



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 09:44 PM UTC

PDB ID : 4MKY / pdb_00004mky
Title : Polymerase Domain from Mycobacterium tuberculosis Ligase D in complex with an annealed double-strand DNA break.
Authors : Brissett, N.C.; Doherty, A.J.
Deposited on : 2013-09-05
Resolution : 2.40 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

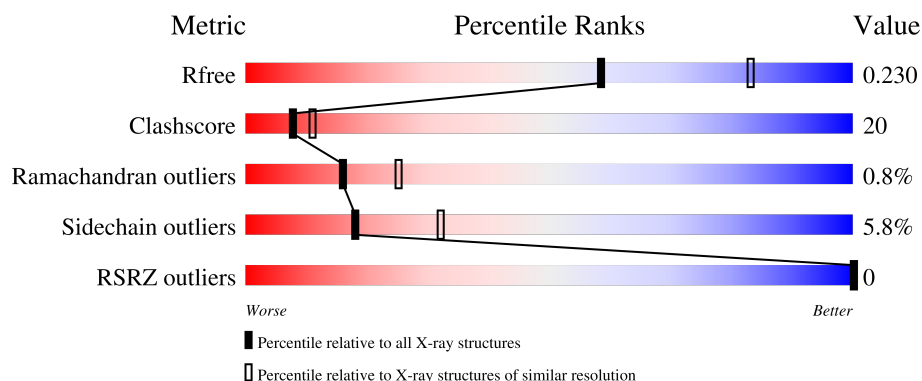
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 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.



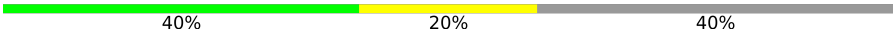
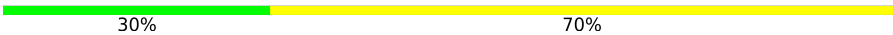
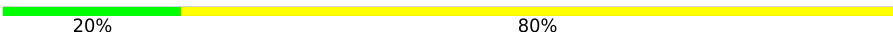
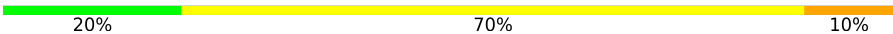
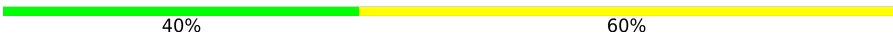
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	4912 (2.40-2.40)
Clashscore	190562	5391 (2.40-2.40)
Ramachandran outliers	187476	5320 (2.40-2.40)
Sidechain outliers	187428	5321 (2.40-2.40)
RSRZ outliers	180081	4916 (2.40-2.40)

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	303	
1	B	303	
1	C	303	
1	D	303	
2	E	5	

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Mol	Chain	Length	Quality of chain
2	G	5	 40% 20% 40%
2	I	5	 60% 40%
2	K	5	 60% 40%
3	F	10	 30% 70%
3	H	10	 20% 80%
3	J	10	 20% 70% 10%
3	L	10	 40% 60%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 9936 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 DNA ligase-like protein Rv0938/MT0965.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	284	Total	C	N	O	S	0	0	0
			2172	1372	387	408	5			
1	B	283	Total	C	N	O	S	0	0	0
			2164	1368	386	405	5			
1	C	284	Total	C	N	O	S	0	0	0
			2172	1372	387	408	5			
1	D	284	Total	C	N	O	S	0	0	0
			2172	1372	387	408	5			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	GLY	-	expression tag	UNP P71571
A	2	SER	-	expression tag	UNP P71571
A	3	HIS	-	expression tag	UNP P71571
B	1	GLY	-	expression tag	UNP P71571
B	2	SER	-	expression tag	UNP P71571
B	3	HIS	-	expression tag	UNP P71571
C	1	GLY	-	expression tag	UNP P71571
C	2	SER	-	expression tag	UNP P71571
C	3	HIS	-	expression tag	UNP P71571
D	1	GLY	-	expression tag	UNP P71571
D	2	SER	-	expression tag	UNP P71571
D	3	HIS	-	expression tag	UNP P71571

