



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 31, 2021 – 09:13 pm BST

PDB ID : 7NX7  
Title : Crystal structure of the K417N mutant receptor binding domain of SARS-CoV-2 Spike glycoprotein in complex with COVOX-222 and EY6A Fabs  
Authors : Zhou, D.; Ren, J.; Stuart, D.  
Deposited on : 2021-03-17  
Resolution : 2.30 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto: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.

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

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.18  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.18

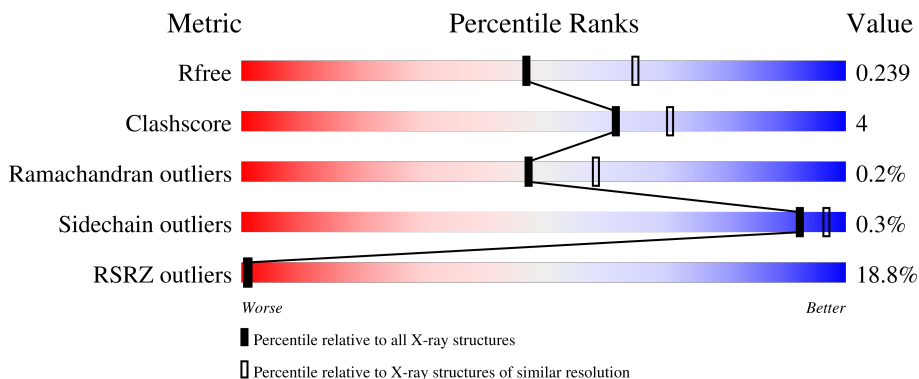
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.30 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))
$R_{free}$	130704	5042 (2.30-2.30)
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)
RSRZ outliers	127900	4938 (2.30-2.30)

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  $\geq 3$ , 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	H	226	
2	L	215	
3	E	205	
4	A	224	
5	B	214	

## 2 Entry composition [i](#)

There are 11 unique types of molecules in this entry. The entry contains 8377 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 EY6A Fab heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	H	214	1628	1036	272	314	6	0	0	0

- Molecule 2 is a protein called EY6A Fab light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	L	214	1631	1019	272	335	5	0	0	0

- Molecule 3 is a protein called Spike protein S1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	E	193	1528	978	255	287	8	0	0	0

There are 11 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
E	324	GLU	-	expression tag	UNP P0DTC2
E	325	THR	-	expression tag	UNP P0DTC2
E	326	GLY	-	expression tag	UNP P0DTC2
E	327	HIS	-	expression tag	UNP P0DTC2
E	328	HIS	-	expression tag	UNP P0DTC2
E	329	HIS	-	expression tag	UNP P0DTC2
E	330	HIS	-	expression tag	UNP P0DTC2
E	331	HIS	-	expression tag	UNP P0DTC2
E	332	HIS	-	expression tag	UNP P0DTC2
E	417	ASN	LYS	engineered mutation	UNP P0DTC2
E	527	LYS	PRO	conflict	UNP P0DTC2

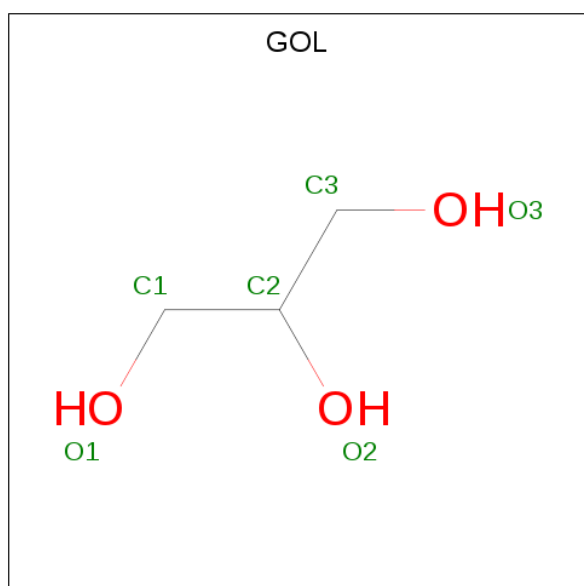
- Molecule 4 is a protein called COVOX-222 Fab heavy chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
4	A	214	1577	995	263	313	6	0	0	0

