WORLDWIDE wwPDB PROTEIN DATA BANK

wwPDB X-ray Structure Validation Summary Report (i)

Jan 19, 2026 – 12:25 pm GMT

PDB ID	:	9THO / pdb_00009tho
Title	:	Crystal structure of the adduct formed upon reaction of [V(IV)O(acetylaceto nate)2] with human serum transferrin with Fe(III) bound at the C-lobe only
Authors	:	Paolillo, M.; Ferraro, G.; Banneville, A.S.; Cornaciu, I.; Pica, A.; Merlino, A.
Deposited on	:	2025-12-03
Resolution	:	2.55 Å(reported)

The following versions of software and data (see references (i)) were used in the production of this report:

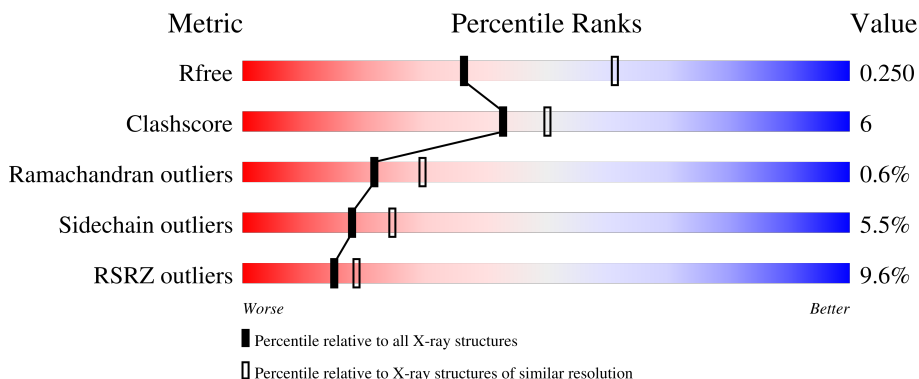|		
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.47

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 2.55 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	Percentile Ranks	Value
Rfree		0.250
Clashscore		6
Ramachandran outliers		0.6%
Sidechain outliers		5.5%
RSRZ outliers		9.6%

Worse ⟶ Better

■ Percentile relative to all X-ray structures
▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	1004 (2.54-2.54)
Clashscore	180529	1055 (2.54-2.54)
Ramachandran outliers	177936	1048 (2.54-2.54)
Sidechain outliers	177891	1048 (2.54-2.54)
RSRZ outliers	164620	1004 (2.54-2.54)

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.

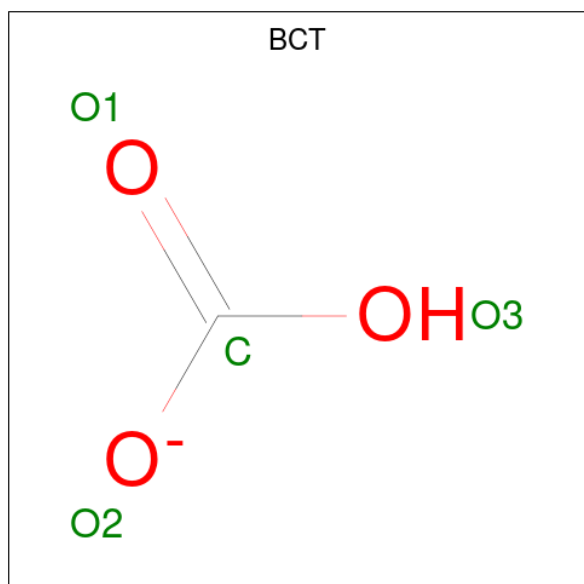| Mol	Chain	Length	Quality of chain
1	AAA	679	9% — 83% — 14% ··

2 Entry composition ⓘ

There are 7 unique types of molecules in this entry. The entry contains 5529 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 Serotransferrin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	AAA	670	Total 5270	C 3306	N 916	O 1001	S 47	0	8	0

- Molecule 2 is BICARBONATE ION (CCD ID: BCT) (formula: CHO_3).

