



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 1, 2016 – 03:36 PM GMT

PDB ID : 4CUB
Title : Unravelling the multiple functions of the architecturally intricate *Streptococcus pneumoniae* beta-galactosidase, BgaA
Authors : Singh, A.K.; Pluvinae, B.; Higgins, M.A.; Dalia, A.B.; Flynn, M.; Lloyd, A.R.; Weiser, J.N.; Stubbs, K.A.; Boraston, A.B.; King, S.J.
Deposited on : 2014-03-17
Resolution : 2.10 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
<http://wwpdb.org/validation/2016/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 : 1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix) : 1.9-1692
EDS : rb-20026688
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac : 5.8.0135
CCP4 : 6.5.0
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : trunk26865

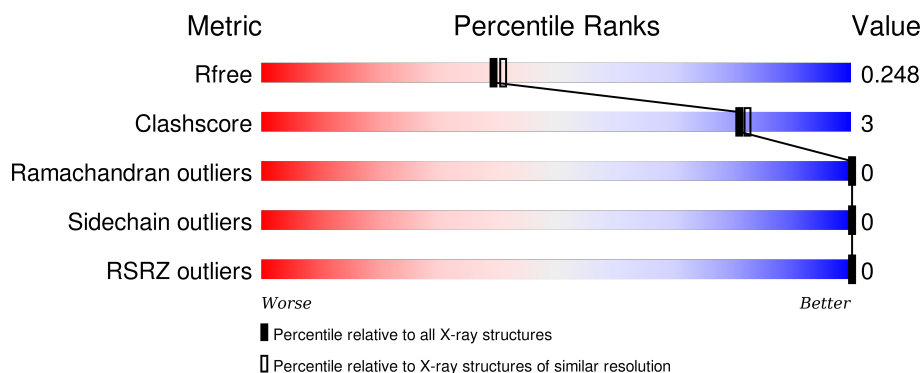
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION



The reported resolution of this entry is 2.10 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}	91344	3939 (2.10-2.10)
Clashscore	102246	4460 (2.10-2.10)
Ramachandran outliers	100387	4413 (2.10-2.10)
Sidechain outliers	100360	4414 (2.10-2.10)
RSRZ outliers	91569	3948 (2.10-2.10)

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. 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	183	 92% 5% .
1	B	183	 91% 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	A	2646	-	-	-	X
3	EDO	A	2649	-	-	-	X
3	EDO	A	2650	-	-	-	X
3	EDO	B	2646	-	-	-	X
4	GAL	A	2651	-	-	-	X
4	NAG	A	2652	-	-	-	X

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 3254 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 BETA-GALACTOSIDASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	179	Total	C	N	O	S	3	5	0
			1420	887	248	283	2			
1	B	180	Total	C	N	O	S	10	6	0
			1433	895	251	285	2			

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

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

- Molecule 3 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: C₂H₆O₂).



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

- Molecule 4 is a polymer of unknown type called SUGAR (2-MER).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	2	Total C N O 26 14 1 11	0	0
4	B	2	Total C N O 26 14 1 11	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	177	Total O 177 177	0	0
5	B	130	Total O 130 130	0	0

3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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.

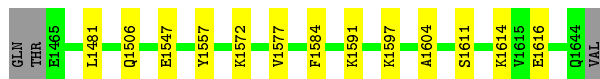
- Molecule 1: BETA-GALACTOSIDASE

Chain A:  92% 5% •



- Molecule 1: BETA-GALACTOSIDASE

Chain B:  91% 7% •



4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, α , β , γ	70.53 Å 70.53 Å 161.56 Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	36.62 – 2.10 36.59 – 2.10	Depositor EDS
% Data completeness (in resolution range)	99.9 (36.62-2.10) 99.9 (36.59-2.10)	Depositor EDS
R_{merge}	0.15	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.09 (at 2.10 Å)	Xtriage
Refinement program	REFMAC 5.7.0032	Depositor
R, R_{free}	0.190 , 0.247 0.190 , 0.248	Depositor DCC
R_{free} test set	1256 reflections (5.38%)	DCC
Wilson B-factor (Å ²)	21.9	Xtriage
Anisotropy	0.076	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 50.1	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning ²	$\langle L \rangle = 0.41$, $\langle L^2 \rangle = 0.24$	Xtriage
Outliers	0 of 24613 reflections	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	3254	wwPDB-VP
Average B, all atoms (Å ²)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.20% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: CA, GAL, NAG, EDO

