



Full wwPDB X-ray Structure Validation Report ⓘ

Aug 6, 2020 – 10:25 AM BST

PDB ID : 6XE1
Title : Structure of SARS-CoV-2 spike protein receptor binding domain in complex with a potent neutralizing antibody, CV30 Fab
Authors : Hurlburt, N.K.; Pancera, M.
Deposited on : 2020-06-11
Resolution : 2.75 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 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 : 2.13.1
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

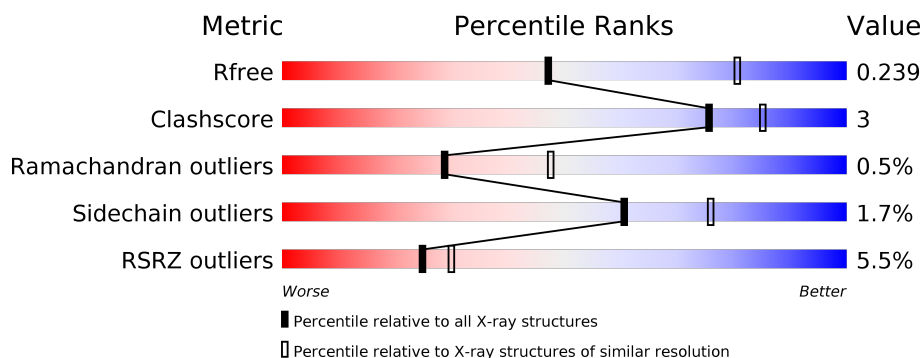
1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.75 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	1235 (2.78-2.74)
Clashscore	141614	1277 (2.78-2.74)
Ramachandran outliers	138981	1257 (2.78-2.74)
Sidechain outliers	138945	1257 (2.78-2.74)
RSRZ outliers	127900	1207 (2.78-2.74)

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 $\leq 5\%$. 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	H	224	<div> <div>10%</div> <div> <div></div> <div>85%</div> <div>12%</div> <div>.</div> </div> </div>
2	L	215	<div> <div>91%</div> <div>7%</div> <div>..</div> </div>
3	E	273	<div> <div>5%</div> <div>70%</div> <div>6%</div> <div>24%</div> </div>

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 4913 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 CV30 Fab Heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	H	219	Total	C	N	O	S	0	0	0
			1611	1010	271	323	7			

- Molecule 2 is a protein called CV30 Fab Kappa chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	L	212	Total	C	N	O	S	0	0	0
			1625	1016	276	329	4			

- Molecule 3 is a protein called Spike protein S1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	E	207	Total	C	N	O	S	0	0	0
			1642	1053	276	305	8			

- Molecule 4 is 2-acetamido-2-deoxy-beta-D-glucopyranose (three-letter code: NAG) (formula: $C_8H_{15}NO_6$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	E	1	Total	C	N	O	0	0
			14	8	1	5		

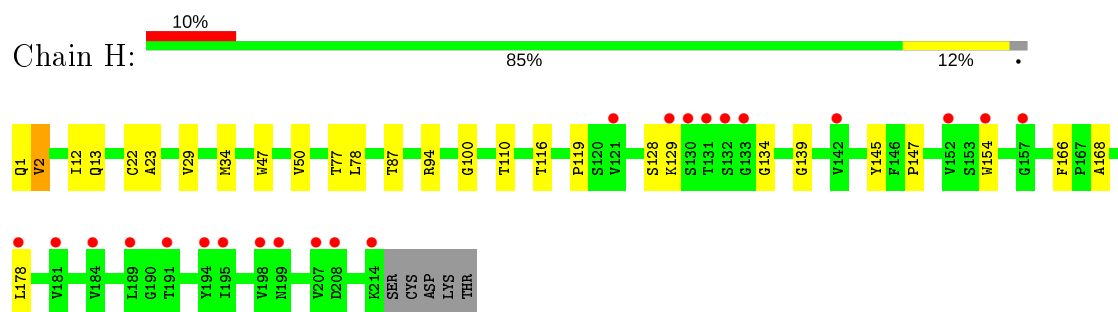
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	H	8	Total	O	0	0
			8	8		
5	L	10	Total	O	0	0
			10	10		
5	E	3	Total	O	0	0
			3	3		

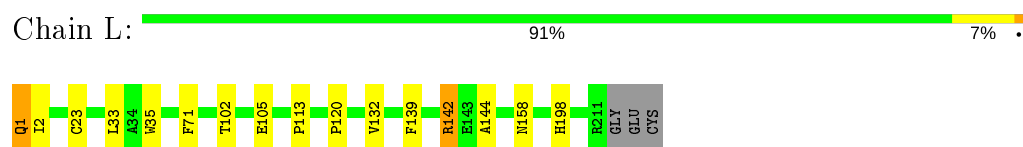
3 Residue-property plots [i](#)

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.

