



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 10:32 AM UTC

PDB ID : 3N8T / pdb_00003n8t
Title : Native structure of TK1436, a GH57 branching enzyme from hyperthermophilic archaeon *Thermococcus kodakaraensis*
Authors : Santos, C.R.; Tonoli, C.C.C.; Trindade, D.M.; Betzel, C.; Takata, H.; Kuriki, T.; Kanai, T.; Imanaka, T.; Arni, R.K.; Murakami, M.T.
Deposited on : 2010-05-28
Resolution : 2.40 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 : 4-5-2 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

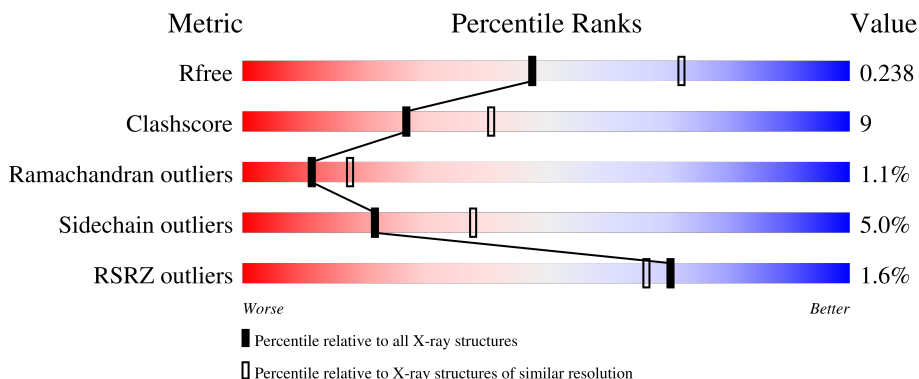
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

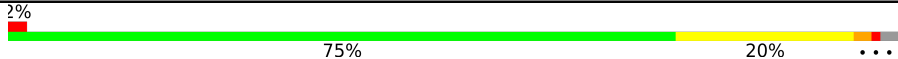
The reported resolution of this entry is 2.40 Å.

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	4912 (2.40-2.40)
Clashscore	190562	5391 (2.40-2.40)
Ramachandran outliers	187476	5320 (2.40-2.40)
Sidechain outliers	187428	5321 (2.40-2.40)
RSRZ outliers	180081	4916 (2.40-2.40)

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	562	

2 Entry composition [i](#)

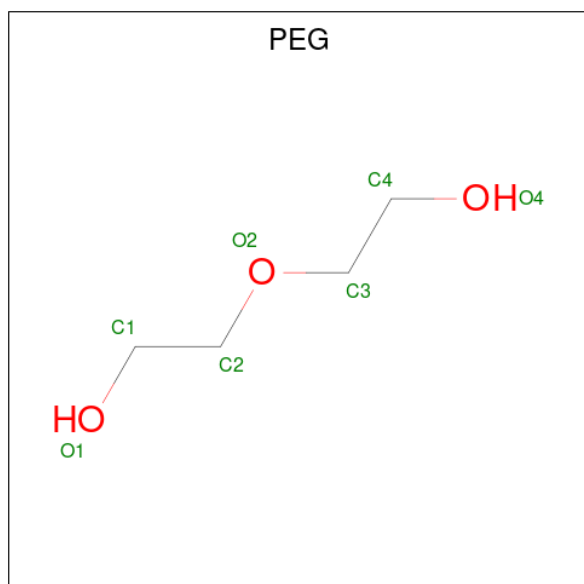
There are 4 unique types of molecules in this entry. The entry contains 4833 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 alpha-amylase, GH57 family.

