



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 06:15 AM UTC

PDB ID : 8BRR / pdb_00008brr
Title : Crystal structure of a variant of penicillin G acylase from Bacillaceae i. s. sp. FJAT-27231 with reduced surface entropy and additionally engineered crystal contact
Authors : Wichmann, J.; Mayer, J.; Mattes, H.; Lukat, P.; Blankenfeldt, W.; Biedendieck, R.
Deposited on : 2022-11-23
Resolution : 1.95 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

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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

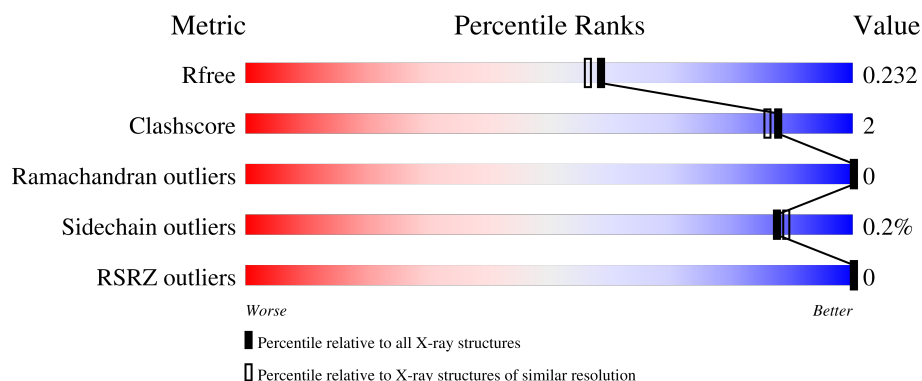
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.95 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	3494 (1.96-1.96)
Clashscore	190562	3612 (1.96-1.96)
Ramachandran outliers	187476	3587 (1.96-1.96)
Sidechain outliers	187428	3587 (1.96-1.96)
RSRZ outliers	180081	3495 (1.96-1.96)

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	212	 88% 5% 8%
1	C	212	 82% 7% 11%
2	B	538	 94% . .
2	D	538	 94% . .

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 24066 atoms, of which 11274 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 Penicillin G acylase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	196	Total	C	H	N	O	S	0	0	0
			3174	1018	1562	274	313	7			
1	C	188	Total	C	H	N	O	S	0	0	0
			3049	980	1503	262	297	7			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	201	ALA	LYS	engineered mutation	UNP A0A0K9H482
A	202	ALA	LYS	engineered mutation	UNP A0A0K9H482
A	203	ALA	GLU	engineered mutation	UNP A0A0K9H482
C	201	ALA	LYS	engineered mutation	UNP A0A0K9H482
C	202	ALA	LYS	engineered mutation	UNP A0A0K9H482
C	203	ALA	GLU	engineered mutation	UNP A0A0K9H482

- Molecule 2 is a protein called Penicillin G acylase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
2	B	527	Total	C	H	N	O	S	0	2	0
			8322	2726	4081	717	788	10			
2	D	527	Total	C	H	N	O	S	0	4	0
			8312	2725	4074	717	786	10			

There are 14 discrepancies between the modelled and reference sequences:

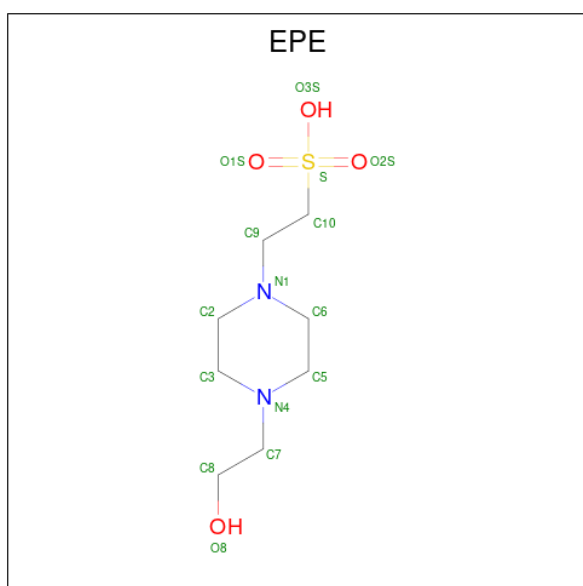
Chain	Residue	Modelled	Actual	Comment	Reference
B	135	ALA	LYS	engineered mutation	UNP A0A0K9H482
B	136	ALA	GLU	engineered mutation	UNP A0A0K9H482
B	137	ALA	LYS	engineered mutation	UNP A0A0K9H482
B	403	ALA	LYS	engineered mutation	UNP A0A0K9H482
B	404	ALA	GLU	engineered mutation	UNP A0A0K9H482
B	405	ALA	GLU	engineered mutation	UNP A0A0K9H482

