



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 03:21 PM UTC

PDB ID : 1SUD / pdb_00001sud
Title : CALCIUM-INDEPENDENT SUBTILISIN BY DESIGN
Authors : Gallagher, T.; Bryan, P.; Gilliland, G.L.
Deposited on : 1992-06-10
Resolution : 1.90 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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

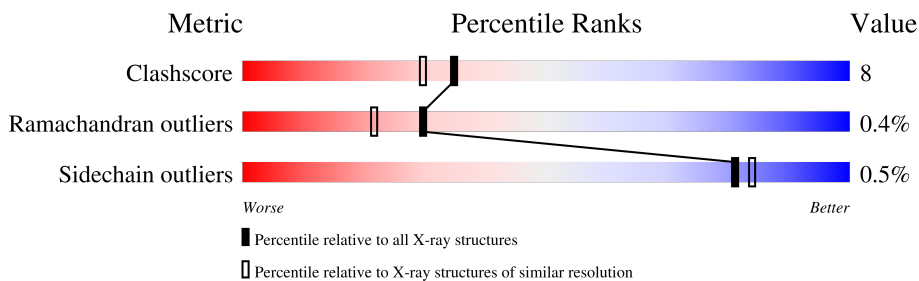
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.90 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))
Clashscore	190562	8410 (1.90-1.90)
Ramachandran outliers	187476	8333 (1.90-1.90)
Sidechain outliers	187428	8333 (1.90-1.90)

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 $\leq 5\%$

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	275	

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 2121 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 SUBTILISIN BPN' CRB-S3.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	275	Total	C	N	O	S	0	0	0
			1938	1204	335	394	5			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	50	PHE	MET	engineered mutation	UNP P00782
A	217	LYS	TYR	engineered mutation	UNP P00782
A	218	SER	ASN	engineered mutation	UNP P00782
A	221	CSD	SER	engineered mutation	UNP P00782

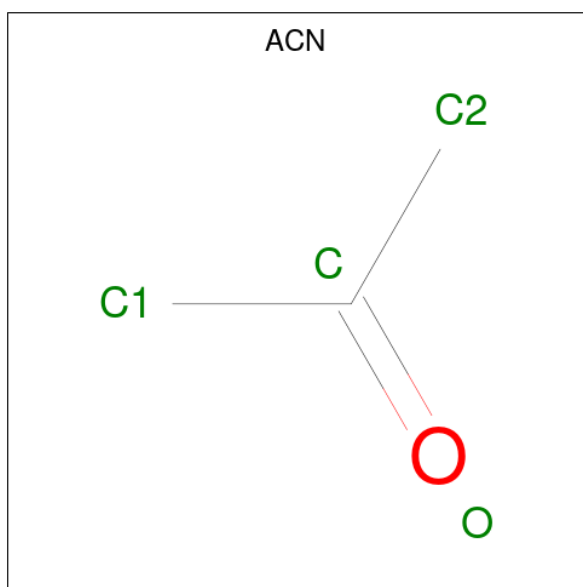
- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

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

- Molecule 3 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	K	0	0
			1	1		

- Molecule 4 is ACETONE (CCD ID: ACN) (formula: C₃H₆O).



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

- Molecule 5 is water.

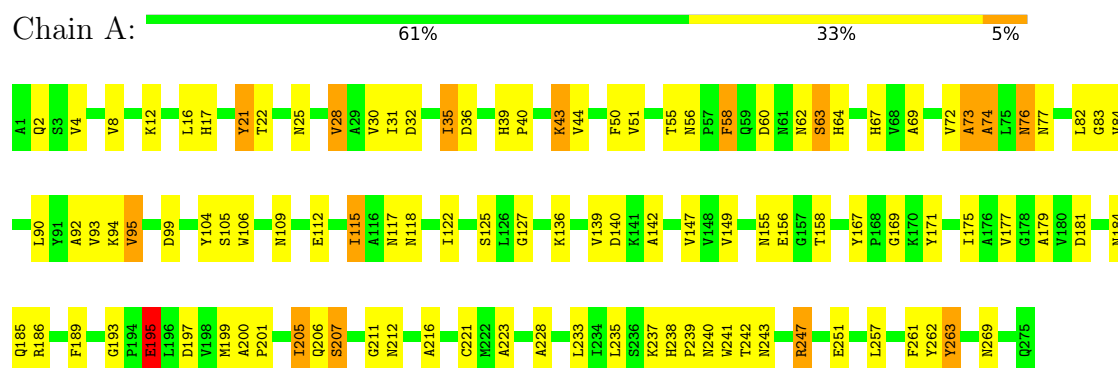
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	176	Total	O	0	0
			176	176		

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. 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. 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.

