



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 06:08 PM UTC

PDB ID : 8QF7 / pdb_00008qf7
Title : Human Carbonic Anhydrase II in complex with (3-((N-(4-sulfamoylbenzyl)phenyl)sulfonamido)methyl)phenyl)glycine
Authors : Angeli, A.; Ferraroni, M.
Deposited on : 2023-09-04
Resolution : 1.23 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
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
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

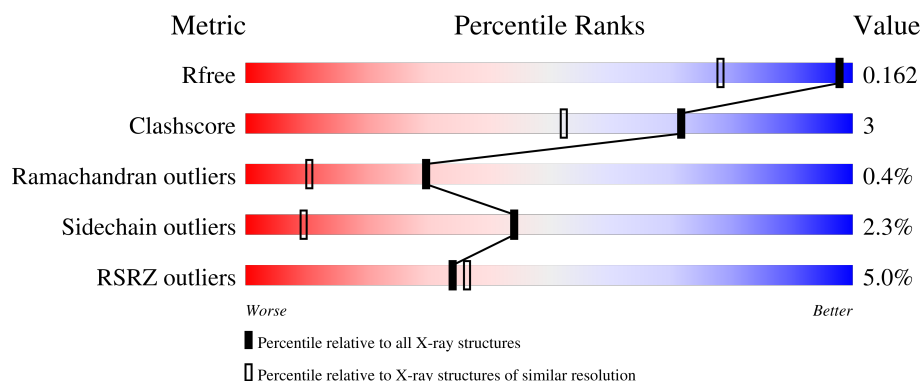
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.23 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	2002 (1.24-1.20)
Clashscore	190562	2061 (1.24-1.20)
Ramachandran outliers	187476	2009 (1.24-1.20)
Sidechain outliers	187428	2008 (1.24-1.20)
RSRZ outliers	180081	2000 (1.24-1.20)

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	AAA	260	5% 87% 12% ..

2 Entry composition [i](#)

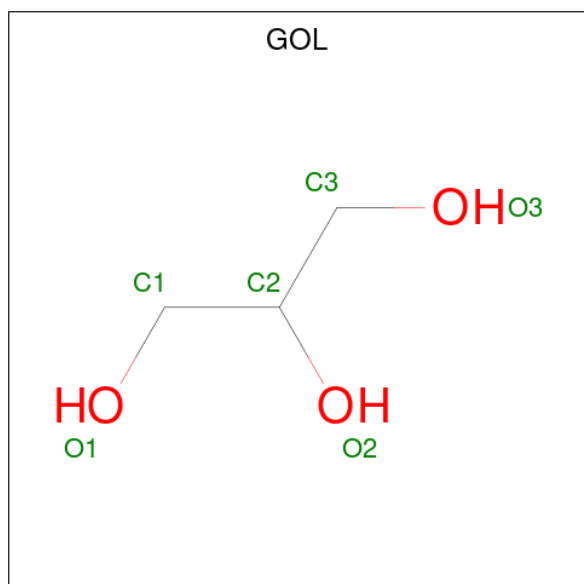
There are 6 unique types of molecules in this entry. The entry contains 2429 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Carbonic anhydrase 2.

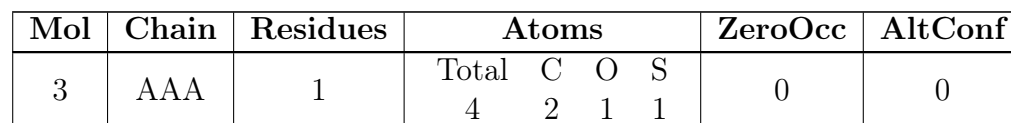
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	AAA	258	2127	1372	361	392	2	0	18	0

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



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	AAA	1	6	3	3	0	0

- Molecule 3 is DIMETHYL SULFOXIDE (CCD ID: DMS) (formula: C_2H_6OS).