BCT

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

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

- Molecule 3 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).
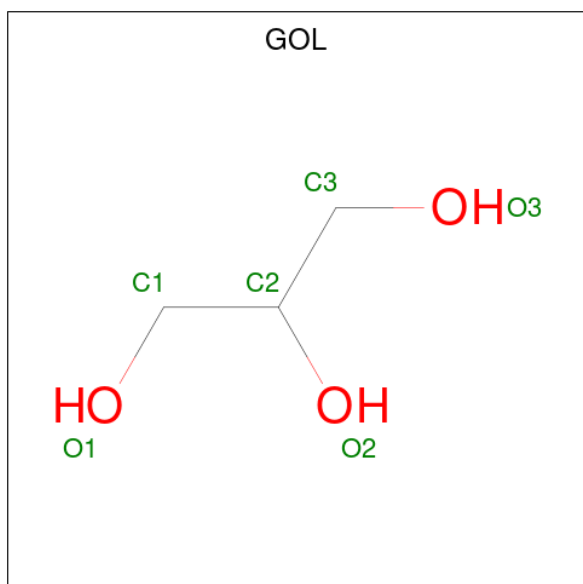
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	AAA	1	Total	C	O		0	0
			6	3	3			
3	AAA	1	Total	C	O		0	0
			6	3	3			

- Molecule 4 is FE (III) ION (CCD ID: FE) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	AAA	1	Total	Fe	0	0
			1	1		

- Molecule 5 is MALONIC ACID (CCD ID: MLA) (formula: $C_3H_4O_4$).
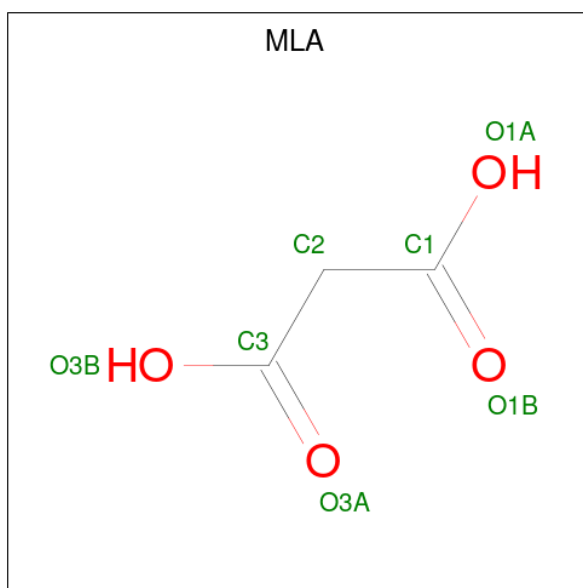
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	AAA	1	Total 7	C 3	O 4	0	0

- Molecule 6 is bis(oxidanyl)-oxidanylidene-(oxidanyl(oxidanylidene)vanadio)oxy-vanadium (CCD ID: A1JJT) (formula: $H_3O_6V_2$) (labeled as "Ligand of Interest" by depositor).
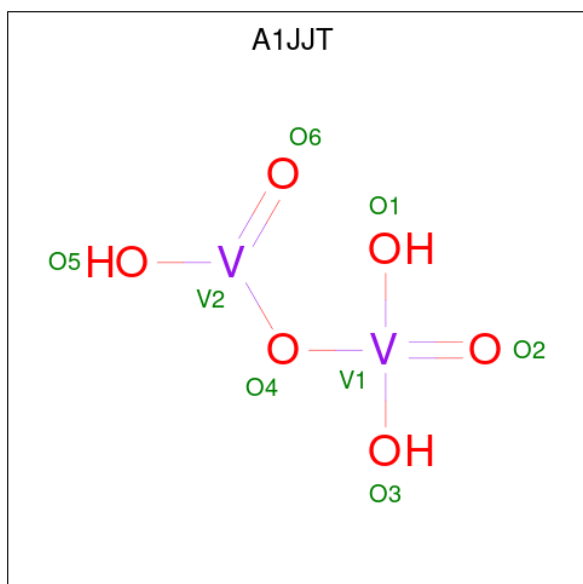
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	AAA	1	Total 8	O 6	V 2	0	0

• Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	AAA	187	Total 187	O 187	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: Serotransferrin
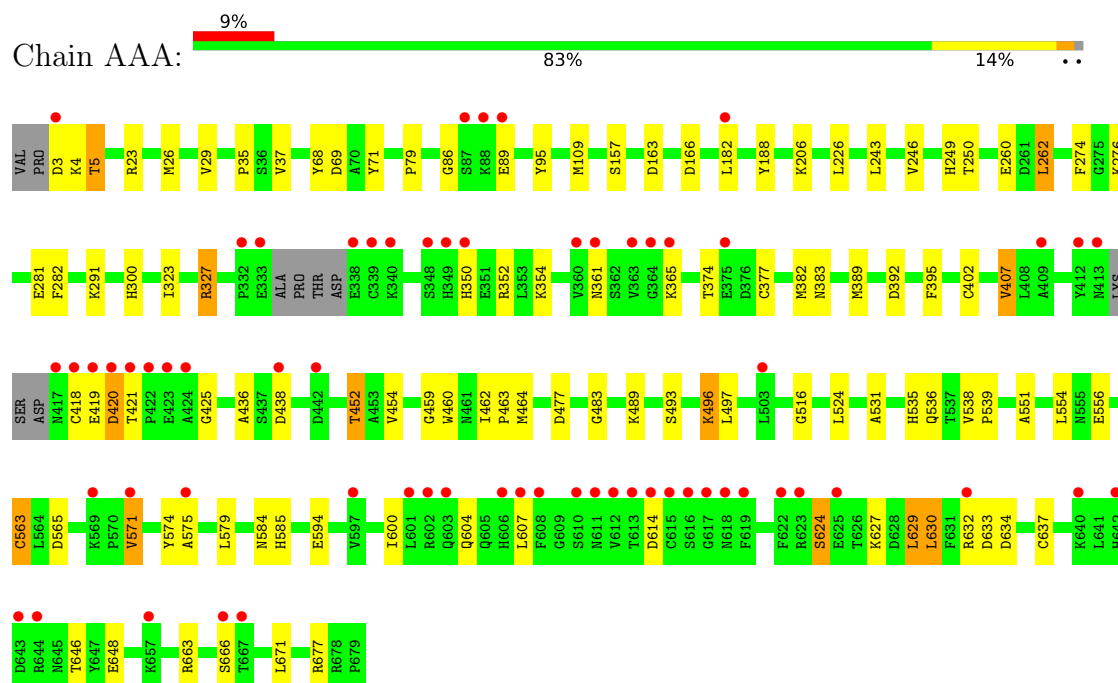
4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	136.13Å 157.69Å 107.22Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	78.85 – 2.55 78.85 – 2.55	Depositor EDS
% Data completeness (in resolution range)	96.2 (78.85-2.55) 96.2 (78.85-2.55)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.20 (at 2.55Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.198 , 0.249 0.203 , 0.250	Depositor DCC
R_{free} test set	1828 reflections (4.82%)	wwPDB-VP
Wilson B-factor (Å^2)	25.4	Xtriage
Anisotropy	0.068	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 37.4	EDS
L-test for twinning [2]	$< |L| > = 0.51, < L^2 > = 0.35$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.92	EDS
Total number of atoms	5529	wwPDB-VP
Average B, all atoms (Å^2)	33.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.07% of the height of the origin peak. No significant pseudotranslation is detected.*

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[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 ⓘ

5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: A1JJT, GOL, MLA, BCT, FE

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	1.08	0/5387	1.44	3/7276 (0.0%)

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

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	AAA	646	THR	CA-CB-OG1	-5.36	101.57	109.60
1	AAA	452	THR	CA-C-N	5.00	131.10	121.54
1	AAA	452	THR	C-N-CA	5.00	131.10	121.54

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	AAA	157	SER	Peptide

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	5270	0	5078	64	0
2	AAA	44	0	0	1	0
3	AAA	12	0	16	0	0
4	AAA	1	0	0	0	0
5	AAA	7	0	2	0	0
6	AAA	8	0	0	0	0
7	AAA	187	0	0	5	0
All	All	5529	0	5096	64	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 6.

