



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 05:04 PM UTC

PDB ID : 1O9K / pdb_00001o9k
Title : Crystal structure of the retinoblastoma tumour suppressor protein bound to E2F peptide
Authors : Xiao, B.; Spencer, J.; Clements, A.; Ali-Khan, N.; Mittnacht, S.; Broceno, C.; Burghammer, M.; Perrakis, A.; Marmorstein, R.; Gamblin, S.J.
Deposited on : 2002-12-16
Resolution : 2.60 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 ⓘ 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
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
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)	:	2.49

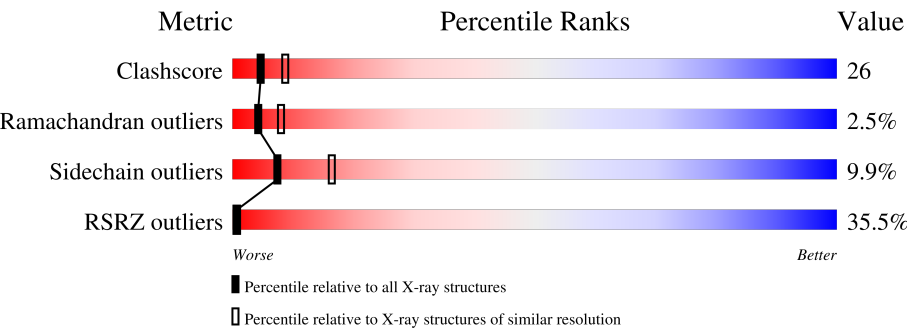
1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.60 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))
Clashscore	190562	4347 (2.60-2.60)
Ramachandran outliers	187476	4277 (2.60-2.60)
Sidechain outliers	187428	4277 (2.60-2.60)
RSRZ outliers	180081	4008 (2.60-2.60)

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 $\leq 5\%$. 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	A	218	
1	C	218	
1	E	218	
1	G	218	
2	B	152	
2	D	152	
2	F	152	

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Mol	Chain	Length	Quality of chain
2	H	152	93% 43% 45% 6% 5%
3	P	18	33% 72% 22% 6%
3	Q	18	28% 50% 39% 11%
3	R	18	78% 39% 44% 11% 6%
3	S	18	100% 39% 50% 11%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 11974 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 RETINOBLASTOMA-ASSOCIATED PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	194	Total	C	N	O	S	0	0	0
			1569	1003	263	290	13			
1	C	194	Total	C	N	O	S	0	0	0
			1569	1003	263	290	13			
1	E	194	Total	C	N	O	S	0	0	0
			1569	1003	263	290	13			
1	G	194	Total	C	N	O	S	0	0	0
			1569	1003	263	290	13			

- Molecule 2 is a protein called RETINOBLASTOMA-ASSOCIATED PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	144	Total	C	N	O	S	0	0	0
			1213	789	205	211	8			
2	D	144	Total	C	N	O	S	0	0	0
			1213	789	205	211	8			
2	F	144	Total	C	N	O	S	0	0	0
			1213	789	205	211	8			
2	H	144	Total	C	N	O	S	0	0	0
			1213	789	205	211	8			

- Molecule 3 is a protein called TRANSCRIPTION FACTOR E2F1.

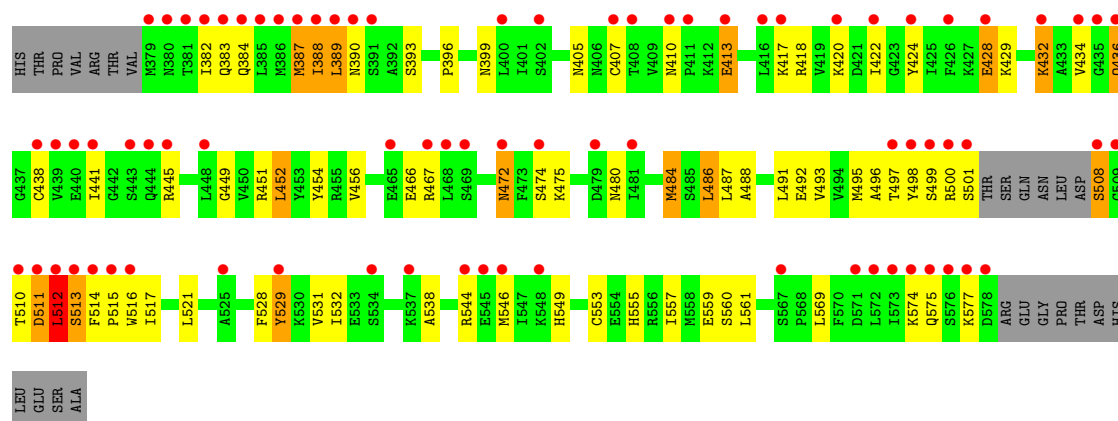
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	P	18	Total	C	N	O	0	0	0
			149	96	23	30			
3	Q	18	Total	C	N	O	0	0	0
			149	96	23	30			
3	R	18	Total	C	N	O	0	0	0
			149	96	23	30			
3	S	18	Total	C	N	O	0	0	0
			149	96	23	30			

