



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 01:41 PM UTC

PDB ID : 5TA9 / pdb_00005ta9
Title : Crystal structure of BuGH117Bwt in complex with neoagarobiose
Authors : Pluinage, B.; Boraston, A.B.
Deposited on : 2016-09-09
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

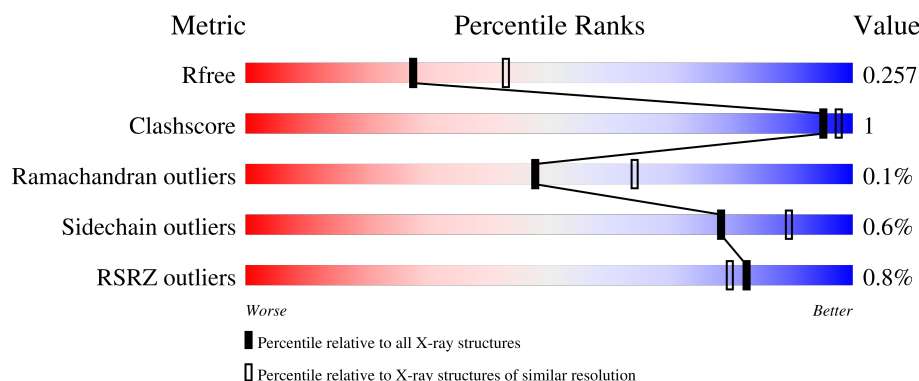
1 Overall quality at a glance

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	400	
1	B	400	
1	C	400	
1	D	400	

2 Entry composition [i](#)

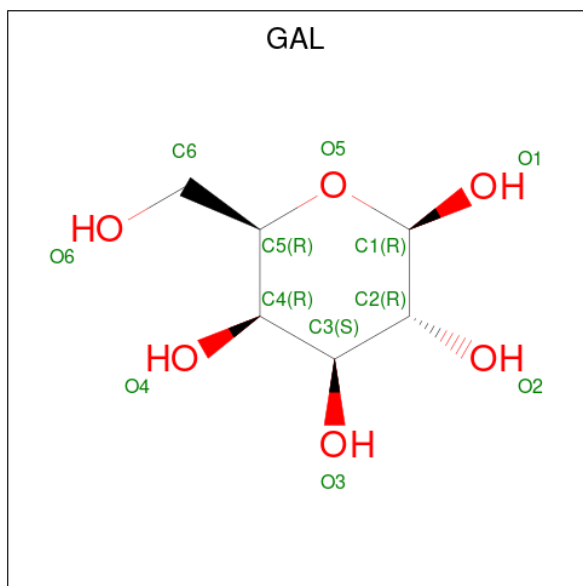
There are 5 unique types of molecules in this entry. The entry contains 12330 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Glycoside Hydrolase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	369	Total	C	N	O	S	0	0	0
			2970	1893	498	564	15			
1	B	369	Total	C	N	O	S	0	0	0
			2961	1889	496	561	15			
1	C	369	Total	C	N	O	S	0	0	0
			2932	1870	491	556	15			
1	D	369	Total	C	N	O	S	0	0	0
			2924	1863	488	558	15			

- Molecule 2 is beta-D-galactopyranose (CCD ID: GAL) (formula: C₆H₁₂O₆).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	0
			12	6	6		
2	B	1	Total	C	O	0	0
			12	6	6		

Continued on next page...

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	C	1	Total C O 12 6 6	0	0
2	D	1	Total C O 12 6 6	0	0

-
- Chemical structure of α -D-glucopyranose in a chair conformation. The structure shows the six-membered ring with carbons C1 through C6 and oxygens O1 through O5. Substituents include H3 and H5 (axial), and OH groups at C2, C3, C4, and C6. Stereochemistry is indicated by (R) and (S) labels for C1, C2, C3, C4, and C5.

