



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 08:50 AM UTC

PDB ID : 9RAT / pdb_00009rat
Title : EFFECTS OF TEMPERATURE ON PROTEIN STRUCTURE AND DYNAMICS: X-RAY CRYSTALLOGRAPHIC STUDIES OF THE PROTEIN RIBONUCLEASE-A AT NINE DIFFERENT TEMPERATURES FROM 98 TO 320 K
Authors : Tilton Jr., R.F.; Dewan, J.C.; Petsko, G.A.; Gilbert, W.
Deposited on : 1991-08-13
Resolution : 1.50 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
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

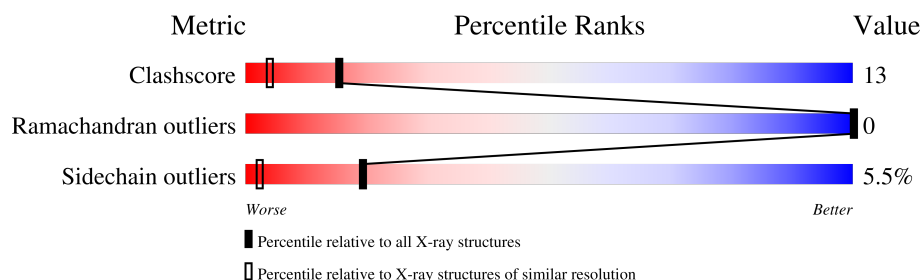
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.50 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	4235 (1.50-1.50)
Ramachandran outliers	187476	4153 (1.50-1.50)
Sidechain outliers	187428	4150 (1.50-1.50)

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	124	25% 57% 18%

2 Entry composition

There is only 1 type of molecule in this entry. The entry contains 951 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 RIBONUCLEASE A.

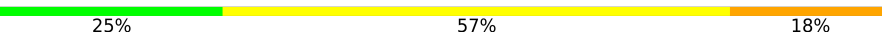
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	124	951	575	171	193	12	0	0	0

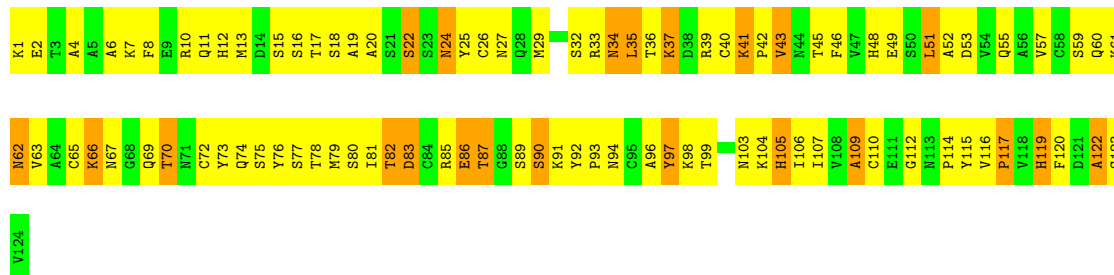
3 Residue-property plots

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: RIBONUCLEASE A

Chain A: 



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	30.40 Å 38.30 Å 53.30 Å 90.00° 106.90° 90.00°	Depositor
Resolution (Å)	(Not available) – 1.50	Depositor
% Data completeness (in resolution range)	(Not available) ((Not available)-1.50)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	PROLSQ	Depositor
R, R_{free}	0.191 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	951	wwPDB-VP
Average B, all atoms (Å ²)	15.0	wwPDB-VP

5 Model quality ⓘ

5.1 Standard geometry ⓘ

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	2.48	52/967 (5.4%)	2.91	114/1304 (8.7%)

