Full wwPDB X-ray Structure Validation Report (i)

Oct 5, 2023 – 10:41 PM EDT

PDB ID	:	6PAK
Title	:	Insight into subtilisin E-S7 cleavage pattern based on crystal structure and hydrolysates peptide analysis
Authors	:	Tang, H.; Shi, K.; Aihara, H.
Deposited on	:	2019-06-11
Resolution	:	1.98 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:

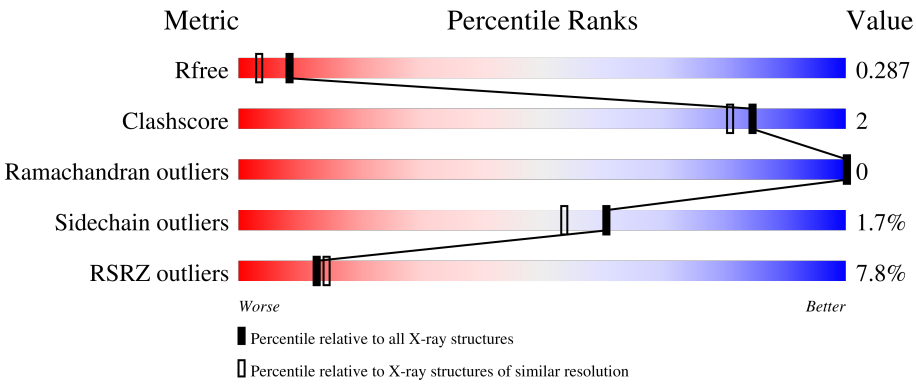
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.35.1
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35.1

1 Overall quality at a glance (i)

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

The reported resolution of this entry is 1.98 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	11647 (2.00-1.96)
Clashscore	141614	1014 (1.98-1.98)
Ramachandran outliers	138981	1006 (1.98-1.98)
Sidechain outliers	138945	1006 (1.98-1.98)
RSRZ outliers	127900	11410 (2.00-1.96)

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 <=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	285	6% 93% 5% •
1	B	285	9% 90% 7% •

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	EDO	B	304	-	-	-	X

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 8292 atoms, of which 3872 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 Subtilisin E.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	H	N	O	S			
1	A	277	3898	1227	1924	342	400	5	0	0	0
1	B	277	3898	1227	1924	342	400	5	0	0	0

There are 34 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	130	SER	THR	engineered mutation	UNP P04189
A	158	GLN	SER	engineered mutation	UNP P04189
A	159	HIS	SER	engineered mutation	UNP P04189
A	160	PRO	GLY	engineered mutation	UNP P04189
A	161	LYS	SER	engineered mutation	UNP P04189
A	162	GLU	THR	engineered mutation	UNP P04189
A	163	GLY	-	insertion	UNP P04189
A	222	CYS	SER	engineered mutation	UNP P04189
A	277	SER	-	expression tag	UNP P04189
A	278	LEU	-	expression tag	UNP P04189
A	279	GLU	-	expression tag	UNP P04189
A	280	HIS	-	expression tag	UNP P04189
A	281	HIS	-	expression tag	UNP P04189
A	282	HIS	-	expression tag	UNP P04189
A	283	HIS	-	expression tag	UNP P04189
A	284	HIS	-	expression tag	UNP P04189
A	285	HIS	-	expression tag	UNP P04189
B	130	SER	THR	engineered mutation	UNP P04189
B	158	GLN	SER	engineered mutation	UNP P04189
B	159	HIS	SER	engineered mutation	UNP P04189
B	160	PRO	GLY	engineered mutation	UNP P04189
B	161	LYS	SER	engineered mutation	UNP P04189
B	162	GLU	THR	engineered mutation	UNP P04189
B	163	GLY	-	insertion	UNP P04189
B	222	CYS	SER	engineered mutation	UNP P04189

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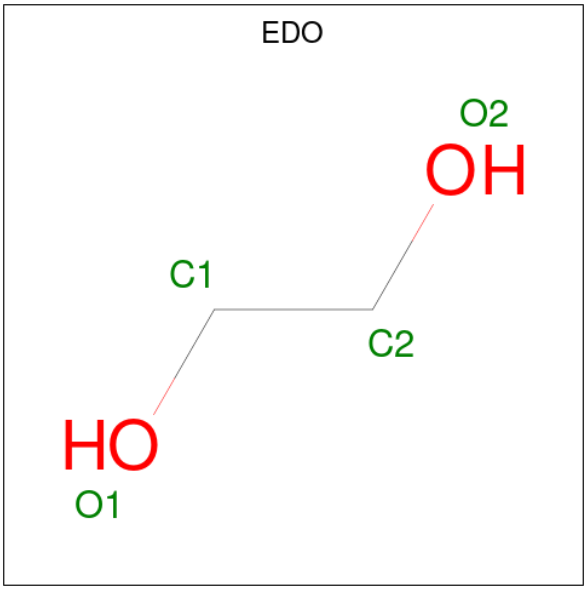
Chain	Residue	Modelled	Actual	Comment	Reference
B	277	SER	-	expression tag	UNP P04189
B	278	LEU	-	expression tag	UNP P04189
B	279	GLU	-	expression tag	UNP P04189
B	280	HIS	-	expression tag	UNP P04189
B	281	HIS	-	expression tag	UNP P04189
B	282	HIS	-	expression tag	UNP P04189
B	283	HIS	-	expression tag	UNP P04189
B	284	HIS	-	expression tag	UNP P04189
B	285	HIS	-	expression tag	UNP P04189

- Molecule 2 is CALCIUM ION (three-letter code: CA) (formula: Ca).

