



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 1, 2016 – 02:08 AM GMT

PDB ID : 2FSV
Title : Structure of transhydrogenase (dI.D135N.NAD⁺)₂(dIII.E155W.NADP⁺)₁ asymmetric complex
Authors : Brondijk, T.H.; van Boxel, G.I.; Mather, O.C.; Quirk, P.G.; White, S.A.; Jackson, J.B.
Deposited on : 2006-01-23
Resolution : 2.30 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
<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

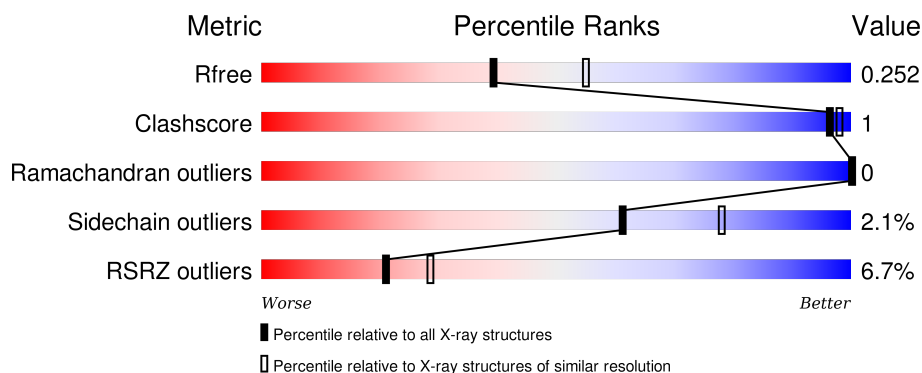
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.30 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	3852 (2.30-2.30)
Clashscore	102246	4452 (2.30-2.30)
Ramachandran outliers	100387	4410 (2.30-2.30)
Sidechain outliers	100360	4409 (2.30-2.30)
RSRZ outliers	91569	3857 (2.30-2.30)

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 ≥ 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	384	<div> <div>8%</div> <div>91%</div> <div>5%</div> </div>
1	B	384	<div> <div>4%</div> <div>89%</div> <div>5%</div> <div>6%</div> </div>
2	C	203	<div> <div>6%</div> <div>82%</div> <div>14%</div> </div>

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
5	GOL	A	803	-	-	-	X

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 7169 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 NAD(P) transhydrogenase subunit alpha part 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	366	Total	C	N	O	S	0	0	0
			2695	1705	467	506	17			
1	B	361	Total	C	N	O	S	0	0	0
			2658	1682	461	499	16			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	135	ASN	ASP	ENGINEERED	UNP Q60164
B	135	ASN	ASP	ENGINEERED	UNP Q60164

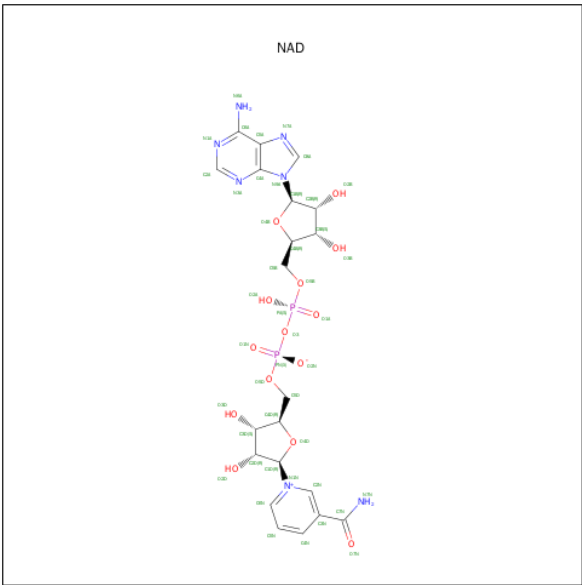
- Molecule 2 is a protein called NAD(P) transhydrogenase subunit beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	174	Total	C	N	O	S	0	1	0
			1324	840	220	253	11			

There is a discrepancy between the modelled and reference sequences:

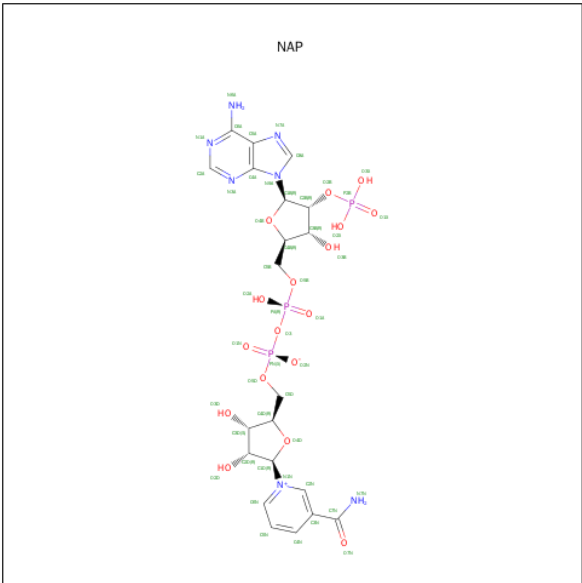
Chain	Residue	Modelled	Actual	Comment	Reference
C	155	TRP	GLU	ENGINEERED	UNP Q59765

- Molecule 3 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (three-letter code: NAD) (formula: C₂₁H₂₇N₇O₁₄P₂).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			44	21	7	14	2		

- Molecule 4 is NADP NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (three-letter code: NAP) (formula: C₂₁H₂₈N₇O₁₇P₃).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	C	1	Total	C	N	O	P	0	0
			48	21	7	17	3		

- Molecule 5 is GLYCEROL (three-letter code: GOL) (formula: C₃H₈O₃).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	1	Total C O 6 3 3	0	0
5	B	1	Total C O 6 3 3	0	0
5	B	1	Total C O 6 3 3	0	0

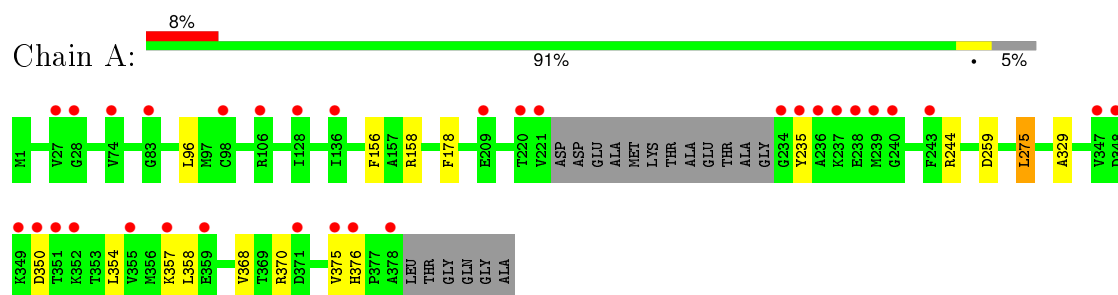
- Molecule 6 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	160	Total O 160 160	0	0
6	B	163	Total O 163 163	0	0
6	C	59	Total O 59 59	0	0

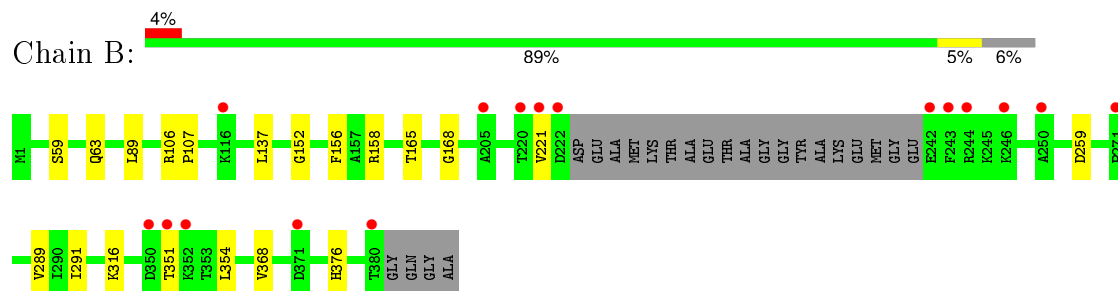
3 Residue-property plots [i](#)

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.