- | Mol | Chain | Residues | Atoms | ZeroOcc | AltConf |
|-----|-------|----------|-----------------|---------|---------|
| 4 | AAA | 1 | Total Zn
1 1 | 0 | 0 |

-
- The chemical structure of the ligand 4-((4-aminophenyl)diazenyl)benzoic acid is shown with atom numbering. The structure consists of a central benzene ring (C6-C7) substituted with a diazenyl group (-N=N-) at C5, a carboxylic acid group (-COOH) at C2, and a 4-aminophenyl group (-CH2-C6H4-NH2) at C1. The diazenyl group connects to another benzene ring (C20-C21) which has an amino group (-NH2) at C28. The carboxylic acid group is represented by C2, O1, and O3. The diazenyl group is represented by N4 and N9. The 4-aminophenyl group is represented by C19, C20, C21, C22, C23, C24, C25, C26, C27, and C28. The central benzene ring is represented by C6, C7, C8, C9, C10, and C11. The carboxylic acid group is represented by C2, O1, and O3. The diazenyl group is represented by N4 and N9. The 4-aminophenyl group is represented by C19, C20, C21, C22, C23, C24, C25, C26, C27, and C28.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
5	AAA	1	Total	C	N	O	S	5	0
			33	22	3	6	2		

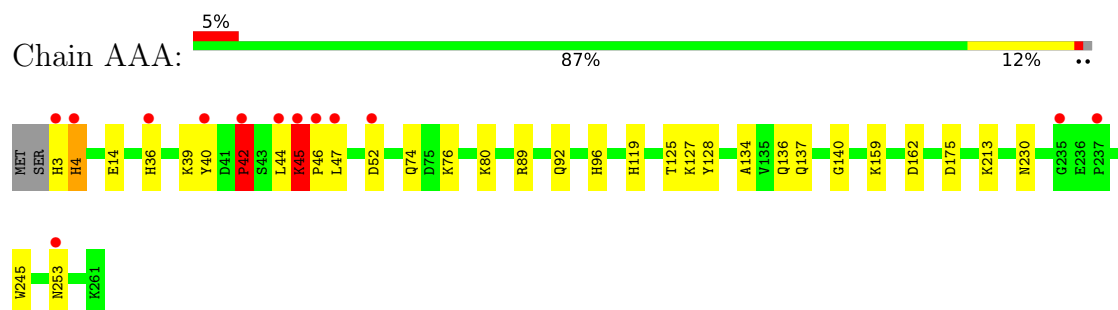
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	AAA	258	Total	O	0	0
			258	258		

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: Carbonic anhydrase 2



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	42.44Å 41.46Å 72.41Å 90.00° 104.41° 90.00°	Depositor
Resolution (Å)	40.11 – 1.23 40.11 – 1.23	Depositor EDS
% Data completeness (in resolution range)	84.6 (40.11-1.23) 84.6 (40.11-1.23)	Depositor EDS
R_{merge}	0.04	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.17 (at 1.22Å)	Xtriage
Refinement program	REFMAC 5.8.0258	Depositor
R, R_{free}	0.117 , 0.152 0.128 , 0.162	Depositor DCC
R_{free} test set	3029 reflections (4.22%)	wwPDB-VP
Wilson B-factor (Å ²)	10.7	Xtriage
Anisotropy	0.705	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 44.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.021 for h,-k,-h-l	Xtriage
F_o, F_c correlation	0.98	EDS
Total number of atoms	2429	wwPDB-VP
Average B, all atoms (Å ²)	19.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.86% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: GOL, DMS, ZN, UIE

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	AAA	1.36	21/2231 (0.9%)	1.21	13/3021 (0.4%)

