Full wwPDB X-ray Structure Validation Report ⓘ

Oct 8, 2026 – 04:11 PM JST

PDB ID	:	5E37 / pdb_00005e37
Title	:	Redox protein from Chlamydomonas reinhardtii
Authors	:	Charoenwattanasatien, R.; Hochmal, A.K.; Zinzius, K.; Muto, R.; Tanaka, H.; Hippler, M.; Kurisu, G.
Deposited on	:	2015-10-02
Resolution	:	1.60 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:

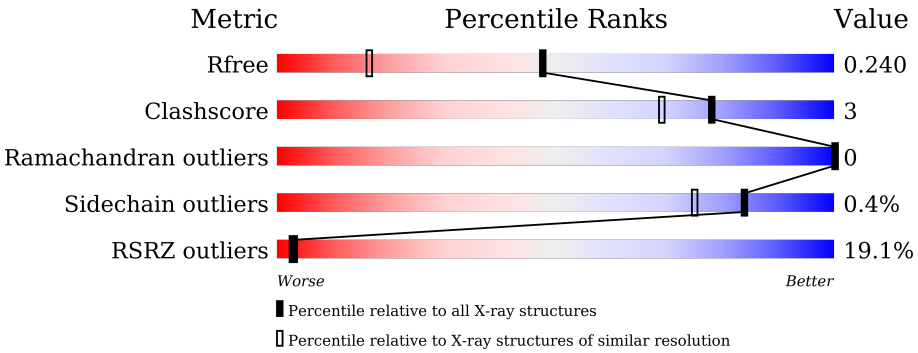
MolProbity	:	4-5-2 with Phenix2.2
Xtriage (Phenix)	:	2.2
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.015 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.51

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 1.60 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	4673 (1.60-1.60)
Clashscore	190562	4931 (1.60-1.60)
Ramachandran outliers	187476	4831 (1.60-1.60)
Sidechain outliers	187428	4830 (1.60-1.60)
RSRZ outliers	180081	4672 (1.60-1.60)

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	356	17% 80% 8% 12%
1	C	356	16% 76% 11% · 13%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 5719 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 EF-Hand domain-containing thioredoxin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	313	Total	C	N	O	S	0	0	0
			2432	1540	397	476	19			
1	C	310	Total	C	N	O	S	0	1	0
			2430	1540	400	471	19			

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

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	4	Total	Ca	0	0
			4	4		
2	C	4	Total	Ca	0	0
			4	4		

- Molecule 3 is water.

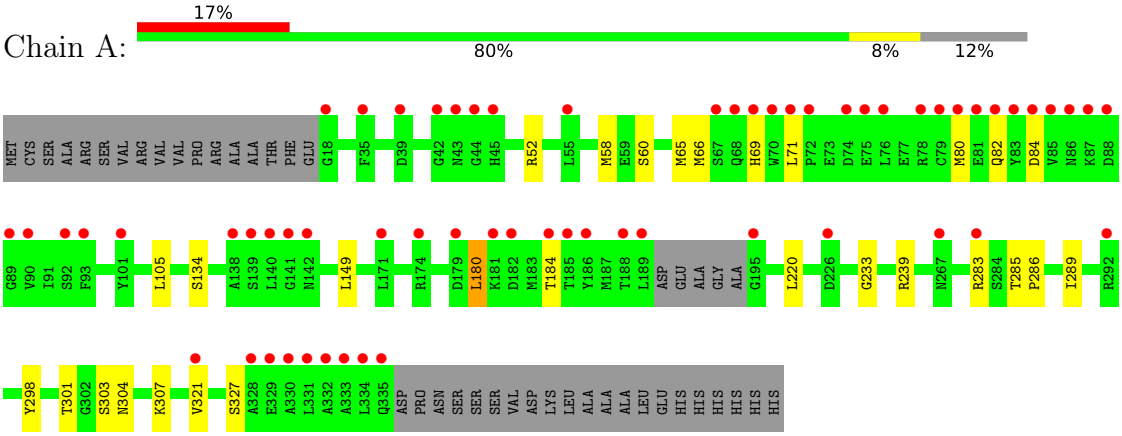
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	410	Total	O	0	0
			410	410		
3	C	439	Total	O	0	0
			439	439		

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.