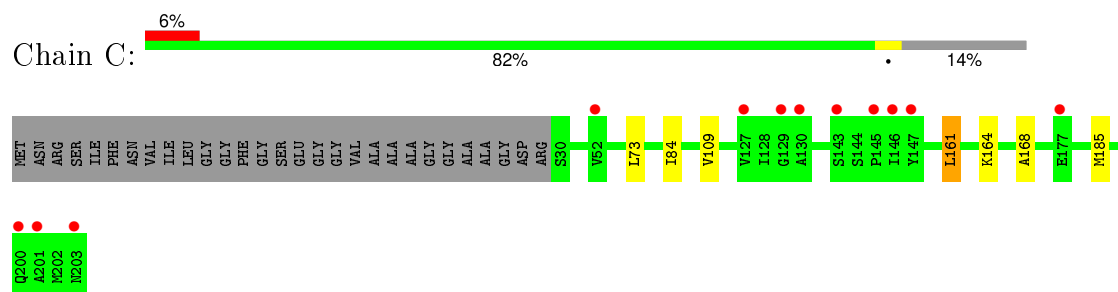
- Molecule 1: NAD(P) transhydrogenase subunit alpha part 1



- Molecule 1: NAD(P) transhydrogenase subunit alpha part 1



- Molecule 2: NAD(P) transhydrogenase subunit beta



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	72.91Å 73.87Å 205.17Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	31.37 – 2.30 31.37 – 2.30	Depositor EDS
% Data completeness (in resolution range)	100.0 (31.37-2.30) 100.0 (31.37-2.30)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.07	Depositor
$\langle I/\sigma(I) \rangle$ ¹	6.34 (at 2.29Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.202 , 0.248 0.206 , 0.252	Depositor DCC
R_{free} test set	2542 reflections (5.34%)	DCC
Wilson B-factor (Å ²)	38.6	Xtriage
Anisotropy	0.651	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 35.1	EDS
Estimated twinning fraction	0.018 for k,h,-l	Xtriage
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Outliers	0 of 50105 reflections	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	7169	wwPDB-VP
Average B, all atoms (Å ²)	53.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.28% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: GOL, NAP, NAD

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	0.33	0/2731	0.55	0/3700
1	B	0.33	0/2693	0.55	0/3652
2	C	0.34	0/1349	0.52	0/1825
All	All	0.33	0/6773	0.54	0/9177

There are no bond length outliers.

There are no bond angle outliers.

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	2695	0	2831	6	0
1	B	2658	0	2799	9	0
2	C	1324	0	1312	5	0
3	A	44	0	26	0	0
4	C	48	0	25	0	0
5	A	6	0	8	0	0
5	B	12	0	16	0	0
6	A	160	0	0	0	0
6	B	163	0	0	0	0
6	C	59	0	0	0	0
All	All	7169	0	7017	19	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 1.

All (19) 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)
2:C:84:ILE:HD11	2:C:109:VAL:HG13	1.80	0.62
2:C:84:ILE:HD12	2:C:84:ILE:N	2.20	0.56
1:B:368:VAL:HA	1:B:376:HIS:HB2	1.93	0.51
2:C:84:ILE:CD1	2:C:109:VAL:HG13	2.41	0.51
1:B:152:GLY:HA2	1:B:291:ILE:HD11	1.96	0.47
1:A:178:PHE:HB3	1:A:275:LEU:HD23	1.98	0.46
1:A:156:PHE:CZ	1:A:259:ASP:HB3	2.52	0.44
1:A:156:PHE:CE2	1:A:158:ARG:HB2	2.53	0.44
1:A:368:VAL:HA	1:A:376:HIS:HB2	2.00	0.43
1:B:59:SER:OG	1:B:63:GLN:NE2	2.46	0.43
1:B:165:THR:OG1	1:B:168:GLY:O	2.21	0.43
1:A:370:ARG:HG2	1:A:375:VAL:HG21	2.02	0.42
1:A:329:ALA:HB3	1:B:158:ARG:HG2	2.01	0.42
2:C:164:LYS:NZ	2:C:168:ALA:O	2.47	0.41
1:B:156:PHE:CZ	1:B:259:ASP:HB3	2.56	0.41
2:C:161:LEU:HA	2:C:185:MET:O	2.21	0.41
1:B:156:PHE:CE2	1:B:158:ARG:HB2	2.57	0.40
1:B:289:VAL:HG22	1:B:316:LYS:HB2	2.03	0.40
1:B:106:ARG:N	1:B:107:PRO:CD	2.84	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	362/384 (94%)	349 (96%)	13 (4%)	0	100	100
1	B	357/384 (93%)	349 (98%)	8 (2%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	C	173/203 (85%)	168 (97%)	5 (3%)	0	100	100
All	All	892/971 (92%)	866 (97%)	26 (3%)	0	100	100

