WORLDWIDE PDB
PROTEIN DATA BANK

Full wwPDB X-ray Structure Validation Report (i)

Dec 20, 2023 – 12:17 pm GMT

PDB ID	:	8QC8
Title	:	Crystal structure of NAD-dependent glycoside hydrolase from Flavobacterium sp. (strain K172) in complex with co-factor NAD+
Authors	:	Pickles, I.B.; Sharma, M.; Davies, G.J.
Deposited on	:	2023-08-25
Resolution	:	2.35 Å(reported)

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

|		
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

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 2.35 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	Percentile Ranks	Value
Rfree		0.280
Clashscore		3
Ramachandran outliers		0.3%
Sidechain outliers		1.1%

Worse *Better*

▌Percentile relative to all X-ray structures

▯Percentile relative to X-ray structures of similar resolution
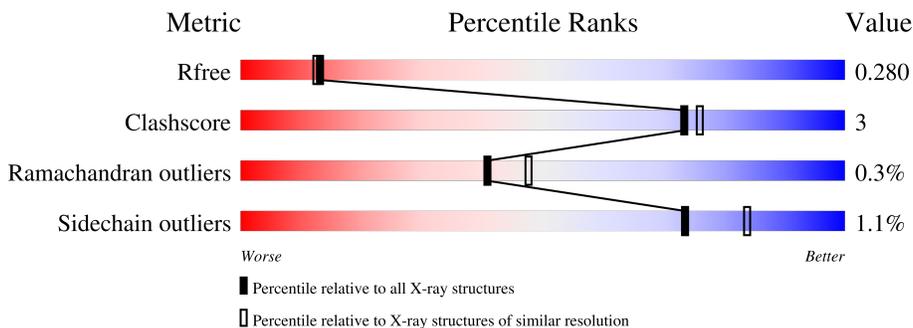
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	1164 (2.36-2.36)
Clashscore	141614	1232 (2.36-2.36)
Ramachandran outliers	138981	1211 (2.36-2.36)
Sidechain outliers	138945	1212 (2.36-2.36)

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%

Mol	Chain	Length	Quality of chain
1	A	393	85% 7% · 7%
1	B	393	86% 7% · 7%
1	C	393	85% 7% · 7%
1	D	393	77% 9% · 14%

2 Entry composition ⓘ

There are 4 unique types of molecules in this entry. The entry contains 11279 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 Gfo/Idh/MocA family oxidoreductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	B	367	Total	C	N	O	S	0	0	0
			2785	1766	476	530	13			
1	C	364	Total	C	N	O	S	0	0	0
			2758	1748	473	525	12			
1	D	339	Total	C	N	O	S	0	0	0
			2513	1585	440	476	12			
1	A	364	Total	C	N	O	S	0	0	0
			2767	1752	472	530	13			

There are 52 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-12	MET	-	initiating methionine	UNP A0A7D7VZ79
B	-11	GLY	-	expression tag	UNP A0A7D7VZ79
B	-10	SER	-	expression tag	UNP A0A7D7VZ79
B	-9	SER	-	expression tag	UNP A0A7D7VZ79
B	-8	HIS	-	expression tag	UNP A0A7D7VZ79
B	-7	HIS	-	expression tag	UNP A0A7D7VZ79
B	-6	HIS	-	expression tag	UNP A0A7D7VZ79
B	-5	HIS	-	expression tag	UNP A0A7D7VZ79
B	-4	HIS	-	expression tag	UNP A0A7D7VZ79
B	-3	HIS	-	expression tag	UNP A0A7D7VZ79
B	-2	SER	-	expression tag	UNP A0A7D7VZ79
B	-1	SER	-	expression tag	UNP A0A7D7VZ79
B	0	GLY	-	expression tag	UNP A0A7D7VZ79
C	-12	MET	-	initiating methionine	UNP A0A7D7VZ79
C	-11	GLY	-	expression tag	UNP A0A7D7VZ79
C	-10	SER	-	expression tag	UNP A0A7D7VZ79
C	-9	SER	-	expression tag	UNP A0A7D7VZ79
C	-8	HIS	-	expression tag	UNP A0A7D7VZ79
C	-7	HIS	-	expression tag	UNP A0A7D7VZ79
C	-6	HIS	-	expression tag	UNP A0A7D7VZ79
C	-5	HIS	-	expression tag	UNP A0A7D7VZ79