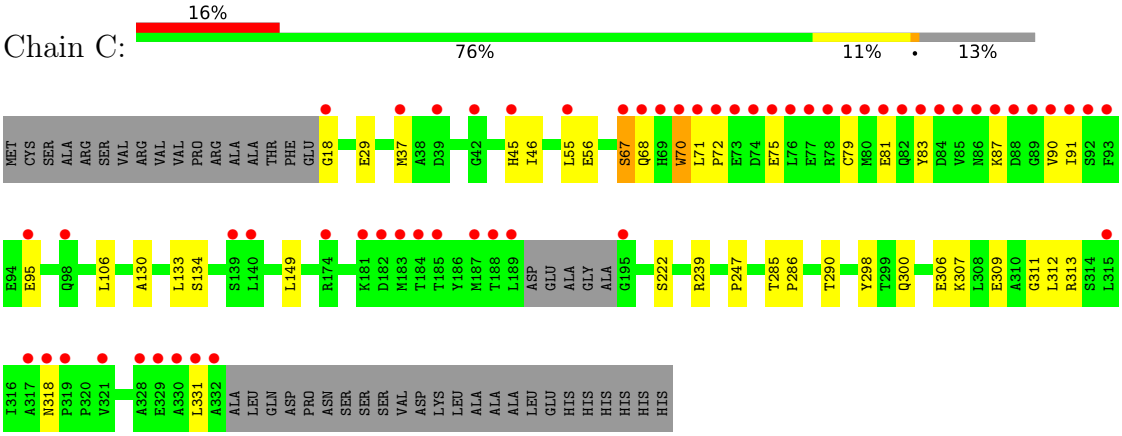
• Molecule 1: EF-Hand domain-containing thioredoxin

Chain A:



• Molecule 1: EF-Hand domain-containing thioredoxin

Chain C:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	85.96Å 55.19Å 89.58Å 90.00° 101.00° 90.00°	Depositor
Resolution (Å)	50.00 – 1.60 50.00 – 1.60	Depositor EDS
% Data completeness (in resolution range)	99.7 (50.00-1.60) 99.7 (50.00-1.60)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.68 (at 1.60Å)	Xtriage
Refinement program	REFMAC 5.8.0103	Depositor
R, R_{free}	0.199 , 0.233 0.207 , 0.240	Depositor DCC
R_{free} test set	5367 reflections (4.92%)	wwPDB-VP
Wilson B-factor (Å^2)	17.4	Xtriage
Anisotropy	0.040	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 42.9	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	0.000 for l,-k,h	Xtriage
F_o,F_c correlation	0.95	EDS
Total number of atoms	5719	wwPDB-VP
Average B, all atoms (Å^2)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 40.58 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 2.6775e-04. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[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

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	1.51	13/2473 (0.5%)	1.31	6/3332 (0.2%)
1	C	1.53	11/2471 (0.4%)	1.36	8/3323 (0.2%)
All	All	1.52	24/4944 (0.5%)	1.33	14/6655 (0.2%)

All (24) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	130	ALA	N-CA	7.09	1.54	1.46
1	A	105	LEU	C-O	-7.05	1.15	1.23
1	A	321	VAL	C-O	6.97	1.32	1.24
1	C	290	THR	C-O	6.96	1.32	1.24
1	A	233	GLY	CA-C	-6.66	1.47	1.52
1	C	133	LEU	CB-CG	-6.49	1.40	1.53
1	C	318	ASN	CA-C	6.29	1.59	1.52
1	C	67	SER	N-CA	6.07	1.54	1.46
1	A	289	ILE	N-CA	5.80	1.53	1.46
1	A	327	SER	CA-C	-5.79	1.45	1.52
1	C	311	GLY	C-O	-5.66	1.17	1.23
1	C	70	TRP	CB-CG	-5.61	1.32	1.50
1	C	18	GLY	N-CA	5.59	1.54	1.45
1	C	312	LEU	N-CA	-5.57	1.39	1.46
1	A	69	HIS	C-O	5.56	1.30	1.23
1	C	222	SER	N-CA	5.38	1.53	1.46
1	A	301	THR	CA-C	-5.15	1.46	1.52
1	A	71	LEU	CA-C	5.13	1.58	1.52
1	A	65	MET	CA-CB	5.11	1.59	1.53
1	C	29	GLU	N-CA	5.08	1.52	1.46
1	A	180	LEU	CA-C	5.06	1.59	1.52
1	A	58	MET	CA-C	5.06	1.59	1.52
1	A	220	LEU	N-CA	-5.05	1.40	1.46
1	A	60	SER	C-O	5.05	1.30	1.23

