wwPDB X-ray Structure Validation Summary Report (i)

Dec 12, 2023 – 12:20 PM JST

PDB ID	:	8I4K
Title	:	Structure of Azami Red1.0, a red fluorescent protein engineered from Azami Green
Authors	:	Otsubo, S.; Takekawa, N.; Imamura, H.; Imada, K.
Deposited on	:	2023-01-19
Resolution	:	1.84 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) 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 (1)) were used in the production of this report:

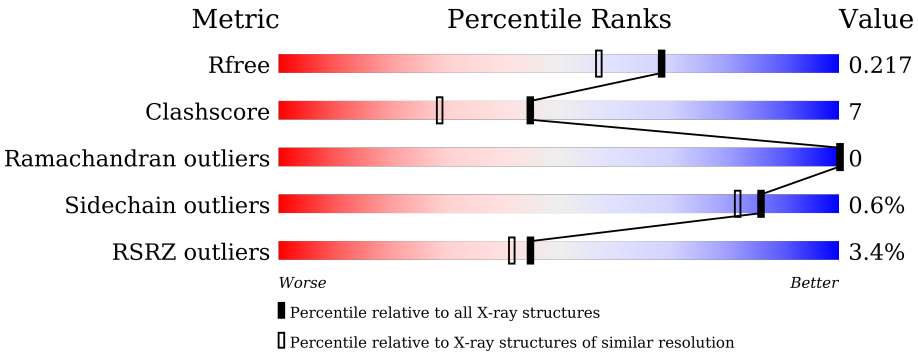
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

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 1.84 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	4003 (1.86-1.82)
Clashscore	141614	4233 (1.86-1.82)
Ramachandran outliers	138981	4185 (1.86-1.82)
Sidechain outliers	138945	4186 (1.86-1.82)
RSRZ outliers	127900	3957 (1.86-1.82)

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	A	227	89% 7%
1	B	227	84% 12%
1	C	227	85% 12%
1	D	227	83% 15%
1	E	227	5% 80% 17%
1	F	227	12% 80% 17%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 11911 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 Azami Red1.0.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	221	Total	C	N	O	S	0	0	0
			1794	1152	300	331	11			
1	B	221	Total	C	N	O	S	0	1	0
			1798	1156	300	331	11			
1	C	221	Total	C	N	O	S	0	1	0
			1805	1158	304	332	11			
1	D	224	Total	C	N	O	S	0	0	0
			1819	1168	304	335	12			
1	E	221	Total	C	N	O	S	0	1	0
			1799	1155	300	333	11			
1	F	221	Total	C	N	O	S	0	0	0
			1794	1152	300	331	11			

- Molecule 2 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	B	1	Total	Ca	0	0
			1	1		
2	C	1	Total	Ca	0	0
			1	1		
2	F	1	Total	Ca	0	0
			1	1		

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	232	Total	O	0	0
			232	232		
3	B	226	Total	O	0	0
			226	226		
3	C	191	Total	O	0	0
			191	191		

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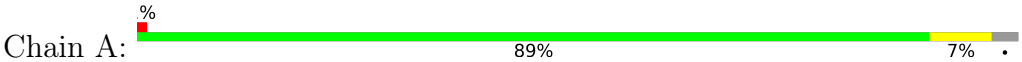
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	D	216	Total O 216 216	0	0
3	E	136	Total O 136 136	0	0
3	F	98	Total O 98 98	0	0

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.

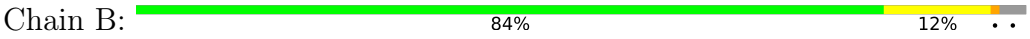
• Molecule 1: Azami Red1.0

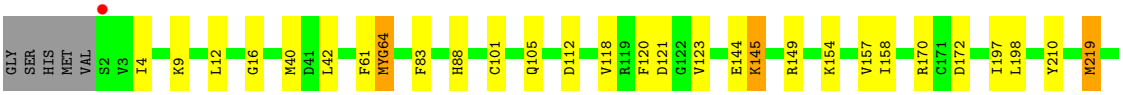
Chain A:



• Molecule 1: Azami Red1.0

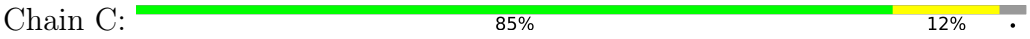
Chain B:





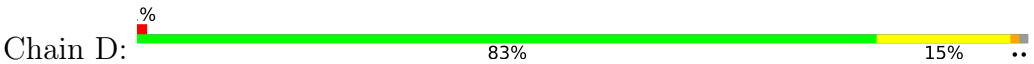
• Molecule 1: Azami Red1.0

Chain C:



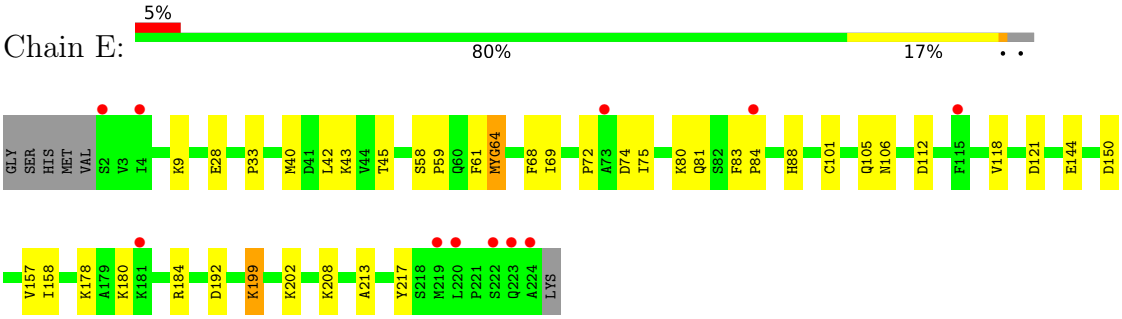
• Molecule 1: Azami Red1.0

Chain D:



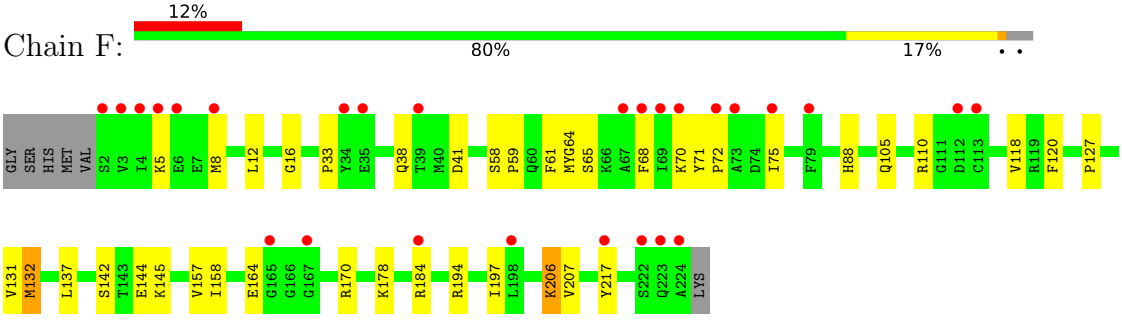
• Molecule 1: Azami Red1.0

Chain E:



• Molecule 1: Azami Red1.0

Chain F:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	I 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	83.13Å 72.77Å 213.84Å 90.00° 99.48° 90.00°	Depositor
Resolution (Å)	72.50 – 1.84 72.50 – 1.84	Depositor EDS
% Data completeness (in resolution range)	99.8 (72.50-1.84) 99.8 (72.50-1.84)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.39 (at 1.84Å)	Xtriage
Refinement program	PHENIX (1.20.1_4487: ???)	Depositor
R, R_{free}	0.176 , 0.217 0.174 , 0.217	Depositor DCC
R_{free} test set	5561 reflections (5.10%)	wwPDB-VP
Wilson B-factor (Å^2)	14.7	Xtriage
Anisotropy	0.819	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 47.6	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	11911	wwPDB-VP
Average B, all atoms (Å^2)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.06% of the height of the origin peak. No significant pseudotranslation is detected.*

[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: CA, NRQ

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	0.44	0/1818	0.69	1/2450 (0.0%)
1	B	0.48	0/1825	0.73	2/2460 (0.1%)
1	C	0.43	0/1829	0.71	1/2464 (0.0%)
1	D	0.44	0/1843	0.72	1/2481 (0.0%)
1	E	0.39	0/1826	0.65	0/2461
1	F	0.38	0/1818	0.66	1/2450 (0.0%)
All	All	0.43	0/10959	0.69	6/14766 (0.0%)

There are no bond length outliers.