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total 11	C 6	O 5	0	0
3	B	1	Total 11	C 6	O 5	0	0
3	C	1	Total 11	C 6	O 5	0	0
3	D	1	Total 11	C 6	O 5	0	0

- | Mol | Chain | Residues | Atoms | ZeroOcc | AltConf |
|-----|-------|----------|-----------------|---------|---------|
| 4 | A | 1 | Total Mg
1 1 | 0 | 0 |
| 4 | B | 1 | Total Mg
1 1 | 0 | 0 |
| 4 | C | 1 | Total Mg
1 1 | 0 | 0 |



WORLD WIDE
PDB
PROTEIN DATA BANK

Continued from previous page...

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	D	1	Total 1	O Mg 1	0	0

- Molecule 5 is water.

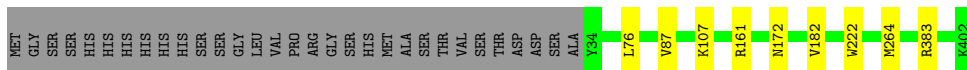
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	129	Total 129	O 129	0	0
5	B	141	Total 141	O 141	0	0
5	C	84	Total 84	O 84	0	0
5	D	93	Total 93	O 93	0	0

3 Residue-property plots

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: Glycoside Hydrolase

Chain A: 



- Molecule 1: Glycoside Hydrolase

Chain B: 



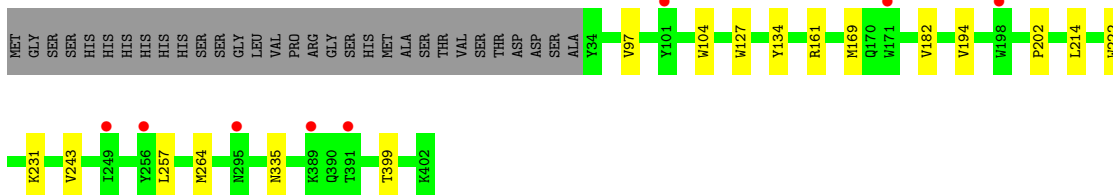
- Molecule 1: Glycoside Hydrolase

Chain C: 



- Molecule 1: Glycoside Hydrolase

Chain D: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	83.51Å 104.38Å 198.50Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	99.25 – 2.40 99.25 – 2.40	Depositor EDS
% Data completeness (in resolution range)	95.6 (99.25-2.40) 95.6 (99.25-2.40)	Depositor EDS
R_{merge}	0.16	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.28 (at 2.40Å)	Xtriage
Refinement program	REFMAC 5.8.0155	Depositor
R, R_{free}	0.207 , 0.253 0.212 , 0.257	Depositor DCC
R_{free} test set	3303 reflections (4.81%)	wwPDB-VP
Wilson B-factor (Å ²)	37.6	Xtriage
Anisotropy	0.061	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 35.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.43$, $\langle L^2 \rangle = 0.25$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	12330	wwPDB-VP
Average B, all atoms (Å ²)	42.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.12% 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: AAL, MG, GAL

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	0.62	0/3061	0.76	0/4155
1	B	0.62	0/3052	0.77	1/4144 (0.0%)
1	C	0.63	0/3023	0.77	1/4112 (0.0%)
1	D	0.62	0/3015	0.78	0/4105
All	All	0.62	0/12151	0.77	2/16516 (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	B	374	ILE	N-CA-C	-6.24	105.65	111.45
1	C	393	THR	N-CA-C	5.37	117.94	108.75

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	2970	0	2809	4	0
1	B	2961	0	2794	6	0
1	C	2932	0	2734	11	0
1	D	2924	0	2705	8	0
2	A	12	0	12	0	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	12	0	12	0	0
2	C	12	0	12	0	0
2	D	12	0	12	0	0
3	A	11	0	10	0	0
3	B	11	0	10	0	0
3	C	11	0	10	0	0
3	D	11	0	10	1	0
4	A	1	0	0	0	0
4	B	1	0	0	0	0
4	C	1	0	0	0	0
4	D	1	0	0	0	0
5	A	129	0	0	0	0
5	B	141	0	0	0	0
5	C	84	0	0	1	0
5	D	93	0	0	0	0
All	All	12330	0	11130	28	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 1.

