Full wwPDB X-ray Structure Validation Report (i)

Aug 16, 2023 – 12:37 AM EDT

PDB ID	:	1U28
Title	:	R. rubrum transhydrogenase asymmetric complex (dI.NAD+)2(dIII.NADP+)1
Authors	:	Mather, O.C.; Singh, A.; van Boxel, G.I.; White, S.A.; Jackson, J.B.
Deposited on	:	2004-07-16
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
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) 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 (1)) were used in the production of this report:

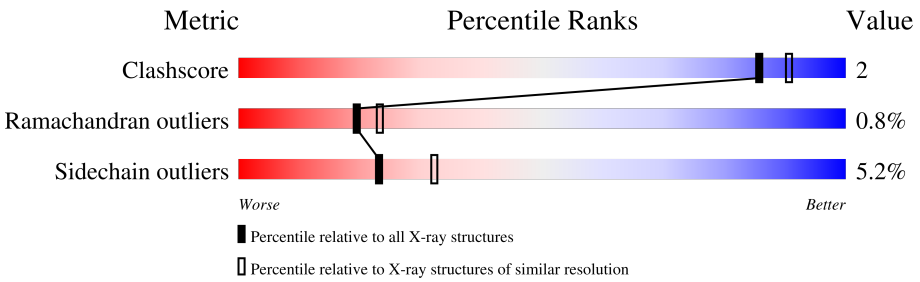
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.35

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 2.30 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))
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (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 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 <=5%

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	384	90% 8% •
1	B	384	86% 6% • 7%
2	C	203	72% 11% • 14%

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 6974 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.

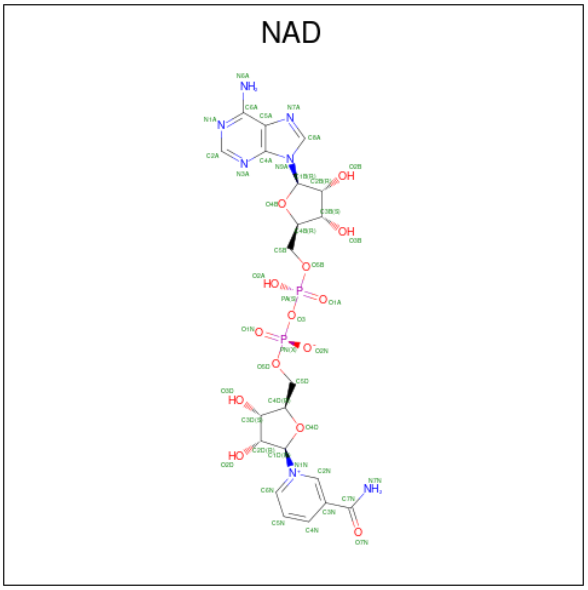
- Molecule 1 is a protein called NAD(P) transhydrogenase subunit alpha part 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	378	2779	1753	479	529	18	0	0	0
1	B	359	2635	1666	458	495	16	0	0	0

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

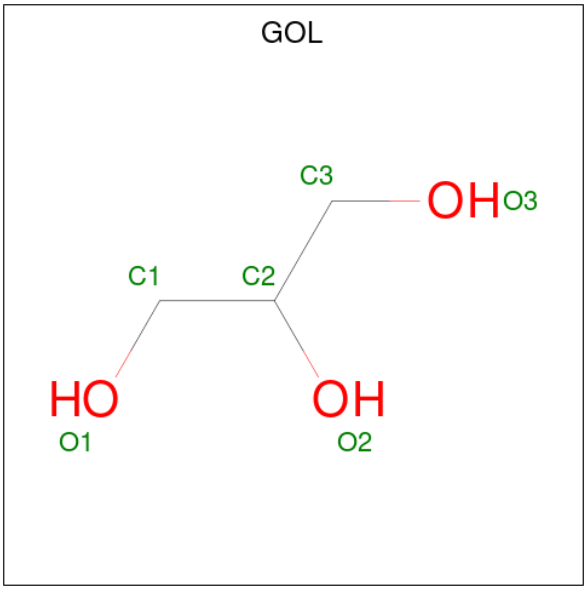
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	C	174	1311	830	217	253	11	0	0	0

- Molecule 3 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (three-letter code: NAD) (formula: $C_{21}H_{27}N_7O_{14}P_2$).