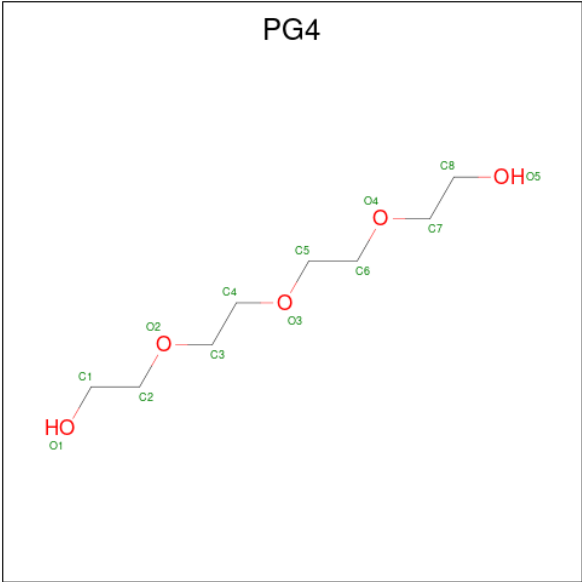
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	550	4588	2964	781	833	10	0	1	0

- Molecule 2 is DI(HYDROXYETHYL)ETHER (CCD ID: PEG) (formula: C₄H₁₀O₃).



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

- Molecule 3 is TETRAETHYLENE GLYCOL (CCD ID: PG4) (formula: C₈H₁₈O₅).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			13	8	5		

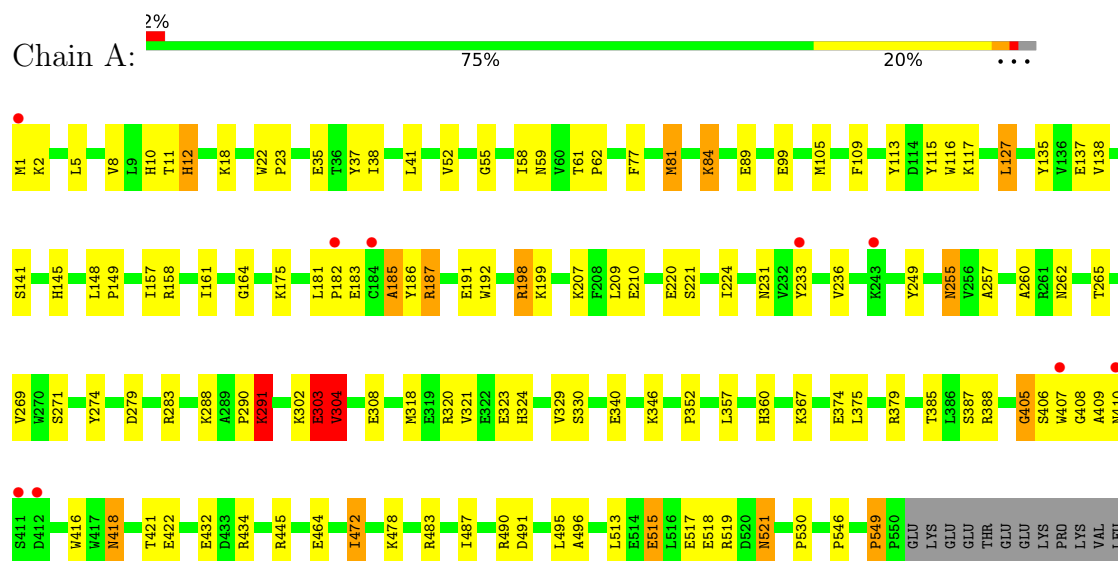
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	225	Total	O	0	0
			225	225		

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: alpha-amylase, GH57 family



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	70.42Å 78.95Å 134.22Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	68.05 – 2.40 68.05 – 2.40	Depositor EDS
% Data completeness (in resolution range)	99.2 (68.05-2.40) 99.2 (68.05-2.40)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.05 (at 2.39Å)	Xtriage
Refinement program	REFMAC 5.5.0102	Depositor
R, R_{free}	0.181 , 0.242 0.178 , 0.238	Depositor DCC
R_{free} test set	1510 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å ²)	40.9	Xtriage
Anisotropy	0.028	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 36.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	4833	wwPDB-VP
Average B, all atoms (Å ²)	40.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.76% 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: PG4, 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	1.17	5/4728 (0.1%)	1.14	13/6400 (0.2%)