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Chain	Residue	Modelled	Actual	Comment	Reference
C	-4	HIS	-	expression tag	UNP A0A7D7VZ79
C	-3	HIS	-	expression tag	UNP A0A7D7VZ79
C	-2	SER	-	expression tag	UNP A0A7D7VZ79
C	-1	SER	-	expression tag	UNP A0A7D7VZ79
C	0	GLY	-	expression tag	UNP A0A7D7VZ79
D	-12	MET	-	initiating methionine	UNP A0A7D7VZ79
D	-11	GLY	-	expression tag	UNP A0A7D7VZ79
D	-10	SER	-	expression tag	UNP A0A7D7VZ79
D	-9	SER	-	expression tag	UNP A0A7D7VZ79
D	-8	HIS	-	expression tag	UNP A0A7D7VZ79
D	-7	HIS	-	expression tag	UNP A0A7D7VZ79
D	-6	HIS	-	expression tag	UNP A0A7D7VZ79
D	-5	HIS	-	expression tag	UNP A0A7D7VZ79
D	-4	HIS	-	expression tag	UNP A0A7D7VZ79
D	-3	HIS	-	expression tag	UNP A0A7D7VZ79
D	-2	SER	-	expression tag	UNP A0A7D7VZ79
D	-1	SER	-	expression tag	UNP A0A7D7VZ79
D	0	GLY	-	expression tag	UNP A0A7D7VZ79
A	-12	MET	-	initiating methionine	UNP A0A7D7VZ79
A	-11	GLY	-	expression tag	UNP A0A7D7VZ79
A	-10	SER	-	expression tag	UNP A0A7D7VZ79
A	-9	SER	-	expression tag	UNP A0A7D7VZ79
A	-8	HIS	-	expression tag	UNP A0A7D7VZ79
A	-7	HIS	-	expression tag	UNP A0A7D7VZ79
A	-6	HIS	-	expression tag	UNP A0A7D7VZ79
A	-5	HIS	-	expression tag	UNP A0A7D7VZ79
A	-4	HIS	-	expression tag	UNP A0A7D7VZ79
A	-3	HIS	-	expression tag	UNP A0A7D7VZ79
A	-2	SER	-	expression tag	UNP A0A7D7VZ79
A	-1	SER	-	expression tag	UNP A0A7D7VZ79
A	0	GLY	-	expression tag	UNP A0A7D7VZ79

- Molecule 2 is PHOSPHATE ION (three-letter code: PO4) (formula: O_4P).

PO4

O3

O⁻

O2 O⁻ — P ═ O O1

P

O⁻

O4
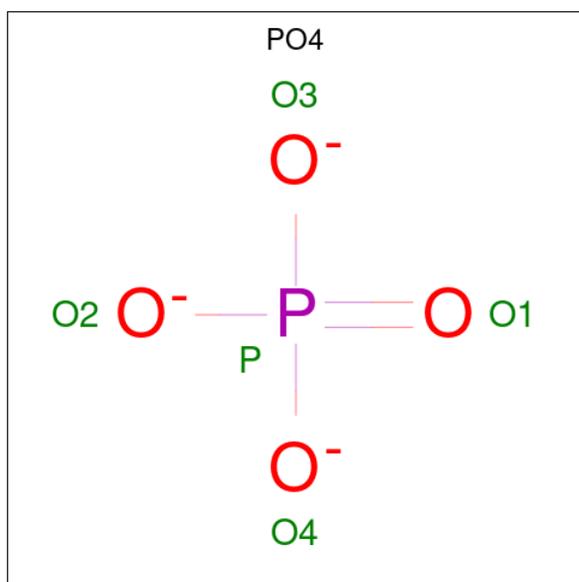
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	B	1	Total 5	O 4	P 1	0	0
2	C	1	Total 5	O 4	P 1	0	0
2	C	1	Total 5	O 4	P 1	0	0
2	C	1	Total 5	O 4	P 1	0	0
2	D	1	Total 5	O 4	P 1	0	0
2	A	1	Total 5	O 4	P 1	0	0

- Molecule 3 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (three-letter code: NAD) (formula: $C_{21}H_{27}N_7O_{14}P_2$) (labeled as "Ligand of Interest" by depositor).
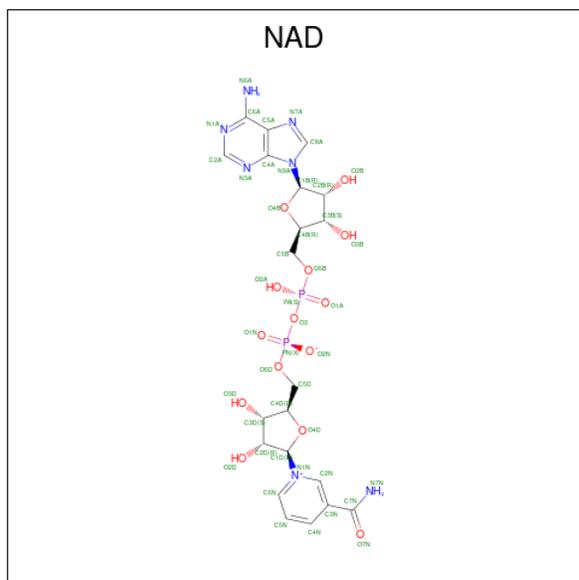
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	B	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
3	C	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
3	D	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
3	A	1	Total	C	N	O	P	0	0
			44	21	7	14	2		

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	78	Total	O	0	0
			78	78		
4	C	71	Total	O	0	0
			71	71		
4	D	38	Total	O	0	0
			38	38		
4	A	63	Total	O	0	0
			63	63		

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.