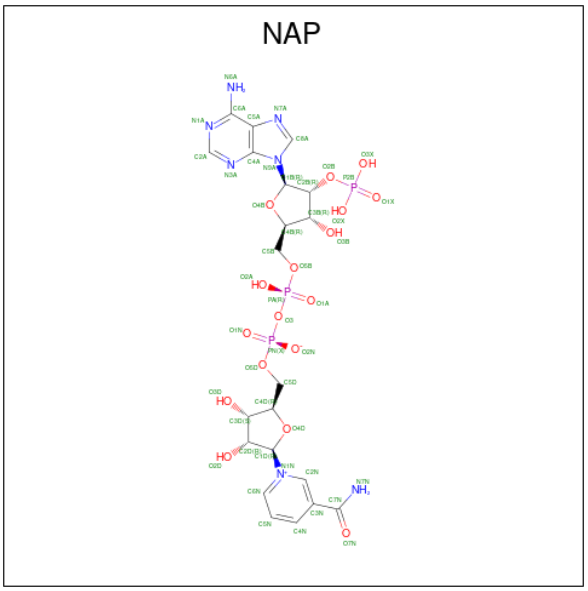
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
3	A	1	52	27	8	15	2	0	1
			Total	C	N	O	P		
3	B	1	27	10	5	10	2	0	0

- Molecule 4 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).



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

- Molecule 5 is NADP NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (three-letter code: NAP) (formula: $C_{21}H_{28}N_7O_{17}P_3$).



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

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
6	A	39	39	39	0	0
			Total	O		
6	B	64	64	64	0	0
			Total	O		
6	C	7	7	7	0	0

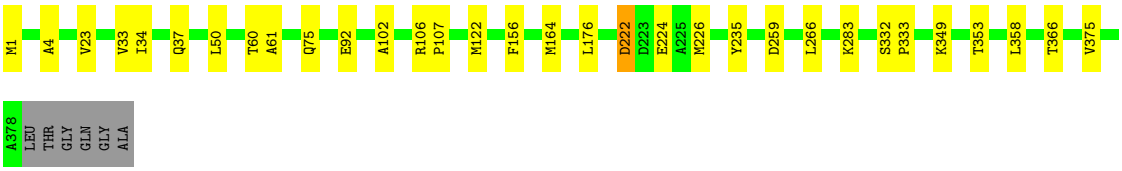
3 Residue-property plots (i)

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. 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.

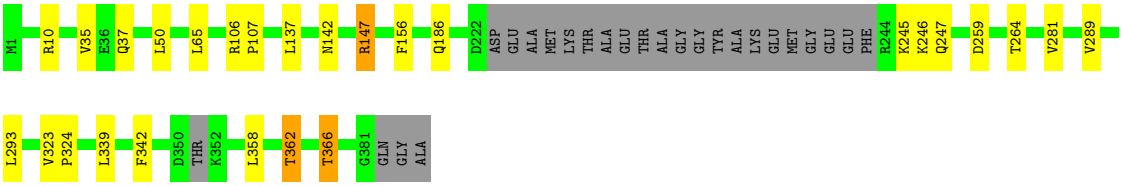
• Molecule 1: NAD(P) transhydrogenase subunit alpha part 1

Chain A:



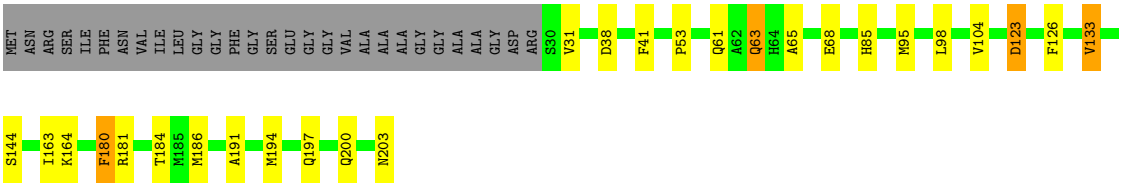
• Molecule 1: NAD(P) transhydrogenase subunit alpha part 1