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	0.56	0/1455	0.66	0/1982
1	B	0.79	4/1469 (0.3%)	0.74	3/2001 (0.1%)
All	All	0.69	4/2924 (0.1%)	0.70	3/3983 (0.1%)

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	1591	LYS	CD-CE	-16.67	1.09	1.51
1	B	1572	LYS	CG-CD	-12.69	1.09	1.52
1	B	1597	LYS	CD-CE	5.59	1.65	1.51
1	B	1506	GLN	CG-CD	-5.58	1.38	1.51

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	1572	LYS	CB-CG-CD	10.74	139.53	111.60
1	B	1591	LYS	CG-CD-CE	9.35	139.93	111.90
1	B	1481	LEU	CA-CB-CG	6.04	129.19	115.30

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	1420	0	1335	9	0
1	B	1433	0	1344	9	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	20	0	30	4	0
3	B	20	0	30	6	0
4	A	26	0	24	1	0
4	B	26	0	24	1	0
5	A	177	0	0	1	0
5	B	130	0	0	2	0
All	All	3254	0	2787	19	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 (19) 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)
4:B:2652:NAG:H83	5:B:2128:HOH:O	1.66	0.96
1:B:1616[A]:GLU:H	3:B:2650:EDO:H21	1.47	0.79
1:B:1616[B]:GLU:H	3:B:2650:EDO:H21	1.53	0.74
1:A:1537:SER:H	3:A:2648:EDO:H12	1.55	0.72
1:B:1557:TYR:CE1	3:B:2648:EDO:H21	2.28	0.68
1:A:1560[B]:GLU:OE2	1:A:1621:ARG:NE	2.29	0.63
1:A:1537:SER:H	3:A:2648:EDO:C1	2.13	0.62
1:A:1556:SER:HG	3:A:2650:EDO:HO1	1.43	0.56
1:B:1584:PHE:HB3	3:B:2649:EDO:H21	1.95	0.49
1:B:1577:VAL:CG1	3:B:2649:EDO:H22	2.47	0.45
1:B:1614:LYS:HB2	1:B:1614:LYS:HE3	1.49	0.44
1:B:1611:SER:HB2	5:B:2113:HOH:O	2.17	0.44
1:A:1506:GLN:HG3	5:A:2061:HOH:O	2.19	0.42
1:A:1514:TRP:CD1	4:A:2651:GAL:H5	2.54	0.42
1:A:1591:LYS:HB3	1:A:1592:PRO:HD2	2.01	0.42
1:B:1547:GLU:HB2	1:B:1604:ALA:CB	2.49	0.42
1:A:1614:LYS:HE2	1:A:1614:LYS:HB3	1.81	0.41
1:A:1474:TRP:CG	3:A:2649:EDO:H12	2.56	0.41
1:B:1557:TYR:CZ	3:B:2648:EDO:H21	2.56	0.41

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	182/183 (100%)	178 (98%)	4 (2%)	0	100	100
1	B	184/183 (100%)	181 (98%)	3 (2%)	0	100	100
All	All	366/366 (100%)	359 (98%)	7 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	155/157 (99%)	155 (100%)	0	100	100
1	B	157/157 (100%)	157 (100%)	0	100	100
All	All	312/314 (99%)	312 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

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 ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

4 carbohydrates 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$
4	GAL	A	2651	4	11,11,12	0.67	0	14,15,17	1.35	1 (7%)
4	NAG	A	2652	4	15,15,15	0.41	0	17,21,21	1.01	0
4	GAL	B	2651	4	11,11,12	0.48	0	14,15,17	1.17	2 (14%)
4	NAG	B	2652	4	15,15,15	0.51	0	17,21,21	1.26	2 (11%)

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	GAL	A	2651	4	-	0/2/19/22	0/1/1/1
4	NAG	A	2652	4	-	0/6/26/26	0/1/1/1
4	GAL	B	2651	4	-	0/2/19/22	0/1/1/1
4	NAG	B	2652	4	-	0/6/26/26	0/1/1/1