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	42	LEU	CA-CB-CG	-7.25	98.63	115.30
1	C	42	LEU	CA-CB-CG	-6.43	100.52	115.30
1	D	42	LEU	CA-CB-CG	-6.26	100.91	115.30
1	B	219	MET	CG-SD-CE	-5.93	90.72	100.20
1	A	42	LEU	CA-CB-CG	-5.34	103.02	115.30

There are no chirality outliers.

There are no planarity outliers.

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	1794	0	1740	21	0
1	B	1798	0	1749	24	0
1	C	1805	0	1752	27	0
1	D	1819	0	1774	30	0
1	E	1799	0	1744	24	0
1	F	1794	0	1740	28	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	F	1	0	0	0	0
3	A	232	0	0	7	2
3	B	226	0	0	2	2
3	C	191	0	0	5	0
3	D	216	0	0	5	0
3	E	136	0	0	1	1
3	F	98	0	0	5	0
All	All	11911	0	10499	139	3

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 7.

The worst 5 of 139 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:F:184:ARG:NH2	3:F:401:HOH:O	2.00	0.94
1:E:199:LYS:HE3	1:E:208:LYS:HE2	1.57	0.85
1:A:206:LYS:NZ	3:A:301:HOH:O	2.14	0.81
1:C:49:PRO:HD2	1:E:28:GLU:HG2	1.65	0.79
1:F:207:VAL:HG23	3:F:406:HOH:O	1.91	0.69

All (3) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:A:415:HOH:O	3:B:557:HOH:O[4_655]	2.10	0.10
3:E:301:HOH:O	3:E:322:HOH:O[2_556]	2.17	0.03
3:A:497:HOH:O	3:B:557:HOH:O[4_655]	2.18	0.02

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	A	216/227 (95%)	214 (99%)	2 (1%)	0	100	100
1	B	217/227 (96%)	216 (100%)	1 (0%)	0	100	100
1	C	217/227 (96%)	216 (100%)	1 (0%)	0	100	100
1	D	219/227 (96%)	217 (99%)	2 (1%)	0	100	100
1	E	217/227 (96%)	214 (99%)	3 (1%)	0	100	100
1	F	216/227 (95%)	215 (100%)	1 (0%)	0	100	100
All	All	1302/1362 (96%)	1292 (99%)	10 (1%)	0	100	100

There are no Ramachandran outliers to report.

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	190/195 (97%)	190 (100%)	0	100	100
1	B	191/195 (98%)	190 (100%)	1 (0%)	88	85
1	C	191/195 (98%)	190 (100%)	1 (0%)	88	85
1	D	193/195 (99%)	192 (100%)	1 (0%)	88	85
1	E	191/195 (98%)	189 (99%)	2 (1%)	76	68
1	F	190/195 (97%)	188 (99%)	2 (1%)	73	64
All	All	1146/1170 (98%)	1139 (99%)	7 (1%)	86	82

5 of 7 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	199	LYS
1	E	202	LYS
1	F	206	LYS
1	F	145	LYS
1	D	199	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	32	ASN
1	C	38	GLN
1	E	106	ASN
1	D	38	GLN
1	C	21	HIS

5.3.3 RNA (i)

There are no RNA molecules in this entry.