- Molecule 1: Gfo/Idh/MocA family oxidoreductase

Chain B:

- Molecule 1: Gfo/Idh/MocA family oxidoreductase

Chain C:
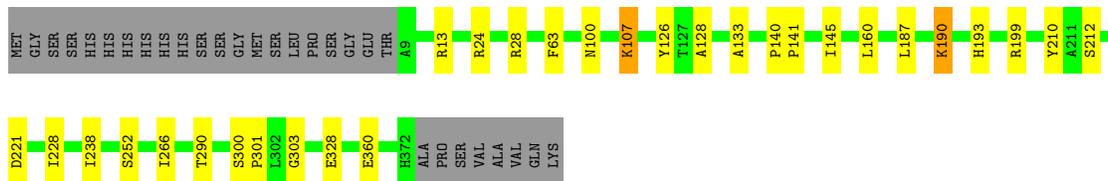
- Molecule 1: Gfo/Idh/MocA family oxidoreductase

Chain D:

- Molecule 1: Gfo/Idh/MocA family oxidoreductase

Chain A:

MET GLY SER SER HIS HIS HIS HIS HIS HIS SER SER GLY MET SER LEU PRO SER GLY GLU THR A9 A23 R24 V27 F63 E106 K107 Y126 T127 A128 A133 Y138 M139 P140 P141 I145 V173 D174 L187 K190 C191 C192 H193 R199 R208

I238 R245 L251 T275 G303 Y327 E328 E360 H372 ALA PRO SER VAL ALA VAL GLN LYS
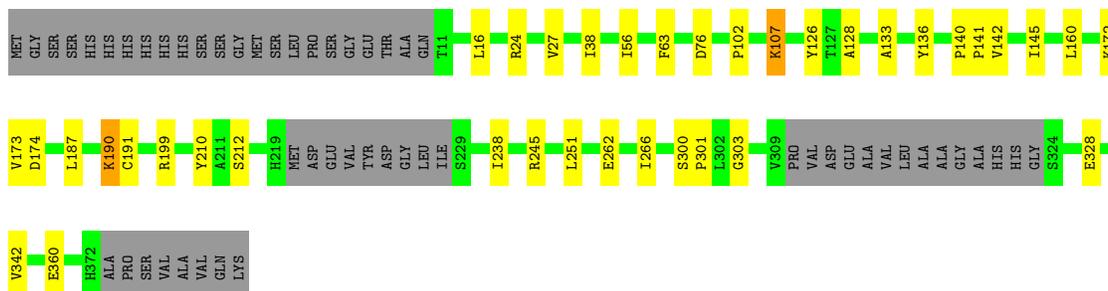
4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	107.78Å 161.49Å 175.74Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	59.45 – 2.35 59.45 – 1.84	Depositor EDS
% Data completeness (in resolution range)	99.6 (59.45-2.35) 73.2 (59.45-1.84)	Depositor EDS
R_{merge}	0.19	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.18 (at 1.84Å)	Xtriage
Refinement program	REFMAC 5.8.0419	Depositor
R, R_{free}	0.229 , 0.278 0.232 , 0.280	Depositor DCC
R_{free} test set	4903 reflections (5.05%)	wwPDB-VP
Wilson B-factor (Å^2)	23.5	Xtriage
Anisotropy	1.186	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 50.6	EDS
L-test for twinning[2]	$< |L| > = 0.49, < L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	11279	wwPDB-VP
Average B, all atoms (Å^2)	56.0	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 39.55 % 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 3.1227e-04. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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[1]Intensities estimated from amplitudes.
[2]Theoretical values of $< |L| >$, $< L^2 >$ 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)

Bond lengths and bond angles in the following residue types are not validated in this section: NAD, PO4

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	0.41	0/2828	0.69	0/3851
1	B	0.39	0/2846	0.68	0/3874
1	C	0.38	0/2818	0.67	1/3837 (0.0%)
1	D	0.38	0/2566	0.67	0/3494
All	All	0.39	0/11058	0.68	1/15056 (0.0%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	3
1	B	0	1
1	C	0	4
1	D	0	3
All	All	0	11

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	C	193	HIS	CB-CA-C	-5.37	99.66	110.40

There are no chirality outliers.

All (11) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	199	ARG	Sidechain

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Mol	Chain	Res	Type	Group
1	A	24	ARG	Sidechain
1	A	245	ARG	Sidechain
1	B	24	ARG	Sidechain
1	C	13	ARG	Sidechain
1	C	199	ARG	Sidechain
1	C	24	ARG	Sidechain
1	C	28	ARG	Sidechain
1	D	199	ARG	Sidechain
1	D	24	ARG	Sidechain
1	D	245	ARG	Sidechain

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	2767	0	2675	19	0
1	B	2785	0	2708	21	0
1	C	2758	0	2683	16	0
1	D	2513	0	2381	23	0
2	A	5	0	0	0	0
2	B	5	0	0	0	0
2	C	15	0	0	0	0
2	D	5	0	0	0	0
3	A	44	0	26	0	0
3	B	44	0	26	0	0
3	C	44	0	26	0	0
3	D	44	0	26	1	0
4	A	63	0	0	1	0
4	B	78	0	0	0	0
4	C	71	0	0	1	0
4	D	38	0	0	1	0
All	All	11279	0	10551	72	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.