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	A	0	1

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	549	PRO	CA-C	5.80	1.55	1.51
1	A	304	VAL	CA-CB	5.22	1.61	1.54
1	A	157	ILE	CA-CB	-5.07	1.48	1.54
1	A	185	ALA	N-CA	5.03	1.52	1.46
1	A	161	ILE	CG1-CD1	-5.00	1.32	1.51

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	405	GLY	N-CA-C	8.07	122.53	110.75
1	A	521	ASN	CA-C-N	-7.30	111.31	120.51
1	A	521	ASN	C-N-CA	-7.30	111.31	120.51
1	A	99	GLU	N-CA-C	6.88	119.62	111.71
1	A	515	GLU	N-CA-C	-6.86	103.73	111.07
1	A	187	ARG	CA-C-N	6.28	126.23	120.21
1	A	187	ARG	C-N-CA	6.28	126.23	120.21
1	A	410	ASN	N-CA-C	6.01	120.41	113.38

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	109	PHE	N-CA-C	5.95	118.72	111.82
1	A	472	ILE	N-CA-C	-5.48	105.51	110.82
1	A	12	HIS	N-CA-C	5.32	118.06	108.48
1	A	175	LYS	CA-C-N	-5.19	115.22	120.31
1	A	175	LYS	C-N-CA	-5.19	115.22	120.31

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	302	LYS	Peptide

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	4588	0	4454	83	0
2	A	7	0	10	0	0
3	A	13	0	18	4	0
4	A	225	0	0	6	0
All	All	4833	0	4482	84	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 9.

All (84) 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:10[A]:HIS:CE1	1:A:407:TRP:HH2	1.60	1.17
1:A:10[A]:HIS:CE1	1:A:407:TRP:CH2	2.33	1.16
1:A:10[A]:HIS:NE2	1:A:407:TRP:CZ2	2.28	1.02
1:A:10[A]:HIS:HE1	1:A:407:TRP:HH2	1.19	0.91
1:A:10[A]:HIS:NE2	1:A:407:TRP:CH2	2.40	0.90
1:A:303:GLU:HG2	1:A:304:VAL:N	1.91	0.85
1:A:10[A]:HIS:HE2	1:A:407:TRP:HZ2	1.27	0.83