The worst 5 of 64 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:425:GLY:HA2	1:AAA:584:ASN:OD1	1.64	0.97
1:AAA:663:ARG:HD3	1:AAA:671:LEU:HD21	1.75	0.69
1:AAA:374:THR:HG21	1:AAA:395:PHE:CD2	2.31	0.64
1:AAA:163:ASP:OD2	1:AAA:166:ASP:OD2	2.17	0.63
1:AAA:538:VAL:HB	1:AAA:539:PRO:HD3	1.79	0.63

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	672/679 (99%)	620 (92%)	48 (7%)	4 (1%)	22	29

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	AAA	419	GLU
1	AAA	436	ALA
1	AAA	614	ASP
1	AAA	634	ASP

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	AAA	572/572 (100%)	540 (94%)	32 (6%)	17	24

5 of 32 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	AAA	632	ARG
1	AAA	637	CYS
1	AAA	407	VAL
1	AAA	365	LYS
1	AAA	648	GLU

Sometimes 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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 16 ligands modelled in this entry, 1 is monoatomic - leaving 15 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	BCT	AAA	710	-	2,3,3	0.79	0	2,3,3	1.37	0
2	BCT	AAA	709	-	2,3,3	0.50	0	2,3,3	1.54	0
5	MLA	AAA	715	4	6,6,6	0.48	0	7,7,7	1.81	2 (28%)
3	GOL	AAA	713	-	5,5,5	0.20	0	5,5,5	0.46	0
2	BCT	AAA	707	-	2,3,3	1.05	0	2,3,3	1.80	1 (50%)
2	BCT	AAA	703	-	2,3,3	0.80	0	2,3,3	1.38	0
2	BCT	AAA	704	-	2,3,3	0.81	0	2,3,3	1.60	1 (50%)
2	BCT	AAA	712	-	2,3,3	0.88	0	2,3,3	1.25	0
6	A1JJT	AAA	716	1	0,7,7	-	-	-		
3	GOL	AAA	708	-	5,5,5	0.34	0	5,5,5	0.67	0
2	BCT	AAA	701	-	2,3,3	0.95	0	2,3,3	1.44	0
2	BCT	AAA	706	-	2,3,3	0.48	0	2,3,3	1.70	1 (50%)
2	BCT	AAA	711	-	2,3,3	0.82	0	2,3,3	1.89	1 (50%)
2	BCT	AAA	705	-	2,3,3	0.79	0	2,3,3	1.79	1 (50%)
2	BCT	AAA	702	-	2,3,3	1.08	0	2,3,3	1.25	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
5	MLA	AAA	715	4	-	0/4/4/4	-
3	GOL	AAA	713	-	-	0/4/4/4	-
3	GOL	AAA	708	-	-	2/4/4/4	-

There are no bond length outliers.

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	AAA	715	MLA	O3A-C3-C2	-2.54	114.65	122.08
2	AAA	711	BCT	O2-C-O1	2.47	125.95	119.55
5	AAA	715	MLA	O1B-C1-C2	-2.40	115.07	122.08
2	AAA	705	BCT	O2-C-O1	2.34	125.62	119.55
2	AAA	707	BCT	O2-C-O1	2.24	125.36	119.55

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	AAA	708	GOL	C1-C2-C3-O3
3	AAA	708	GOL	O2-C2-C3-O3

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	AAA	712	BCT	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 then 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.