All (72) 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:145:ILE:HG23	1:B:266:ILE:HD11	1.78	0.65
1:C:145:ILE:HG23	1:C:266:ILE:HD11	1.80	0.64
1:A:107:LYS:HE2	1:A:107:LYS:C	2.18	0.64
1:C:107:LYS:HE2	1:C:107:LYS:C	2.18	0.63
1:D:145:ILE:HG23	1:D:266:ILE:HD11	1.83	0.60
1:D:238:ILE:HD11	1:A:238:ILE:HG13	1.86	0.58
1:B:238:ILE:HG13	1:C:238:ILE:HD11	1.85	0.57
1:D:136:TYR:OH	1:D:262:GLU:HG2	2.04	0.57
1:A:145:ILE:HD13	1:A:275:THR:HG22	1.87	0.56
1:B:107:LYS:O	1:B:107:LYS:HE2	2.06	0.56
1:D:107:LYS:O	1:D:107:LYS:HE2	2.07	0.55
1:B:238:ILE:HD11	1:C:238:ILE:HG13	1.90	0.53
1:A:245:ARG:HH11	1:A:245:ARG:HG3	1.74	0.53
1:D:238:ILE:HG13	1:A:238:ILE:HD11	1.91	0.52
1:B:107:LYS:HE2	1:B:107:LYS:C	2.31	0.51
1:A:190:LYS:HA	1:A:190:LYS:HE2	1.93	0.51
1:B:140:PRO:HB2	1:B:141:PRO:HD3	1.93	0.50
1:B:208:ARG:NH1	1:C:210:TYR:OH	2.41	0.50
1:D:107:LYS:HE2	1:D:107:LYS:C	2.32	0.50
1:C:140:PRO:HB2	1:C:141:PRO:HD3	1.94	0.49
1:B:190:LYS:HA	1:B:190:LYS:HE2	1.94	0.49
1:A:140:PRO:HB2	1:A:141:PRO:HD3	1.94	0.48
1:D:140:PRO:HB2	1:D:141:PRO:HD3	1.96	0.48
1:C:126:TYR:CE2	1:C:128:ALA:HB3	2.49	0.47
1:D:38:ILE:HD12	1:D:56:ILE:HG23	1.97	0.47
1:D:187:LEU:HB2	1:D:360:GLU:HG2	1.96	0.47
1:A:145:ILE:HD13	1:A:275:THR:CG2	2.44	0.47
1:B:187:LEU:HB2	1:B:360:GLU:HG2	1.96	0.47
1:C:221:ASP:HA	1:C:228:ILE:HD11	1.97	0.46
1:D:210:TYR:OH	1:A:208:ARG:NH1	2.46	0.46
1:C:190:LYS:HE2	1:C:190:LYS:HA	1.97	0.46
1:B:126:TYR:CE2	1:B:128:ALA:HB3	2.50	0.46
1:D:190:LYS:HA	1:D:190:LYS:HE2	1.98	0.45
1:A:193:HIS:CD2	4:A:530:HOH:O	2.70	0.45
1:D:126:TYR:CE2	1:D:128:ALA:HB3	2.51	0.45
1:B:245:ARG:HG3	1:B:245:ARG:HH11	1.80	0.45
1:D:136:TYR:CE1	1:D:142:VAL:HG21	2.52	0.45
1:B:138:TYR:HB3	1:B:327:TYR:HB2	1.99	0.44
1:C:133:ALA:HA	1:C:328:GLU:OE2	2.17	0.44
1:D:191:CYS:SG	1:D:251:LEU:HD22	2.58	0.44
1:B:300:SER:HA	1:B:301:PRO:HA	1.88	0.44
1:C:160:LEU:HD13	1:C:266:ILE:HG12	2.00	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:173:VAL:O	1:D:174:ASP:HB2	2.17	0.43
1:C:300:SER:HA	1:C:301:PRO:HA	1.90	0.43
1:A:126:TYR:CE2	1:A:128:ALA:HB3	2.54	0.43
1:A:106:GLU:HA	1:A:133:ALA:HB3	2.01	0.43
1:D:342:VAL:N	4:D:501:HOH:O	2.27	0.43
1:A:138:TYR:HB3	1:A:327:TYR:HB2	2.01	0.43
1:B:145:ILE:HG23	1:B:266:ILE:CD1	2.46	0.43
1:C:187:LEU:HB2	1:C:360:GLU:HG2	2.00	0.43
1:D:172:LYS:HB3	3:D:402:NAD:O1A	2.19	0.43
1:D:133:ALA:HA	1:D:328:GLU:OE2	2.19	0.42
1:B:106:GLU:HA	1:B:133:ALA:HB3	2.01	0.42
1:B:159:MET:SD	1:C:252:SER:HB2	2.59	0.42
1:C:100:ASN:HB2	4:C:537:HOH:O	2.20	0.42
1:D:76:ASP:O	1:D:102:PRO:HD2	2.20	0.42
1:A:63:PHE:CD1	1:A:63:PHE:N	2.88	0.41
1:A:187:LEU:HB2	1:A:360:GLU:HG2	2.01	0.41
1:A:191:CYS:SG	1:A:251:LEU:HD22	2.60	0.41
1:D:16:LEU:HD11	1:D:27:VAL:HG12	2.02	0.41
1:B:197:LEU:HD23	1:B:197:LEU:HA	1.91	0.41
1:D:160:LEU:HD13	1:D:266:ILE:HG12	2.02	0.41
1:A:133:ALA:HA	1:A:328:GLU:OE2	2.20	0.41
1:B:107:LYS:HD2	1:B:193:HIS:CE1	2.55	0.41
1:A:23:ALA:O	1:A:27:VAL:HG13	2.21	0.41
1:A:173:VAL:O	1:A:174:ASP:HB2	2.19	0.41
1:C:63:PHE:CD1	1:C:63:PHE:N	2.88	0.41
1:D:63:PHE:CD1	1:D:63:PHE:N	2.89	0.41
1:B:63:PHE:CD1	1:B:63:PHE:N	2.88	0.41
1:B:23:ALA:O	1:B:27:VAL:HG13	2.21	0.40
1:B:133:ALA:HA	1:B:328:GLU:OE2	2.21	0.40
1:D:300:SER:HA	1:D:301:PRO:HA	1.89	0.40