- Molecule 5 is a protein called COVOX-222 Fab light chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
5	B	213	1640	1025	279	330	6	0	2	0

- Molecule 6 is GLYCEROL (three-letter code: GOL) (formula: C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
6	E	1	6	3	3	0	0
6	A	1	6	3	3	0	0
6	B	1	6	3	3	0	0

- Molecule 7 is 2-acetamido-2-deoxy-beta-D-glucopyranose (three-letter code: NAG) (formula: C<sub>8</sub>H<sub>15</sub>NO<sub>6</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	
			Total	C	N			O
7	E	1	14	8	1	5	0	0

- Molecule 8 is SULFATE ION (three-letter code: SO<sub>4</sub>) (formula: O<sub>4</sub>S).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			O	S		
8	E	1	Total 5	4 1	0	0
8	E	1	Total 5	4 1	0	0
8	E	1	Total 5	4 1	0	0

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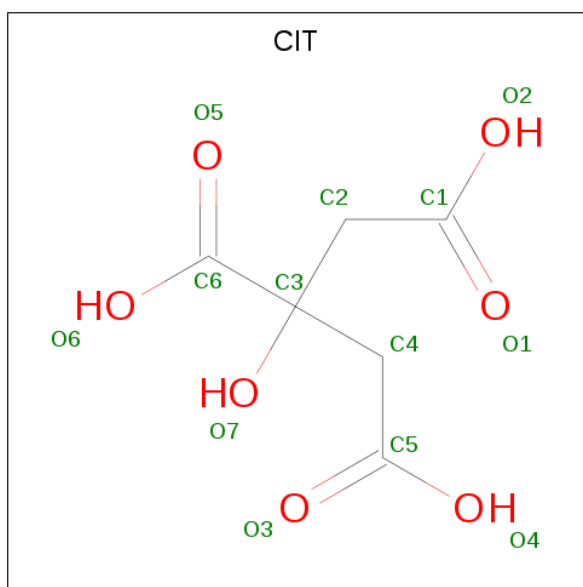
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Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	A	1	Total O S 5 4 1	0	0
8	A	1	Total O S 5 4 1	0	0
8	A	1	Total O S 5 4 1	0	0
8	B	1	Total O S 5 4 1	0	0
8	B	1	Total O S 5 4 1	0	0
8	B	1	Total O S 5 4 1	0	0
8	B	1	Total O S 5 4 1	0	0
8	B	1	Total O S 5 4 1	0	0
8	B	1	Total O S 5 4 1	0	0
8	B	1	Total O S 5 4 1	0	0

- Molecule 9 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
9	A	1	Total Cl 1 1	0	0

- Molecule 10 is CITRIC ACID (three-letter code: CIT) (formula: C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	B	1	Total	C O	0	0
			13	6 7		

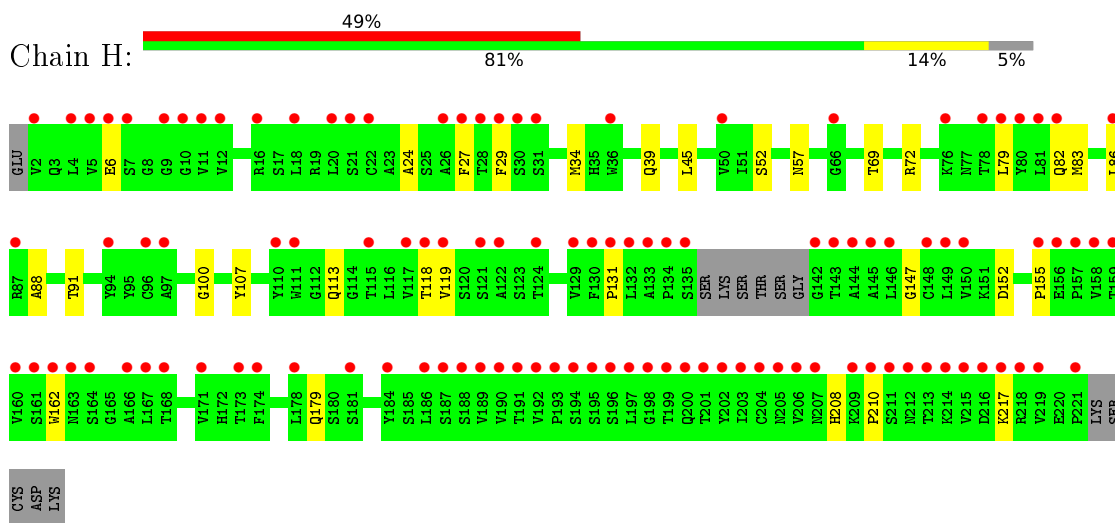
- Molecule 11 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
11	H	1	Total	O	0	0
			1	1		
11	L	13	Total	O	0	0
			13	13		
11	E	62	Total	O	0	0
			62	62		
11	A	95	Total	O	0	0
			95	95		
11	B	91	Total	O	0	0
			91	91		