All (28) 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:B:163:VAL:HG12	1:B:181:THR:HG22	1.79	0.65
1:B:222:TRP:CE2	1:B:264:MET:HE3	2.40	0.56
1:A:222:TRP:CE2	1:A:264:MET:HE3	2.44	0.53
1:C:277:HIS:CE1	1:C:304:ILE:HD13	2.47	0.50
1:D:194:VAL:HG23	1:D:243:VAL:HG23	1.95	0.48
1:C:161:ARG:HB3	1:C:182:VAL:HG13	1.96	0.48
1:B:222:TRP:CD2	1:B:264:MET:HE3	2.49	0.47
1:A:87:VAL:O	1:A:107:LYS:HA	2.14	0.47
1:B:299:ASN:HD21	1:B:323:GLU:CD	2.23	0.47
1:C:222:TRP:CE2	1:C:264:MET:HE3	2.50	0.46
1:D:222:TRP:CH2	1:D:264:MET:HG2	2.51	0.46
1:D:161:ARG:HB3	1:D:182:VAL:HG23	1.97	0.45
1:D:214:LEU:HD22	1:D:257:LEU:HD22	1.98	0.45
1:A:161:ARG:HB3	1:A:182:VAL:HG13	1.97	0.45
1:C:34:TYR:N	5:C:603:HOH:O	2.48	0.44
1:C:34:TYR:HB3	1:C:50:LEU:HD11	2.00	0.44
1:B:305:CYS:HB3	1:B:316:LEU:HB3	2.00	0.44
1:C:52:ALA:HB2	1:D:335:ASN:HB3	2.00	0.43

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:218:ASP:N	1:C:218:ASP:OD1	2.51	0.43
1:C:297:ILE:HD13	1:C:336:PHE:CE1	2.53	0.43
1:B:373:TYR:HA	1:B:379:GLN:HG3	2.01	0.43
1:C:89:ARG:HD2	1:C:379:GLN:OE1	2.19	0.43
1:C:107:LYS:O	1:C:130:CYS:HA	2.20	0.42
1:D:104:TRP:CD1	1:D:134:TYR:HB3	2.55	0.41
1:C:87:VAL:O	1:C:107:LYS:HA	2.21	0.40
1:D:97:VAL:HG11	1:D:202:PRO:HG2	2.03	0.40
1:A:76:LEU:HD21	1:A:383:ARG:HB2	2.02	0.40
1:D:127:TRP:CE2	3:D:502:AAL:H5	2.56	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	367/400 (92%)	360 (98%)	7 (2%)	0	100	100
1	B	367/400 (92%)	356 (97%)	11 (3%)	0	100	100
1	C	367/400 (92%)	353 (96%)	13 (4%)	1 (0%)	36	50
1	D	367/400 (92%)	352 (96%)	15 (4%)	0	100	100
All	All	1468/1600 (92%)	1421 (97%)	46 (3%)	1 (0%)	48	64

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	302	HIS

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	311/341 (91%)	310 (100%)	1 (0%)	86	93
1	B	308/341 (90%)	307 (100%)	1 (0%)	86	93
1	C	301/341 (88%)	299 (99%)	2 (1%)	76	88
1	D	299/341 (88%)	296 (99%)	3 (1%)	68	84
All	All	1219/1364 (89%)	1212 (99%)	7 (1%)	78	89

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

Mol	Chain	Res	Type
1	A	172	ASN
1	B	371	HIS
1	C	164	PHE
1	C	266	GLU
1	D	169	MET
1	D	231	LYS
1	D	399	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	357	ASN
1	C	36	GLN
1	C	193	ASN
1	C	284	ASN
1	C	347	HIS
1	D	193	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](#)