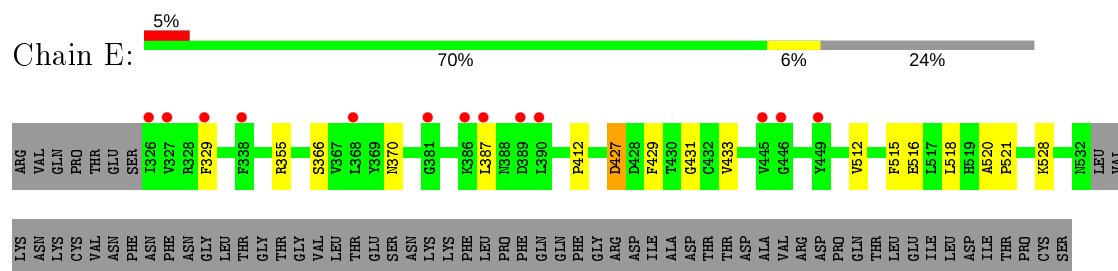
- Molecule 1: CV30 Fab Heavy chain



- Molecule 2: CV30 Fab Kappa chain



- Molecule 3: Spike protein S1



4 Data and refinement statistics

Property	Value	Source
Space group	P 63	Depositor
Cell constants a, b, c, α , β , γ	147.44 Å 147.44 Å 89.38 Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	48.26 – 2.75 48.26 – 2.75	Depositor EDS
% Data completeness (in resolution range)	99.9 (48.26-2.75) 99.9 (48.26-2.75)	Depositor EDS
R_{merge}	0.03	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.59 (at 2.77 Å)	Xtriage
Refinement program	PHENIX 1.17.1_3660	Depositor
R, R_{free}	0.212 , 0.239 0.212 , 0.239	Depositor DCC
R_{free} test set	1424 reflections (4.93%)	wwPDB-VP
Wilson B-factor (Å ²)	74.2	Xtriage
Anisotropy	0.220	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 42.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.037 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	4913	wwPDB-VP
Average B, all atoms (Å ²)	78.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.56% 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: PCA, NAG

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	H	0.30	0/1638	0.55	1/2233 (0.0%)
2	L	0.33	0/1653	0.51	1/2246 (0.0%)
3	E	0.26	0/1688	0.44	0/2297
All	All	0.30	0/4979	0.50	2/6776 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	H	1	PCA	O-C-N	11.37	140.89	122.70
2	L	1	PCA	O-C-N	9.73	138.26	122.70

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	H	1611	0	1588	13	0
2	L	1625	0	1581	8	0
3	E	1642	0	1569	9	0
4	E	14	0	13	0	0
5	E	3	0	0	1	0
5	H	8	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	L	10	0	0	1	0
All	All	4913	0	4751	30	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.

All (30) 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)
3:E:412:PRO:HG3	3:E:429:PHE:HB3	1.71	0.73
1:H:2:VAL:HG12	1:H:2:VAL:O	2.03	0.58
2:L:120:PRO:HD3	2:L:132:VAL:HG22	1.87	0.56
3:E:355:ARG:NH2	5:E:701:HOH:O	2.38	0.56
1:H:119:PRO:HB3	1:H:145:TYR:HB3	1.88	0.55
1:H:116:THR:HG22	1:H:147:PRO:HD3	1.91	0.52
3:E:366:SER:O	3:E:370:ASN:ND2	2.44	0.50
3:E:329:PHE:CE2	3:E:528:LYS:HB2	2.47	0.50
1:H:166:PHE:O	1:H:178:LEU:HD11	2.13	0.49
2:L:144:ALA:HB2	2:L:198:HIS:HD2	1.77	0.49
2:L:142:ARG:NH1	5:L:302:HOH:O	2.45	0.48
3:E:387:LEU:HD21	3:E:515:PHE:CZ	2.49	0.48
1:H:23:ALA:HA	1:H:77:THR:HG22	1.95	0.48
2:L:113:PRO:HB3	2:L:139:PHE:HB3	1.97	0.47
1:H:34:MET:HB3	1:H:78:LEU:HD22	1.99	0.45
2:L:158:ASN:OD1	2:L:158:ASN:N	2.50	0.44
3:E:431:GLY:HA2	3:E:515:PHE:CE2	2.52	0.44
1:H:168:ALA:HA	1:H:178:LEU:HD13	1.99	0.44
3:E:433:VAL:HG22	3:E:512:VAL:HG22	2.01	0.43
1:H:87:THR:HG23	1:H:110:THR:HA	1.99	0.42
2:L:1:PCA:HB2	2:L:2:ILE:H	1.51	0.42
2:L:33:LEU:HD22	2:L:71:PHE:CD2	2.54	0.42
1:H:22:CYS:HB3	1:H:78:LEU:HB3	2.01	0.42
1:H:139:GLY:HA2	1:H:154:TRP:CH2	2.54	0.42
1:H:128:SER:OG	1:H:129:LYS:N	2.54	0.41
3:E:520:ALA:HB1	3:E:521:PRO:HD2	2.01	0.41
1:H:47:TRP:HZ2	1:H:50:VAL:HG12	1.86	0.41
3:E:427:ASP:OD1	3:E:427:ASP:N	2.54	0.41
2:L:23:CYS:HB2	2:L:35:TRP:CH2	2.56	0.41
1:H:29:VAL:HA	1:H:34:MET:HE2	2.03	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	H	217/224 (97%)	204 (94%)	10 (5%)	3 (1%)	11	19
2	L	210/215 (98%)	201 (96%)	9 (4%)	0	100	100
3	E	205/273 (75%)	195 (95%)	10 (5%)	0	100	100
All	All	632/712 (89%)	600 (95%)	29 (5%)	3 (0%)	29	47