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:519:ARG:HD3	4:A:754:HOH:O	1.76	0.83
1:A:10[A]:HIS:NE2	1:A:407:TRP:HZ2	1.75	0.82
1:A:321:VAL:HG11	1:A:367:LYS:HG2	1.65	0.78
1:A:483:ARG:NH1	1:A:549:PRO:O	2.22	0.73
1:A:35:GLU:OE1	1:A:360:HIS:HD2	1.72	0.72
1:A:183:GLU:HG3	1:A:416:TRP:CZ2	2.26	0.70
1:A:255:ASN:H	1:A:255:ASN:HD22	1.39	0.69
1:A:207:LYS:NZ	1:A:210:GLU:OE1	2.19	0.69
1:A:10[B]:HIS:ND1	1:A:59:ASN:ND2	2.41	0.68
1:A:220:GLU:OE2	1:A:407:TRP:HB2	1.94	0.67
1:A:77:PHE:CZ	1:A:81:MET:HG2	2.30	0.66
1:A:290:PRO:O	1:A:291:LYS:HB2	1.98	0.63
1:A:18:LYS:HE3	1:A:518:GLU:OE2	1.99	0.62
1:A:224:ILE:HD12	1:A:260:ALA:HB2	1.84	0.59
1:A:321:VAL:HG21	1:A:367:LYS:HD3	1.86	0.58
1:A:255:ASN:H	1:A:255:ASN:ND2	2.01	0.57
1:A:185:ALA:HA	1:A:405:GLY:O	2.06	0.56
1:A:12:HIS:ND1	1:A:61:THR:HG21	2.20	0.55
1:A:388:ARG:HB3	4:A:680:HOH:O	2.06	0.55
1:A:186:TYR:N	1:A:405:GLY:O	2.33	0.55
1:A:148:LEU:HB2	1:A:149:PRO:HD3	1.88	0.54
1:A:181:LEU:O	1:A:182:PRO:C	2.48	0.54
1:A:303:GLU:CG	1:A:304:VAL:N	2.66	0.54
1:A:472:ILE:HA	1:A:478:LYS:HG3	1.90	0.54
1:A:255:ASN:HD22	1:A:255:ASN:N	1.99	0.54
1:A:62:PRO:HG2	1:A:164:GLY:HA2	1.90	0.53
1:A:183:GLU:HA	1:A:183:GLU:OE1	2.09	0.52
1:A:35:GLU:OE1	1:A:360:HIS:CD2	2.60	0.52
1:A:262:ASN:ND2	1:A:265:THR:H	2.08	0.51
1:A:183:GLU:O	1:A:406:SER:HB2	2.09	0.51
3:A:564:PG4:H21	4:A:656:HOH:O	2.11	0.50
1:A:303:GLU:HG2	1:A:304:VAL:CA	2.40	0.50
1:A:418:ASN:HD21	1:A:421:THR:HG23	1.76	0.50
1:A:11:THR:CG2	1:A:37:TYR:CE2	2.95	0.50
1:A:113:TYR:CE1	1:A:117:LYS:HE3	2.46	0.50
1:A:8:VAL:O	1:A:352:PRO:HA	2.13	0.49
1:A:318:MET:HG2	1:A:367:LYS:HE2	1.94	0.48
1:A:303:GLU:HG2	1:A:304:VAL:C	2.39	0.48
1:A:233:TYR:CE1	1:A:408:GLY:HA2	2.48	0.48
1:A:432:GLU:OE2	1:A:464:GLU:OE2	2.31	0.48
1:A:41:LEU:HD21	1:A:127:LEU:HD13	1.95	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:145:HIS:HA	1:A:182:PRO:HG3	1.96	0.46
1:A:2:LYS:HE3	1:A:379:ARG:O	2.15	0.46
1:A:192:TRP:O	1:A:199:LYS:HA	2.16	0.46
1:A:58:ILE:O	1:A:138:VAL:HA	2.17	0.45
1:A:116:TRP:CD1	1:A:116:TRP:C	2.94	0.45
1:A:262:ASN:HD22	1:A:265:THR:H	1.65	0.45
1:A:513:LEU:O	1:A:517:GLU:HG3	2.16	0.45
1:A:231:ASN:O	1:A:409:ALA:HB1	2.17	0.45
1:A:269:VAL:HG11	1:A:357:LEU:HD21	1.98	0.45
1:A:22:TRP:CG	1:A:23:PRO:HA	2.53	0.44
1:A:490:ARG:HD2	1:A:491:ASP:OD1	2.16	0.44
1:A:490:ARG:HA	1:A:546:PRO:HD2	1.99	0.44
1:A:38:ILE:HG23	1:A:115:TYR:CD2	2.52	0.44
1:A:320:ARG:HD3	1:A:323:GLU:OE1	2.18	0.44
1:A:483:ARG:O	1:A:487:ILE:HG13	2.18	0.44
1:A:1:MET:O	1:A:346:LYS:NZ	2.38	0.43
1:A:274:TYR:O	3:A:564:PG4:H31	2.18	0.43
1:A:324:HIS:CD2	3:A:564:PG4:H61	2.54	0.43
1:A:105:MET:HE1	1:A:283:ARG:HH11	1.84	0.42
1:A:137:GLU:HB2	1:A:385:THR:HB	2.01	0.42
1:A:220:GLU:HG3	4:A:574:HOH:O	2.19	0.42
1:A:434:ARG:NH1	1:A:496:ALA:HB3	2.35	0.42
1:A:52:VAL:HG21	1:A:374:GLU:HG2	2.01	0.42
1:A:483:ARG:HG2	1:A:487:ILE:HD11	2.01	0.42
1:A:418:ASN:HD22	1:A:418:ASN:C	2.28	0.42
1:A:55:GLY:HA2	1:A:135:TYR:O	2.19	0.42
1:A:84:LYS:HE2	4:A:777:HOH:O	2.20	0.41
1:A:329:VAL:HG21	1:A:375:LEU:HB2	2.02	0.41
1:A:187:ARG:NH1	1:A:192:TRP:HB3	2.35	0.41
1:A:288:LYS:HD3	4:A:704:HOH:O	2.20	0.41
1:A:158:ARG:HG2	1:A:530:PRO:HB3	2.02	0.41
1:A:249:TYR:O	1:A:257:ALA:HA	2.20	0.40
1:A:62:PRO:CG	1:A:164:GLY:HA2	2.51	0.40
1:A:279:ASP:HA	3:A:564:PG4:H11	2.04	0.40
1:A:183:GLU:HG3	1:A:416:TRP:HZ2	1.84	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	549/562 (98%)	526 (96%)	17 (3%)	6 (1%)	11	18