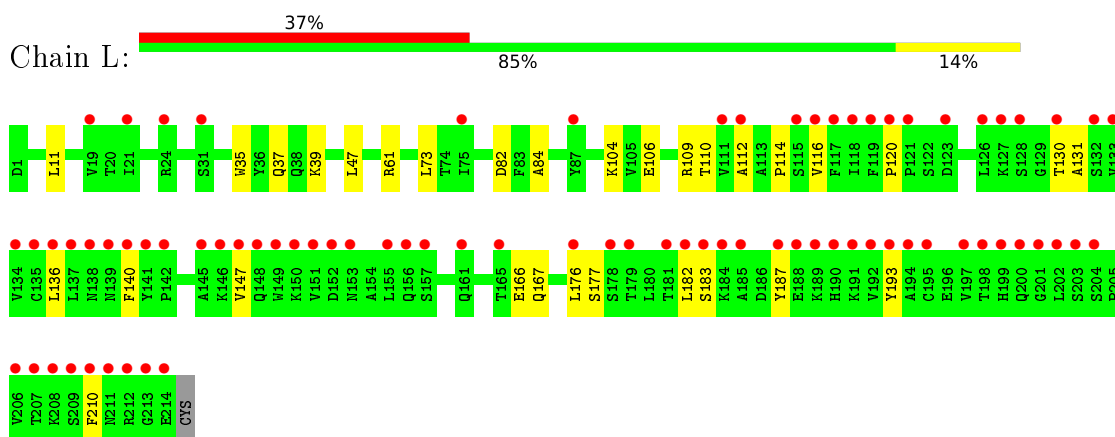
### 3 Residue-property plots [i](#)

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.

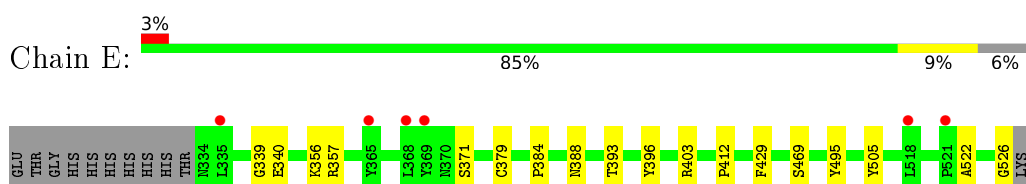
- Molecule 1: EY6A Fab heavy chain



- Molecule 2: EY6A Fab light chain




- Molecule 3: Spike protein S1






- Molecule 4: COVOX-222 Fab heavy chain

Chain A:  88% 7%



- Molecule 5: COVOX-222 Fab light chain

Chain B:  86% 13%



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	54.71Å 122.36Å 213.73Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	80.49 – 2.30 80.49 – 2.30	Depositor EDS
% Data completeness (in resolution range)	99.9 (80.49-2.30) 100.0 (80.49-2.30)	Depositor EDS
$R_{merge}$	0.24	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	0.99 (at 2.29Å)	Xtrriage
Refinement program	PHENIX 1.19_4092	Depositor
R, $R_{free}$	0.207 , 0.239 0.209 , 0.239	Depositor DCC
$R_{free}$ test set	3234 reflections (4.98%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	51.7	Xtrriage
Anisotropy	0.136	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 51.4	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	8377	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	86.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.09% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: SO4, GOL, CL, CIT, NAG