Note EDS was not executed.

- Molecule 1: SUBTILISIN BPN' CRB-S3



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	41.68Å 79.35Å 37.07Å 90.00° 114.62° 90.00°	Depositor
Resolution (Å)	8.00 – 1.90	Depositor
% Data completeness (in resolution range)	(Not available) (8.00-1.90)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	PROFFT	Depositor
R, R_{free}	0.179 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2121	wwPDB-VP
Average B, all atoms (Å ²)	10.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: K, ACN, CSD, 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	1.30	2/1968 (0.1%)	2.49	111/2685 (4.1%)

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	A	0	2

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	200	ALA	C-O	5.77	1.30	1.24
1	A	181	ASP	N-CA	5.04	1.51	1.45

All (111) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	25	ASN	CA-CB-CG	11.50	124.10	112.60
1	A	239	PRO	CA-C-N	11.43	137.68	120.31
1	A	239	PRO	C-N-CA	11.43	137.68	120.31
1	A	118	ASN	CA-CB-CG	11.20	123.80	112.60
1	A	50	PHE	CA-C-N	10.58	129.79	122.60
1	A	50	PHE	C-N-CA	10.58	129.79	122.60
1	A	109	ASN	CA-CB-CG	9.92	122.52	112.60
1	A	58	PHE	CA-CB-CG	9.56	123.36	113.80
1	A	17	HIS	CA-CB-CG	9.55	123.35	113.80
1	A	243	ASN	CA-CB-CG	9.13	121.73	112.60
1	A	99	ASP	CA-CB-CG	8.74	121.34	112.60

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	184	ASN	CA-CB-CG	8.66	121.26	112.60
1	A	206	GLN	CB-CG-CD	8.60	127.22	112.60
1	A	181	ASP	CA-CB-CG	8.40	121.00	112.60
1	A	261	PHE	CA-CB-CG	7.72	121.52	113.80
1	A	56	ASN	CA-CB-CG	7.71	120.31	112.60
1	A	269	ASN	CA-CB-CG	7.67	120.27	112.60
1	A	76	ASN	CA-CB-CG	7.57	120.17	112.60
1	A	36	ASP	CA-CB-CG	7.50	120.10	112.60
1	A	195	GLU	CB-CG-CD	7.48	125.31	112.60
1	A	106	TRP	CA-CB-CG	7.24	127.36	113.60
1	A	257	LEU	CB-CA-C	7.10	124.55	110.42
1	A	95	VAL	CB-CA-C	7.05	117.56	110.65
1	A	12	LYS	CA-C-N	7.02	129.84	120.58
1	A	12	LYS	C-N-CA	7.02	129.84	120.58
1	A	185	GLN	CB-CG-CD	6.92	124.36	112.60
1	A	60	ASP	CA-CB-CG	6.86	119.45	112.60
1	A	63	SER	N-CA-CB	6.85	122.06	110.49
1	A	169	GLY	CA-C-N	6.71	129.95	120.28
1	A	169	GLY	C-N-CA	6.71	129.95	120.28
1	A	28	VAL	CA-CB-CG2	6.70	121.79	110.40
1	A	251	GLU	CB-CG-CD	6.70	123.99	112.60
1	A	140	ASP	CA-CB-CG	6.68	119.28	112.60
1	A	93	VAL	CA-CB-CG2	6.68	121.75	110.40
1	A	247	ARG	CD-NE-CZ	6.60	133.64	124.40
1	A	77	ASN	CA-CB-CG	6.57	119.17	112.60
1	A	155	ASN	CA-CB-CG	6.55	119.15	112.60
1	A	197	ASP	CA-CB-CG	6.53	119.13	112.60
1	A	94	LYS	CA-C-O	6.52	127.97	120.60
1	A	238	HIS	CA-CB-CG	6.49	120.29	113.80
1	A	51	VAL	CB-CA-C	6.47	118.45	110.95
1	A	4	VAL	CB-CA-C	6.43	118.63	111.04
1	A	30	VAL	CB-CA-C	6.41	120.60	111.81
1	A	200	ALA	O-C-N	-6.38	116.99	121.65
1	A	64	HIS	CA-CB-CG	6.37	120.17	113.80
1	A	56	ASN	CB-CA-C	6.32	117.05	109.85
1	A	22	THR	CA-C-N	6.32	132.38	121.07
1	A	22	THR	C-N-CA	6.32	132.38	121.07
1	A	51	VAL	CA-C-O	6.26	122.63	119.12
1	A	247	ARG	NE-CZ-NH1	6.21	127.71	121.50
1	A	223	ALA	CA-C-N	6.19	130.13	120.97
1	A	223	ALA	C-N-CA	6.19	130.13	120.97
1	A	109	ASN	CA-C-N	6.19	126.81	120.00