There are no Ramachandran outliers to report.

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	285/296 (96%)	277 (97%)	8 (3%)	51	68
1	B	283/296 (96%)	278 (98%)	5 (2%)	66	82
2	C	139/154 (90%)	137 (99%)	2 (1%)	74	86
All	All	707/746 (95%)	692 (98%)	15 (2%)	61	78

All (15) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	96	LEU
1	A	235	TYR
1	A	244	ARG
1	A	275	LEU
1	A	350	ASP
1	A	354	LEU
1	A	357	LYS
1	A	358	LEU
1	B	89	LEU
1	B	137	LEU
1	B	221	VAL
1	B	351	THR
1	B	354	LEU
2	C	73	LEU
2	C	161	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such

sidechains are listed below:

Mol	Chain	Res	Type
1	A	247	GLN
1	B	63	GLN
1	B	210	GLN
2	C	120	GLN
2	C	197	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](#)

5 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	$\# Z > 2$
3	NAD	A	600	-	38,48,48	2.18	8 (21%)	47,73,73	1.97	7 (14%)
5	GOL	A	803	-	5,5,5	0.37	0	5,5,5	0.39	0
5	GOL	B	801	-	5,5,5	0.34	0	5,5,5	0.36	0
5	GOL	B	802	-	5,5,5	0.35	0	5,5,5	0.26	0
4	NAP	C	700	-	42,52,52	2.16	8 (19%)	54,80,80	1.92	8 (14%)

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
3	NAD	A	600	-	-	0/22/62/62	0/5/5/5
5	GOL	A	803	-	-	0/4/4/4	0/0/0/0
5	GOL	B	801	-	-	0/4/4/4	0/0/0/0
5	GOL	B	802	-	-	0/4/4/4	0/0/0/0
4	NAP	C	700	-	-	0/27/67/67	0/5/5/5

All (16) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	600	NAD	C2N-C3N	-3.00	1.34	1.39
4	C	700	NAP	C2N-C3N	-2.79	1.34	1.39
3	A	600	NAD	C3N-C7N	-2.52	1.46	1.50
4	C	700	NAP	C6N-C5N	-2.34	1.33	1.38
4	C	700	NAP	C3N-C7N	-2.24	1.47	1.50
3	A	600	NAD	C6N-C5N	-2.22	1.33	1.38
4	C	700	NAP	O4D-C1D	2.01	1.43	1.41
3	A	600	NAD	C5A-C4A	2.19	1.45	1.40
4	C	700	NAP	C6N-N1N	4.25	1.46	1.35
3	A	600	NAD	C6N-N1N	4.89	1.48	1.35
4	C	700	NAP	C4A-N3A	5.82	1.44	1.35
3	A	600	NAD	C5N-C4N	5.95	1.51	1.38
3	A	600	NAD	C4A-N3A	6.14	1.44	1.35
4	C	700	NAP	C5N-C4N	6.32	1.51	1.38
3	A	600	NAD	C4N-C3N	6.48	1.50	1.39
4	C	700	NAP	C4N-C3N	7.55	1.52	1.39

