Full wwPDB X-ray Structure Validation Report (i)

May 26, 2026 – 04:19 pm BST

PDB ID	:	9TP8 / pdb_00009tp8
Title	:	Crystal structure of the C-terminal Ser/Thr phosphatase D510N H707K mutant of the Kelch phosphatase BSU1 from Arabidopsis thaliana
Authors	:	Moretti, A.; Hothorn, M.
Deposited on	:	2025-12-17
Resolution	:	1.60 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 (i) 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 (i)) were used in the production of this report:

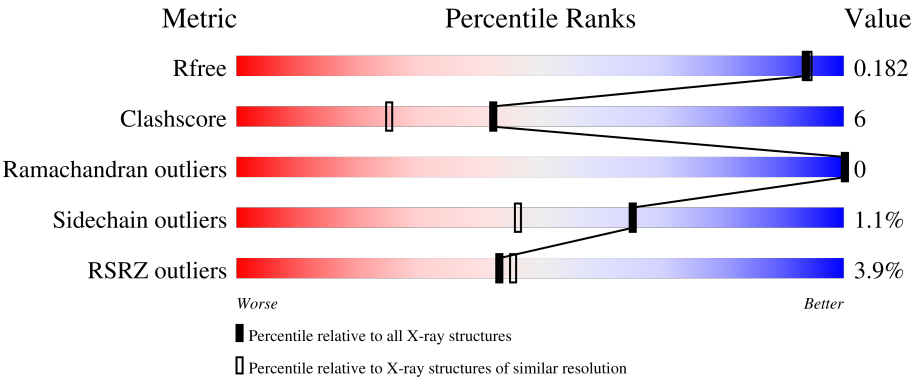
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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	4673 (1.60-1.60)
Clashscore	190562	4931 (1.60-1.60)
Ramachandran outliers	187476	4831 (1.60-1.60)
Sidechain outliers	187428	4830 (1.60-1.60)
RSRZ outliers	180081	4672 (1.60-1.60)

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 <=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	387	3% 71% 9% · 20%

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
2	GOL	A	906	-	-	X	-

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 5243 atoms, of which 2564 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.

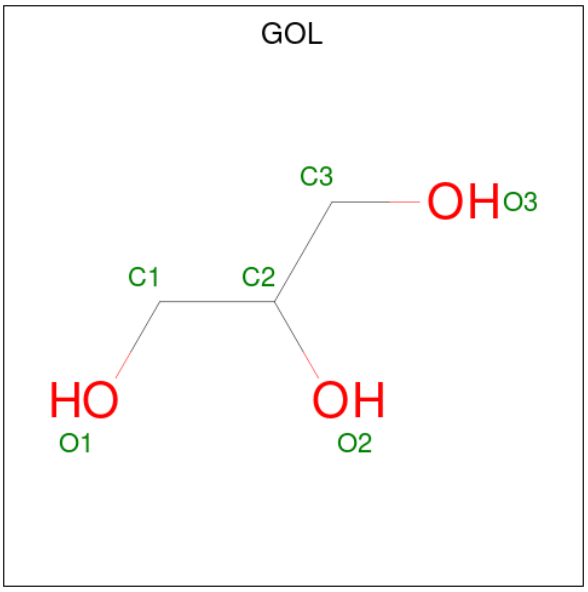
- Molecule 1 is a protein called Serine/threonine-protein phosphatase BSU1.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	H	N	O	S			
1	A	311	5027	1622	2521	417	452	15	0	5	0

There are 16 discrepancies between the modelled and reference sequences:

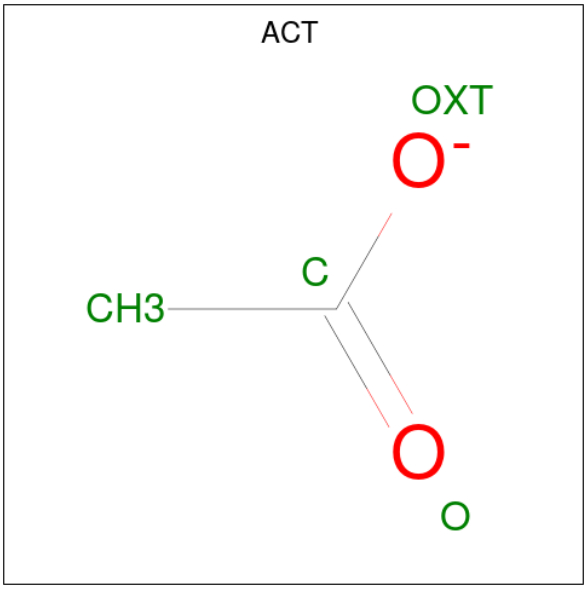
Chain	Residue	Modelled	Actual	Comment	Reference
A	420	MET	-	initiating methionine	UNP Q9LR78
A	510	ASN	ASP	engineered mutation	UNP Q9LR78
A	707	LYS	HIS	engineered mutation	UNP Q9LR78
A	819	ALA	-	expression tag	UNP Q9LR78
A	820	ALA	-	expression tag	UNP Q9LR78
A	821	ALA	-	expression tag	UNP Q9LR78
A	822	GLU	-	expression tag	UNP Q9LR78
A	823	ASN	-	expression tag	UNP Q9LR78
A	824	LEU	-	expression tag	UNP Q9LR78
A	825	TYR	-	expression tag	UNP Q9LR78
A	826	PHE	-	expression tag	UNP Q9LR78
A	827	GLN	-	expression tag	UNP Q9LR78
A	828	LEU	-	expression tag	UNP Q9LR78
A	829	ASN	-	expression tag	UNP Q9LR78
A	830	ILE	-	expression tag	UNP Q9LR78
A	831	GLU	-	expression tag	UNP Q9LR78