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

- Molecule 3 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: $C_2H_6O_2$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	H	O		
3	A	1	10	2	6	2	0	0
			Total	C	H	O		
3	A	1	10	2	6	2	0	0

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	H	O		
3	B	1	10	2	6	2	0	0
			Total	C	H	O		
3	B	1	10	2	6	2	0	0

- Molecule 4 is water.

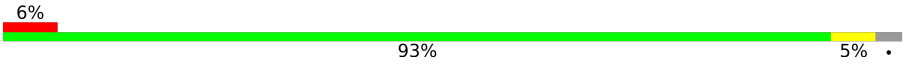
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	237	237	237	0	0
			Total	O		
4	B	217	217	217	0	0

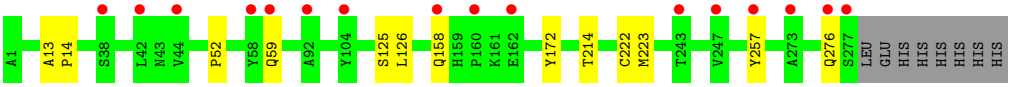
3 Residue-property plots (i)

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: Subtilisin E

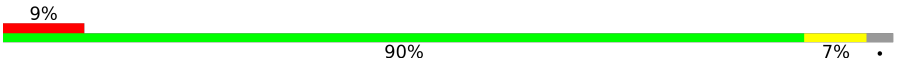
Chain A:

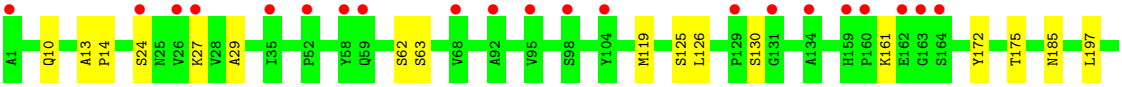


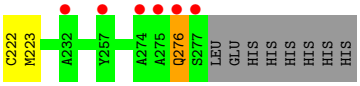


- Molecule 1: Subtilisin E

Chain B:







4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	74.25Å 80.47Å 86.92Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	46.22 – 1.98 46.22 – 1.98	Depositor EDS
% Data completeness (in resolution range)	98.7 (46.22-1.98) 98.9 (46.22-1.98)	Depositor EDS
R_{merge}	0.21	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.16 (at 1.98Å)	Xtriage
Refinement program	PHENIX (1.14_3219: ???)	Depositor
R, R_{free}	0.239 , 0.286 0.240 , 0.287	Depositor DCC
R_{free} test set	1794 reflections (4.91%)	wwPDB-VP
Wilson B-factor (Å^2)	20.7	Xtriage
Anisotropy	0.254	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.39 , 67.5	EDS
L-test for twinning[2]	$< \|L\| > = 0.47$, $< L^2 > = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	8292	wwPDB-VP
Average B, all atoms (Å^2)	32.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 57.50 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 2.3460e-05. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[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 (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: EDO, 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	0.30	0/2015	0.50	0/2752
1	B	0.29	0/2015	0.48	0/2752
All	All	0.30	0/4030	0.49	0/5504

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	1974	1924	1924	7	2
1	B	1974	1924	1924	11	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	8	12	12	0	0
3	B	8	12	12	0	0
4	A	237	0	0	4	7
4	B	217	0	0	5	5
All	All	4420	3872	3872	18	10

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 (18) 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:158:GLN:NE2	4:A:402:HOH:O	2.01	0.94
1:B:276:GLN:NE2	4:B:402:HOH:O	2.09	0.86
1:B:24:SER:O	4:B:401:HOH:O	1.96	0.82
1:A:172:TYR:O	4:A:403:HOH:O	2.05	0.75
1:B:27:LYS:NZ	4:B:405:HOH:O	2.22	0.69
1:B:175:THR:O	4:B:403:HOH:O	2.14	0.64
1:A:126:LEU:C	1:A:126:LEU:HD12	2.29	0.52
1:A:214:THR:OG1	4:A:405:HOH:O	2.19	0.51
1:B:172:TYR:O	4:B:403:HOH:O	2.20	0.50
1:B:62:SER:O	1:B:63:SER:CB	2.61	0.48
1:B:13:ALA:N	1:B:14:PRO:CD	2.77	0.47
1:A:13:ALA:N	1:A:14:PRO:CD	2.77	0.47
1:A:257:TYR:OH	4:A:404:HOH:O	2.12	0.47
1:B:126:LEU:HD12	1:B:126:LEU:C	2.34	0.46
1:B:10:GLN:NE2	1:B:185:ASN:OD1	2.49	0.46
1:B:29:ALA:HB2	1:B:119:MET:HG3	2.02	0.41
1:B:125:SER:HB3	1:B:222:CYS:HB3	2.02	0.41
1:A:125:SER:HB3	1:A:222:CYS:HB3	2.04	0.40