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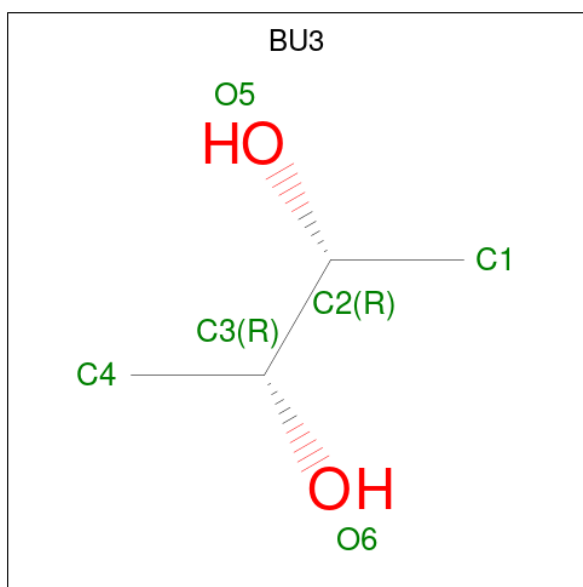
Chain	Residue	Modelled	Actual	Comment	Reference
B	408	VAL	LYS	engineered mutation	UNP A0A0K9H482
D	135	ALA	LYS	engineered mutation	UNP A0A0K9H482
D	136	ALA	GLU	engineered mutation	UNP A0A0K9H482
D	137	ALA	LYS	engineered mutation	UNP A0A0K9H482
D	403	ALA	LYS	engineered mutation	UNP A0A0K9H482
D	404	ALA	GLU	engineered mutation	UNP A0A0K9H482
D	405	ALA	GLU	engineered mutation	UNP A0A0K9H482
D	408	VAL	LYS	engineered mutation	UNP A0A0K9H482

- Molecule 3 is 4-(2-HYDROXYETHYL)-1-PIPERAZINE ETHANESULFONIC ACID (CCD ID: EPE) (formula: $C_8H_{18}N_2O_4S$).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
3	B	1	Total	C	H	N	O	S	0	0
			32	8	17	2	4	1		
3	D	1	Total	C	H	N	O	S	0	0
			32	8	17	2	4	1		

- Molecule 4 is (R,R)-2,3-BUTANEDIOL (CCD ID: BU3) (formula: $C_4H_{10}O_2$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	B	1	Total	C	H	O	0	0
			16	4	10	2		
4	D	1	Total	C	H	O	0	0
			16	4	10	2		

- Molecule 5 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	2	Total	Ca	0	0
			2	2		
5	D	2	Total	Ca	0	0
			2	2		

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	173	Total	O	0	0
			173	173		
6	B	413	Total	O	0	0
			413	413		
6	C	142	Total	O	0	0
			142	142		
6	D	381	Total	O	0	0
			381	381		

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: Penicillin G acylase

Chain A: 

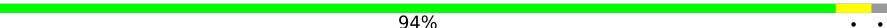


- Molecule 1: Penicillin G acylase

Chain C: 



- Molecule 2: Penicillin G acylase

Chain B: 



- Molecule 2: Penicillin G acylase

Chain D: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	61.28Å 139.23Å 100.64Å 90.00° 91.51° 90.00°	Depositor
Resolution (Å)	50.30 – 1.95 50.30 – 1.95	Depositor EDS
% Data completeness (in resolution range)	89.9 (50.30-1.95) 90.0 (50.30-1.95)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.17 (at 1.95Å)	Xtriage
Refinement program	PHENIX 1.20-4459	Depositor
R, R_{free}	0.191 , 0.232 0.193 , 0.232	Depositor DCC
R_{free} test set	5323 reflections (4.37%)	wwPDB-VP
Wilson B-factor (Å ²)	22.8	Xtriage
Anisotropy	0.972	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 27.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	0.145 for h,-k,-l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	24066	wwPDB-VP
Average B, all atoms (Å ²)	35.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.42% 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: BU3, EPE, CA