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	H	100	GLY
1	H	2	VAL
1	H	134	GLY

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	H	182/187 (97%)	179 (98%)	3 (2%)	62	77
2	L	183/185 (99%)	180 (98%)	3 (2%)	62	77
3	E	180/240 (75%)	177 (98%)	3 (2%)	60	76
All	All	545/612 (89%)	536 (98%)	9 (2%)	60	76

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	H	12	ILE
1	H	13	GLN
1	H	94	ARG
2	L	102	THR
2	L	105	GLU
2	L	142	ARG
3	E	427	ASP
3	E	516	GLU
3	E	518	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

2 non-standard protein/DNA/RNA residues 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	PCA	L	1	2	7,8,9	1.07	0	9,10,12	2.32	1 (11%)
1	PCA	H	1	1	7,8,9	1.00	1 (14%)	9,10,12	2.72	2 (22%)

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	PCA	L	1	2	-	0/0/11/13	0/1/1/1
1	PCA	H	1	1	-	0/0/11/13	0/1/1/1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	H	1	PCA	O-C	2.04	1.28	1.19

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	L	1	PCA	O-C-CA	-6.65	107.34	124.78
1	H	1	PCA	O-C-CA	-5.78	109.63	124.78
1	H	1	PCA	CB-CA-C	-5.71	104.85	112.70

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	L	1	PCA	1	0

5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

1 ligand is 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	$\# Z > 2$
4	NAG	E	601	3	14,14,15	0.32	0	17,19,21	0.62	1 (5%)

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	NAG	E	601	3	-	2/6/23/26	0/1/1/1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	E	601	NAG	C1-O5-C5	2.14	115.09	112.19

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	E	601	NAG	O5-C5-C6-O6
4	E	601	NAG	C4-C5-C6-O6

There are no ring outliers.

No monomer is involved in short contacts.

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, 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	H	218/224 (97%)	0.68	22 (10%) 7 7	52, 81, 122, 147	0
2	L	211/215 (98%)	0.18	0 100 100	53, 69, 97, 110	0
3	E	207/273 (75%)	0.56	13 (6%) 20 24	53, 76, 112, 131	0
All	All	636/712 (89%)	0.47	35 (5%) 25 30	52, 74, 114, 147	0

All (35) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	H	132	SER	7.1
1	H	130	SER	4.5
1	H	133	GLY	4.4
3	E	445	VAL	4.0
1	H	129	LYS	3.9
3	E	329	PHE	3.5
1	H	191	THR	3.5
1	H	195	ILE	3.3
3	E	326	ILE	3.2
1	H	189	LEU	3.1
1	H	152	VAL	3.1
1	H	131	THR	3.0
1	H	199	ASN	3.0
1	H	194	TYR	3.0
1	H	181	VAL	3.0
3	E	449	TYR	3.0
3	E	338	PHE	2.9
1	H	198	VAL	2.9
3	E	387	LEU	2.7
1	H	178	LEU	2.7
3	E	381	GLY	2.6
3	E	368	LEU	2.6
3	E	327	VAL	2.4

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Mol	Chain	Res	Type	RSRZ
3	E	386	LYS	2.4
1	H	157	GLY	2.4
3	E	390	LEU	2.3
3	E	446	GLY	2.3
1	H	121	VAL	2.2
1	H	142	VAL	2.2
3	E	389	ASP	2.2
1	H	154	TRP	2.2
1	H	214	LYS	2.1
1	H	207	VAL	2.1
1	H	208	ASP	2.0
1	H	184	VAL	2.0

6.2 Non-standard residues in protein, DNA, RNA chains [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
1	PCA	H	1	8/9	0.88	0.16	119,130,138,140	0
2	PCA	L	1	8/9	0.91	0.22	77,93,102,102	0

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
4	NAG	E	601	14/15	0.90	0.15	69,99,111,116	0

6.5 Other polymers

There are no such residues in this entry.