- Molecule 2 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total C H O 14 3 8 3	0	0
2	A	1	Total C H O 14 3 8 3	0	0
2	A	1	Total C H O 14 3 8 3	0	0
2	A	1	Total C H O 14 3 8 3	0	0
2	A	1	Total C H O 14 3 8 3	0	0

- Molecule 3 is ACETATE ION (CCD ID: ACT) (formula: $C_2H_3O_2$).



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

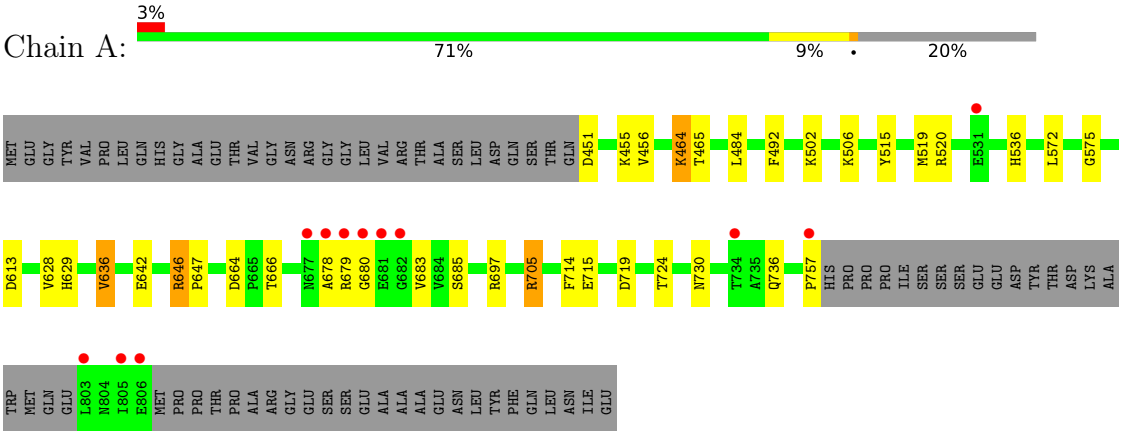
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	139	Total	O	0	0
			139	139		

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: Serine/threonine-protein phosphatase BSU1



4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	139.76Å 44.05Å 79.24Å 90.00° 121.07° 90.00°	Depositor
Resolution (Å)	41.34 – 1.60 41.34 – 1.60	Depositor EDS
% Data completeness (in resolution range)	99.2 (41.34-1.60) 89.3 (41.34-1.60)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	0.85 (at 1.60Å)	Xtriage
Refinement program	PHENIX 1.21.1_5286	Depositor
R, R_{free}	0.161 , 0.182 0.160 , 0.182	Depositor DCC
R_{free} test set	2743 reflections (2.56%)	wwPDB-VP
Wilson B-factor (Å^2)	18.0	Xtriage
Anisotropy	0.407	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.45 , 42.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	5243	wwPDB-VP
Average B, all atoms (Å^2)	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.99% 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: GOL, ACT

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	0.68	1/2577 (0.0%)	0.78	0/3487

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 (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	506	LYS	CB-CG	-5.00	1.37	1.52

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	646	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	2506	2521	2523	28	1
2	A	30	40	40	10	0
3	A	4	3	3	0	0
4	A	139	0	0	8	0
All	All	2679	2564	2566	32	1

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 6.

