (98%)	32 (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	207/236 (88%)	206 (100%)	1 (0%)	88	92
1	B	194/236 (82%)	194 (100%)	0	100	100
1	C	202/236 (86%)	200 (99%)	2 (1%)	76	82
1	D	191/236 (81%)	190 (100%)	1 (0%)	88	92
1	E	208/236 (88%)	208 (100%)	0	100	100
1	F	205/236 (87%)	205 (100%)	0	100	100
All	All	1207/1416 (85%)	1203 (100%)	4 (0%)	92	95

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	124	MET
1	C	155	LYS
1	C	159	ARG
1	D	102	LYS

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 monosaccharides in this entry.

5.6 Ligand geometry (i)

14 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	SO4	C	301	-	4,4,4	0.23	0	6,6,6	0.38	0
2	SO4	F	301	-	4,4,4	0.12	0	6,6,6	0.34	0
3	PO4	C	302	-	4,4,4	1.21	0	6,6,6	0.63	0
2	SO4	D	301	-	4,4,4	0.12	0	6,6,6	0.21	0
2	SO4	A	302	-	4,4,4	0.14	0	6,6,6	0.05	0
3	PO4	E	302	-	4,4,4	1.16	0	6,6,6	0.73	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
2	SO4	A	301	-	4,4,4	0.13	0	6,6,6	0.26	0
3	PO4	A	303	-	4,4,4	0.93	0	6,6,6	0.47	0
3	PO4	B	302	-	4,4,4	1.13	0	6,6,6	0.39	0
3	PO4	D	302	-	4,4,4	1.05	0	6,6,6	0.57	0
2	SO4	F	302	-	4,4,4	0.24	0	6,6,6	0.55	0
3	PO4	F	303	-	4,4,4	1.11	0	6,6,6	0.70	0
2	SO4	B	301	1	4,4,4	0.11	0	6,6,6	0.27	0
2	SO4	E	301	-	4,4,4	0.14	0	6,6,6	0.28	0

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.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	303	PO4	1	0
3	F	303	PO4	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	263/286 (91%)	0.09	4 (1%)	73	77	27, 50, 76, 87	0
1	B	245/286 (85%)	-0.04	2 (0%)	86	88	25, 44, 63, 72	0
1	C	249/286 (87%)	-0.01	6 (2%)	59	64	24, 38, 61, 81	0
1	D	240/286 (83%)	0.12	4 (1%)	70	74	26, 48, 69, 86	0
1	E	262/286 (91%)	0.03	6 (2%)	60	65	27, 49, 70, 83	0
1	F	250/286 (87%)	0.13	10 (4%)	38	44	26, 40, 59, 73	0
All	All	1509/1716 (87%)	0.05	32 (2%)	63	68	24, 44, 70, 87	0

The worst 5 of 32 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	174	ALA	5.4
1	C	174	ALA	5.2
1	D	173	VAL	4.2
1	F	98	TYR	3.7
1	F	97[A]	TRP	3.7

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
2	SO4	B	301	5/5	0.84	0.19	38,42,44,44	5
2	SO4	A	302	5/5	0.91	0.16	83,85,90,94	0
2	SO4	C	301	5/5	0.91	0.17	39,45,49,54	5
2	SO4	D	301	5/5	0.92	0.13	44,50,52,58	5
2	SO4	F	301	5/5	0.93	0.14	50,55,57,64	5
2	SO4	A	301	5/5	0.94	0.12	49,52,56,63	5
2	SO4	F	302	5/5	0.95	0.18	39,48,53,58	5
2	SO4	E	301	5/5	0.95	0.13	35,58,66,66	5
3	PO4	D	302	5/5	0.98	0.11	38,44,47,50	0
3	PO4	E	302	5/5	0.99	0.15	34,39,46,46	0
3	PO4	C	302	5/5	0.99	0.12	39,39,39,45	0
3	PO4	F	303	5/5	0.99	0.12	35,40,43,49	0
3	PO4	A	303	5/5	0.99	0.10	34,35,38,43	0
3	PO4	B	302	5/5	0.99	0.12	40,43,44,46	0

6.5 Other polymers

There are no such residues in this entry.