All (52) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	12	HIS	CE1-NE2	17.17	1.49	1.32
1	A	49	GLU	C-O	7.88	1.33	1.23
1	A	117	PRO	N-CD	7.84	1.58	1.47
1	A	2	GLU	N-CA	7.73	1.55	1.46
1	A	123	SER	N-CA	7.46	1.55	1.46
1	A	81	ILE	N-CA	7.34	1.54	1.46
1	A	27	ASN	C-N	-7.28	1.24	1.33
1	A	32	SER	C-O	7.26	1.33	1.24
1	A	90	SER	C-O	-7.17	1.15	1.23
1	A	10	ARG	CD-NE	-7.07	1.36	1.46
1	A	24	ASN	C-N	7.06	1.42	1.33
1	A	7	LYS	CA-CB	-7.03	1.42	1.53
1	A	70	THR	N-CA	6.76	1.53	1.46
1	A	67	ASN	N-CA	6.60	1.54	1.46
1	A	41	LYS	C-N	-6.39	1.25	1.34
1	A	16	SER	C-N	-6.37	1.24	1.33
1	A	74	GLN	N-CA	6.25	1.53	1.46
1	A	98	LYS	N-CA	6.25	1.54	1.46
1	A	40	CYS	N-CA	6.18	1.53	1.46
1	A	12	HIS	CG-CD2	-6.16	1.29	1.35
1	A	65	CYS	C-N	-6.15	1.25	1.34
1	A	106	ILE	CA-CB	-6.03	1.47	1.54
1	A	55	GLN	N-CA	5.86	1.53	1.46
1	A	46	PHE	C-O	5.83	1.30	1.23
1	A	60	GLN	CA-C	-5.79	1.50	1.53
1	A	97	TYR	C-O	-5.78	1.16	1.23
1	A	52	ALA	C-O	5.77	1.30	1.24
1	A	66	LYS	N-CA	5.67	1.53	1.46

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	122	ALA	N-CA	5.52	1.52	1.46
1	A	81	ILE	CA-CB	-5.50	1.46	1.54
1	A	39	ARG	C-O	5.49	1.29	1.23
1	A	20	ALA	CA-C	-5.47	1.45	1.52
1	A	73	TYR	N-CA	5.46	1.52	1.46
1	A	97	TYR	CA-C	5.46	1.59	1.52
1	A	80	SER	CA-CB	-5.42	1.46	1.53
1	A	59	SER	N-CA	5.37	1.52	1.46
1	A	13	MET	N-CA	5.35	1.52	1.46
1	A	66	LYS	CA-CB	-5.34	1.44	1.53
1	A	106	ILE	C-O	-5.33	1.18	1.24
1	A	90	SER	N-CA	5.30	1.52	1.46
1	A	61	LYS	C-O	-5.25	1.17	1.24
1	A	62	ASN	C-N	5.25	1.40	1.33
1	A	104	LYS	CA-CB	5.19	1.63	1.53
1	A	12	HIS	CA-C	-5.17	1.45	1.52
1	A	83	ASP	N-CA	5.13	1.52	1.46
1	A	90	SER	CA-CB	-5.12	1.45	1.53
1	A	43	VAL	C-N	5.11	1.39	1.33
1	A	33	ARG	CD-NE	5.11	1.53	1.46
1	A	32	SER	C-N	-5.09	1.26	1.33
1	A	20	ALA	N-CA	5.06	1.52	1.46
1	A	15	SER	CB-OG	5.03	1.52	1.42
1	A	49	GLU	C-N	-5.02	1.26	1.33

All (114) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	60	GLN	CA-C-O	12.45	126.17	118.33
1	A	6	ALA	O-C-N	10.90	135.68	122.27
1	A	13	MET	CA-C-O	10.20	131.50	120.38
1	A	80	SER	O-C-N	9.87	136.10	122.77
1	A	53	ASP	CA-CB-CG	9.63	122.23	112.60
1	A	27	ASN	O-C-N	9.28	131.96	122.12
1	A	12	HIS	CE1-NE2-CD2	-8.75	100.25	109.00
1	A	120	PHE	CA-CB-CG	-8.73	105.07	113.80
1	A	97	TYR	O-C-N	8.68	134.47	123.19
1	A	12	HIS	CA-C-O	-8.34	109.73	118.90
1	A	48	HIS	ND1-CG-CD2	7.95	114.05	106.10
1	A	115	TYR	O-C-N	7.94	132.46	122.93
1	A	27	ASN	CA-C-O	-7.92	112.16	120.55
1	A	4	ALA	N-CA-C	-7.79	102.79	111.28