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

6 non-standard protein/DNA/RNA residues are 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	NRQ	E	64	1	23,24,25	0.92	1 (4%)	23,32,34	1.42	5 (21%)
1	NRQ	B	64	1	23,24,25	1.01	1 (4%)	23,32,34	1.73	7 (30%)
1	NRQ	C	64	1	23,24,25	1.03	1 (4%)	23,32,34	1.65	7 (30%)
1	NRQ	F	64	1	23,24,25	0.94	1 (4%)	23,32,34	1.49	5 (21%)
1	NRQ	A	64	1	23,24,25	0.96	1 (4%)	23,32,34	1.52	5 (21%)
1	NRQ	D	64	1	23,24,25	0.95	1 (4%)	23,32,34	1.54	4 (17%)

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	NRQ	E	64	1	-	1/9/31/32	0/2/2/2
1	NRQ	B	64	1	-	2/9/31/32	0/2/2/2
1	NRQ	C	64	1	-	1/9/31/32	0/2/2/2
1	NRQ	F	64	1	-	2/9/31/32	0/2/2/2
1	NRQ	A	64	1	-	2/9/31/32	0/2/2/2
1	NRQ	D	64	1	-	2/9/31/32	0/2/2/2

The worst 5 of 6 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	64	NRQ	C1-N2	3.91	1.41	1.33
1	B	64	NRQ	C1-N2	3.61	1.41	1.33
1	D	64	NRQ	C1-N2	3.44	1.40	1.33
1	F	64	NRQ	C1-N2	3.40	1.40	1.33
1	A	64	NRQ	C1-N2	3.27	1.40	1.33

The worst 5 of 33 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	64	NRQ	CA2-C2-N3	4.56	105.53	103.37
1	C	64	NRQ	CA2-C2-N3	4.56	105.53	103.37
1	D	64	NRQ	CA2-C2-N3	4.39	105.45	103.37
1	A	64	NRQ	CA2-C2-N3	4.28	105.39	103.37
1	E	64	NRQ	CA2-C2-N3	4.00	105.26	103.37

There are no chirality outliers.

5 of 10 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	64	NRQ	C1-CA1-CB1-CG1
1	D	64	NRQ	C1-CA1-CB1-CG1
1	E	64	NRQ	C1-CA1-CB1-CG1
1	B	64	NRQ	CB1-CG1-SD-CE
1	A	64	NRQ	CB1-CG1-SD-CE

There are no ring outliers.

5 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	E	64	NRQ	1	0
1	B	64	NRQ	1	0
1	C	64	NRQ	1	0
1	A	64	NRQ	4	0
1	D	64	NRQ	1	0

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 3 ligands modelled in this entry, 3 are monoatomic - leaving 0 for Mogul analysis.

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

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^{th} 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	220/227 (96%)	-0.22	2 (0%)	84	84	7, 13, 28, 66	0
1	B	220/227 (96%)	-0.26	1 (0%)	91	91	7, 13, 27, 46	0
1	C	220/227 (96%)	-0.21	1 (0%)	91	91	9, 16, 33, 86	0
1	D	223/227 (98%)	-0.21	3 (1%)	77	77	9, 16, 33, 56	0
1	E	220/227 (96%)	0.40	11 (5%)	28	26	13, 27, 51, 77	0
1	F	220/227 (96%)	0.84	27 (12%)	4	3	16, 33, 56, 105	0
All	All	1323/1362 (97%)	0.06	45 (3%)	45	41	7, 18, 44, 105	0

The worst 5 of 45 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	224	ALA	8.2
1	E	224	ALA	6.8
1	F	224	ALA	6.7
1	A	224	ALA	5.7
1	F	223	GLN	5.5

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

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^{th} 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
1	NRQ	F	64	23/24	0.81	0.21	30,37,45,49	0
1	NRQ	E	64	23/24	0.88	0.19	22,34,42,46	0
1	NRQ	D	64	23/24	0.93	0.14	16,22,27,30	0
1	NRQ	C	64	23/24	0.94	0.12	12,19,24,30	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
1	NRQ	A	64	23/24	0.94	0.12	15,19,26,30	0
1	NRQ	B	64	23/24	0.95	0.11	13,19,22,23	0

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^{th} 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	CA	F	301	1/1	0.95	0.20	38,38,38,38	0
2	CA	C	301	1/1	0.98	0.10	32,32,32,32	0
2	CA	B	301	1/1	0.98	0.14	34,34,34,34	0

6.5 Other polymers (i)

There are no such residues in this entry.