Ligand A1JJT AAA 716

Bond lengths · Bond angles · Torsions · Rings
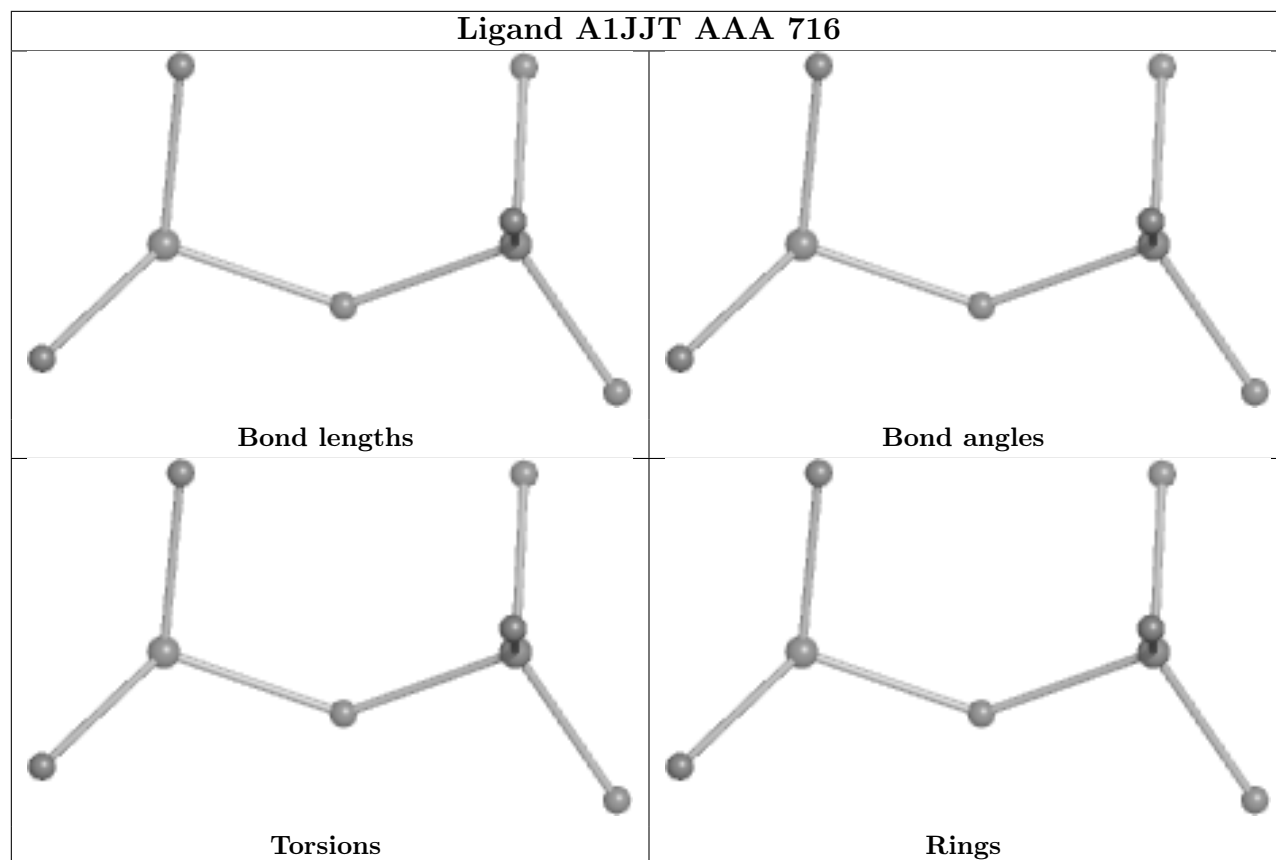
5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

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	AAA	670/679 (98%)	0.30	64 (9%)	15	19	5, 27, 73, 120	8 (1%)

The worst 5 of 64 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	AAA	424	ALA	9.9
1	AAA	422	PRO	7.9
1	AAA	606[A]	HIS	5.9
1	AAA	613	THR	4.9
1	AAA	417	ASN	4.7