- Molecule 2 is a DNA chain called 5'-D(P*DGP*DCP*DGP*DGP*DC)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	E	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			
2	G	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	I	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			
2	K	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			

- Molecule 3 is a DNA chain called 5'-D(*DGP*DCP*DCP*DGP*DCP*DAP*DGP*DTP*DAP*DC)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	F	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			
3	H	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			
3	J	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			
3	L	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			

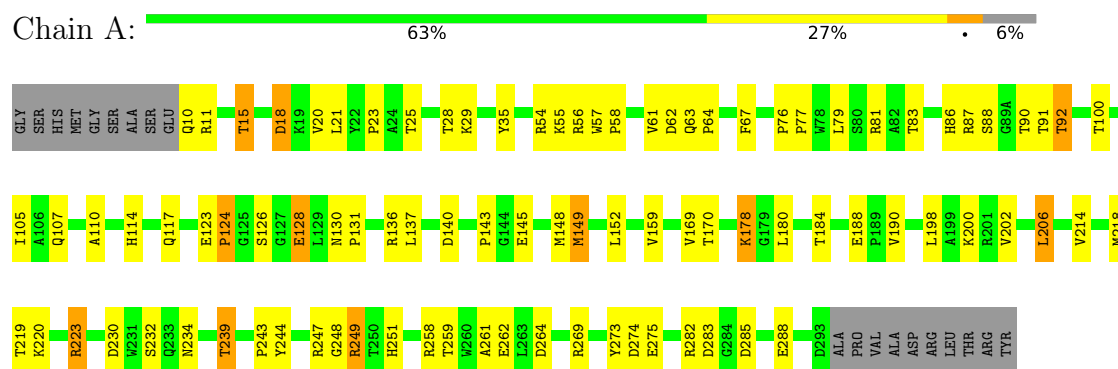
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	48	Total	O	0	0
			48	48		
4	B	23	Total	O	0	0
			23	23		
4	C	40	Total	O	0	0
			40	40		
4	D	56	Total	O	0	0
			56	56		
4	G	1	Total	O	0	0
			1	1		
4	K	2	Total	O	0	0
			2	2		
4	F	7	Total	O	0	0
			7	7		
4	H	7	Total	O	0	0
			7	7		
4	J	5	Total	O	0	0
			5	5		
4	L	7	Total	O	0	0
			7	7		

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.

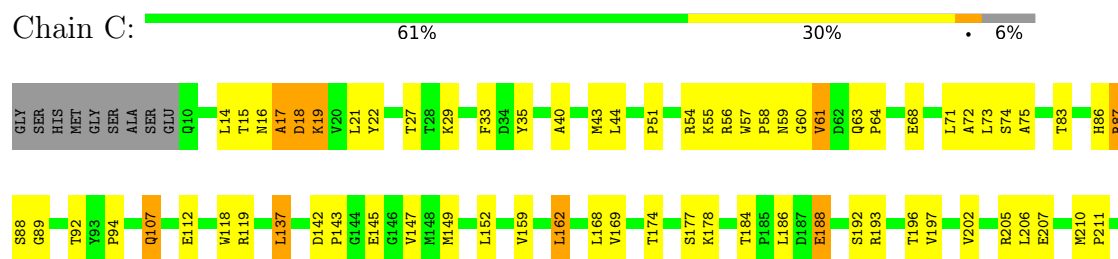
• Molecule 1: DNA ligase-like protein Rv0938/MT0965