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	AAA	0	1

All (21) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	AAA	52	ASP	CG-OD2	19.67	1.62	1.25
1	AAA	36	HIS	CE1-NE2	11.82	1.44	1.32
1	AAA	46	PRO	C-O	-11.28	1.10	1.23
1	AAA	36	HIS	CG-ND1	10.63	1.50	1.38
1	AAA	42	PRO	C-N	9.81	1.47	1.33
1	AAA	45	LYS	C-N	9.51	1.46	1.33
1	AAA	46	PRO	C-N	9.35	1.46	1.33
1	AAA	14	GLU	CD-OE2	8.28	1.41	1.25
1	AAA	45	LYS	C-O	8.11	1.34	1.24
1	AAA	42	PRO	CA-C	7.78	1.64	1.52
1	AAA	47	LEU	CA-C	7.21	1.62	1.52
1	AAA	76	LYS	C-O	-6.99	1.18	1.23
1	AAA	3	HIS	CE1-NE2	6.95	1.39	1.32
1	AAA	253	ASN	C-O	6.51	1.34	1.23
1	AAA	45	LYS	N-CA	5.87	1.54	1.46
1	AAA	4	HIS	CE1-NE2	5.64	1.38	1.32
1	AAA	162	ASP	CG-OD2	-5.48	1.15	1.25
1	AAA	46	PRO	CA-C	5.42	1.59	1.52

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	AAA	119	HIS	CE1-NE2	5.24	1.37	1.32
1	AAA	3	HIS	CG-ND1	5.08	1.43	1.38
1	AAA	46	PRO	N-CD	5.03	1.54	1.47

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	AAA	46	PRO	CB-CA-C	10.54	125.05	111.46
1	AAA	46	PRO	CA-C-O	-7.66	112.61	121.34
1	AAA	52	ASP	CB-CG-OD2	-6.76	102.86	118.40
1	AAA	14	GLU	CB-CG-CD	6.03	122.84	112.60
1	AAA	74	GLN	CA-C-O	-5.91	115.12	121.45
1	AAA	42	PRO	CA-C-O	-5.83	109.99	119.84
1	AAA	36	HIS	CA-CB-CG	-5.82	107.98	113.80
1	AAA	47	LEU	N-CA-C	5.71	118.52	109.96
1	AAA	52	ASP	CB-CG-OD1	5.65	131.39	118.40
1	AAA	44	LEU	N-CA-CB	-5.43	101.31	110.49
1	AAA	230	ASN	CA-CB-CG	5.20	117.80	112.60
1	AAA	96	HIS	CE1-NE2-CD2	-5.11	103.89	109.00
1	AAA	42	PRO	N-CD-CG	-5.04	95.64	103.20

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	AAA	42	PRO	Mainchain

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	AAA	2127	0	2115	12	0
2	AAA	6	0	8	2	0
3	AAA	4	0	6	1	0
4	AAA	1	0	0	0	0
5	AAA	33	0	0	0	0
6	AAA	258	0	0	9	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	2429	0	2129	14	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 (14) 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:AAA:213[A]:LYS:HE3	6:AAA:501:HOH:O	1.35	1.23
1:AAA:89[A]:ARG:HG3	6:AAA:572:HOH:O	1.67	0.92
2:AAA:301:GOL:H31	6:AAA:419:HOH:O	1.88	0.73
1:AAA:89[A]:ARG:CG	6:AAA:572:HOH:O	2.32	0.69
1:AAA:40:TYR:CZ	1:AAA:42:PRO:HA	2.30	0.65
1:AAA:175[B]:ASP:OD1	6:AAA:401:HOH:O	2.15	0.63
1:AAA:245:TRP:O	3:AAA:302:DMS:H12	2.02	0.59
1:AAA:127:LYS:HE3	1:AAA:128:TYR:CZ	2.48	0.48
1:AAA:134:ALA:O	1:AAA:140:GLY:HA3	2.14	0.47
1:AAA:137:GLN:NE2	6:AAA:402:HOH:O	2.22	0.45
1:AAA:39:LYS:NZ	6:AAA:410:HOH:O	2.49	0.44
1:AAA:136:GLN:HG2	6:AAA:625:HOH:O	2.17	0.44
1:AAA:89[B]:ARG:HG3	1:AAA:125:THR:CG2	2.47	0.44
2:AAA:301:GOL:C3	6:AAA:419:HOH:O	2.58	0.41

There are no symmetry-related clashes.