- Molecule 4 is water.

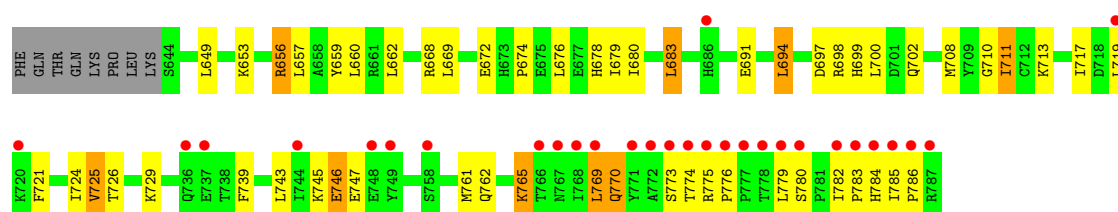
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	39	Total 39	O 39	0	0
4	B	18	Total 18	O 18	0	0
4	C	47	Total 47	O 47	0	0
4	D	24	Total 24	O 24	0	0
4	E	38	Total 38	O 38	0	0
4	F	16	Total 16	O 16	0	0
4	G	39	Total 39	O 39	0	0
4	H	15	Total 15	O 15	0	0
4	P	1	Total 1	O 1	0	0
4	Q	4	Total 4	O 4	0	0
4	R	4	Total 4	O 4	0	0
4	S	5	Total 5	O 5	0	0



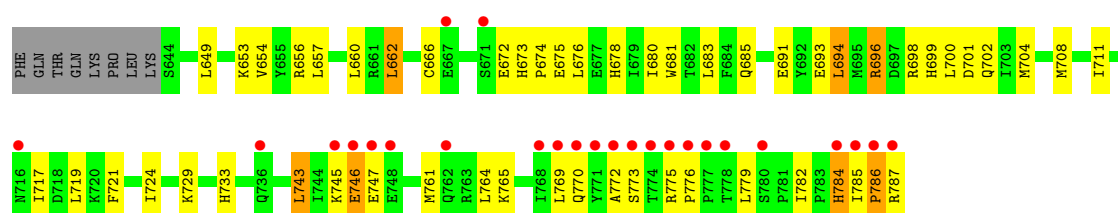
• Molecule 1: RETINOBLASTOMA-ASSOCIATED PROTEIN



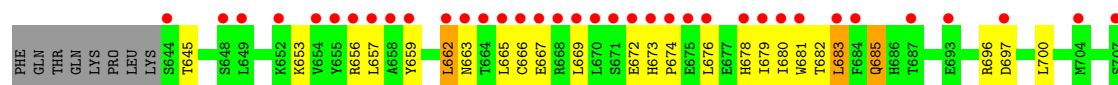
• Molecule 2: RETINOBLASTOMA-ASSOCIATED PROTEIN

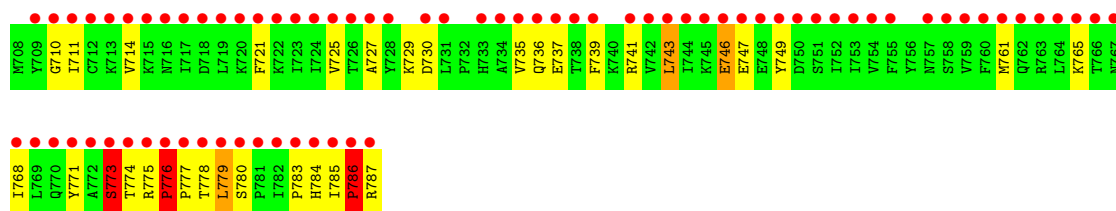


• Molecule 2: RETINOBLASTOMA-ASSOCIATED PROTEIN

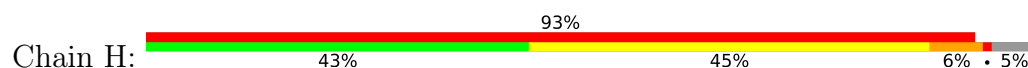


• Molecule 2: RETINOBLASTOMA-ASSOCIATED PROTEIN

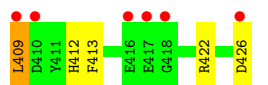




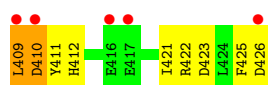
● Molecule 2: RETINOBLASTOMA-ASSOCIATED PROTEIN