Of 12 ligands modelled in this entry, 4 are monoatomic - leaving 8 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	$\# Z > 2$
2	GAL	C	501	-	12,12,12	0.51	0	17,17,17	0.66	0
3	AAL	B	502	-	12,12,12	0.55	0	16,18,18	0.88	1 (6%)
2	GAL	B	501	-	12,12,12	0.51	0	17,17,17	0.73	0
3	AAL	C	502	-	12,12,12	0.67	0	16,18,18	1.08	1 (6%)
3	AAL	D	502	-	12,12,12	0.64	0	16,18,18	1.02	1 (6%)
2	GAL	A	501	-	12,12,12	0.61	0	17,17,17	0.67	0
3	AAL	A	502	-	12,12,12	0.76	0	16,18,18	1.12	2 (12%)
2	GAL	D	501	-	12,12,12	0.65	0	17,17,17	0.61	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	GAL	C	501	-	-	0/2/22/22	0/1/1/1
3	AAL	B	502	-	-	-	0/3/2/2
2	GAL	B	501	-	-	0/2/22/22	0/1/1/1
3	AAL	C	502	-	-	-	0/3/2/2
3	AAL	D	502	-	-	-	0/3/2/2
2	GAL	A	501	-	-	0/2/22/22	0/1/1/1

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	AAL	A	502	-	-	-	0/3/2/2
2	GAL	D	501	-	-	0/2/22/22	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(°)
3	B	502	AAL	C3-C4-C5	-2.53	96.55	101.99
3	C	502	AAL	C3-C4-C5	-2.50	96.61	101.99
3	D	502	AAL	C3-C4-C5	-2.45	96.72	101.99
3	A	502	AAL	C3-C4-C5	-2.33	96.98	101.99
3	A	502	AAL	O2-C2-C1	2.25	114.45	109.25

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
3	D	502	AAL	1	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	369/400 (92%)	-0.16	0	100	100	23, 36, 52, 71	0
1	B	369/400 (92%)	-0.18	0	100	100	23, 34, 52, 69	0
1	C	369/400 (92%)	0.40	4 (1%)	78	74	25, 48, 69, 78	0
1	D	369/400 (92%)	0.40	8 (2%)	62	58	25, 48, 72, 84	0
All	All	1476/1600 (92%)	0.12	12 (0%)	82	80	23, 40, 67, 84	0

All (12) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	391	THR	3.2
1	D	198	TRP	2.9
1	C	119	VAL	2.8
1	D	171	TRP	2.5
1	D	256	TYR	2.4
1	D	295	ASN	2.2
1	D	389	LYS	2.2
1	C	49	LYS	2.0
1	D	249	ILE	2.0
1	D	101	TYR	2.0
1	C	50	LEU	2.0
1	C	44	ILE	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 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(Å ²)	Q<0.9
3	AAL	C	502	11/11	0.84	0.15	56,61,62,63	0
2	GAL	C	501	12/12	0.88	0.12	50,55,57,58	0
3	AAL	D	502	11/11	0.89	0.10	36,39,41,46	0
3	AAL	A	502	11/11	0.90	0.12	41,48,49,52	0
3	AAL	B	502	11/11	0.92	0.12	50,56,58,64	0
2	GAL	B	501	12/12	0.93	0.08	36,38,41,44	0
2	GAL	A	501	12/12	0.93	0.09	36,38,41,42	0
2	GAL	D	501	12/12	0.95	0.07	28,31,32,34	0
4	MG	B	503	1/1	0.99	0.02	19,19,19,19	0
4	MG	C	503	1/1	0.99	0.01	24,24,24,24	0
4	MG	A	503	1/1	1.00	0.03	28,28,28,28	0
4	MG	D	503	1/1	1.00	0.03	31,31,31,31	0

6.5 Other polymers [i](#)

There are no such residues in this entry.