Chain B:



• Molecule 2: NAD(P) transhydrogenase subunit beta

Chain C:



4 Data and refinement statistics (i)

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	71.66Å 73.96Å 204.17Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	49.00 – 2.30	Depositor
% Data completeness (in resolution range)	(Not available) (49.00-2.30)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	0.08	Depositor
Refinement program	REFMAC 5.0, TNT	Depositor
R, R_{free}	0.241 , 0.275	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	6974	wwPDB-VP
Average B, all atoms (Å^2)	63.0	wwPDB-VP

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: GOL, NAD, 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	0/2816	0.55	0/3816
1	B	0.42	0/2668	0.60	2/3616 (0.1%)
2	C	0.40	0/1334	0.52	0/1803
All	All	0.41	0/6818	0.56	2/9235 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	B	147	ARG	NE-CZ-NH2	-6.30	117.15	120.30
1	B	147	ARG	NE-CZ-NH1	5.46	123.03	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	2779	0	2904	8	0
1	B	2635	0	2777	9	0
2	C	1311	0	1303	13	0
3	A	52	0	12	0	0
3	B	27	0	12	0	0
4	B	12	0	16	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	C	48	0	25	1	0
6	A	39	0	0	0	0
6	B	64	0	0	1	0
6	C	7	0	0	0	0
All	All	6974	0	7049	30	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 2.

All (30) 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:B:142:ASN:HD21	1:B:186:GLN:HE21	1.10	0.91
1:B:142:ASN:ND2	1:B:186:GLN:HE21	1.90	0.65
2:C:63:GLN:HG2	2:C:98:LEU:HB3	1.85	0.58
1:B:362:THR:HG21	6:B:810:HOH:O	2.09	0.52
1:A:23:VAL:HG12	1:A:33:VAL:HG11	1.92	0.52
1:A:122:MET:HA	1:A:122:MET:HE2	1.91	0.51
1:A:332:SER:HB2	1:A:333:PRO:HD3	1.93	0.50
1:B:156:PHE:CZ	1:B:259:ASP:HB3	2.46	0.50
2:C:126:PHE:CZ	2:C:163:ILE:HD11	2.47	0.49
2:C:194:MET:HA	2:C:197:GLN:HE21	1.78	0.48
2:C:85:HIS:CG	2:C:133:VAL:HG22	2.47	0.48
1:B:10:ARG:HH11	1:B:10:ARG:HG3	1.80	0.47
2:C:53:PRO:HB2	2:C:95:MET:CE	2.46	0.46
1:B:264:THR:HG22	1:B:293:LEU:HD12	1.98	0.45
1:A:4:ALA:HA	1:A:34:ILE:O	2.17	0.44
1:A:106:ARG:N	1:A:107:PRO:CD	2.80	0.44
2:C:184:THR:HG22	2:C:186:MET:CE	2.47	0.44
1:A:156:PHE:CZ	1:A:259:ASP:HB3	2.53	0.44
1:B:342:PHE:CZ	1:B:366:THR:HG21	2.53	0.43
1:B:106:ARG:N	1:B:107:PRO:CD	2.81	0.43
2:C:41:PHE:CD1	2:C:41:PHE:C	2.91	0.43
2:C:31:VAL:HG12	2:C:180:PHE:CD1	2.55	0.42
2:C:191:ALA:HB2	5:C:400:NAP:C2A	2.50	0.42
1:A:222:ASP:HA	1:A:226:MET:HG3	2.02	0.41
2:C:65:ALA:HA	2:C:68:GLU:HG2	2.02	0.41
1:B:323:VAL:N	1:B:324:PRO:CD	2.83	0.41
2:C:61:GLN:HA	2:C:63:GLN:OE1	2.20	0.41
2:C:63:GLN:HE21	2:C:63:GLN:HB2	1.66	0.41
2:C:123:ASP:N	2:C:123:ASP:OD2	2.53	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:60:THR:OG1	1:A:61:ALA:N	2.54	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	376/384 (98%)	350 (93%)	19 (5%)	7 (2%)	8 7
1	B	353/384 (92%)	344 (98%)	9 (2%)	0	100 100
2	C	172/203 (85%)	166 (96%)	6 (4%)	0	100 100
All	All	901/971 (93%)	860 (95%)	34 (4%)	7 (1%)	19 23