All (10) 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:52:PRO:O	1:A:276:GLN:NE2[3_554]	1.90	0.30
4:A:467:HOH:O	4:B:554:HOH:O[1_655]	1.95	0.25
4:A:584:HOH:O	4:A:585:HOH:O[3_544]	1.96	0.24
4:A:478:HOH:O	4:B:501:HOH:O[2_454]	1.99	0.21
4:A:512:HOH:O	4:B:565:HOH:O[1_655]	1.99	0.21
4:A:441:HOH:O	4:A:597:HOH:O[3_554]	2.00	0.20
4:B:513:HOH:O	4:B:596:HOH:O[3_454]	2.03	0.17
4:A:594:HOH:O	4:B:473:HOH:O[2_455]	2.07	0.13
1:A:52:PRO:O	1:A:276:GLN:HE21[3_554]	1.51	0.09
4:A:606:HOH:O	4:A:626:HOH:O[3_544]	2.13	0.07

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	275/285 (96%)	267 (97%)	8 (3%)	0	100	100
1	B	275/285 (96%)	266 (97%)	9 (3%)	0	100	100
All	All	550/570 (96%)	533 (97%)	17 (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	209/217 (96%)	207 (99%)	2 (1%)	76	73
1	B	209/217 (96%)	204 (98%)	5 (2%)	49	41
All	All	418/434 (96%)	411 (98%)	7 (2%)	60	53

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

Mol	Chain	Res	Type
1	A	59	GLN
1	A	223	MET
1	B	130	SER
1	B	161	LYS
1	B	197	LEU
1	B	223	MET
1	B	276	GLN

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 6 ligands modelled in this entry, 2 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	$\#\|Z\| > 2$
3	EDO	A	304	-	3,3,3	0.47	0	2,2,2	0.30	0
3	EDO	B	303	-	3,3,3	0.44	0	2,2,2	0.38	0
3	EDO	A	303	-	3,3,3	0.56	0	2,2,2	0.32	0
3	EDO	B	304	-	3,3,3	0.45	0	2,2,2	0.31	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	EDO	A	304	-	-	0/1/1/1	-
3	EDO	B	303	-	-	0/1/1/1	-
3	EDO	A	303	-	-	1/1/1/1	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	EDO	B	304	-	-	0/1/1/1	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	303	EDO	O1-C1-C2-O2

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 (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	277/285 (97%)	0.79	16 (5%)	23	25	14, 24, 43, 78	0
1	B	277/285 (97%)	0.95	27 (9%)	7	8	15, 25, 47, 132	0
All	All	554/570 (97%)	0.87	43 (7%)	13	14	14, 25, 43, 132	0

All (43) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	276	GLN	7.8
1	A	158	GLN	4.8
1	B	59	GLN	3.8
1	B	160	PRO	3.8
1	B	26	VAL	3.8
1	A	257	TYR	3.5
1	A	243	THR	3.4
1	B	159	HIS	3.4
1	B	27	LYS	3.3
1	B	58	TYR	3.2
1	A	58	TYR	3.2
1	B	95	VAL	3.1
1	A	162	GLU	3.1
1	B	277	SER	3.0
1	A	160	PRO	3.0
1	B	35	ILE	3.0
1	B	104	TYR	3.0
1	B	129	PRO	2.9
1	B	1	ALA	2.7
1	B	52	PRO	2.6
1	A	247	VAL	2.6
1	B	134	ALA	2.5
1	A	92	ALA	2.5
1	B	131	GLY	2.5

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Mol	Chain	Res	Type	RSRZ
1	B	274	ALA	2.4
1	B	68	VAL	2.4
1	B	92	ALA	2.4
1	B	275	ALA	2.3
1	B	98	SER	2.3
1	A	104	TYR	2.2
1	B	257	TYR	2.2
1	B	24	SER	2.2
1	B	232	ALA	2.2
1	A	273	ALA	2.2
1	B	164	SER	2.1
1	A	44	VAL	2.1
1	A	59	GLN	2.1
1	B	162	GLU	2.1
1	A	276	GLN	2.1
1	A	277	SER	2.0
1	B	163	GLY	2.0
1	A	42	LEU	2.0
1	A	38	SER	2.0

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
3	EDO	B	304	4/4	0.20	0.56	88,106,111,112	0
3	EDO	A	303	4/4	0.64	0.29	39,56,67,67	0
3	EDO	B	303	4/4	0.65	0.27	54,66,69,79	0
3	EDO	A	304	4/4	0.75	0.27	67,80,85,89	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	CA	B	301	1/1	0.92	0.35	58,58,58,58	0
2	CA	A	301	1/1	0.98	0.04	16,16,16,16	0

6.5 Other polymers (i)

There are no such residues in this entry.