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	10	ARG	NE-CZ-NH2	7.64	126.08	119.20
1	A	78	THR	CA-CB-OG1	-7.60	98.20	109.60
1	A	70	THR	N-CA-CB	-7.57	98.71	111.20
1	A	24	ASN	CA-CB-CG	-7.55	105.05	112.60
1	A	48	HIS	ND1-CE1-NE2	7.52	115.92	108.40
1	A	90	SER	O-C-N	7.38	132.09	122.95
1	A	123	SER	N-CA-C	-7.36	96.94	109.24
1	A	15	SER	CA-CB-OG	-7.33	96.45	111.10
1	A	48	HIS	CB-CA-C	-7.29	101.75	111.74
1	A	80	SER	CA-C-N	-7.25	110.61	122.57
1	A	80	SER	C-N-CA	-7.25	110.61	122.57
1	A	107	ILE	CA-C-O	7.25	127.93	120.39
1	A	115	TYR	CA-C-O	-7.21	112.86	120.58
1	A	78	THR	N-CA-C	-7.18	99.89	110.52
1	A	69	GLN	O-C-N	7.11	131.07	122.75
1	A	80	SER	CA-C-O	-6.93	112.37	120.62
1	A	27	ASN	CA-CB-CG	-6.90	105.70	112.60
1	A	87	THR	O-C-N	6.89	130.66	122.94
1	A	62	ASN	OD1-CG-ND2	-6.85	115.75	122.60
1	A	119	HIS	CA-CB-CG	6.83	120.63	113.80
1	A	19	ALA	O-C-N	6.77	130.06	123.29
1	A	74	GLN	CA-C-N	6.76	130.35	120.82
1	A	74	GLN	C-N-CA	6.76	130.35	120.82
1	A	60	GLN	O-C-N	-6.75	116.05	121.65
1	A	12	HIS	CG-CD2-NE2	6.74	113.94	107.20
1	A	119	HIS	O-C-N	6.68	131.42	123.33
1	A	93	PRO	O-C-N	6.66	133.76	121.10
1	A	78	THR	O-C-N	6.63	130.37	122.94
1	A	104	LYS	CA-CB-CG	-6.61	100.89	114.10
1	A	20	ALA	N-CA-CB	-6.52	99.24	109.87
1	A	76	TYR	O-C-N	6.50	129.56	122.15
1	A	8	PHE	CA-C-O	-6.50	114.00	120.82
1	A	62	ASN	CA-C-O	6.47	127.85	120.54
1	A	19	ALA	CA-C-O	-6.42	114.41	121.28
1	A	18	SER	O-C-N	6.33	131.13	122.46
1	A	45	THR	OG1-CB-CG2	6.32	121.94	109.30
1	A	78	THR	CA-C-O	-6.30	114.29	121.72
1	A	61	LYS	O-C-N	6.28	130.75	123.02
1	A	97	TYR	N-CA-CB	6.27	121.80	111.08
1	A	35	LEU	O-C-N	6.25	131.56	122.43
1	A	53	ASP	O-C-N	6.23	129.93	122.27
1	A	82	THR	CA-C-N	-6.22	112.89	122.09

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	82	THR	C-N-CA	-6.22	112.89	122.09
1	A	109	ALA	O-C-N	6.18	130.26	123.27
1	A	87	THR	CA-CB-OG1	-6.18	100.33	109.60
1	A	51	LEU	N-CA-CB	-6.17	101.07	110.01
1	A	80	SER	N-CA-CB	6.15	119.69	109.60
1	A	42	PRO	CA-C-N	6.13	131.88	122.25
1	A	42	PRO	C-N-CA	6.13	131.88	122.25
1	A	43	VAL	CA-C-O	6.07	127.39	120.90
1	A	72	CYS	O-C-N	6.05	129.84	123.06
1	A	97	TYR	CA-CB-CG	-6.02	103.07	113.90
1	A	48	HIS	CG-ND1-CE1	-6.01	99.08	109.30
1	A	20	ALA	CB-CA-C	5.96	120.07	110.29
1	A	109	ALA	CA-C-O	-5.93	113.97	120.43
1	A	41	LYS	CA-C-N	5.91	125.61	119.05
1	A	41	LYS	C-N-CA	5.91	125.61	119.05
1	A	105	HIS	O-C-N	5.89	129.96	123.01
1	A	10	ARG	CD-NE-CZ	5.88	132.63	124.40
1	A	96	ALA	O-C-N	5.78	130.07	123.31
1	A	73	TYR	CA-C-N	-5.77	114.85	122.99
1	A	73	TYR	C-N-CA	-5.77	114.85	122.99
1	A	87	THR	CA-C-O	-5.75	114.94	121.72
1	A	37	LYS	CA-C-O	-5.74	114.97	121.00
1	A	59	SER	CA-C-N	-5.71	117.02	123.13
1	A	59	SER	C-N-CA	-5.71	117.02	123.13
1	A	112	GLY	N-CA-C	5.70	122.56	112.53
1	A	106	ILE	CB-CG1-CD1	5.65	125.66	113.80
1	A	70	THR	CB-CA-C	5.60	120.09	111.02
1	A	41	LYS	N-CA-C	-5.59	99.32	109.44
1	A	46	PHE	N-CA-CB	5.57	119.70	110.52
1	A	36	THR	O-C-N	5.56	129.10	122.26
1	A	85	ARG	CD-NE-CZ	-5.56	116.62	124.40
1	A	42	PRO	N-CA-CB	5.55	109.44	103.33
1	A	55	GLN	O-C-N	5.51	128.67	122.22
1	A	69	GLN	N-CA-CB	5.48	118.10	110.26
1	A	42	PRO	O-C-N	-5.46	115.68	122.23
1	A	86	GLU	OE1-CD-OE2	5.36	135.77	122.90
1	A	114	PRO	CA-C-N	5.36	129.56	122.42
1	A	114	PRO	C-N-CA	5.36	129.56	122.42
1	A	2	GLU	CB-CG-CD	-5.35	103.51	112.60
1	A	12	HIS	O-C-N	5.34	128.47	122.27
1	A	119	HIS	CA-C-O	-5.32	114.22	120.60
1	A	105	HIS	N-CA-C	-5.29	101.84	110.20

