



# wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 1, 2016 – 07:05 PM GMT

PDB ID : 4NMK  
Title : Thermostable aldehyde dehydrogenase from *Pyrobaculum* sp. crystallized in microgravity (complex with NADP+)  
Authors : Petrova, T.; Boyko, K.M.; Bezsudnova, E.Y.; Mardanov, A.V.; Gumerov, V.M.; Ravin, N.V.; Popov, V.O.  
Deposited on : 2013-11-15  
Resolution : 1.90 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](mailto:validation@mail.wwpdb.org)  
A user guide is available at  
<http://wwpdb.org/validation/2016/XrayValidationReportHelp>  
with specific help available everywhere you see the ⓘ symbol.

---

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.7 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Refmac : 5.8.0135  
CCP4 : 6.5.0  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : trunk26865

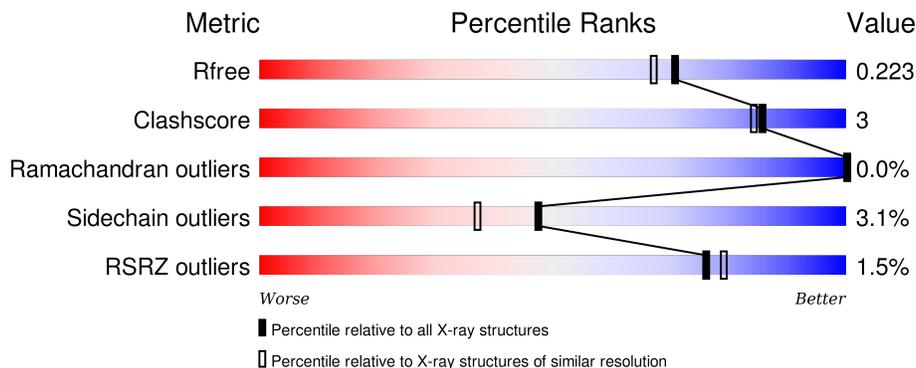
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 1.90 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))
$R_{free}$	91344	4755 (1.90-1.90)
Clashscore	102246	5398 (1.90-1.90)
Ramachandran outliers	100387	5338 (1.90-1.90)
Sidechain outliers	100360	5339 (1.90-1.90)
RSRZ outliers	91569	4766 (1.90-1.90)

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 on the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria. 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	491	 92% 7%
1	B	491	 92% 6%
1	C	491	 91% 9%
1	D	491	 87% 10%
1	E	491	 89% 9%

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Length	Quality of chain
1	F	491	2% 91% 8% .
1	G	491	% 90% 8% ..
1	H	491	% 92% 7% ..

## 2 Entry composition [i](#)

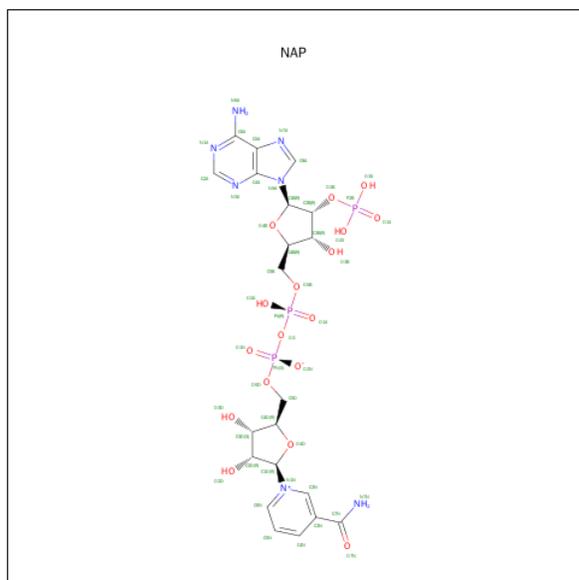
There are 3 unique types of molecules in this entry. The entry contains 33972 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Aldehyde dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	488	3810	2429	664	705	12	0	2	0
1	B	484	3784	2410	661	701	12	0	2	0
1	C	490	3866	2464	672	717	13	0	10	0
1	D	485	3787	2412	661	702	12	0	2	0
1	E	485	3789	2413	662	702	12	0	2	0
1	F	490	3830	2439	669	710	12	0	2	0
1	G	484	3780	2409	658	701	12	0	2	0
1	H	488	3854	2459	671	711	13	0	8	0