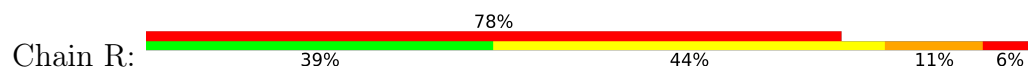
● Molecule 3: TRANSCRIPTION FACTOR E2F1



● Molecule 3: TRANSCRIPTION FACTOR E2F1



● Molecule 3: TRANSCRIPTION FACTOR E2F1



● Molecule 3: TRANSCRIPTION FACTOR E2F1



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	102.00Å 158.55Å 110.62Å 90.00° 93.70° 90.00°	Depositor
Resolution (Å)	20.00 – 2.60 20.00 – 2.60	Depositor EDS
% Data completeness (in resolution range)	88.2 (20.00-2.60) 87.9 (20.00-2.60)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.09	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.80 (at 2.59Å)	Xtriage
Refinement program	REFMAC 5.0	Depositor
R, R_{free}	0.229 , 0.285 0.228 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	18.3	Xtriage
Anisotropy	0.129	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 60.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.82	EDS
Total number of atoms	11974	wwPDB-VP
Average B, all atoms (Å ²)	38.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.02% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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](#)

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	0.72	1/1595 (0.1%)	1.07	9/2141 (0.4%)
1	C	0.67	0/1595	1.04	3/2141 (0.1%)
1	E	0.66	0/1595	1.02	4/2141 (0.2%)
1	G	0.67	0/1595	1.01	5/2141 (0.2%)
2	B	0.60	0/1242	0.93	0/1680
2	D	0.55	0/1242	0.93	0/1680
2	F	0.52	0/1242	0.94	2/1680 (0.1%)
2	H	0.58	1/1242 (0.1%)	0.94	0/1680
3	P	0.52	0/152	0.80	0/203
3	Q	0.45	0/152	0.77	0/203
3	R	0.55	0/152	0.98	0/203
3	S	0.51	0/152	0.88	0/203
All	All	0.63	2/11956 (0.0%)	0.99	23/16096 (0.1%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	510	THR	CA-C	-6.67	1.44	1.52
2	H	708	MET	SD-CE	5.73	1.93	1.79

The worst 5 of 23 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	468	LEU	N-CA-C	-10.51	93.24	109.85
1	E	513	SER	N-CA-C	-10.34	95.61	110.59
1	A	509	GLY	N-CA-C	-9.77	90.02	113.18
1	G	513	SER	N-CA-C	-9.70	96.96	110.35
1	C	513	SER	N-CA-C	-7.92	100.70	110.61

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	1569	0	1592	87	0
1	C	1569	0	1592	79	0
1	E	1569	0	1592	110	0
1	G	1569	0	1592	116	0
2	B	1213	0	1246	48	0
2	D	1213	0	1246	43	0
2	F	1213	0	1246	56	0
2	H	1213	0	1246	69	0
3	P	149	0	129	5	0
3	Q	149	0	129	11	0
3	R	149	0	129	17	0
3	S	149	0	129	10	0
4	A	39	0	0	9	0
4	B	18	0	0	3	0
4	C	47	0	0	14	0
4	D	24	0	0	1	0
4	E	38	0	0	9	0
4	F	16	0	0	3	0
4	G	39	0	0	9	0
4	H	15	0	0	8	0
4	P	1	0	0	0	0
4	Q	4	0	0	1	0
4	R	4	0	0	1	0
4	S	5	0	0	3	0
All	All	11974	0	11868	610	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 26.