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	66	LYS	N-CA-CB	5.26	118.33	110.22
1	A	77	SER	CA-C-O	-5.26	115.51	121.72
1	A	123	SER	N-CA-CB	5.25	120.50	111.00
1	A	97	TYR	CB-CG-CD2	-5.24	112.93	120.80
1	A	73	TYR	CB-CG-CD2	5.24	128.66	120.80
1	A	17	THR	OG1-CB-CG2	5.24	119.77	109.30
1	A	61	LYS	CB-CA-C	-5.17	101.81	110.29
1	A	110	CYS	O-C-N	5.16	129.93	123.23
1	A	13	MET	O-C-N	-5.15	117.21	123.29
1	A	22	SER	O-C-N	-5.12	117.94	123.42
1	A	62	ASN	CA-CB-CG	5.12	117.72	112.60
1	A	57	VAL	O-C-N	5.10	127.87	122.06
1	A	33	ARG	CB-CA-C	5.08	118.57	110.09
1	A	94	ASN	CA-CB-CG	-5.07	107.53	112.60
1	A	123	SER	CB-CA-C	5.06	119.37	109.35
1	A	69	GLN	CA-C-O	-5.01	116.36	121.87

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	951	0	905	25	0
All	All	951	0	905	25	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 13.

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:A:87:THR:HG22	1:A:89:SER:H	1.31	0.94
1:A:66:LYS:HE3	1:A:122:ALA:HB2	1.55	0.89
1:A:34:ASN:ND2	1:A:37:LYS:HD2	1.98	0.78

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:34:ASN:HD21	1:A:37:LYS:HD2	1.58	0.69
1:A:41:LYS:HE2	1:A:43:VAL:O	1.93	0.67
1:A:26:CYS:HB3	1:A:97:TYR:HB2	1.78	0.65
1:A:109:ALA:HB3	1:A:119:HIS:HB3	1.78	0.65
1:A:11:GLN:HG2	1:A:35:LEU:HD21	1.80	0.64
1:A:116:VAL:HB	1:A:117:PRO:HD2	1.86	0.56
1:A:34:ASN:HD21	1:A:37:LYS:CD	2.19	0.55
1:A:66:LYS:HE3	1:A:122:ALA:CB	2.34	0.55
1:A:116:VAL:HB	1:A:117:PRO:CD	2.37	0.54
1:A:25:TYR:CD2	1:A:82:THR:HG21	2.43	0.54
1:A:75:SER:O	1:A:105:HIS:HD2	1.91	0.51
1:A:25:TYR:CZ	1:A:29:MET:HG3	2.44	0.51
1:A:11:GLN:HG2	1:A:35:LEU:CD2	2.43	0.47
1:A:86:GLU:HG2	1:A:90:SER:CB	2.45	0.46
1:A:62:ASN:C	1:A:63:VAL:HG13	2.40	0.46
1:A:26:CYS:HB2	1:A:99:THR:OG1	2.16	0.45
1:A:91:LYS:O	1:A:92:TYR:C	2.61	0.43
1:A:34:ASN:HD21	1:A:37:LYS:NZ	2.17	0.42
1:A:79:MET:O	1:A:103:ASN:HA	2.19	0.42
1:A:86:GLU:CG	1:A:90:SER:CB	2.98	0.42
1:A:86:GLU:OE2	1:A:90:SER:OG	2.29	0.41
1:A:24:ASN:O	1:A:25:TYR:C	2.64	0.40

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	122/124 (98%)	119 (98%)	3 (2%)	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	109/109 (100%)	103 (94%)	6 (6%)	19 2

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	LYS
1	A	22	SER
1	A	34	ASN
1	A	51	LEU
1	A	70	THR
1	A	83	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	24	ASN
1	A	34	ASN
1	A	105	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

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.