All (7) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	102	ALA
1	A	222	ASP
1	A	349	LYS
1	A	366	THR
1	A	224	GLU
1	A	358	LEU
1	A	375	VAL

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	293/296 (99%)	282 (96%)	11 (4%)	33	47
1	B	280/296 (95%)	265 (95%)	15 (5%)	22	30
2	C	138/154 (90%)	127 (92%)	11 (8%)	12	15
All	All	711/746 (95%)	674 (95%)	37 (5%)	23	32

All (37) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	MET
1	A	37	GLN
1	A	50	LEU
1	A	75	GLN
1	A	92	GLU
1	A	164	MET
1	A	176	LEU
1	A	235	TYR
1	A	266	LEU
1	A	283	LYS
1	A	353	THR
1	B	35	VAL
1	B	37	GLN
1	B	50	LEU
1	B	65	LEU
1	B	137	LEU
1	B	147	ARG
1	B	245	LYS
1	B	246	LYS
1	B	247	GLN
1	B	281	VAL
1	B	289	VAL
1	B	339	LEU
1	B	358	LEU
1	B	362	THR
1	B	366	THR
2	C	38	ASP
2	C	63	GLN
2	C	104	VAL
2	C	123	ASP
2	C	133	VAL
2	C	144	SER
2	C	164	LYS
2	C	180	PHE

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Mol	Chain	Res	Type
2	C	181	ARG
2	C	200	GLN
2	C	203	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (14) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	75	GLN
1	A	105	ASN
1	A	132	GLN
1	A	247	GLN
1	A	338	ASN
1	B	67	GLN
1	B	142	ASN
1	B	210	GLN
1	B	247	GLN
2	C	45	ASN
2	C	63	GLN
2	C	131	ASN
2	C	197	GLN
2	C	203	ASN

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 monosaccharides in this entry.

5.6 Ligand geometry (i)

6 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	500[B]	-	42,48,48	1.77	4 (9%)	50,73,73	1.19	3 (6%)
5	NAP	C	400	-	45,52,52	1.67	3 (6%)	56,80,80	1.23	2 (3%)
4	GOL	B	800	-	5,5,5	0.36	0	5,5,5	0.27	0
4	GOL	B	700	-	5,5,5	0.36	0	5,5,5	0.33	0
3	NAD	B	600	-	24,29,48	0.96	1 (4%)	29,45,73	1.40	4 (13%)
3	NAD	A	500[A]	-	42,48,48	1.82	4 (9%)	50,73,73	1.17	2 (4%)

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	500[B]	-	-	4/26/62/62	0/5/5/5
5	NAP	C	400	-	-	9/31/67/67	0/5/5/5
4	GOL	B	800	-	-	2/4/4/4	-
4	GOL	B	700	-	-	2/4/4/4	-
3	NAD	B	600	-	-	3/12/32/62	0/3/3/5
3	NAD	A	500[A]	-	-	5/26/62/62	0/5/5/5

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	500[A]	NAD	O7N-C7N	9.35	1.42	1.24
3	A	500[B]	NAD	O7N-C7N	8.98	1.41	1.24
5	C	400	NAP	O7N-C7N	8.52	1.40	1.24
3	A	500[A]	NAD	C2A-N3A	4.24	1.38	1.32
3	A	500[B]	NAD	C2A-N3A	4.24	1.38	1.32
5	C	400	NAP	C2A-N3A	4.12	1.38	1.32
3	A	500[A]	NAD	C2A-N1A	2.65	1.38	1.33
3	A	500[B]	NAD	C2A-N1A	2.65	1.38	1.33
5	C	400	NAP	C2A-N1A	2.61	1.38	1.33

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	600	NAD	C5A-C4A	2.56	1.47	1.40
3	A	500[A]	NAD	C2N-N1N	2.29	1.37	1.35
3	A	500[B]	NAD	C2N-N1N	2.27	1.37	1.35