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	362/393 (92%)	355 (98%)	6 (2%)	1 (0%)	41	47
1	B	365/393 (93%)	356 (98%)	8 (2%)	1 (0%)	41	47
1	C	362/393 (92%)	351 (97%)	10 (3%)	1 (0%)	41	47
1	D	333/393 (85%)	322 (97%)	10 (3%)	1 (0%)	41	47
All	All	1422/1572 (90%)	1384 (97%)	34 (2%)	4 (0%)	41	47

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	303	GLY
1	C	303	GLY
1	D	303	GLY
1	A	303	GLY

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	286/320 (89%)	284 (99%)	2 (1%)	84	91
1	B	287/320 (90%)	284 (99%)	3 (1%)	76	85
1	C	285/320 (89%)	281 (99%)	4 (1%)	67	78
1	D	250/320 (78%)	247 (99%)	3 (1%)	71	82
All	All	1108/1280 (87%)	1096 (99%)	12 (1%)	73	84

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	107	LYS
1	B	190	LYS
1	B	290	THR
1	C	107	LYS

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Mol	Chain	Res	Type
1	C	190	LYS
1	C	212	SER
1	C	290	THR
1	D	107	LYS
1	D	190	LYS
1	D	212	SER
1	A	107	LYS
1	A	190	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

There are no monosaccharides in this entry.

5.6 Ligand geometry ⓘ

10 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	PO4	B	401	-	4,4,4	1.72	1 (25%)	6,6,6	0.73	0
3	NAD	A	402	-	42,48,48	0.72	1 (2%)	50,73,73	0.81	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	#|Z| > 2	Counts	RMSZ	#|Z| > 2
2	PO4	D	401	-	4,4,4	1.14	0	6,6,6	0.58	0
2	PO4	C	401	-	4,4,4	1.31	1 (25%)	6,6,6	0.67	0
3	NAD	D	402	-	42,48,48	0.79	2 (4%)	50,73,73	1.00	3 (6%)
2	PO4	A	401	-	4,4,4	1.73	1 (25%)	6,6,6	0.59	0
2	PO4	C	403	-	4,4,4	1.50	1 (25%)	6,6,6	0.34	0
2	PO4	C	402	-	4,4,4	0.72	0	6,6,6	0.49	0
3	NAD	B	402	-	42,48,48	0.77	2 (4%)	50,73,73	0.83	2 (4%)
3	NAD	C	404	-	42,48,48	0.75	2 (4%)	50,73,73	0.87	0

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	C	404	-	-	1/26/62/62	0/5/5/5
3	NAD	B	402	-	-	4/26/62/62	0/5/5/5
3	NAD	A	402	-	-	6/26/62/62	0/5/5/5
3	NAD	D	402	-	-	7/26/62/62	0/5/5/5

All (11) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	401	PO4	P-O1	3.29	1.58	1.50
2	B	401	PO4	P-O1	3.27	1.58	1.50
2	C	403	PO4	P-O1	2.82	1.57	1.50
3	D	402	NAD	C2N-N1N	2.60	1.38	1.35
3	A	402	NAD	C2N-N1N	2.44	1.37	1.35
3	C	404	NAD	C2N-N1N	2.35	1.37	1.35
3	D	402	NAD	C8A-N7A	-2.07	1.31	1.34
2	C	401	PO4	P-O3	2.07	1.60	1.54
3	B	402	NAD	C2N-N1N	2.06	1.37	1.35
3	C	404	NAD	C8A-N7A	-2.04	1.31	1.34
3	B	402	NAD	O4D-C1D	2.03	1.43	1.41

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	D	402	NAD	O4B-C1B-C2B	-2.66	103.04	106.93
3	D	402	NAD	C6N-N1N-C2N	-2.37	119.82	121.97

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	B	402	NAD	C6N-N1N-C2N	-2.32	119.86	121.97
3	D	402	NAD	O2B-C2B-C3B	2.07	118.52	111.82
3	B	402	NAD	O4B-C1B-C2B	-2.01	103.98	106.93

There are no chirality outliers.

All (18) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	402	NAD	O4D-C1D-N1N-C2N
3	B	402	NAD	O4D-C1D-N1N-C6N
3	D	402	NAD	C5D-O5D-PN-O2N
3	D	402	NAD	O4D-C1D-N1N-C6N
3	A	402	NAD	O4D-C1D-N1N-C2N
3	A	402	NAD	O4D-C1D-N1N-C6N
3	A	402	NAD	C2D-C1D-N1N-C2N
3	D	402	NAD	O4B-C4B-C5B-O5B
3	D	402	NAD	C3B-C4B-C5B-O5B
3	D	402	NAD	C5D-O5D-PN-O3
3	D	402	NAD	C5D-O5D-PN-O1N
3	B	402	NAD	O4B-C4B-C5B-O5B
3	D	402	NAD	PA-O3-PN-O2N
3	A	402	NAD	O4B-C4B-C5B-O5B
3	B	402	NAD	C2D-C1D-N1N-C2N
3	C	404	NAD	O4B-C4B-C5B-O5B
3	A	402	NAD	PA-O3-PN-O1N
3	A	402	NAD	PA-O3-PN-O2N