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	109	ASN	C-N-CA	6.19	126.81	120.00
1	A	125	SER	CA-C-O	6.14	129.29	120.51
1	A	195	GLU	CA-CB-CG	6.13	126.35	114.10
1	A	241	TRP	CA-CB-CG	6.13	125.24	113.60
1	A	212	ASN	CA-CB-CG	6.03	118.63	112.60
1	A	205	ILE	CB-CA-C	5.96	118.05	111.08
1	A	112	GLU	CB-CG-CD	5.91	122.65	112.60
1	A	50	PHE	CA-CB-CG	5.90	119.70	113.80
1	A	205	ILE	CA-CB-CG1	5.84	120.33	110.40
1	A	104	TYR	CA-C-N	5.83	128.09	120.28
1	A	104	TYR	C-N-CA	5.83	128.09	120.28
1	A	73	ALA	N-CA-C	5.75	119.49	111.56
1	A	73	ALA	N-CA-CB	-5.73	103.23	111.54
1	A	243	ASN	CA-C-N	5.68	127.83	120.44
1	A	243	ASN	C-N-CA	5.68	127.83	120.44
1	A	228	ALA	CA-C-N	5.63	126.23	119.98
1	A	228	ALA	C-N-CA	5.63	126.23	119.98
1	A	16	LEU	CA-C-N	5.62	127.81	120.28
1	A	16	LEU	C-N-CA	5.62	127.81	120.28
1	A	62	ASN	CA-C-N	5.60	132.24	121.54
1	A	62	ASN	C-N-CA	5.60	132.24	121.54
1	A	193	GLY	CA-C-N	5.58	125.42	119.28
1	A	193	GLY	C-N-CA	5.58	125.42	119.28
1	A	186	ARG	CD-NE-CZ	5.54	132.15	124.40
1	A	60	ASP	CB-CA-C	5.50	119.57	110.78
1	A	263	TYR	CA-C-N	5.48	128.89	120.07
1	A	263	TYR	C-N-CA	5.48	128.89	120.07
1	A	105	SER	CA-C-N	5.44	127.83	120.44
1	A	105	SER	C-N-CA	5.44	127.83	120.44
1	A	235	LEU	N-CA-C	5.44	117.96	111.71
1	A	189	PHE	CA-CB-CG	5.42	119.22	113.80
1	A	207	SER	CA-C-N	5.42	128.56	120.87
1	A	207	SER	C-N-CA	5.42	128.56	120.87
1	A	74	ALA	N-CA-CB	5.40	118.05	109.51
1	A	21	TYR	CA-CB-CG	5.39	123.60	113.90
1	A	139	VAL	N-CA-CB	5.38	118.65	110.58
1	A	32	ASP	N-CA-C	5.38	115.65	108.23
1	A	240	ASN	CA-CB-CG	5.30	117.90	112.60
1	A	55	THR	N-CA-C	5.30	119.37	113.01
1	A	179	ALA	CA-C-N	5.29	130.62	122.68
1	A	179	ALA	C-N-CA	5.29	130.62	122.68
1	A	205	ILE	CA-CB-CG2	5.28	119.48	110.50

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	117	ASN	CA-C-O	5.26	125.79	119.43
1	A	8	VAL	CB-CA-C	5.22	118.34	111.81
1	A	115	ILE	N-CA-CB	5.22	117.25	110.57
1	A	242	THR	CA-CB-CG2	5.21	119.36	110.50
1	A	95	VAL	CA-CB-CG1	5.20	119.24	110.40
1	A	177	VAL	CA-C-O	5.18	125.83	120.39
1	A	83	GLY	CA-C-N	5.17	127.08	120.56
1	A	83	GLY	C-N-CA	5.17	127.08	120.56
1	A	251	GLU	CA-CB-CG	5.12	124.34	114.10
1	A	156	GLU	CB-CG-CD	5.12	121.30	112.60
1	A	58	PHE	CA-C-O	5.11	125.86	119.78
1	A	43	LYS	N-CA-CB	5.09	118.69	110.65
1	A	149	VAL	CB-CA-C	5.02	118.29	110.96
1	A	211	GLY	CA-C-N	5.02	129.25	122.07
1	A	211	GLY	C-N-CA	5.02	129.25	122.07
1	A	44	VAL	CB-CA-C	5.02	117.85	110.98