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	C	400	NAP	N3A-C2A-N1A	-6.07	119.19	128.68
3	A	500[A]	NAD	N3A-C2A-N1A	-5.63	119.88	128.68
3	A	500[B]	NAD	N3A-C2A-N1A	-5.63	119.88	128.68
3	B	600	NAD	N3A-C2A-N1A	-4.01	122.42	128.68
3	B	600	NAD	C4A-C5A-N7A	-2.72	106.57	109.40
3	A	500[A]	NAD	PN-O3-PA	-2.39	124.62	132.83
3	A	500[B]	NAD	PN-O3-PA	-2.39	124.62	132.83
3	B	600	NAD	C2A-N1A-C6A	2.38	122.82	118.75
3	A	500[B]	NAD	C3N-C7N-N7N	2.32	120.54	117.75
3	B	600	NAD	C1B-N9A-C4A	-2.31	122.58	126.64
5	C	400	NAP	C1B-N9A-C4A	-2.23	122.72	126.64

There are no chirality outliers.

All (25) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	500[A]	NAD	C5D-O5D-PN-O3
3	A	500[A]	NAD	O4D-C1D-N1N-C6N
3	A	500[B]	NAD	C5D-O5D-PN-O3
3	B	600	NAD	C5B-O5B-PA-O3
4	B	800	GOL	O1-C1-C2-C3
5	C	400	NAP	O4D-C1D-N1N-C2N
5	C	400	NAP	O4D-C1D-N1N-C6N
5	C	400	NAP	C2D-C1D-N1N-C6N
4	B	700	GOL	C1-C2-C3-O3
4	B	800	GOL	O1-C1-C2-O2
4	B	700	GOL	O2-C2-C3-O3
5	C	400	NAP	PN-O3-PA-O1A
3	A	500[A]	NAD	C5D-O5D-PN-O1N
3	A	500[A]	NAD	C5D-O5D-PN-O2N
3	A	500[B]	NAD	C5D-O5D-PN-O1N
3	A	500[B]	NAD	C5D-O5D-PN-O2N
3	B	600	NAD	C5B-O5B-PA-O1A
3	B	600	NAD	C5B-O5B-PA-O2A
5	C	400	NAP	O4B-C4B-C5B-O5B

Continued on next page...

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Mol	Chain	Res	Type	Atoms
5	C	400	NAP	C5B-O5B-PA-O3
5	C	400	NAP	C2D-C1D-N1N-C2N
3	A	500[A]	NAD	C5B-O5B-PA-O1A
3	A	500[B]	NAD	C5B-O5B-PA-O1A
5	C	400	NAP	C5B-O5B-PA-O2A
5	C	400	NAP	O4D-C4D-C5D-O5D

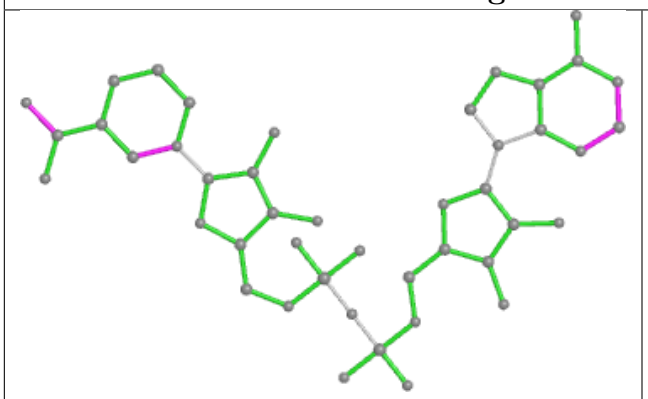
There are no ring outliers.

1 monomer is involved in 1 short contact:

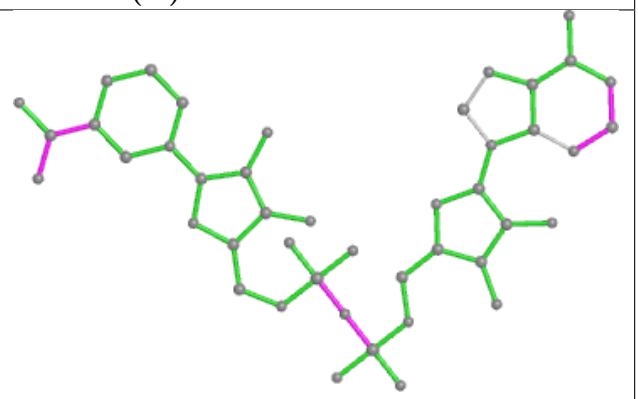
Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	C	400	NAP	1	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