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	AAA	270/260 (104%)	262 (97%)	7 (3%)	1 (0%)	30 10

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	AAA	45	LYS

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	AAA	235/225 (104%)	230 (98%)	5 (2%)	47 11

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	AAA	4	HIS
1	AAA	45	LYS
1	AAA	80	LYS
1	AAA	92	GLN
1	AAA	159	LYS

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 oligosaccharides in this entry.

5.6 Ligand geometry

Of 4 ligands modelled in this entry, 1 is monoatomic - leaving 3 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	GOL	AAA	301	-	5,5,5	0.20	0	5,5,5	0.52	0
3	DMS	AAA	302	-	3,3,3	1.74	1 (33%)	3,3,3	2.41	1 (33%)
5	UIE	AAA	304	4	35,35,35	1.52	2 (5%)	50,50,50	1.45	10 (20%)

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	AAA	301	-	-	2/4/4/4	-
5	UIE	AAA	304	4	-	11/31/31/31	0/3/3/3

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	AAA	304	UIE	S10-N9	7.26	1.73	1.63
5	AAA	304	UIE	C5-N4	-2.82	1.30	1.38
3	AAA	302	DMS	O-S	2.48	1.66	1.50

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	AAA	304	UIE	C7-C8-N9	4.66	121.23	112.14
3	AAA	302	DMS	O-S-C1	4.04	126.69	106.49
5	AAA	304	UIE	C8-N9-S10	3.35	125.38	117.47
5	AAA	304	UIE	O25-S24-N26	2.55	111.03	107.35
5	AAA	304	UIE	C20-C19-N9	2.47	116.94	112.14
5	AAA	304	UIE	O25-S24-C23	-2.34	104.70	107.35
5	AAA	304	UIE	C32-C5-N4	-2.34	115.67	120.96

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	AAA	304	UIE	C2-C3-N4	2.31	115.01	110.77
5	AAA	304	UIE	C19-N9-C8	-2.14	111.88	116.27
5	AAA	304	UIE	C19-N9-S10	2.13	122.49	117.47
5	AAA	304	UIE	C3-N4-C5	2.01	126.30	122.42

There are no chirality outliers.

All (13) torsion outliers are listed below:

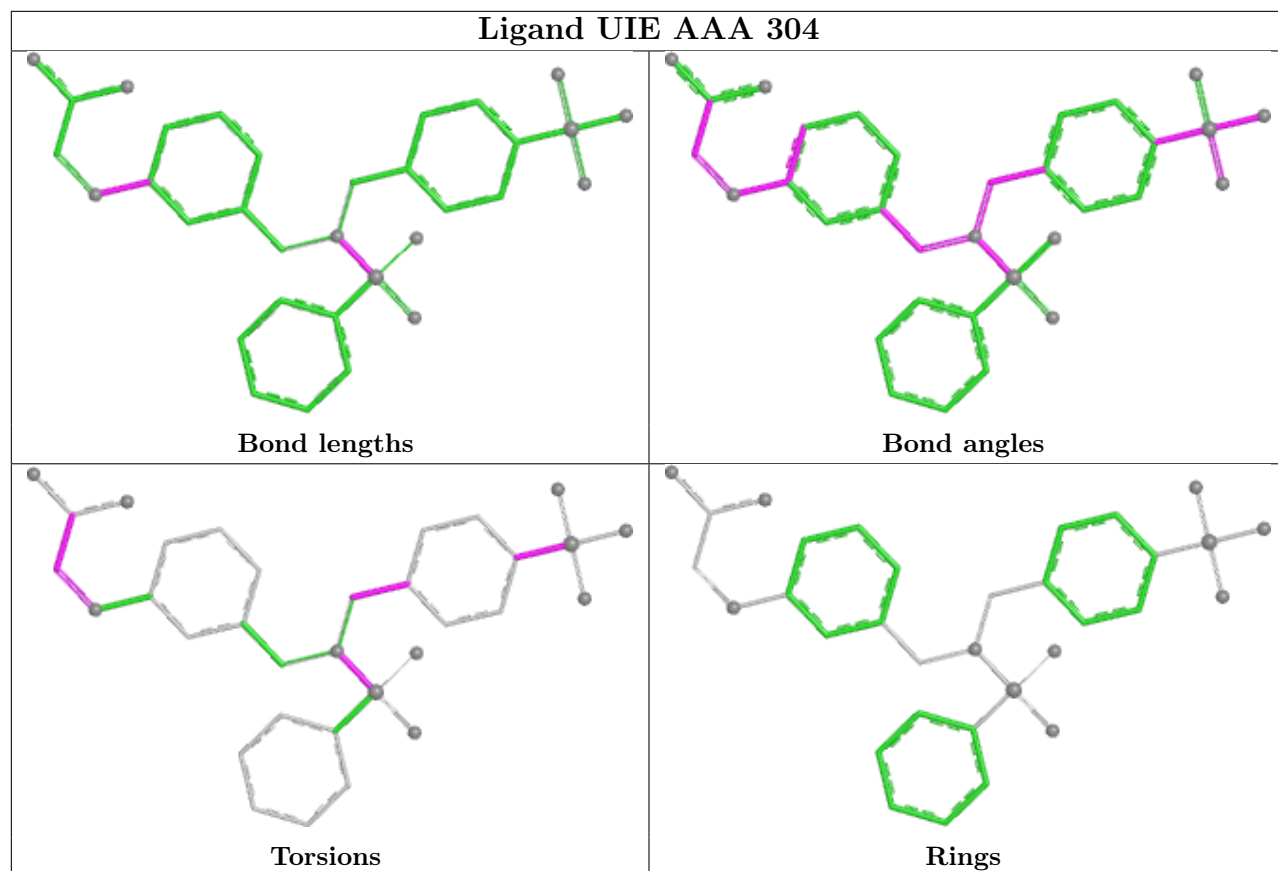
Mol	Chain	Res	Type	Atoms
5	AAA	304	UIE	C2-C3-N4-C5
2	AAA	301	GOL	C1-C2-C3-O3
5	AAA	304	UIE	C22-C23-S24-O27
5	AAA	304	UIE	C28-C23-S24-O27
5	AAA	304	UIE	C22-C23-S24-N26
5	AAA	304	UIE	N9-C19-C20-C21
5	AAA	304	UIE	C8-N9-S10-O17
5	AAA	304	UIE	N9-C19-C20-C29
5	AAA	304	UIE	C28-C23-S24-N26
5	AAA	304	UIE	C8-N9-S10-O18
5	AAA	304	UIE	O33-C2-C3-N4
2	AAA	301	GOL	O2-C2-C3-O3
5	AAA	304	UIE	O1-C2-C3-N4

There are no ring outliers.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	AAA	301	GOL	2	0
3	AAA	302	DMS	1	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.



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	AAA	258/260 (99%)	-0.20	13 (5%) 34 36	7, 13, 39, 135	15 (5%)

All (13) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	AAA	46	PRO	10.4
1	AAA	40	TYR	6.1
1	AAA	3	HIS	5.1
1	AAA	42	PRO	4.2
1	AAA	45	LYS	3.8
1	AAA	4	HIS	3.6
1	AAA	253	ASN	3.1
1	AAA	47	LEU	2.9
1	AAA	44	LEU	2.8
1	AAA	237	PRO	2.8
1	AAA	235	GLY	2.5
1	AAA	52	ASP	2.4
1	AAA	36	HIS	2.1

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](#)