All (32) 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:666:THR:O	2:A:901:GOL:H12	1.93	0.68
1:A:613:ASP:OD1	2:A:903:GOL:H31	2.01	0.59
2:A:903:GOL:H32	4:A:1011:HOH:O	2.04	0.58
1:A:464:LYS:HD2	1:A:465:THR:N	2.22	0.55
1:A:502:LYS:N	2:A:906:GOL:H31	2.23	0.54
1:A:464:LYS:HE3	1:A:464:LYS:H	1.75	0.52
1:A:502:LYS:H	2:A:906:GOL:H31	1.75	0.52
1:A:464:LYS:HD2	1:A:465:THR:H	1.76	0.51
1:A:464:LYS:H	1:A:464:LYS:CE	2.26	0.49
1:A:451:ASP:OD1	1:A:455:LYS:HE3	2.15	0.47
1:A:456:VAL:HG21	1:A:484:LEU:HD11	1.96	0.46
1:A:664:ASP:O	1:A:685:SER:HA	2.15	0.46
2:A:906:GOL:C1	4:A:1065:HOH:O	2.63	0.45
1:A:492:PHE:HZ	1:A:572[B]:LEU:HD12	1.82	0.45
1:A:730:ASN:OD1	1:A:757:PRO:HG3	2.18	0.45
1:A:736[A]:GLN:NE2	4:A:1003:HOH:O	2.34	0.44
2:A:903:GOL:C3	4:A:1011:HOH:O	2.64	0.43
1:A:646:ARG:HA	1:A:647:PRO:C	2.44	0.43
1:A:515:TYR:CZ	1:A:519:MET:HE3	2.54	0.42
1:A:715:GLU:OE1	2:A:901:GOL:H32	2.19	0.42
1:A:464:LYS:CD	1:A:465:THR:HG23	2.49	0.42
1:A:520:ARG:NH1	4:A:1009:HOH:O	2.47	0.42
1:A:502:LYS:H	2:A:906:GOL:C3	2.33	0.41
1:A:679:ARG:HD3	1:A:683:VAL:HG21	2.02	0.41
2:A:906:GOL:H11	4:A:1065:HOH:O	2.18	0.41
1:A:714:PHE:HA	1:A:724:THR:O	2.20	0.41
1:A:642:GLU:HG3	4:A:1111:HOH:O	2.20	0.41
1:A:575:GLY:HA2	1:A:629:HIS:CG	2.55	0.41
1:A:636:VAL:O	1:A:697:ARG:HD2	2.21	0.41
1:A:719:ASP:CB	4:A:1002:HOH:O	2.68	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:678:ALA:C	1:A:680:GLY:N	2.78	0.40
1:A:628:VAL:O	1:A:705:ARG:HA	2.21	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:536:HIS:HD2	1:A:536:HIS:HD2[2_555]	1.26	0.34

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	312/387 (81%)	300 (96%)	12 (4%)	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	274/333 (82%)	271 (99%)	3 (1%)	65 46

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	464	LYS
1	A	636	VAL
1	A	705	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	523	HIS
1	A	569	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)

6 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	GOL	A	903	-	5,5,5	0.48	0	5,5,5	0.74	0
2	GOL	A	906	-	5,5,5	0.38	0	5,5,5	1.30	0
2	GOL	A	904	-	5,5,5	0.68	0	5,5,5	1.45	1 (20%)
2	GOL	A	901	-	5,5,5	0.19	0	5,5,5	0.87	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
2	GOL	A	905	-	5,5,5	0.17	0	5,5,5	0.62	0
3	ACT	A	902	-	3,3,3	1.23	0	3,3,3	1.14	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
2	GOL	A	903	-	-	2/4/4/4	-
2	GOL	A	906	-	-	3/4/4/4	-
2	GOL	A	904	-	-	4/4/4/4	-
2	GOL	A	901	-	-	2/4/4/4	-
2	GOL	A	905	-	-	0/4/4/4	-

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	A	904	GOL	O3-C3-C2	2.30	121.21	110.20

There are no chirality outliers.

All (11) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	901	GOL	C1-C2-C3-O3
2	A	903	GOL	O1-C1-C2-C3
2	A	904	GOL	O1-C1-C2-C3
2	A	906	GOL	O1-C1-C2-O2
2	A	904	GOL	C1-C2-C3-O3
2	A	906	GOL	O1-C1-C2-C3
2	A	903	GOL	O1-C1-C2-O2
2	A	904	GOL	O1-C1-C2-O2
2	A	901	GOL	O2-C2-C3-O3
2	A	904	GOL	O2-C2-C3-O3
2	A	906	GOL	O2-C2-C3-O3

There are no ring outliers.

3 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	903	GOL	3	0
2	A	906	GOL	5	0
2	A	901	GOL	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

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	311/387 (80%)	-0.06	12 (3%) 43 45	11, 30, 55, 88	5 (1%)

All (12) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	682	GLY	4.6
1	A	803	LEU	4.0
1	A	757	PRO	3.6
1	A	805	ILE	3.5
1	A	681	GLU	3.5
1	A	806	GLU	3.3
1	A	679	ARG	3.2
1	A	678	ALA	3.2
1	A	680	GLY	3.0
1	A	734	THR	2.9
1	A	531	GLU	2.5
1	A	677	ASN	2.2

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 oligosaccharides 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	GOL	A	905	6/6	0.75	0.23	42,66,82,82	0
3	ACT	A	902	4/4	0.80	0.18	45,53,54,66	0
2	GOL	A	903	6/6	0.86	0.14	33,46,66,80	0
2	GOL	A	904	6/6	0.86	0.19	38,60,80,80	0
2	GOL	A	901	6/6	0.89	0.15	28,38,69,83	0
2	GOL	A	906	6/6	0.91	0.13	32,52,72,74	0

6.5 Other polymers (i)

There are no such residues in this entry.