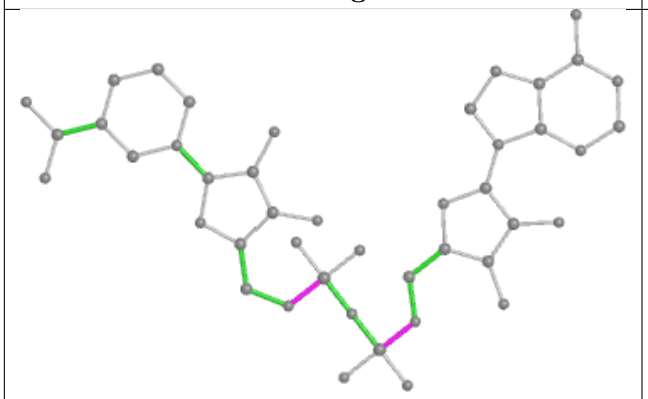
Ligand NAD A 500 (B)



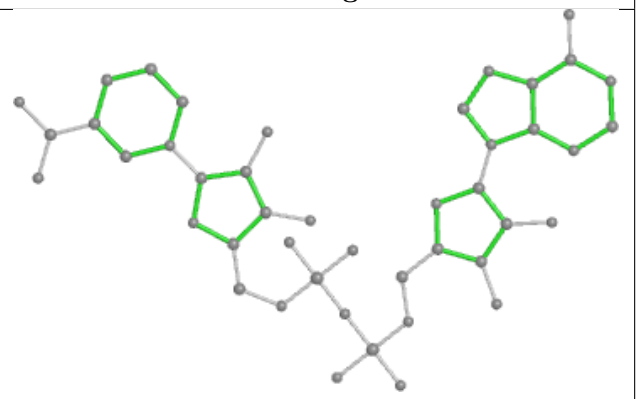
Bond lengths



Bond angles

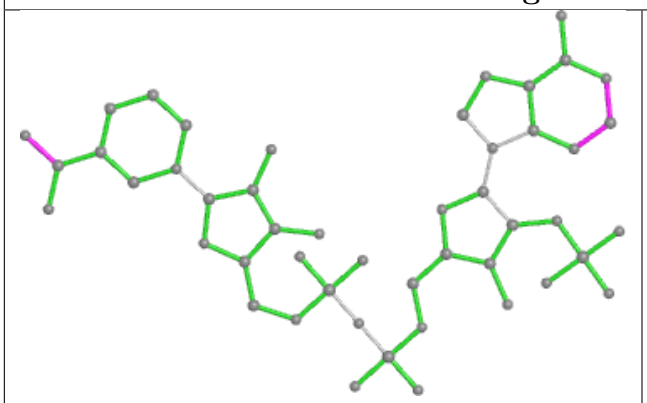


Torsions

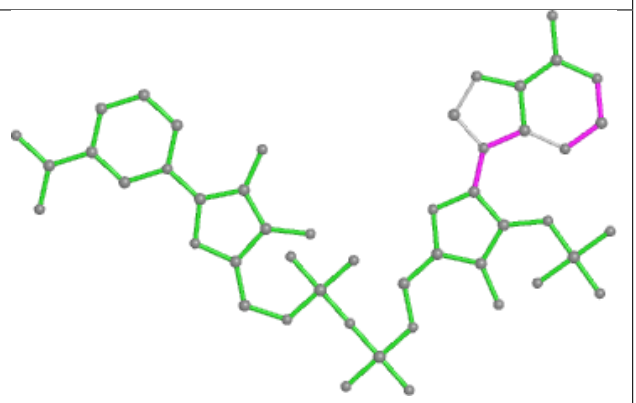


Rings

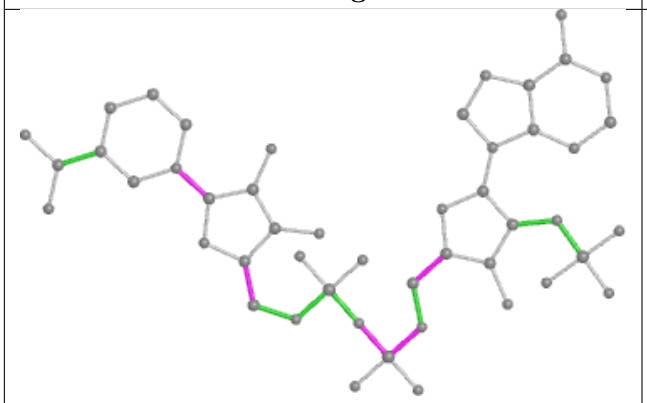
Ligand NAP C 400



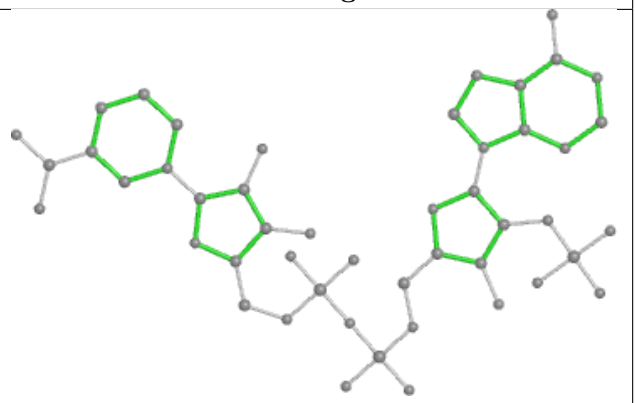
