



Full wwPDB X-ray Structure Validation Report ⓘ

Sep 19, 2023 – 01:38 AM EDT

PDB ID : 5BNC
Title : Structure of heme binding protein MSMEG_6519 from Mycobacterium smegmatis
Authors : Ahmed, F.H.; Carr, P.D.; Jackson, C.J.
Deposited on : 2015-05-26
Resolution : 2.25 Å (reported)

This is a Full wwPDB X-ray Structure Validation 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 : 4.02b-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

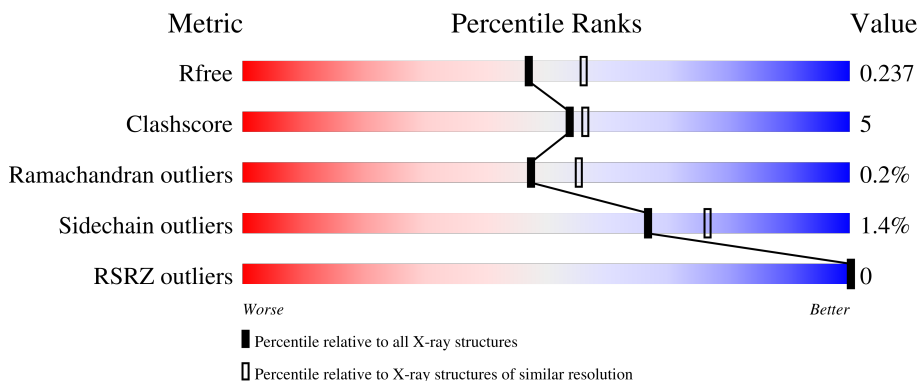
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

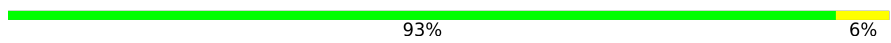

The reported resolution of this entry is 2.25 Å.

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	1377 (2.26-2.26)
Clashscore	141614	1487 (2.26-2.26)
Ramachandran outliers	138981	1449 (2.26-2.26)
Sidechain outliers	138945	1450 (2.26-2.26)
RSRZ outliers	127900	1356 (2.26-2.26)

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	252	 93% 6%
1	B	252	 88% 8% . .

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
3	EPE	A	302	-	-	X	-
3	EPE	A	304	-	-	X	-

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 3989 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.

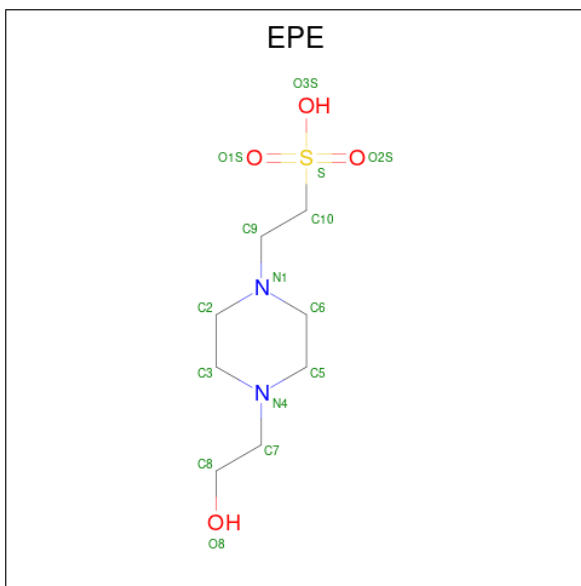
- Molecule 1 is a protein called heme binding protein MSMEG_6519.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	252	Total 1859	C 1158	N 332	O 364	S 5	0	3	0
1	B	242	Total 1812	C 1125	N 327	O 354	S 6	0	5	0

- Molecule 2 is NICKEL (II) ION (three-letter code: NI) (formula: Ni).

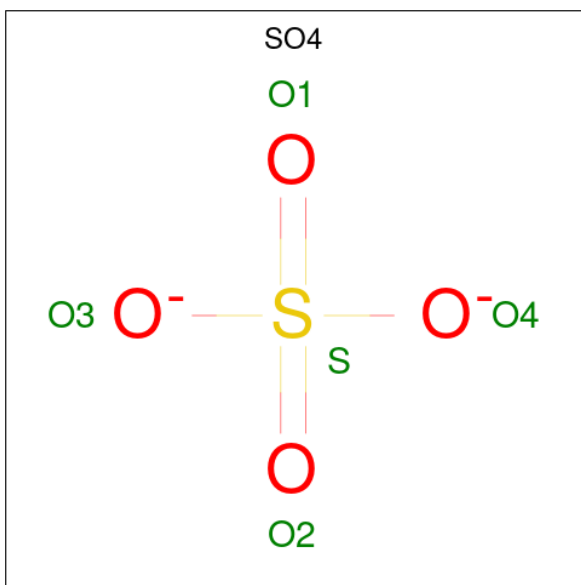
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total 1	Ni 1	0	0
2	B	1	Total 1	Ni 1	0	0