• Molecule 1: DNA ligase-like protein Rv0938/MT0965

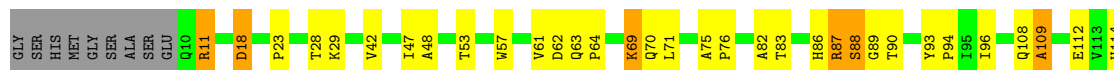


• Molecule 1: DNA ligase-like protein Rv0938/MT0965

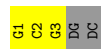




- Molecule 1: DNA ligase-like protein Rv0938/MT0965



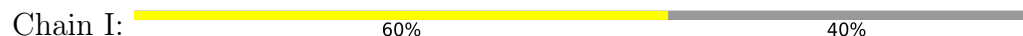
- Molecule 2: 5'-D(P*DGP*DCP*DGP*DGP*DC)-3'



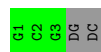
- Molecule 2: 5'-D(P*DGP*DCP*DGP*DGP*DC)-3'



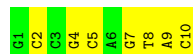
- Molecule 2: 5'-D(P*DGP*DCP*DGP*DGP*DC)-3'



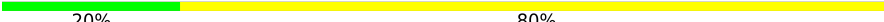
- Molecule 2: 5'-D(P*DGP*DCP*DGP*DGP*DC)-3'



- Molecule 3: 5'-D(*DGP*DCP*DCP*DGP*DCP*DAP*DGP*DTP*DAP*DC)-3'

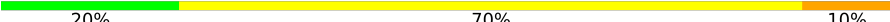


- Molecule 3: 5'-D(*DGP*DCP*DCP*DGP*DCP*DAP*DGP*DTP*DAP*DC)-3'

Chain H:  20% 80%

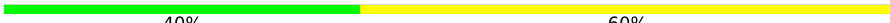


● Molecule 3: 5'-D(*DGP*DCP*DCP*DGP*DCP*DAP*DGP*DTP*DAP*DC)-3'

Chain J:  20% 70% 10%



● Molecule 3: 5'-D(*DGP*DCP*DCP*DGP*DCP*DAP*DGP*DTP*DAP*DC)-3'

Chain L:  40% 60%



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	87.58Å 80.11Å 118.39Å 90.00° 111.62° 90.00°	Depositor
Resolution (Å)	37.64 – 2.40 37.64 – 2.40	Depositor EDS
% Data completeness (in resolution range)	98.1 (37.64-2.40) 98.1 (37.64-2.40)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.12	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.17 (at 2.39Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.197 , 0.245 (Not available) , 0.230	Depositor DCC
R_{free} test set	2988 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å ²)	40.4	Xtriage
Anisotropy	0.638	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 26.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.41$, $\langle L^2 \rangle = 0.24$	Xtriage
Estimated twinning fraction	0.289 for h,-k,-h-l	Xtriage
Reported twinning fraction	0.710 for H, K, L 0.290 for H, -K, -H-L	Depositor
Outliers	1 of 58942 reflections (0.002%)	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	9936	wwPDB-VP
Average B, all atoms (Å ²)	46.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 18.60% 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	0.67	0/2222	0.97	1/3035 (0.0%)
1	B	0.62	0/2214	0.92	3/3024 (0.1%)
1	C	0.64	0/2222	0.94	3/3035 (0.1%)
1	D	0.80	0/2222	1.05	2/3035 (0.1%)
2	E	0.35	0/71	0.62	0/106
2	G	0.38	0/71	0.80	0/106
2	I	0.31	0/71	0.66	0/106
2	K	0.44	0/71	0.85	0/106
3	F	0.33	0/225	0.68	0/345
3	H	0.32	0/225	0.58	0/345
3	J	0.34	0/225	0.73	1/345 (0.3%)
3	L	0.36	0/225	0.77	0/345
All	All	0.66	0/10064	0.94	10/13933 (0.1%)

There are no bond length outliers.