- Molecule 2 is NADP NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (three-letter code: NAP) (formula: C<sub>21</sub>H<sub>28</sub>N<sub>7</sub>O<sub>17</sub>P<sub>3</sub>).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
2	A	1	48	21	7	17	3	0	1
2	B	1	48	21	7	17	3	0	1
2	C	1	48	21	7	17	3	0	1
2	D	1	48	21	7	17	3	0	1
2	E	1	48	21	7	17	3	0	1
2	F	1	48	21	7	17	3	0	1
2	G	1	48	21	7	17	3	0	1
2	H	1	48	21	7	17	3	0	1

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	431	Total	O	0	7
			431	431		
3	B	385	Total	O	0	7
			385	385		
3	C	420	Total	O	0	10
			420	420		
3	D	356	Total	O	0	2
			356	356		

*Continued on next page...*

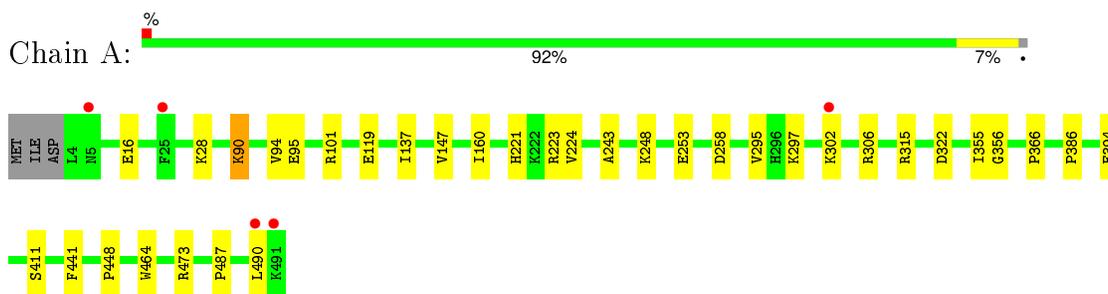
*Continued from previous page...*

<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
3	E	331	Total 331	O 331	0	7
3	F	382	Total 382	O 382	0	4
3	G	363	Total 363	O 363	0	6
3	H	420	Total 420	O 420	0	5

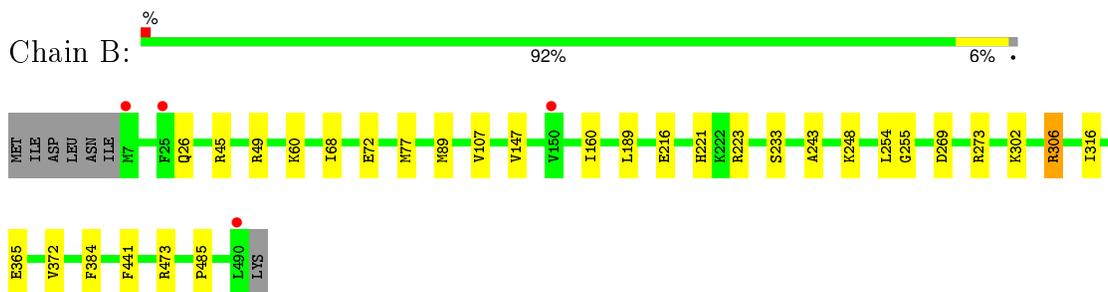
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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.