- Molecule 3 is 4-(2-HYDROXYETHYL)-1-PIPERAZINE ETHANESULFONIC ACID (three-letter code: EPE) (formula: C₈H₁₈N₂O₄S).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	S	0	0
			15	8	2	4	1		
3	A	1	Total	C	N	O	S	0	0
			15	8	2	4	1		
3	A	1	Total	C	N	O	S	0	0
			15	8	2	4	1		
3	B	1	Total	C	N	O	S	0	0
			15	8	2	4	1		

- Molecule 4 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	1	Total	O S	0	0
			5	4 1		

- Molecule 5 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	1	Total	Mg	0	0
			1	1		

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	116	Total	O	0	0
			116	116		

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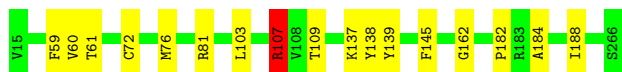
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	134	Total 134	O 134	0	0

3 Residue-property plots


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.

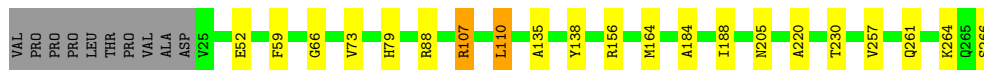
- Molecule 1: heme binding protein MSMEG_6519

Chain A:  93% 6%



- Molecule 1: heme binding protein MSMEG_6519

Chain B:  88% 8% . . .



4 Data and refinement statistics

Property	Value	Source
Space group	P 61	Depositor
Cell constants a, b, c, α , β , γ	62.10Å 62.10Å 301.41Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	43.77 – 2.25 40.13 – 2.25	Depositor EDS
% Data completeness (in resolution range)	99.9 (43.77-2.25) 99.9 (40.13-2.25)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.51 (at 2.24Å)	Xtrriage
Refinement program	REFMAC 5.8.0049	Depositor
R, R_{free}	0.185 , 0.230 0.190 , 0.237	Depositor DCC
R_{free} test set	1588 reflections (5.12%)	wwPDB-VP
Wilson B-factor (Å ²)	30.0	Xtrriage
Anisotropy	0.045	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 23.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.42$, $\langle L^2 \rangle = 0.25$	Xtrriage
Estimated twinning fraction	0.124 for h,-h-k,-l	Xtrriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	3989	wwPDB-VP
Average B, all atoms (Å ²)	33.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.77% 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 [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: MG, SO4, NI, EPE

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	0.69	0/1906	0.85	2/2610 (0.1%)
1	B	0.71	0/1858	0.88	4/2536 (0.2%)
All	All	0.70	0/3764	0.86	6/5146 (0.1%)

There are no bond length outliers.

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	107	ARG	NE-CZ-NH1	11.22	125.91	120.30
1	A	107	ARG	NE-CZ-NH2	10.52	125.56	120.30
1	B	107	ARG	NE-CZ-NH2	-7.54	116.53	120.30
1	A	107	ARG	NE-CZ-NH1	-6.91	116.84	120.30
1	B	110	LEU	CB-CG-CD2	5.25	119.92	111.00
1	B	110	LEU	CA-CB-CG	5.20	127.25	115.30

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	1859	0	1820	22	0
1	B	1812	0	1775	18	0
2	A	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	1	0	0	0	0
3	A	45	0	51	23	0
3	B	15	0	17	0	0
4	B	5	0	0	0	0
5	B	1	0	0	0	0
6	A	116	0	0	2	0
6	B	134	0	0	4	0
All	All	3989	0	3663	39	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 5.