All (6) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	304	VAL
1	A	198	ARG
1	A	291	LYS
1	A	303	GLU
1	A	445	ARG
1	A	521	ASN

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	478/489 (98%)	454 (95%)	24 (5%)	22	38

All (24) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	5	LEU
1	A	81	MET
1	A	84	LYS
1	A	89	GLU
1	A	127	LEU

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Mol	Chain	Res	Type
1	A	141	SER
1	A	191	GLU
1	A	198	ARG
1	A	209	LEU
1	A	221	SER
1	A	236	VAL
1	A	255	ASN
1	A	271	SER
1	A	291	LYS
1	A	303	GLU
1	A	304	VAL
1	A	308	GLU
1	A	330	SER
1	A	340	GLU
1	A	387	SER
1	A	418	ASN
1	A	422	GLU
1	A	495	LEU
1	A	515	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	59	ASN
1	A	255	ASN
1	A	262	ASN
1	A	267	HIS
1	A	268	GLN
1	A	360	HIS
1	A	410	ASN
1	A	418	ASN
1	A	476	GLN
1	A	535	ASN

5.3.3 RNA ⓘ

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](#)

2 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	$\# Z > 2$
3	PG4	A	564	-	12,12,12	0.71	0	11,11,11	0.77	0
2	PEG	A	563	-	6,6,6	0.49	0	5,5,5	0.40	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
3	PG4	A	564	-	-	3/10/10/10	-
2	PEG	A	563	-	-	3/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (6) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	563	PEG	O1-C1-C2-O2
2	A	563	PEG	O2-C3-C4-O4

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Mol	Chain	Res	Type	Atoms
3	A	564	PG4	O4-C7-C8-O5
3	A	564	PG4	C6-C5-O3-C4
3	A	564	PG4	O1-C1-C2-O2
2	A	563	PEG	C1-C2-O2-C3

There are no ring outliers.

1 monomer is involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	564	PG4	4	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	550/562 (97%)	-0.26	9 (1%)	70 66	19, 38, 61, 73	24 (4%)

All (9) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	410	ASN	4.0
1	A	407	TRP	3.7
1	A	411	SER	3.2
1	A	412	ASP	2.8
1	A	233	TYR	2.5
1	A	1	MET	2.3
1	A	182	PRO	2.1
1	A	243	LYS	2.1
1	A	184	CYS	2.1

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
3	PG4	A	564	13/13	0.79	0.17	61,65,67,68	0
2	PEG	A	563	7/7	0.92	0.12	70,72,73,73	0

6.5 Other polymers [i](#)

There are no such residues in this entry.