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	H	0.27	0/1670	0.50	0/2276
2	L	0.28	0/1664	0.49	0/2258
3	E	0.28	0/1571	0.49	0/2139
4	A	0.29	0/1615	0.52	0/2203
5	B	0.28	0/1683	0.54	0/2287
All	All	0.28	0/8203	0.51	0/11163

There are no bond length outliers.

There are no bond angle outliers.

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	H	1628	0	1582	15	0
2	L	1631	0	1591	19	0
3	E	1528	0	1438	9	0
4	A	1577	0	1534	10	0
5	B	1640	0	1594	16	0
6	A	6	0	8	0	0
6	B	6	0	8	1	0
6	E	6	0	8	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
7	E	14	0	13	1	0
8	A	15	0	0	0	0
8	B	35	0	0	1	0
8	E	15	0	0	0	0
9	A	1	0	0	1	0
10	B	13	0	5	2	0
11	A	95	0	0	1	0
11	B	91	0	0	2	0
11	E	62	0	0	0	0
11	H	1	0	0	0	0
11	L	13	0	0	0	0
All	All	8377	0	7781	70	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 4.

The worst 5 of 70 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)
5:B:81:PRO:HA	5:B:106:ILE:HD13	1.69	0.74
1:H:6:GLU:H	1:H:113:GLN:HE22	1.36	0.72
4:A:22:CYS:HB3	4:A:78:LEU:HB3	1.75	0.68
2:L:37:GLN:HB2	2:L:47:LEU:HD11	1.74	0.67
3:E:340:GLU:OE1	3:E:356:LYS:NZ	2.30	0.65

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	H	210/226 (93%)	201 (96%)	8 (4%)	1 (0%)	29 35

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	L	212/215 (99%)	200 (94%)	12 (6%)	0	100	100
3	E	191/205 (93%)	186 (97%)	4 (2%)	1 (0%)	29	35
4	A	210/224 (94%)	203 (97%)	7 (3%)	0	100	100
5	B	213/214 (100%)	206 (97%)	7 (3%)	0	100	100
All	All	1036/1084 (96%)	996 (96%)	38 (4%)	2 (0%)	47	58

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	E	371	SER
1	H	155	PRO

### 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	H	180/191 (94%)	180 (100%)	0	100	100
2	L	187/188 (100%)	187 (100%)	0	100	100
3	E	166/177 (94%)	165 (99%)	1 (1%)	86	94
4	A	176/186 (95%)	176 (100%)	0	100	100
5	B	186/185 (100%)	184 (99%)	2 (1%)	73	86
All	All	895/927 (96%)	892 (100%)	3 (0%)	92	97

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	E	469	SER
5	B	26	SER
5	B	34	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
3	E	501	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 monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 19 ligands modelled in this entry, 1 is monoatomic - leaving 18 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	$\# Z  > 2$
8	SO4	B	405	-	4,4,4	0.14	0	6,6,6	0.07	0
10	CIT	B	402	-	3,12,12	1.29	0	3,17,17	1.50	1 (33%)
8	SO4	E	704	-	4,4,4	0.14	0	6,6,6	0.08	0
8	SO4	A	304	-	4,4,4	0.15	0	6,6,6	0.05	0
6	GOL	E	701	-	5,5,5	0.88	0	5,5,5	1.02	0
8	SO4	B	408	-	4,4,4	0.15	0	6,6,6	0.05	0
8	SO4	B	409	-	4,4,4	0.15	0	6,6,6	0.06	0
8	SO4	B	404	-	4,4,4	0.14	0	6,6,6	0.10	0
8	SO4	A	302	-	4,4,4	0.14	0	6,6,6	0.09	0
8	SO4	B	406	-	4,4,4	0.15	0	6,6,6	0.09	0
7	NAG	E	702	3	14,14,15	0.35	0	17,19,21	0.58	0
8	SO4	A	303	-	4,4,4	0.14	0	6,6,6	0.07	0
6	GOL	B	401	-	5,5,5	0.87	0	5,5,5	1.07	0
8	SO4	E	705	-	4,4,4	0.14	0	6,6,6	0.06	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
8	SO4	B	407	-	4,4,4	0.14	0	6,6,6	0.05	0
8	SO4	E	703	-	4,4,4	0.15	0	6,6,6	0.06	0
8	SO4	B	403	-	4,4,4	0.14	0	6,6,6	0.06	0
6	GOL	A	301	-	5,5,5	0.91	0	5,5,5	0.95	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
10	CIT	B	402	-	-	4/6/16/16	-
6	GOL	E	701	-	-	2/4/4/4	-
7	NAG	E	702	3	-	2/6/23/26	0/1/1/1
6	GOL	B	401	-	-	3/4/4/4	-
6	GOL	A	301	-	-	4/4/4/4	-