All (39) 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:109:THR:OG1	3:A:304:EPE:O2S	1.72	1.06
3:A:302:EPE:O2S	1:B:107:ARG:HD2	1.70	0.92
1:A:107:ARG:HE	3:A:304:EPE:H22	1.36	0.91
1:A:107:ARG:HE	3:A:304:EPE:C2	1.85	0.90
1:A:72:CYS:O	3:A:302:EPE:H72	1.75	0.86
1:A:59:PHE:O	3:A:302:EPE:H102	1.81	0.79
1:B:184:ALA:O	1:B:188:ILE:HG12	1.89	0.72
1:A:184:ALA:O	1:A:188:ILE:HG12	1.93	0.69
1:A:107:ARG:HH11	3:A:304:EPE:H32	1.60	0.66
1:A:107:ARG:NE	3:A:304:EPE:H22	2.12	0.62
1:A:182:PRO:HG2	6:A:432:HOH:O	1.99	0.62
1:A:60:VAL:HG12	3:A:302:EPE:H21	1.82	0.62
1:A:107:ARG:HE	3:A:304:EPE:H21	1.64	0.61
3:A:304:EPE:H91	1:B:59:PHE:HB3	1.86	0.58
1:A:76:MET:HG2	6:A:500:HOH:O	2.04	0.57
1:A:109:THR:CB	3:A:304:EPE:O2S	2.51	0.56
1:A:107:ARG:HH11	3:A:304:EPE:C3	2.23	0.52
1:B:205:ASN:HB3	1:B:266:SER:HB2	1.93	0.50
1:A:61:THR:OG1	3:A:302:EPE:H51	2.12	0.50
1:A:103:LEU:HD23	1:B:135:ALA:HB3	1.95	0.48
1:B:264:LYS:NZ	6:B:406:HOH:O	2.47	0.47
1:A:59:PHE:O	3:A:302:EPE:C10	2.58	0.46
3:A:304:EPE:H72	1:B:59:PHE:O	2.16	0.46
3:A:304:EPE:H51	1:B:79:HIS:HE1	1.81	0.46
1:B:188:ILE:HD11	1:B:220:ALA:N	2.31	0.46
1:A:59:PHE:O	3:A:302:EPE:H91	2.16	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:60:VAL:HA	3:A:302:EPE:H62	1.99	0.45
1:A:60:VAL:HA	3:A:302:EPE:H21	1.98	0.45
1:B:156:ARG:NH2	1:B:164:MET:HG3	2.33	0.44
1:B:66:GLY:O	6:B:401:HOH:O	2.21	0.43
1:A:137:LYS:HE3	1:A:138:TYR:CE1	2.53	0.43
1:B:257:VAL:O	1:B:261[B]:GLN:HG3	2.19	0.43
1:B:88:ARG:NH1	6:B:410:HOH:O	2.50	0.42
3:A:304:EPE:H51	1:B:79:HIS:CE1	2.55	0.41
3:A:302:EPE:O2S	1:B:107:ARG:CD	2.55	0.41
1:B:73:VAL:HG13	1:B:79:HIS:NE2	2.35	0.41
3:A:304:EPE:C5	1:B:79:HIS:CE1	3.03	0.41
1:A:139:TYR:HD2	1:A:145:PHE:CZ	2.38	0.41
1:B:230:THR:HG21	6:B:515:HOH:O	2.22	0.40

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	253/252 (100%)	247 (98%)	5 (2%)	1 (0%)	34	37
1	B	245/252 (97%)	241 (98%)	4 (2%)	0	100	100
All	All	498/504 (99%)	488 (98%)	9 (2%)	1 (0%)	47	55

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	162	GLY

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	184/182 (101%)	181 (98%)	3 (2%)	62	73
1	B	178/182 (98%)	174 (98%)	4 (2%)	52	61
All	All	362/364 (100%)	355 (98%)	7 (2%)	67	66

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	81[A]	ARG
1	A	81[B]	ARG
1	A	107	ARG
1	B	52[A]	GLU
1	B	52[B]	GLU
1	B	110	LEU
1	B	138	TYR

Sometimes 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](#)

Of 8 ligands modelled in this entry, 3 are monoatomic - leaving 5 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
3	EPE	A	303	-	15,15,15	1.57	1 (6%)	18,20,20	2.34	6 (33%)
3	EPE	B	301	-	15,15,15	1.76	1 (6%)	18,20,20	2.09	4 (22%)
4	SO4	B	303	-	4,4,4	0.58	0	6,6,6	0.30	0
3	EPE	A	302	-	15,15,15	2.25	3 (20%)	18,20,20	4.15	8 (44%)
3	EPE	A	304	-	15,15,15	1.82	3 (20%)	18,20,20	2.94	9 (50%)

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
3	EPE	A	303	-	-	4/9/19/19	0/1/1/1
3	EPE	A	304	-	-	3/9/19/19	0/1/1/1
3	EPE	A	302	-	-	4/9/19/19	0/1/1/1
3	EPE	B	301	-	-	2/9/19/19	0/1/1/1