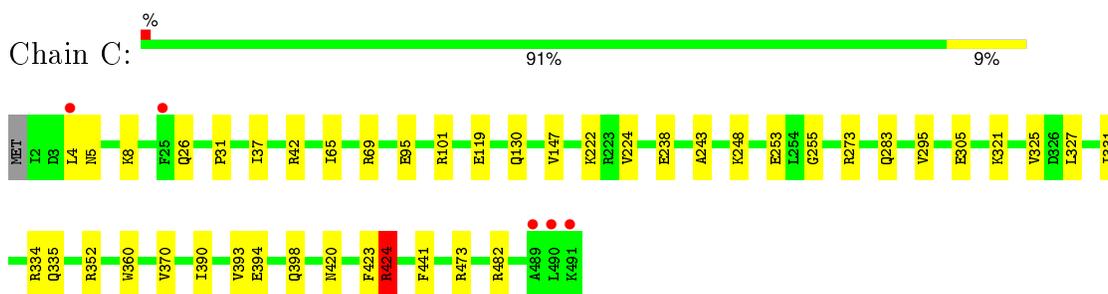
- Molecule 1: Aldehyde dehydrogenase



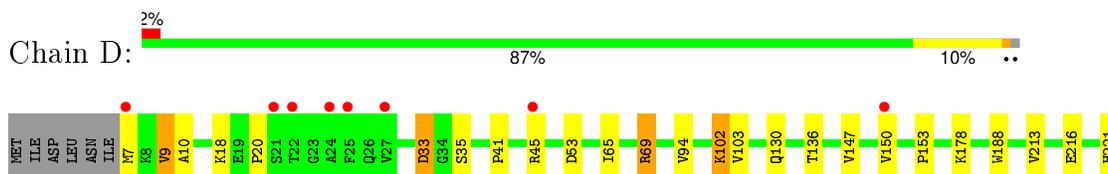
- Molecule 1: Aldehyde dehydrogenase

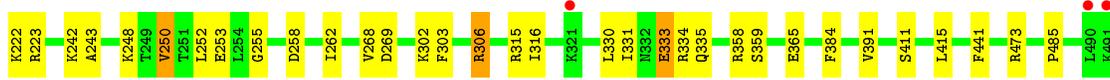


- Molecule 1: Aldehyde dehydrogenase

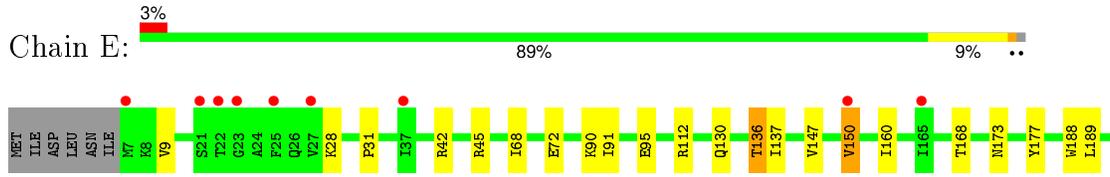


- Molecule 1: Aldehyde dehydrogenase

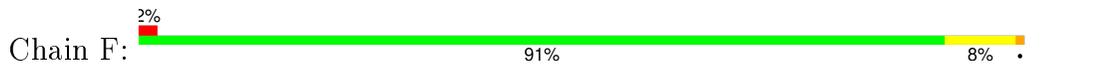




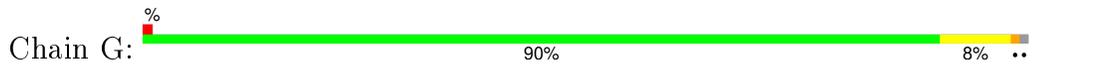
● Molecule 1: Aldehyde dehydrogenase



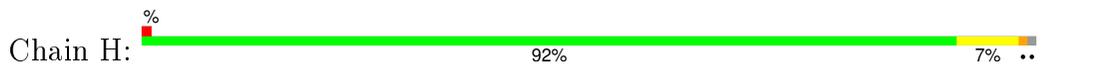
● Molecule 1: Aldehyde dehydrogenase



● Molecule 1: Aldehyde dehydrogenase



● Molecule 1: Aldehyde dehydrogenase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 2 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	163.81Å 185.36Å 208.30Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.14 – 1.90 29.63 – 1.90	Depositor EDS
% Data completeness (in resolution range)	87.6 (29.14-1.90) 87.6 (29.63-1.90)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.22 (at 1.89Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.2_1309)	Depositor
R, $R_{free}$	0.189 , 0.221 0.192 , 0.223	Depositor DCC
$R_{free}$ test set	21766 reflections (5.28%)	DCC
Wilson B-factor (Å <sup>2</sup> )	25.0	Xtriage
Anisotropy	0.176	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.36 , 47.9	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.52$ , $\langle L^2 \rangle = 0.35$	Xtriage
Outliers	7 of 434135 reflections (0.002%)	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	33972	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	22.0	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 47.96 % 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 9.2060e-05. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.375 respectively for untwinned datasets, and 0.333, 0.2 for perfectly twinned datasets.