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	188	GLU	CA-C-N	-7.65	112.46	120.03
1	C	188	GLU	C-N-CA	-7.65	112.46	120.03
1	A	178	LYS	N-CA-C	-6.25	106.63	114.56
3	J	9	DA	C2'-C3'-O3'	6.24	120.86	111.50
1	D	109	ALA	N-CA-C	-6.01	105.90	113.23

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	2172	0	2176	71	0
1	B	2164	0	2172	99	0
1	C	2172	0	2176	86	1
1	D	2172	0	2176	73	0
2	E	64	0	34	5	0
2	G	64	0	34	1	0
2	I	64	0	34	5	0
2	K	64	0	34	0	0
3	F	201	0	113	18	1
3	H	201	0	113	15	0
3	J	201	0	113	16	1
3	L	201	0	113	20	0
4	A	48	0	0	4	1
4	B	23	0	0	5	0
4	C	40	0	0	2	0
4	D	56	0	0	8	0
4	F	7	0	0	3	0
4	G	1	0	0	0	0
4	H	7	0	0	1	0
4	J	5	0	0	3	0
4	K	2	0	0	0	0
4	L	7	0	0	0	0
All	All	9936	0	9288	378	2

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 20.

The worst 5 of 378 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)
3:F:7:DG:N2	3:H:10:DC:N3	1.66	1.41
1:C:29:LYS:NZ	2:I:1:DG:OP1	1.74	1.19
1:A:249:ARG:HG2	1:A:249:ARG:HH11	1.04	1.16
3:J:8:DT:O4	3:L:9:DA:N6	1.83	1.12
1:B:241:ILE:HD12	1:B:241:ILE:H	1.11	1.12

All (2) 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:C:87:ARG:O	4:A:423:HOH:O[1_565]	1.94	0.26
3:F:2:DC:O2	3:J:1:DG:N2[2_646]	2.19	0.01

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	282/303 (93%)	265 (94%)	15 (5%)	2 (1%)	18	28
1	B	281/303 (93%)	262 (93%)	16 (6%)	3 (1%)	11	18
1	C	282/303 (93%)	264 (94%)	16 (6%)	2 (1%)	18	28
1	D	282/303 (93%)	260 (92%)	20 (7%)	2 (1%)	18	28
All	All	1127/1212 (93%)	1051 (93%)	67 (6%)	9 (1%)	16	25

5 of 9 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	18	ASP
1	C	18	ASP
1	C	87	ARG
1	D	87	ARG
1	D	150	ALA

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	228/242 (94%)	214 (94%)	14 (6%)	17	30
1	B	227/242 (94%)	212 (93%)	15 (7%)	15	26
1	C	228/242 (94%)	216 (95%)	12 (5%)	20	36
1	D	228/242 (94%)	216 (95%)	12 (5%)	20	36
All	All	911/968 (94%)	858 (94%)	53 (6%)	18	32

5 of 53 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	283	ASP
1	C	147	VAL
1	D	192	SER
1	C	19	LYS
1	C	107	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 13 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	114	HIS
1	D	59	ASN
1	D	251	HIS
1	D	130	ASN
1	D	208	GLN

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	284/303 (93%)	-1.45	0 100 100	23, 39, 61, 79	0
1	B	283/303 (93%)	-1.32	0 100 100	30, 50, 81, 95	0
1	C	284/303 (93%)	-1.33	0 100 100	27, 45, 77, 90	0
1	D	284/303 (93%)	-1.52	0 100 100	21, 32, 45, 60	0
2	E	3/5 (60%)	-1.61	0 100 100	61, 61, 64, 65	0
2	G	3/5 (60%)	-1.84	0 100 100	48, 48, 50, 53	0
2	I	3/5 (60%)	-1.67	0 100 100	65, 65, 65, 66	0
2	K	3/5 (60%)	-1.75	0 100 100	41, 41, 44, 51	0
3	F	10/10 (100%)	-1.57	0 100 100	63, 73, 76, 83	0
3	H	10/10 (100%)	-1.66	0 100 100	49, 57, 81, 81	0
3	J	10/10 (100%)	-1.64	0 100 100	61, 69, 77, 78	0
3	L	10/10 (100%)	-1.65	0 100 100	43, 54, 78, 80	0
All	All	1187/1272 (93%)	-1.41	0 100 100	21, 41, 76, 95	0

There are no RSRZ outliers to report.

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.