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
10	B	402	CIT	C3-C4-C5	-2.26	111.37	114.98

There are no chirality outliers.

5 of 15 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	E	701	GOL	O1-C1-C2-C3
7	E	702	NAG	O5-C5-C6-O6
6	A	301	GOL	O1-C1-C2-C3
6	A	301	GOL	C1-C2-C3-O3
6	B	401	GOL	O1-C1-C2-C3

There are no ring outliers.

4 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
8	B	405	SO4	1	0
10	B	402	CIT	2	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
7	E	702	NAG	1	0
6	B	401	GOL	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, 95<sup>th</sup> 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 <sup>2</sup> )	Q < 0.9
1	H	214/226 (94%)	2.81	111 (51%) 0 0	72, 142, 188, 207	0
2	L	214/215 (99%)	2.05	79 (36%) 0 0	57, 117, 179, 199	0
3	E	193/205 (94%)	0.49	6 (3%) 49 56	39, 57, 117, 145	0
4	A	214/224 (95%)	0.45	1 (0%) 91 94	39, 50, 81, 127	0
5	B	213/214 (99%)	0.34	0 100 100	42, 54, 75, 111	0
All	All	1048/1084 (96%)	1.24	197 (18%) 1 1	39, 67, 176, 207	0

The worst 5 of 197 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	H	135	SER	16.0
2	L	194	ALA	14.6
1	H	160	VAL	13.3
1	H	192	VAL	11.9
2	L	193	TYR	11.4

### 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 monosaccharides 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
6	GOL	B	401	6/6	0.69	0.21	76,88,90,91	0
8	SO4	A	304	5/5	0.69	0.35	94,101,113,167	0
8	SO4	B	403	5/5	0.72	0.22	112,115,137,153	0
7	NAG	E	702	14/15	0.76	0.24	108,117,124,126	0
10	CIT	B	402	13/13	0.77	0.20	74,89,124,125	0
8	SO4	B	408	5/5	0.78	0.15	140,144,153,194	0
8	SO4	E	704	5/5	0.78	0.26	105,117,121,130	0
8	SO4	E	705	5/5	0.81	0.22	114,121,139,175	0
8	SO4	B	405	5/5	0.84	0.22	86,99,107,125	0
8	SO4	A	303	5/5	0.87	0.18	81,83,87,160	0
8	SO4	B	406	5/5	0.87	0.24	84,89,122,161	0
6	GOL	E	701	6/6	0.88	0.14	64,68,75,83	0
8	SO4	B	407	5/5	0.88	0.29	115,122,163,164	0
8	SO4	B	409	5/5	0.89	0.19	98,109,140,141	0
8	SO4	B	404	5/5	0.89	0.12	73,85,101,103	0
8	SO4	E	703	5/5	0.90	0.23	83,87,123,134	0
6	GOL	A	301	6/6	0.91	0.23	50,58,62,77	0
9	CL	A	305	1/1	0.97	0.11	64,64,64,64	0
8	SO4	A	302	5/5	0.97	0.14	64,74,82,84	0

## 6.5 Other polymers [\(i\)](#)

There are no such residues in this entry.