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

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

6.3 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands ⓘ

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
2	BCT	AAA	711	4/4	0.72	0.26	59,65,70,80	0
2	BCT	AAA	709	4/4	0.79	0.18	36,40,46,49	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	GOL	AAA	708	6/6	0.79	0.21	40,48,53,54	0
2	BCT	AAA	706	4/4	0.80	0.19	41,46,47,54	0
2	BCT	AAA	705	4/4	0.81	0.25	65,68,69,72	0
2	BCT	AAA	710	4/4	0.82	0.23	52,53,59,64	0
2	BCT	AAA	712	4/4	0.86	0.18	47,56,59,60	0
2	BCT	AAA	703	4/4	0.87	0.15	45,48,54,56	0
2	BCT	AAA	704	4/4	0.93	0.10	30,30,30,37	0
5	MLA	AAA	715	7/7	0.93	0.10	17,18,20,23	0
3	GOL	AAA	713	6/6	0.94	0.09	20,21,22,23	0
2	BCT	AAA	702	4/4	0.94	0.09	32,37,39,41	0
2	BCT	AAA	707	4/4	0.95	0.08	32,32,33,38	0
6	A1JJT	AAA	716	8/8	0.97	0.12	20,29,39,45	8
2	BCT	AAA	701	4/4	0.98	0.05	22,24,25,25	0
4	FE	AAA	714	1/1	0.99	0.02	26,26,26,26	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.

Electron density around A1JJT AAA 716:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)
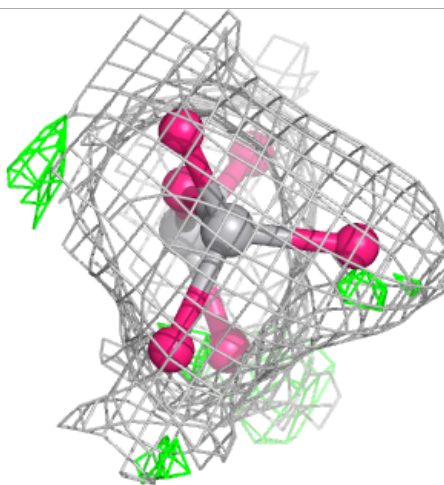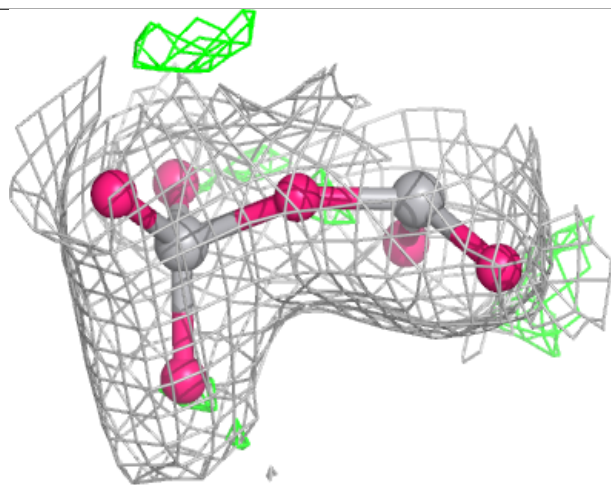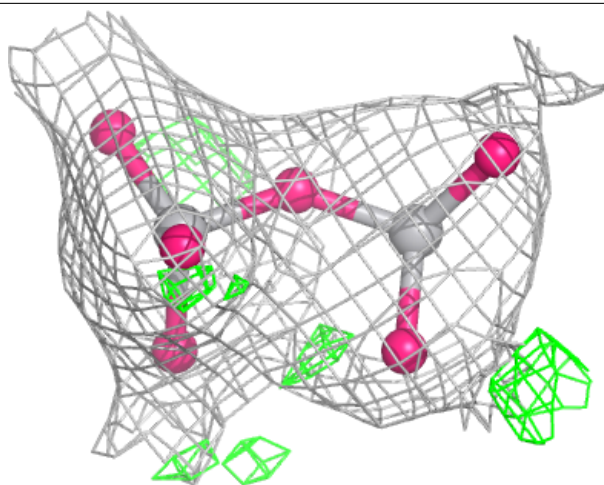
6.5 Other polymers (i)

There are no such residues in this entry.