## 5 Model quality [i](#)

### 5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: NAP

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	0.39	0/3889	0.53	0/5271
1	B	0.38	0/3863	0.52	0/5236
1	C	0.48	2/3947 (0.1%)	0.55	1/5351 (0.0%)
1	D	0.39	0/3866	0.52	0/5241
1	E	0.36	0/3868	0.51	0/5243
1	F	0.38	0/3909	0.53	0/5298
1	G	0.37	0/3859	0.52	0/5231
1	H	0.40	0/3937	0.53	0/5335
All	All	0.39	2/31138 (0.0%)	0.53	1/42206 (0.0%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	8[A]	LYS	CD-CE	11.55	1.80	1.51
1	C	8[B]	LYS	CD-CE	11.55	1.80	1.51

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	424	ARG	NE-CZ-NH1	5.75	123.17	120.30

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	3810	0	3815	19	0
1	B	3784	0	3784	18	0
1	C	3866	0	3860	22	0
1	D	3787	0	3779	26	0
1	E	3789	0	3786	30	0
1	F	3830	0	3831	23	0
1	G	3780	0	3777	24	0
1	H	3854	0	3864	17	0
2	A	48	0	13	1	0
2	B	48	0	13	3	0
2	C	48	0	13	1	0
2	D	48	0	13	2	0
2	E	48	0	12	5	0
2	F	48	0	13	1	0
2	G	48	0	13	1	0
2	H	48	0	13	2	0
3	A	431	0	0	0	0
3	B	385	0	0	3	0
3	C	420	0	0	4	0
3	D	356	0	0	3	0
3	E	331	0	0	1	0
3	F	382	0	0	2	0
3	G	363	0	0	1	0
3	H	420	0	0	2	0
All	All	33972	0	30599	170	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 3.

The worst 5 of 170 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:H:255:GLY:H	2:H:500[C]:NAP:H71N	1.27	0.83
1:E:255:GLY:H	2:E:500[C]:NAP:H71N	1.26	0.80
1:D:20:PRO:HG3	1:D:41:PRO:HB3	1.65	0.79
1:G:255:GLY:H	2:G:500[C]:NAP:H71N	1.36	0.74
1:A:315:ARG:NH2	1:A:322:ASP:OD2	2.23	0.69

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	488/491 (99%)	475 (97%)	13 (3%)	0	100	100
1	B	484/491 (99%)	472 (98%)	12 (2%)	0	100	100
1	C	496/491 (101%)	483 (97%)	13 (3%)	0	100	100
1	D	485/491 (99%)	475 (98%)	9 (2%)	1 (0%)	52	42
1	E	485/491 (99%)	473 (98%)	12 (2%)	0	100	100
1	F	490/491 (100%)	478 (98%)	12 (2%)	0	100	100
1	G	484/491 (99%)	470 (97%)	14 (3%)	0	100	100
1	H	493/491 (100%)	481 (98%)	12 (2%)	0	100	100
All	All	3905/3928 (99%)	3807 (98%)	97 (2%)	1 (0%)	100	100

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	153	PRO

### 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	404/408 (99%)	395 (98%)	9 (2%)	60	53
1	B	401/408 (98%)	394 (98%)	7 (2%)	68	64
1	C	410/408 (100%)	395 (96%)	15 (4%)	41	29
1	D	400/408 (98%)	378 (94%)	22 (6%)	27	14

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	E	401/408 (98%)	389 (97%)	12 (3%)	48	38
1	F	406/408 (100%)	395 (97%)	11 (3%)	52	43
1	G	400/408 (98%)	386 (96%)	14 (4%)	43	31
1	H	409/408 (100%)	391 (96%)	18 (4%)	35	22
All	All	3231/3264 (99%)	3123 (97%)	108 (3%)	47	34

5 of 108 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	333	GLU
1	E	321	LYS
1	H	250	VAL
1	D	415	LEU
1	E	136	THR

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

Mol	Chain	Res	Type
1	C	26	GLN
1	D	26	GLN
1	E	130	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 carbohydrates in this entry.

### 5.6 Ligand geometry [i](#)

8 ligands 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
2	NAP	A	500[C]	-	42,52,52	2.86	16 (38%)	54,80,80	2.11	12 (22%)
2	NAP	B	500[C]	-	42,52,52	2.85	16 (38%)	54,80,80	2.31	13 (24%)
2	NAP	C	500[C]	-	42,52,52	2.80	16 (38%)	54,80,80	2.13	10 (18%)
2	NAP	D	500[C]	-	42,52,52	2.77	15 (35%)	54,80,80	2.20	12 (22%)
2	NAP	E	500[C]	-	42,52,52	2.82	15 (35%)	54,80,80	2.34	14 (25%)
2	NAP	F	500[C]	-	42,52,52	2.72	14 (33%)	54,80,80	2.50	12 (22%)
2	NAP	G	500[C]	-	42,52,52	2.79	16 (38%)	54,80,80	2.02	11 (20%)
2	NAP	H	500[C]	-	42,52,52	2.81	14 (33%)	54,80,80	2.09	16 (29%)