All (15) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	600	NAD	N3A-C2A-N1A	-9.00	122.00	128.89
4	C	700	NAP	N3A-C2A-N1A	-8.86	122.11	128.89
4	C	700	NAP	C5N-C4N-C3N	-5.11	113.91	120.33
4	C	700	NAP	C4A-C5A-N7A	-4.42	105.42	109.48
3	A	600	NAD	C4A-C5A-N7A	-4.29	105.54	109.48
3	A	600	NAD	PN-O3-PA	-3.11	123.99	132.73
3	A	600	NAD	C4B-O4B-C1B	-2.09	107.42	109.72
3	A	600	NAD	C3N-C7N-N7N	2.10	120.12	117.82
4	C	700	NAP	C2N-C3N-C4N	2.29	120.84	118.29
4	C	700	NAP	C3N-C7N-N7N	2.59	120.65	117.82
4	C	700	NAP	C2A-N1A-C6A	2.61	123.43	118.77

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	C	700	NAP	O3X-P2B-O2X	2.66	117.51	107.38
3	A	600	NAD	C2A-N1A-C6A	3.08	124.27	118.77
4	C	700	NAP	O4D-C1D-N1N	3.09	111.53	108.13
3	A	600	NAD	O4D-C1D-N1N	5.24	113.89	108.13

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 [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 ⓘ

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	366/384 (95%)	0.45	32 (8%) 13 18	28, 53, 100, 127	1 (0%)
1	B	361/384 (94%)	0.27	16 (4%) 38 47	26, 46, 78, 128	1 (0%)
2	C	174/203 (85%)	0.51	12 (6%) 20 27	31, 58, 80, 96	1 (0%)
All	All	901/971 (92%)	0.39	60 (6%) 21 29	26, 51, 88, 128	3 (0%)

All (60) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	222	ASP	6.7
1	A	235	TYR	6.5
1	A	350	ASP	6.5
1	A	349	LYS	5.9
1	B	221	VAL	5.6
1	B	242	GLU	5.2
1	A	234	GLY	5.1
1	A	376	HIS	5.0
1	A	347	VAL	4.7
1	A	351	THR	4.6
1	B	244	ARG	4.6
1	A	237	LYS	4.5
1	A	348	ASP	4.4
1	A	378	ALA	4.4
2	C	203	ASN	4.0
1	A	106	ARG	3.7
1	B	205	ALA	3.7
1	B	351	THR	3.4
1	B	220	THR	3.3
1	A	371	ASP	3.3
1	B	352	LYS	3.3
2	C	143	SER	3.2
1	B	243	PHE	3.1

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Mol	Chain	Res	Type	RSRZ
2	C	146	ILE	3.0
1	A	128	ILE	3.0
1	A	243	PHE	3.0
1	A	74	VAL	3.0
1	A	355	VAL	3.0
1	A	357	LYS	2.9
1	A	375	VAL	2.8
1	A	352	LYS	2.8
1	B	250	ALA	2.8
1	A	98	CYS	2.8
1	A	221	VAL	2.7
1	B	380	THR	2.7
1	A	28	GLY	2.7
2	C	129	GLY	2.7
1	B	246	LYS	2.7
1	A	239	MET	2.7
1	A	220	THR	2.6
2	C	127	VAL	2.6
1	A	27	VAL	2.5
2	C	177	GLU	2.5
2	C	52	VAL	2.5
2	C	145	PRO	2.4
1	B	116	LYS	2.4
2	C	200	GLN	2.3
1	A	209	GLU	2.3
2	C	147	TYR	2.3
1	A	236	ALA	2.3
2	C	130	ALA	2.3
2	C	201	ALA	2.3
1	A	83	GLY	2.2
1	B	371	ASP	2.1
1	B	271	PRO	2.1
1	A	238	GLU	2.1
1	A	359	GLU	2.1
1	B	350	ASP	2.1
1	A	240	GLY	2.0
1	A	136	ILE	2.0

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

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, 95th 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(\AA^2)	Q<0.9
5	GOL	A	803	6/6	0.78	0.43	5.57	82,83,83,83	0
5	GOL	B	802	6/6	0.85	0.18	1.23	54,56,57,57	0
5	GOL	B	801	6/6	0.95	0.16	0.37	45,45,46,46	0
3	NAD	A	600	44/44	0.90	0.20	0.05	50,57,80,80	0
4	NAP	C	700	48/48	0.95	0.14	-0.24	41,45,51,53	0

6.5 Other polymers [i](#)

There are no such residues in this entry.