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	B	2652	NAG	O7-C7-C8	-2.88	116.78	122.06
4	B	2652	NAG	C3-C2-N2	2.34	115.52	110.66
4	B	2651	GAL	C1-O5-C5	2.44	115.34	112.25
4	B	2651	GAL	O5-C5-C6	2.59	112.96	107.35
4	A	2651	GAL	C1-O5-C5	4.54	118.01	112.25

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	2651	GAL	1	0
4	B	2652	NAG	1	0

5.6 Ligand geometry [i](#)

Of 12 ligands modelled in this entry, 2 are monoatomic - leaving 10 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	2646	-	3,3,3	0.40	0	2,2,2	0.57	0
3	EDO	A	2647	-	3,3,3	0.52	0	2,2,2	0.45	0
3	EDO	A	2648	-	3,3,3	0.46	0	2,2,2	0.44	0
3	EDO	A	2649	-	3,3,3	0.31	0	2,2,2	1.29	0
3	EDO	A	2650	-	3,3,3	0.41	0	2,2,2	0.57	0
3	EDO	B	2646	-	3,3,3	0.63	0	2,2,2	0.11	0
3	EDO	B	2647	-	3,3,3	0.40	0	2,2,2	0.65	0
3	EDO	B	2648	-	3,3,3	0.46	0	2,2,2	0.43	0
3	EDO	B	2649	-	3,3,3	0.53	0	2,2,2	0.09	0
3	EDO	B	2650	-	3,3,3	0.42	0	2,2,2	0.51	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	2646	-	-	0/1/1/1	0/0/0/0
3	EDO	A	2647	-	-	0/1/1/1	0/0/0/0
3	EDO	A	2648	-	-	0/1/1/1	0/0/0/0

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	EDO	A	2649	-	-	0/1/1/1	0/0/0/0
3	EDO	A	2650	-	-	0/1/1/1	0/0/0/0
3	EDO	B	2646	-	-	0/1/1/1	0/0/0/0
3	EDO	B	2647	-	-	0/1/1/1	0/0/0/0
3	EDO	B	2648	-	-	0/1/1/1	0/0/0/0
3	EDO	B	2649	-	-	0/1/1/1	0/0/0/0
3	EDO	B	2650	-	-	0/1/1/1	0/0/0/0

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

6 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	2648	EDO	2	0
3	A	2649	EDO	1	0
3	A	2650	EDO	1	0
3	B	2648	EDO	2	0
3	B	2649	EDO	2	0
3	B	2650	EDO	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	179/183 (97%)	-0.64	0 100 100	12, 20, 29, 47	1 (0%)
1	B	180/183 (98%)	-0.51	0 100 100	14, 22, 30, 53	4 (2%)
All	All	359/366 (98%)	-0.58	0 100 100	12, 21, 30, 53	5 (1%)

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](#)

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å ²)	Q<0.9
4	NAG	A	2652	15/15	0.87	0.18	5.86	31,34,40,43	0
4	GAL	A	2651	11/12	0.94	0.10	2.11	19,23,26,26	0
4	NAG	B	2652	15/15	0.92	0.12	0.30	23,26,30,31	0
4	GAL	B	2651	11/12	0.97	0.08	-0.50	20,22,22,23	0

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. LLDF column lists the quality of electron

density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(Å ²)	Q<0.9
3	EDO	A	2650	4/4	0.96	0.14	12.12	24,25,27,27	0
3	EDO	A	2649	4/4	0.94	0.17	5.92	25,27,28,31	0
3	EDO	A	2646	4/4	0.95	0.11	3.21	26,26,27,28	0
3	EDO	B	2646	4/4	0.96	0.12	2.49	19,19,19,19	0
3	EDO	B	2647	4/4	0.94	0.12	1.86	30,33,34,35	0
3	EDO	A	2648	4/4	0.90	0.15	1.73	37,39,40,45	0
3	EDO	A	2647	4/4	0.99	0.08	0.98	23,24,25,25	0
3	EDO	B	2649	4/4	0.96	0.10	0.28	22,23,25,26	0
2	CA	A	2645	1/1	0.99	0.07	-1.29	15,15,15,15	0
2	CA	B	2645	1/1	0.99	0.06	-1.70	19,19,19,19	0
3	EDO	B	2650	4/4	0.90	0.12	-	26,40,42,45	0
3	EDO	B	2648	4/4	0.86	0.11	-	31,32,33,38	0

6.5 Other polymers

There are no such residues in this entry.