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	321	VAL	N-CA-CB	7.76	118.99	110.53
1	A	303	SER	CA-CB-OG	-6.86	97.38	111.10
1	A	321	VAL	CA-C-O	6.83	128.63	120.85
1	C	313	ARG	CA-C-O	-6.70	112.27	119.97
1	C	313	ARG	O-C-N	6.40	130.14	122.27
1	A	82	GLN	N-CA-C	6.29	117.94	111.14
1	C	309	GLU	O-C-N	6.21	129.22	122.15
1	C	87	LYS	N-CA-C	6.11	119.96	111.90
1	C	306	GLU	N-CA-C	5.75	117.55	111.28
1	C	239	ARG	CA-C-N	-5.65	113.06	119.28
1	C	239	ARG	C-N-CA	-5.65	113.06	119.28
1	C	56	GLU	N-CA-C	5.51	120.00	113.16
1	A	52	ARG	N-CA-C	-5.29	104.77	111.11
1	A	298	TYR	OH-CZ-CE2	-5.05	104.75	119.90

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	A	2432	0	2362	7	1
1	C	2430	0	2385	18	1
2	A	4	0	0	0	0
2	C	4	0	0	0	0
3	A	410	0	0	2	0
3	C	439	0	0	4	0
All	All	5719	0	4747	25	1

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 (25) 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:C:45:HIS:CD2	1:C:90:VAL:HG11	2.21	0.75
1:C:81:GLU:CB	3:C:865:HOH:O	2.39	0.70
1:C:45:HIS:CG	1:C:90:VAL:HG11	2.32	0.65
1:A:80:MET:HE3	1:A:84:ASP:HB2	1.85	0.58
1:C:300[B]:GLN:NE2	3:C:505:HOH:O	2.40	0.55
1:C:90:VAL:HG12	1:C:91:ILE:N	2.24	0.53
1:C:70:TRP:CZ2	1:C:106:LEU:HD11	2.48	0.48
1:C:71:LEU:HG	1:C:75:GLU:HB3	1.95	0.48
1:C:45:HIS:CD2	1:C:90:VAL:CG1	2.95	0.47
1:C:72:PRO:O	1:C:75:GLU:N	2.48	0.47
1:C:331:LEU:CG	3:C:501:HOH:O	2.62	0.46
1:A:239:ARG:NH1	3:A:508:HOH:O	2.49	0.46
1:C:68:GLN:HG2	3:C:624:HOH:O	2.16	0.45
1:A:283:ARG:NH1	3:A:509:HOH:O	2.50	0.44
1:C:285:THR:HA	1:C:286:PRO:C	2.43	0.44
1:C:300[B]:GLN:OE1	1:C:307:LYS:HE2	2.18	0.44
1:A:180:LEU:O	1:A:184:THR:HG23	2.19	0.43
1:A:285:THR:HA	1:A:286:PRO:C	2.45	0.42
1:C:83:TYR:O	1:C:95:GLU:HB3	2.19	0.42
1:C:298:TYR:OH	1:C:300[A]:GLN:OE1	2.32	0.42
1:A:134:SER:HB2	1:A:149:LEU:HD11	2.00	0.42
1:A:304:ASN:ND2	1:A:307:LYS:HE3	2.35	0.42
1:C:46:ILE:HB	1:C:91:ILE:HB	2.01	0.41
1:C:134:SER:HB2	1:C:149:LEU:HD11	2.01	0.41
1:C:55:LEU:HD11	1:C:79:CYS:SG	2.61	0.41

All (1) 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)
1:A:66:MET:O	1:C:37:MET:SD[1_656]	1.90	0.30

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	309/356 (87%)	306 (99%)	3 (1%)	0	100	100
1	C	307/356 (86%)	305 (99%)	2 (1%)	0	100	100
All	All	616/712 (86%)	611 (99%)	5 (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	259/305 (85%)	259 (100%)	0	100	100
1	C	261/305 (86%)	259 (99%)	2 (1%)	73	59
All	All	520/610 (85%)	518 (100%)	2 (0%)	84	75

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	67	SER
1	C	247	PRO

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	318	ASN
1	C	68	GLN

5.3.3 RNA (i)

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 8 ligands modelled in this entry, 8 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

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, 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	313/356 (87%)	0.84	62 (19%)	3 2	11, 22, 48, 78	0
1	C	310/356 (87%)	0.77	57 (18%)	3 3	8, 21, 49, 70	1 (0%)
All	All	623/712 (87%)	0.81	119 (19%)	3 3	8, 22, 49, 78	1 (0%)