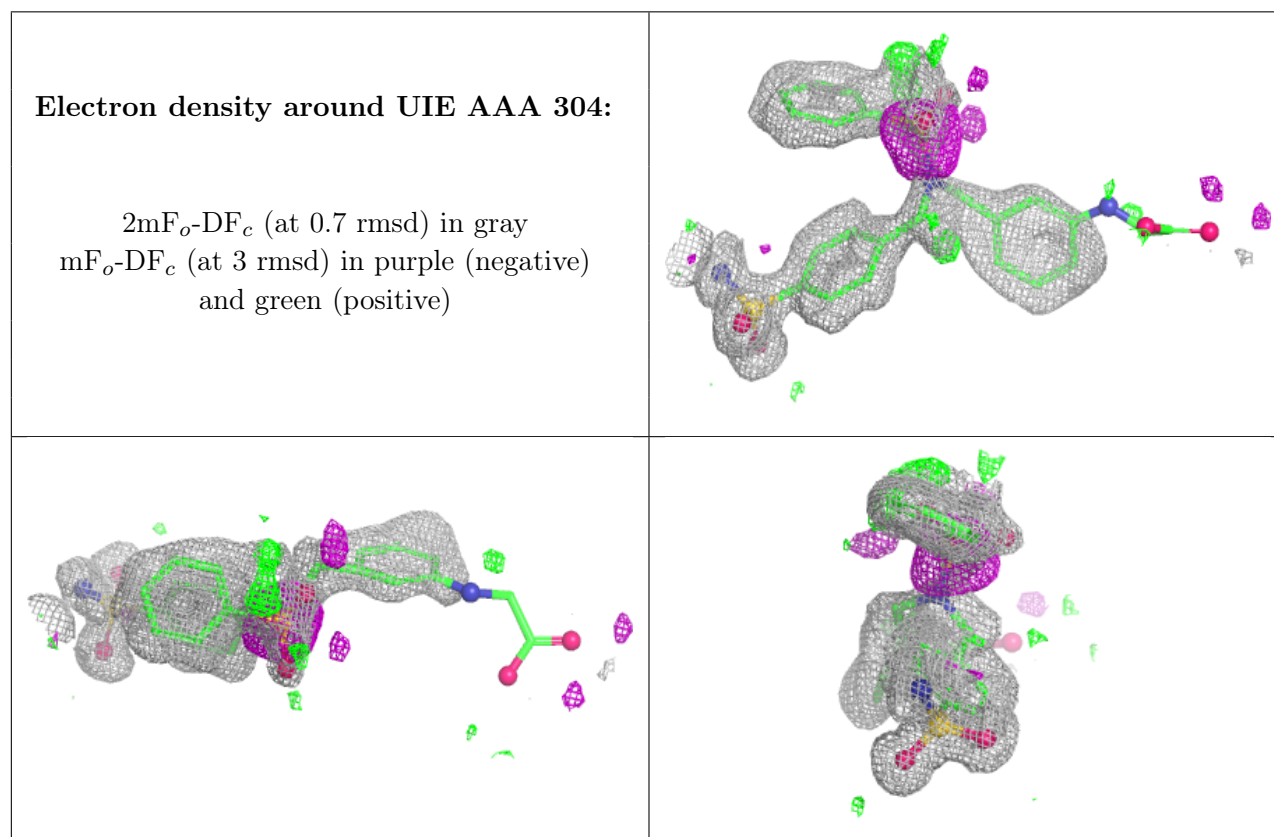
There are no oligosaccharides in this entry.

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($\text{\AA}^2$)	Q<0.9
2	GOL	AAA	301	6/6	0.75	0.15	43,49,57,61	0
3	DMS	AAA	302	4/4	0.88	0.15	19,20,45,54	0
5	UIE	AAA	304	33/33	0.97	0.10	7,31,100,132	5
4	ZN	AAA	303	1/1	1.00	0.01	7,7,7,7	0

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.



6.5 Other polymers [i](#)

There are no such residues in this entry.