The worst 5 of 610 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:512:LEU:HD22	1:A:512:LEU:O	1.28	1.27
1:C:513:SER:O	1:C:515:PRO:HD2	1.35	1.23
2:H:737:GLU:HB2	4:H:2008:HOH:O	1.36	1.21

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:509:GLY:HA2	4:C:2028:HOH:O	1.50	1.10
1:A:512:LEU:O	1:A:512:LEU:CD2	2.05	1.04

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	A	190/218 (87%)	178 (94%)	6 (3%)	6 (3%)	3	5
1	C	190/218 (87%)	170 (90%)	14 (7%)	6 (3%)	3	5
1	E	190/218 (87%)	178 (94%)	10 (5%)	2 (1%)	11	25
1	G	190/218 (87%)	174 (92%)	10 (5%)	6 (3%)	3	5
2	B	142/152 (93%)	129 (91%)	11 (8%)	2 (1%)	9	19
2	D	142/152 (93%)	127 (89%)	13 (9%)	2 (1%)	9	19
2	F	142/152 (93%)	127 (89%)	11 (8%)	4 (3%)	4	6
2	H	142/152 (93%)	124 (87%)	15 (11%)	3 (2%)	5	11
3	P	16/18 (89%)	14 (88%)	2 (12%)	0	100	100
3	Q	16/18 (89%)	14 (88%)	1 (6%)	1 (6%)	1	1
3	R	16/18 (89%)	13 (81%)	1 (6%)	2 (12%)	0	0
3	S	16/18 (89%)	13 (81%)	2 (12%)	1 (6%)	1	1
All	All	1392/1552 (90%)	1261 (91%)	96 (7%)	35 (2%)	4	8

5 of 35 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	514	PHE
1	C	514	PHE
2	D	784	HIS

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Mol	Chain	Res	Type
2	D	786	PRO
2	F	779	LEU

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	178/200 (89%)	160 (90%)	18 (10%)	7	15
1	C	178/200 (89%)	162 (91%)	16 (9%)	9	20
1	E	178/200 (89%)	158 (89%)	20 (11%)	6	12
1	G	178/200 (89%)	162 (91%)	16 (9%)	9	20
2	B	139/147 (95%)	122 (88%)	17 (12%)	5	10
2	D	139/147 (95%)	127 (91%)	12 (9%)	10	22
2	F	139/147 (95%)	128 (92%)	11 (8%)	11	26
2	H	139/147 (95%)	124 (89%)	15 (11%)	6	13
3	P	15/15 (100%)	14 (93%)	1 (7%)	15	33
3	Q	15/15 (100%)	14 (93%)	1 (7%)	15	33
3	R	15/15 (100%)	11 (73%)	4 (27%)	0	1
3	S	15/15 (100%)	14 (93%)	1 (7%)	15	33
All	All	1328/1448 (92%)	1196 (90%)	132 (10%)	7	16

5 of 132 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	H	694	LEU
2	H	735	VAL
3	R	422	ARG
1	C	523	LEU
1	C	519	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 57 such sidechains are listed below:

Mol	Chain	Res	Type
2	D	736	GLN
3	R	412	HIS
1	E	541	ASN
3	Q	412	HIS
2	H	678	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](#)

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

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

There are no ligands in this entry.

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, 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	A	194/218 (88%)	0.62	15 (7%) 19 15	20, 29, 56, 74	0
1	C	194/218 (88%)	0.72	20 (10%) 12 9	20, 29, 55, 69	0
1	E	194/218 (88%)	1.54	43 (22%) 2 2	21, 30, 56, 77	0
1	G	194/218 (88%)	2.02	78 (40%) 0 0	21, 29, 58, 75	0
2	B	144/152 (94%)	1.35	29 (20%) 3 2	21, 38, 71, 79	0
2	D	144/152 (94%)	1.12	25 (17%) 4 3	24, 39, 72, 80	0
2	F	144/152 (94%)	3.10	111 (77%) 0 0	27, 43, 73, 80	0
2	H	144/152 (94%)	4.84	142 (98%) 0 0	27, 40, 72, 83	0
3	P	18/18 (100%)	1.86	6 (33%) 1 1	41, 48, 61, 64	0
3	Q	18/18 (100%)	1.45	5 (27%) 1 1	40, 49, 58, 61	0
3	R	18/18 (100%)	3.15	14 (77%) 0 0	39, 52, 65, 68	0
3	S	18/18 (100%)	6.21	18 (100%) 0 0	41, 51, 62, 64	0
All	All	1424/1552 (91%)	1.88	506 (35%) 1 1	20, 36, 65, 83	0

The worst 5 of 506 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	H	774	THR	11.4
2	H	787	ARG	11.2
2	F	777	PRO	9.4
2	H	772	ALA	9.0
2	H	766	THR	9.0

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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.