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	0.41	0/1643	0.41	0/2211
1	C	0.40	0/1577	0.38	0/2124
2	B	0.41	0/4366	0.41	0/5904
2	D	0.38	0/4371	0.39	0/5912
All	All	0.40	0/11957	0.40	0/16151

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	1612	1562	1560	9	0
1	C	1546	1503	1502	10	0
2	B	4241	4081	4076	17	0
2	D	4238	4074	4057	18	0
3	B	15	17	17	2	0
3	D	15	17	17	0	0
4	B	6	10	10	3	0
4	D	6	10	10	0	0
5	B	2	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	D	2	0	0	0	0
6	A	173	0	0	2	0
6	B	413	0	0	3	0
6	C	142	0	0	1	0
6	D	381	0	0	2	0
All	All	12792	11274	11249	45	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.

All (45) 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:196:ASP:OD2	6:A:301:HOH:O	2.06	0.71
1:C:193:GLN:NE2	6:C:302:HOH:O	2.32	0.63
2:D:166:ASN:ND2	6:D:702:HOH:O	2.26	0.62
2:B:181:LEU:CD2	4:B:602:BU3:H12	2.30	0.61
2:B:181:LEU:HD22	4:B:602:BU3:H12	1.84	0.60
1:C:145:MET:HG3	2:D:179:MET:HE2	1.84	0.58
2:D:260:VAL:HG23	2:D:261:TRP:CD1	2.42	0.55
1:C:84:MET:HE2	2:D:149:GLY:HA2	1.90	0.53
2:B:415:ASP:OD2	6:B:701:HOH:O	2.19	0.53
1:C:11:ILE:HG12	1:C:21:LEU:HD22	1.91	0.51
2:D:503:GLU:HB2	2:D:506:LEU:HD12	1.93	0.51
2:D:447:ILE:CD1	2:D:449:ILE:HD11	2.41	0.50
2:D:498:LEU:HD13	2:D:502:TYR:CD2	2.47	0.49
1:A:56:VAL:HG21	2:B:449:ILE:HG21	1.94	0.49
1:C:56:VAL:HG21	2:D:449:ILE:HG21	1.96	0.48
2:B:24:VAL:HG11	2:B:49:PHE:CZ	2.49	0.47
2:B:494:LYS:NZ	6:B:718:HOH:O	2.47	0.47
2:B:181:LEU:O	2:B:197:VAL:HG22	2.13	0.47
1:A:58:GLU:HG2	2:B:107:ILE:HB	1.97	0.47
1:A:62:GLU:HA	1:A:65:VAL:HG23	1.96	0.47
2:B:100:GLU:HB2	2:B:124:HIS:HB2	1.96	0.47
1:C:149:MET:HE3	2:D:179:MET:HB3	1.97	0.46
1:C:58:GLU:C	1:C:59:ILE:HD13	2.41	0.46
1:A:49:ARG:NH1	6:A:315:HOH:O	2.48	0.45
1:A:84:MET:HE2	2:B:149:GLY:HA2	1.98	0.45
2:D:319:GLU:HA	2:D:319:GLU:OE1	2.17	0.45
1:A:145:MET:HG3	2:B:179:MET:HE2	1.98	0.45
2:B:372:ASP:OD1	2:B:372:ASP:N	2.48	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:D:4:MET:HG2	2:D:242:VAL:HG12	1.99	0.45
1:C:109:GLU:OE2	1:C:117:LYS:NZ	2.36	0.44
2:B:150:THR:HB	2:B:178:THR:HG21	2.00	0.44
1:C:147:TYR:CD2	2:D:446:LEU:HD13	2.53	0.43
2:D:492:ILE:HG12	2:D:498:LEU:HD22	1.99	0.43
2:D:20:SER:OG	2:D:469:HIS:HB2	2.19	0.42
2:D:103:THR:O	2:D:103:THR:HG23	2.19	0.42
2:D:447:ILE:HD11	2:D:449:ILE:HD11	2.00	0.42
2:D:85:ALA:O	6:D:701:HOH:O	2.21	0.42
1:A:24:LYS:N	1:A:24:LYS:HD2	2.35	0.42
1:A:144:SER:HG	2:B:52:TYR:HH	1.64	0.42
2:B:266:ARG:HH22	3:B:601:EPE:H101	1.85	0.42
2:B:490:GLY:O	6:B:702:HOH:O	2.22	0.42
2:D:43:ASP:O	2:D:60:ASN:HA	2.20	0.41
3:B:601:EPE:O1S	3:B:601:EPE:N1	2.53	0.41
2:B:49:PHE:CZ	4:B:602:BU3:H2	2.56	0.41
1:C:165:GLU:HG3	1:C:170:LYS:HA	2.02	0.40