All (8) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	302	EPE	C10-S	-7.28	1.67	1.77
3	B	301	EPE	C10-S	-6.06	1.68	1.77
3	A	304	EPE	C10-S	-5.68	1.69	1.77
3	A	303	EPE	C10-S	-5.35	1.69	1.77
3	A	304	EPE	C7-N4	2.62	1.53	1.47
3	A	302	EPE	C3-N4	2.46	1.53	1.46
3	A	302	EPE	O1S-S	2.13	1.51	1.45
3	A	304	EPE	O1S-S	2.04	1.51	1.45

All (27) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	302	EPE	O2S-S-C10	11.93	121.28	106.92
3	A	302	EPE	O1S-S-C10	-9.92	94.97	106.92
3	A	304	EPE	O1S-S-C10	8.21	116.81	106.92
3	B	301	EPE	O1S-S-C10	6.84	115.16	106.92
3	A	303	EPE	O2S-S-C10	6.79	115.09	106.92
3	A	304	EPE	O2S-S-O1S	-4.72	97.62	113.95
3	A	304	EPE	O2S-S-C10	3.72	111.39	106.92
3	A	302	EPE	C5-N4-C3	3.21	116.05	108.83
3	A	304	EPE	C3-C2-N1	3.05	116.90	110.64
3	A	302	EPE	C5-C6-N1	-2.99	104.50	110.64
3	A	303	EPE	O3S-S-C10	2.98	110.59	105.77
3	A	302	EPE	C9-N1-C6	-2.94	103.73	111.23
3	A	303	EPE	C3-C2-N1	2.92	116.63	110.64
3	A	303	EPE	O1S-S-C10	2.90	110.41	106.92
3	A	304	EPE	C9-N1-C6	2.78	118.35	111.23
3	A	302	EPE	C8-C7-N4	2.72	123.18	113.40
3	A	303	EPE	O3S-S-O1S	-2.72	104.63	111.27
3	A	303	EPE	C6-C5-N4	-2.70	105.11	110.64
3	A	302	EPE	O3S-S-O1S	2.68	117.82	111.27
3	A	302	EPE	C9-N1-C2	2.66	118.05	111.23
3	A	304	EPE	C5-N4-C3	-2.56	103.07	108.83
3	B	301	EPE	O2S-S-C10	2.48	109.90	106.92
3	A	304	EPE	C6-C5-N4	2.39	115.56	110.64
3	B	301	EPE	C6-C5-N4	2.28	115.33	110.64
3	A	304	EPE	C6-N1-C2	-2.27	103.71	108.83
3	B	301	EPE	C9-N1-C6	2.25	117.00	111.23
3	A	304	EPE	C7-N4-C5	2.25	116.98	111.23

There are no chirality outliers.

All (13) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	302	EPE	C10-C9-N1-C2
3	A	302	EPE	C8-C7-N4-C5
3	A	302	EPE	S-C10-C9-N1
3	A	304	EPE	C10-C9-N1-C6
3	B	301	EPE	C10-C9-N1-C6
3	B	301	EPE	N4-C7-C8-O8
3	A	303	EPE	C9-C10-S-O3S
3	A	304	EPE	S-C10-C9-N1
3	A	304	EPE	N4-C7-C8-O8

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Mol	Chain	Res	Type	Atoms
3	A	303	EPE	N4-C7-C8-O8
3	A	303	EPE	C9-C10-S-O1S
3	A	303	EPE	C9-C10-S-O2S
3	A	302	EPE	C8-C7-N4-C3

There are no ring outliers.

2 monomers are involved in 23 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	302	EPE	10	0
3	A	304	EPE	13	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	252/252 (100%)	-0.70	0 100 100	19, 30, 51, 80	0
1	B	242/252 (96%)	-0.65	0 100 100	18, 30, 56, 74	0
All	All	494/504 (98%)	-0.68	0 100 100	18, 30, 55, 80	0

There are no RSRZ outliers to report.

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 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, 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(Å ²)	Q<0.9
5	MG	B	304	1/1	0.77	0.13	61,61,61,61	0
3	EPE	A	304	15/15	0.84	0.26	33,39,45,46	15
3	EPE	A	302	15/15	0.86	0.26	22,30,37,38	15
4	SO4	B	303	5/5	0.90	0.20	69,70,81,88	0
3	EPE	A	303	15/15	0.93	0.15	41,55,66,72	15
3	EPE	B	301	15/15	0.98	0.10	35,41,43,44	15
2	NI	A	301	1/1	1.00	0.12	26,26,26,26	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(\AA^2)	Q<0.9
2	NI	B	302	1/1	1.00	0.11	28,28,28,28	0

6.5 Other polymers [i](#)

There are no such residues in this entry.