Bond lengths



Bond angles

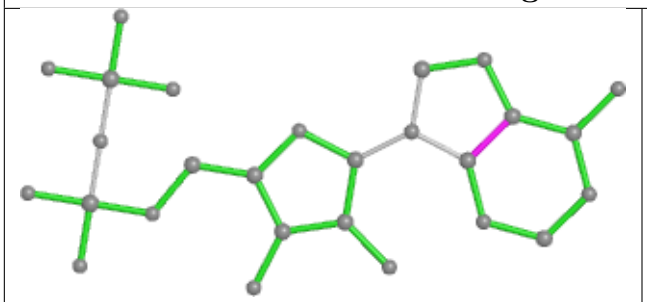


Torsions

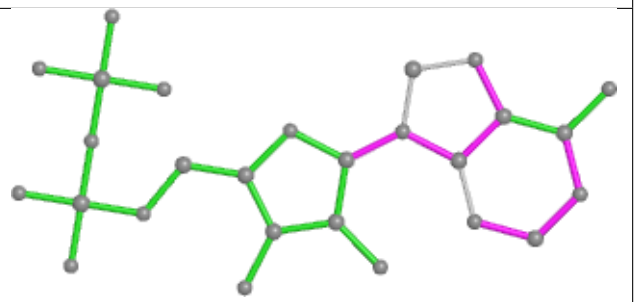


Rings

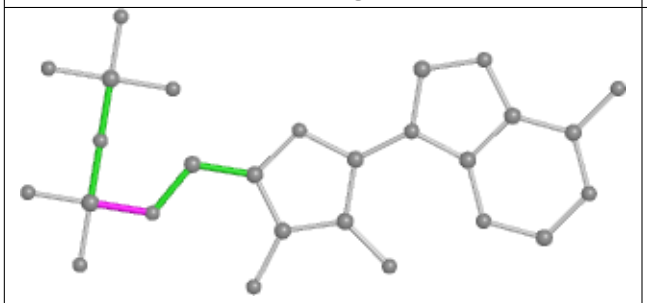
Ligand NAD B 600



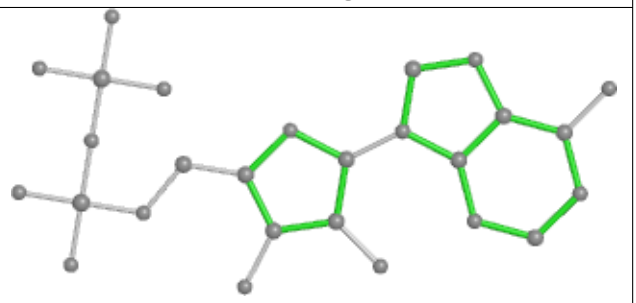
Bond lengths



Bond angles

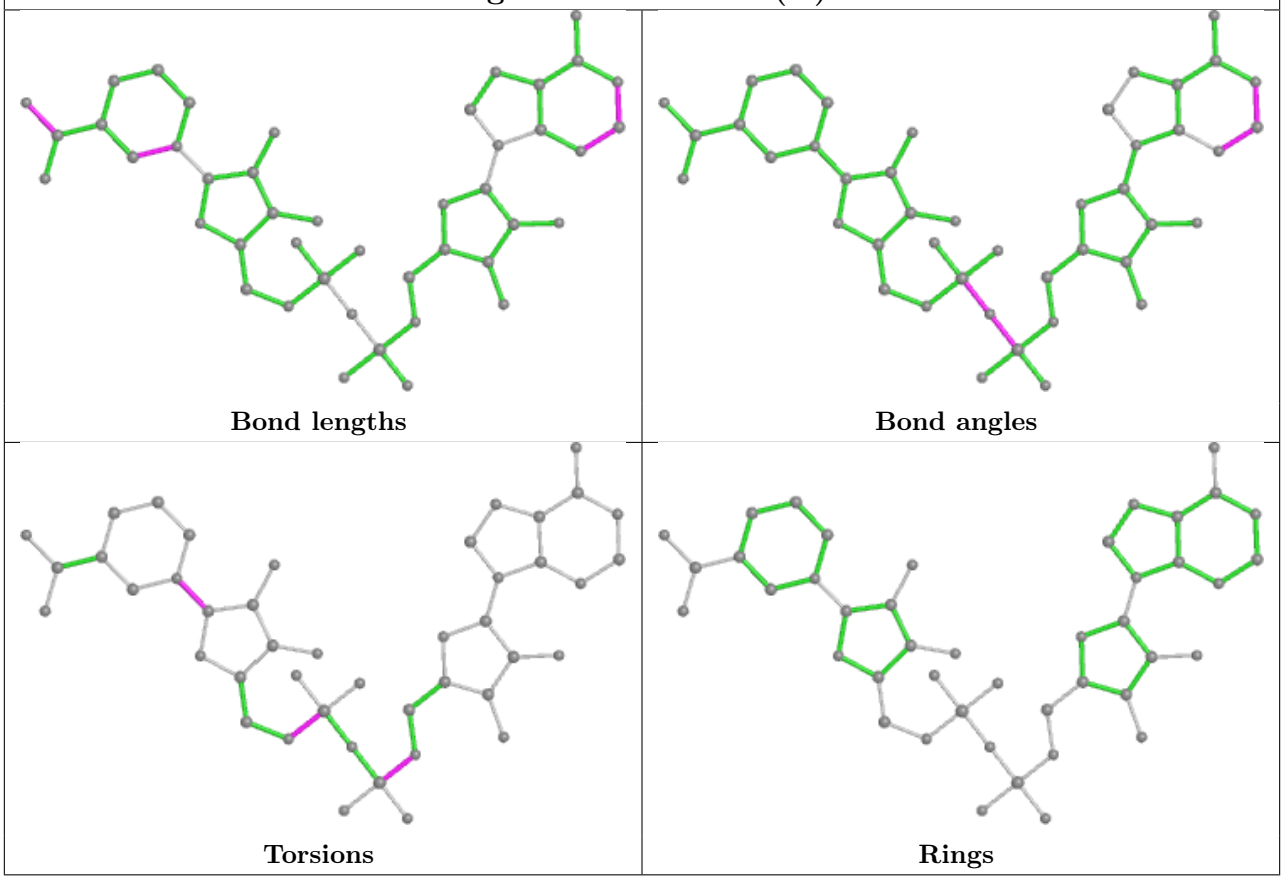


Torsions



Rings

Ligand NAD A 500 (A)



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)

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates (i)

EDS was not executed - this section is therefore empty.

6.4 Ligands (i)

EDS was not executed - this section is therefore empty.

6.5 Other polymers (i)

EDS was not executed - this section is therefore empty.