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	194/212 (92%)	188 (97%)	6 (3%)	0	100	100
1	C	186/212 (88%)	183 (98%)	3 (2%)	0	100	100
2	B	527/538 (98%)	511 (97%)	16 (3%)	0	100	100
2	D	529/538 (98%)	512 (97%)	17 (3%)	0	100	100
All	All	1436/1500 (96%)	1394 (97%)	42 (3%)	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	171/186 (92%)	171 (100%)	0	100	100
1	C	164/186 (88%)	164 (100%)	0	100	100
2	B	436/451 (97%)	435 (100%)	1 (0%)	87	89
2	D	435/451 (96%)	434 (100%)	1 (0%)	87	89
All	All	1206/1274 (95%)	1204 (100%)	2 (0%)	87	89

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	158	TYR
2	D	158	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	70	GLN
2	B	268	GLN
2	B	482	ASN
2	D	62	HIS
2	D	98	ASN
2	D	171	GLN
2	D	326	GLN
2	D	511	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 8 ligands modelled in this entry, 4 are monoatomic - leaving 4 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	BU3	B	602	-	4,5,5	0.30	0	6,6,6	0.72	0
4	BU3	D	602	-	4,5,5	0.42	0	6,6,6	0.46	0
3	EPE	B	601	-	15,15,15	0.94	1 (6%)	19,20,20	1.71	6 (31%)
3	EPE	D	601	-	15,15,15	0.94	1 (6%)	19,20,20	1.57	2 (10%)

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	BU3	B	602	-	-	1/4/4/4	-
4	BU3	D	602	-	-	0/4/4/4	-
3	EPE	B	601	-	-	4/9/19/19	0/1/1/1
3	EPE	D	601	-	-	1/9/19/19	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	D	601	EPE	C10-S	2.79	1.81	1.77
3	B	601	EPE	C10-S	2.28	1.80	1.77

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	D	601	EPE	C5-N4-C3	4.45	118.43	108.84
3	B	601	EPE	C5-N4-C3	3.56	116.52	108.84
3	B	601	EPE	O3S-S-C10	3.50	112.85	106.00
3	D	601	EPE	C7-N4-C3	2.95	119.10	111.24
3	B	601	EPE	C7-N4-C5	2.72	118.49	111.24
3	B	601	EPE	O2S-S-C10	2.44	110.41	106.73
3	B	601	EPE	C7-N4-C3	2.10	116.84	111.24
3	B	601	EPE	O2S-S-O1S	-2.08	107.06	113.82

There are no chirality outliers.

All (6) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	601	EPE	N4-C7-C8-O8
3	B	601	EPE	S-C10-C9-N1
3	B	601	EPE	C10-C9-N1-C2
3	B	601	EPE	C10-C9-N1-C6
3	D	601	EPE	C8-C7-N4-C3
4	B	602	BU3	O5-C2-C3-O6

There are no ring outliers.

2 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	602	BU3	3	0
3	B	601	EPE	2	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	196/212 (92%)	-1.35	0 100 100	23, 31, 58, 94	0
1	C	188/212 (88%)	-1.38	0 100 100	26, 35, 52, 84	0
2	B	527/538 (97%)	-1.41	0 100 100	19, 31, 55, 78	1 (0%)
2	D	527/538 (97%)	-1.37	0 100 100	21, 33, 61, 95	2 (0%)
All	All	1438/1500 (95%)	-1.38	0 100 100	19, 32, 58, 95	3 (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 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(Å ²)	Q<0.9
4	BU3	D	602	6/6	0.98	0.07	32,39,45,45	0
3	EPE	D	601	15/15	0.99	0.04	27,38,49,50	32
4	BU3	B	602	6/6	0.99	0.07	30,38,40,43	0
3	EPE	B	601	15/15	0.99	0.05	35,44,51,52	32

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
5	CA	B	603	1/1	1.00	0.00	21,21,21,21	0
5	CA	B	604	1/1	1.00	0.02	34,34,34,34	0
5	CA	D	603	1/1	1.00	0.01	19,19,19,19	0
5	CA	D	604	1/1	1.00	0.02	38,38,38,38	0

6.5 Other polymers [i](#)

There are no such residues in this entry.