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	35	ILE	Mainchain
1	A	74	ALA	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	A	1938	0	1902	29	0
2	A	2	0	0	0	0
3	A	1	0	0	0	0
4	A	4	0	6	0	0
5	A	176	0	0	2	0
All	All	2121	0	1908	29	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 8.

All (29) 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:31:ILE:HD12	1:A:122:ILE:HG23	1.41	1.01
1:A:2:GLN:HE22	1:A:76:ASN:HD22	1.18	0.90
1:A:122:ILE:HD12	1:A:147:VAL:HG11	1.63	0.80
1:A:35:ILE:HD12	1:A:92:ALA:HB2	1.64	0.79
1:A:43:LYS:HD2	5:A:473:HOH:O	1.91	0.69
1:A:31:ILE:HD12	1:A:122:ILE:CG2	2.22	0.66
1:A:175:ILE:HD11	1:A:247:ARG:HG3	1.79	0.63
1:A:73:ALA:HB3	1:A:90:LEU:HD13	1.80	0.62
1:A:2:GLN:HE22	1:A:76:ASN:ND2	1.95	0.58
1:A:195:GLU:HB3	5:A:368:HOH:O	2.09	0.53
1:A:21:TYR:CZ	1:A:237:LYS:HG3	2.45	0.52
1:A:76:ASN:HB2	1:A:82:LEU:CD1	2.39	0.52
1:A:28:VAL:HG11	1:A:72:VAL:HG11	1.95	0.48
1:A:67:HIS:CD2	1:A:207:SER:HB3	2.50	0.47
1:A:201:PRO:C	1:A:205:ILE:HD11	2.40	0.47
1:A:205:ILE:O	1:A:216:ALA:HA	2.14	0.46
1:A:136:LYS:HG3	1:A:171:TYR:CD1	2.49	0.46
1:A:175:ILE:CD1	1:A:247:ARG:HG3	2.44	0.46
1:A:69:ALA:HB1	1:A:90:LEU:HD21	1.99	0.45
1:A:127:GLY:HA2	1:A:167:TYR:O	2.17	0.44
1:A:158:THR:HG22	1:A:262:TYR:HE2	1.83	0.43
1:A:31:ILE:HG22	1:A:95:VAL:HG21	2.01	0.43
1:A:122:ILE:HD12	1:A:147:VAL:CG1	2.44	0.42
1:A:35:ILE:O	1:A:58:PHE:HA	2.19	0.41
1:A:84:VAL:O	1:A:233:LEU:HD11	2.21	0.41
1:A:175:ILE:CG1	1:A:247:ARG:HG3	2.50	0.41
1:A:115:ILE:HG12	1:A:142:ALA:HA	2.03	0.41
1:A:39:HIS:HA	1:A:40:PRO:HD3	1.92	0.40
1:A:199:MET:HG2	1:A:263:TYR:O	2.20	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	272/275 (99%)	260 (96%)	11 (4%)	1 (0%)	30	22

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	63	SER

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	204/204 (100%)	203 (100%)	1 (0%)	81	84

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	195	GLU

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

Mol	Chain	Res	Type
1	A	76	ASN
1	A	103	GLN
1	A	123	ASN
1	A	243	ASN
1	A	271	GLN
1	A	275	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

1 non-standard protein/DNA/RNA residue is 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	$\# Z > 2$
1	CSD	A	221	1	4,7,8	14.85	1 (25%)	1,8,10	5.82	1 (100%)

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
1	CSD	A	221	1	-	0/2/6/8	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	221	CSD	OD1-SG	29.67	1.74	1.47

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	221	CSD	OD1-SG-CB	-5.82	94.89	105.60

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 4 ligands modelled in this entry, 3 are monoatomic - leaving 1 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	$\# Z > 2$
4	ACN	A	298	-	3,3,3	0.32	0	3,3,3	0.63	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.

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

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.