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
2	NAP	A	500[C]	-	-	0/27/67/67	0/5/5/5
2	NAP	B	500[C]	-	-	0/27/67/67	0/5/5/5
2	NAP	C	500[C]	-	-	0/27/67/67	0/5/5/5
2	NAP	D	500[C]	-	-	0/27/67/67	0/5/5/5
2	NAP	E	500[C]	-	-	0/27/67/67	0/5/5/5
2	NAP	F	500[C]	-	-	0/27/67/67	0/5/5/5
2	NAP	G	500[C]	-	-	0/27/67/67	0/5/5/5
2	NAP	H	500[C]	-	-	0/27/67/67	0/5/5/5

The worst 5 of 122 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	500[C]	NAP	C3B-C2B	-5.06	1.41	1.53
2	C	500[C]	NAP	C3B-C2B	-5.03	1.41	1.53
2	F	500[C]	NAP	C3B-C2B	-4.96	1.41	1.53
2	G	500[C]	NAP	C3B-C2B	-4.90	1.41	1.53
2	H	500[C]	NAP	C3B-C2B	-4.87	1.42	1.53

The worst 5 of 100 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	500[C]	NAP	C1B-N9A-C4A	-8.41	114.26	126.94
2	B	500[C]	NAP	N3A-C2A-N1A	-8.37	122.49	128.89
2	D	500[C]	NAP	N3A-C2A-N1A	-8.24	122.58	128.89
2	F	500[C]	NAP	N3A-C2A-N1A	-8.13	122.67	128.89
2	E	500[C]	NAP	N3A-C2A-N1A	-8.00	122.77	128.89

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

8 monomers are involved in 16 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	500[C]	NAP	1	0
2	B	500[C]	NAP	3	0
2	C	500[C]	NAP	1	0
2	D	500[C]	NAP	2	0
2	E	500[C]	NAP	5	0
2	F	500[C]	NAP	1	0
2	G	500[C]	NAP	1	0
2	H	500[C]	NAP	2	0

## 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q < 0.9
1	A	488/491 (99%)	-0.21	5 (1%) 84 86	9, 17, 33, 52	0
1	B	484/491 (98%)	-0.24	4 (0%) 87 88	10, 18, 36, 55	0
1	C	490/491 (99%)	-0.25	5 (1%) 84 86	10, 18, 32, 66	3 (0%)
1	D	485/491 (98%)	-0.15	11 (2%) 64 67	10, 21, 40, 64	0
1	E	485/491 (98%)	-0.06	13 (2%) 58 61	11, 23, 42, 67	0
1	F	490/491 (99%)	-0.26	8 (1%) 74 78	10, 19, 36, 59	0
1	G	484/491 (98%)	-0.22	7 (1%) 78 80	9, 21, 36, 48	0
1	H	488/491 (99%)	-0.26	7 (1%) 78 80	9, 17, 33, 65	1 (0%)
All	All	3894/3928 (99%)	-0.21	60 (1%) 76 79	9, 19, 36, 67	4 (0%)

The worst 5 of 60 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	E	491	LYS	7.4
1	D	7	MET	6.9
1	F	491	LYS	5.2
1	C	491	LYS	5.1
1	H	491	LYS	5.0

### 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 carbohydrates 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. The B-factors column lists the minimum, median, 95<sup>th</sup> 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	LLDF	B-factors(Å <sup>2</sup> )	Q<0.9
2	NAP	D	500[C]	48/48	0.92	0.14	1.56	20,26,31,38	21
2	NAP	B	500[C]	48/48	0.93	0.14	1.08	18,25,30,33	21
2	NAP	H	500[C]	48/48	0.95	0.12	1.02	15,22,29,30	17
2	NAP	C	500[C]	48/48	0.95	0.12	0.72	16,22,29,32	17
2	NAP	F	500[C]	48/48	0.95	0.12	0.71	15,25,31,33	17
2	NAP	E	500[C]	48/48	0.93	0.12	0.58	19,31,38,42	21
2	NAP	G	500[C]	48/48	0.95	0.11	0.49	17,25,32,36	17
2	NAP	A	500[C]	48/48	0.95	0.10	0.19	14,23,27,33	17

## 6.5 Other polymers [i](#)

There are no such residues in this entry.