All (119) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	84	ASP	8.0
1	A	85	VAL	7.1
1	C	85	VAL	6.4
1	A	332	ALA	6.3
1	C	75	GLU	6.1
1	A	71	LEU	6.1
1	C	90	VAL	6.0
1	C	188	THR	5.7
1	A	90	VAL	4.9
1	C	182	ASP	4.9
1	C	72	PRO	4.8
1	C	84	ASP	4.8
1	A	44	GLY	4.8
1	A	86	ASN	4.7
1	C	74	ASP	4.7
1	A	39	ASP	4.4
1	C	332	ALA	4.4
1	A	188	THR	4.4
1	C	321	VAL	4.3
1	A	72	PRO	4.3
1	A	141	GLY	4.3
1	A	321	VAL	4.3
1	A	42	GLY	4.2
1	C	317	ALA	4.2

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Mol	Chain	Res	Type	RSRZ
1	C	95	GLU	4.2
1	A	330	ALA	4.2
1	A	67	SER	4.1
1	C	68	GLN	4.1
1	A	139	SER	4.1
1	C	18	GLY	4.0
1	C	37	MET	4.0
1	C	331	LEU	3.9
1	A	93	PHE	3.9
1	C	184	THR	3.9
1	C	81	GLU	3.9
1	A	70	TRP	3.8
1	A	140	LEU	3.8
1	A	45	HIS	3.8
1	C	69	HIS	3.7
1	A	18	GLY	3.7
1	C	45	HIS	3.7
1	C	195	GLY	3.7
1	C	187	MET	3.6
1	C	93	PHE	3.6
1	A	43	ASN	3.6
1	C	189	LEU	3.6
1	A	328	ALA	3.5
1	C	330	ALA	3.5
1	A	79	CYS	3.5
1	A	92	SER	3.4
1	A	331	LEU	3.4
1	C	55	LEU	3.4
1	A	182	ASP	3.4
1	C	181	LYS	3.4
1	C	71	LEU	3.3
1	A	75	GLU	3.3
1	C	78	ARG	3.3
1	C	83	TYR	3.2
1	A	87	LYS	3.2
1	A	171	LEU	3.2
1	A	189	LEU	3.2
1	A	333	ALA	3.2
1	C	318	ASN	3.1
1	C	76	LEU	3.1
1	C	39	ASP	3.1
1	A	195	GLY	3.1

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Mol	Chain	Res	Type	RSRZ
1	C	87	LYS	3.1
1	A	82	GLN	3.0
1	A	335	GLN	3.0
1	C	328	ALA	3.0
1	C	79	CYS	3.0
1	A	88	ASP	3.0
1	C	139	SER	2.9
1	A	179	ASP	2.9
1	C	183	MET	2.8
1	A	334	LEU	2.8
1	C	92	SER	2.8
1	C	140	LEU	2.8
1	C	185	THR	2.8
1	C	89	GLY	2.8
1	C	73	GLU	2.7
1	C	86	ASN	2.7
1	A	80	MET	2.7
1	A	78	ARG	2.6
1	A	329	GLU	2.6
1	A	69	HIS	2.6
1	C	319	PRO	2.6
1	C	82	GLN	2.5
1	A	174	ARG	2.5
1	A	55	LEU	2.5
1	A	83	TYR	2.5
1	C	67	SER	2.5
1	A	74	ASP	2.4
1	C	77	GLU	2.4
1	A	89	GLY	2.4
1	A	101	TYR	2.4
1	A	181	LYS	2.4
1	C	70	TRP	2.3
1	C	80	MET	2.3
1	C	329	GLU	2.3
1	A	138	ALA	2.2
1	A	142	ASN	2.2
1	A	226	ASP	2.2
1	A	76	LEU	2.2
1	A	35	PHE	2.2
1	A	283	ARG	2.2
1	C	91	ILE	2.2
1	A	186	TYR	2.1

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Mol	Chain	Res	Type	RSRZ
1	A	267	ASN	2.1
1	A	68	GLN	2.1
1	A	185	THR	2.1
1	C	174	ARG	2.1
1	C	42	GLY	2.1
1	A	292	ARG	2.1
1	A	184	THR	2.1
1	A	81	GLU	2.0
1	C	98	GLN	2.0
1	C	88	ASP	2.0
1	C	315	LEU	2.0

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, 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	A	401	1/1	0.91	0.13	33,33,33,33	0
2	CA	A	402	1/1	0.94	0.14	36,36,36,36	0
2	CA	C	402	1/1	0.94	0.11	41,41,41,41	0
2	CA	C	401	1/1	0.95	0.10	28,28,28,28	0
2	CA	A	403	1/1	0.99	0.03	15,15,15,15	0
2	CA	A	404	1/1	0.99	0.02	15,15,15,15	0
2	CA	C	403	1/1	1.00	0.02	13,13,13,13	0
2	CA	C	404	1/1	1.00	0.01	13,13,13,13	0

6.5 Other polymers (i)

There are no such residues in this entry.