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	D	402	NAD	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 402

Bond lengths

Bond angles

Torsions

Rings

Ligand NAD D 402

Bond lengths

Bond angles

Torsions

Rings

Ligand NAD B 402

Bond lengths

Bond angles

Torsions

Rings

Ligand NAD C 404

Bond lengths

Bond angles

Torsions

Rings
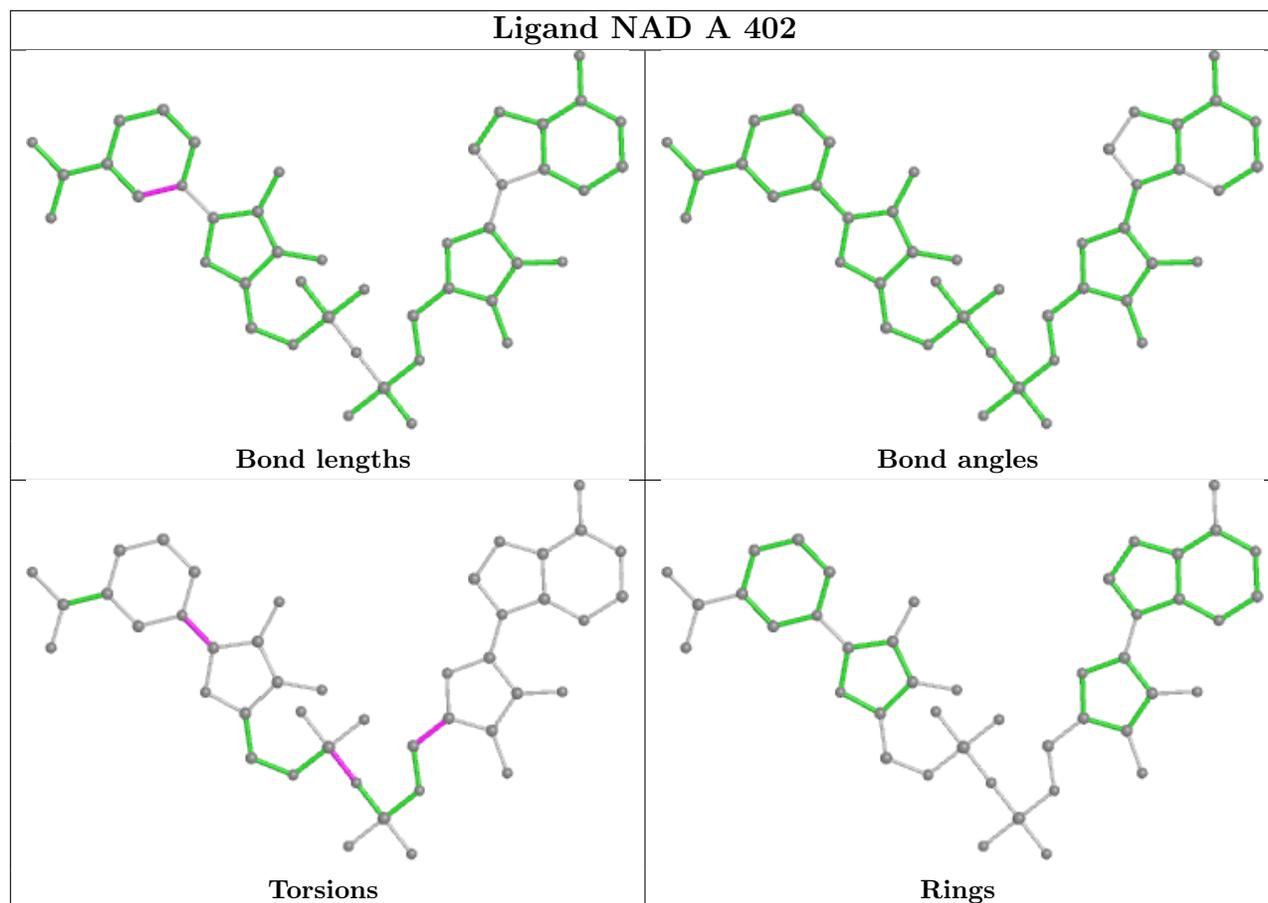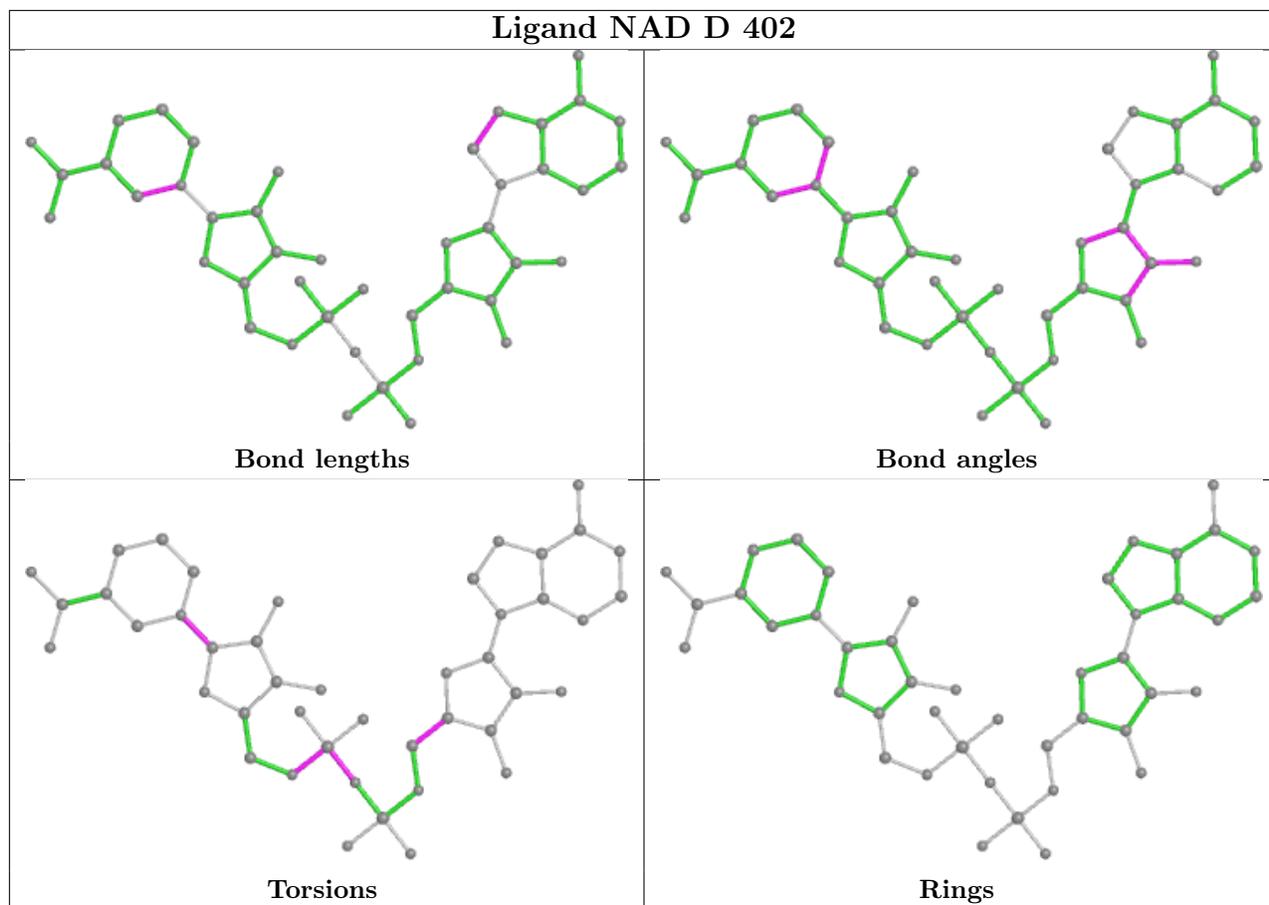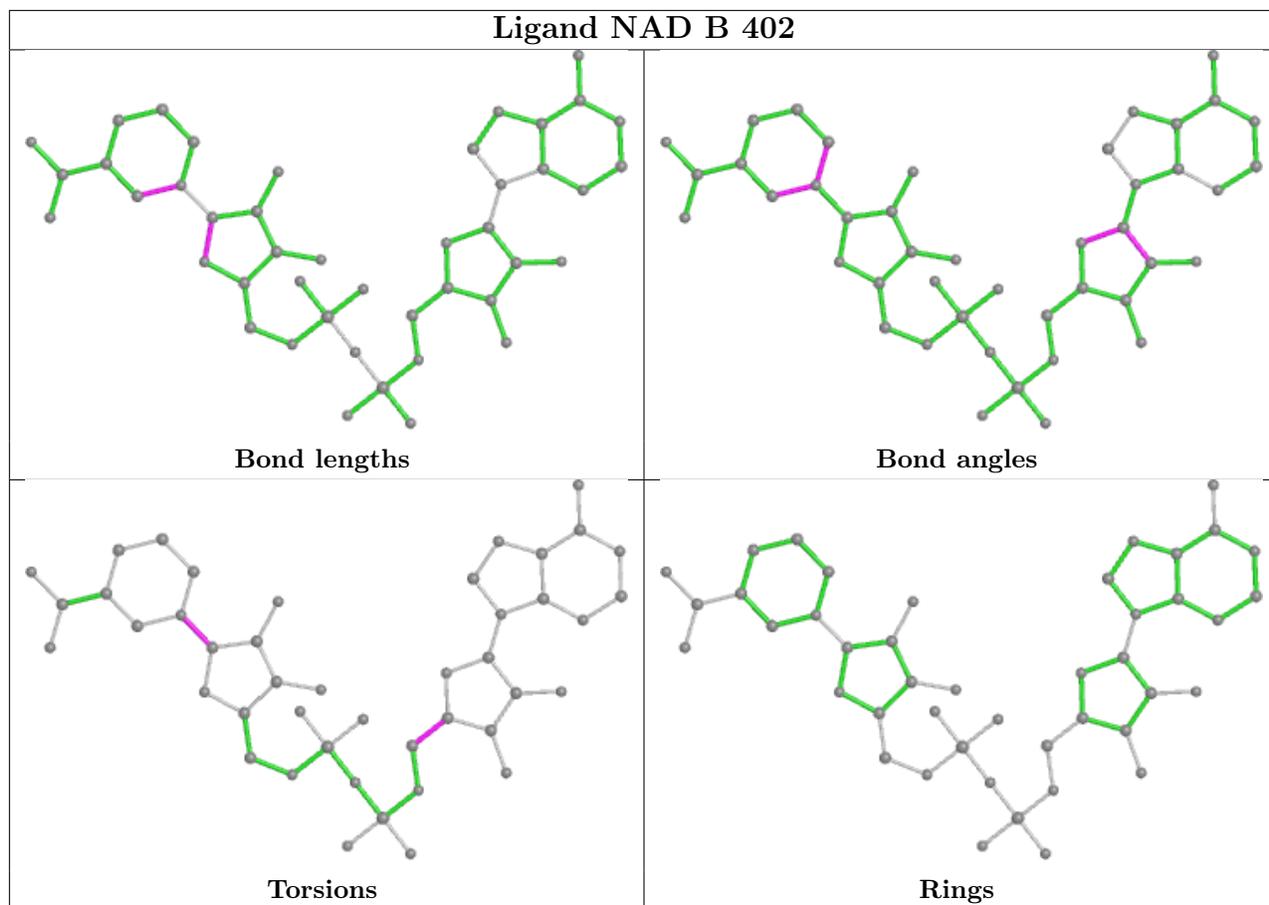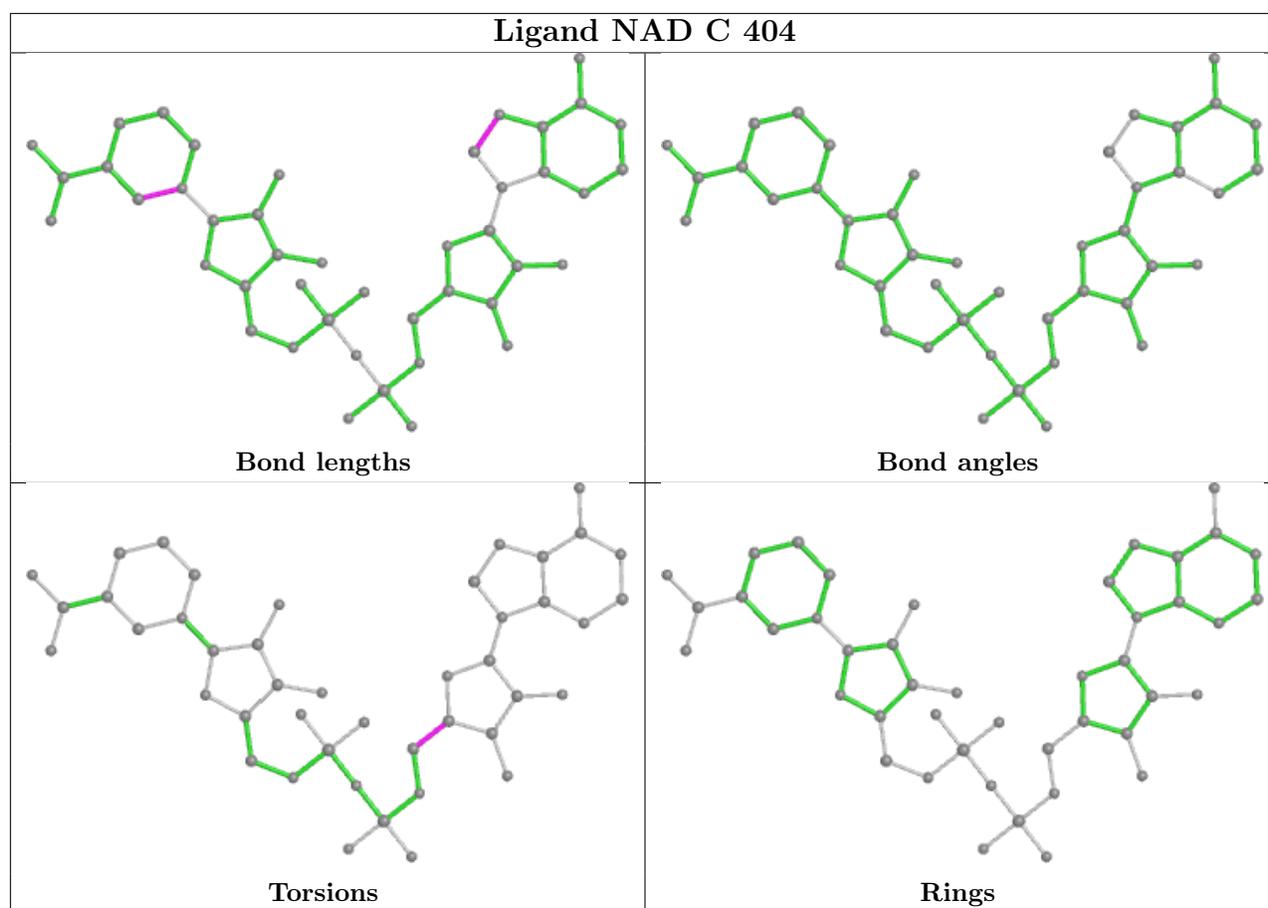
5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.

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

Unable to reproduce the depositors R factor - this section is therefore empty.

6.3 Carbohydrates ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.

6.4 Ligands ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around NAD B 402:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)
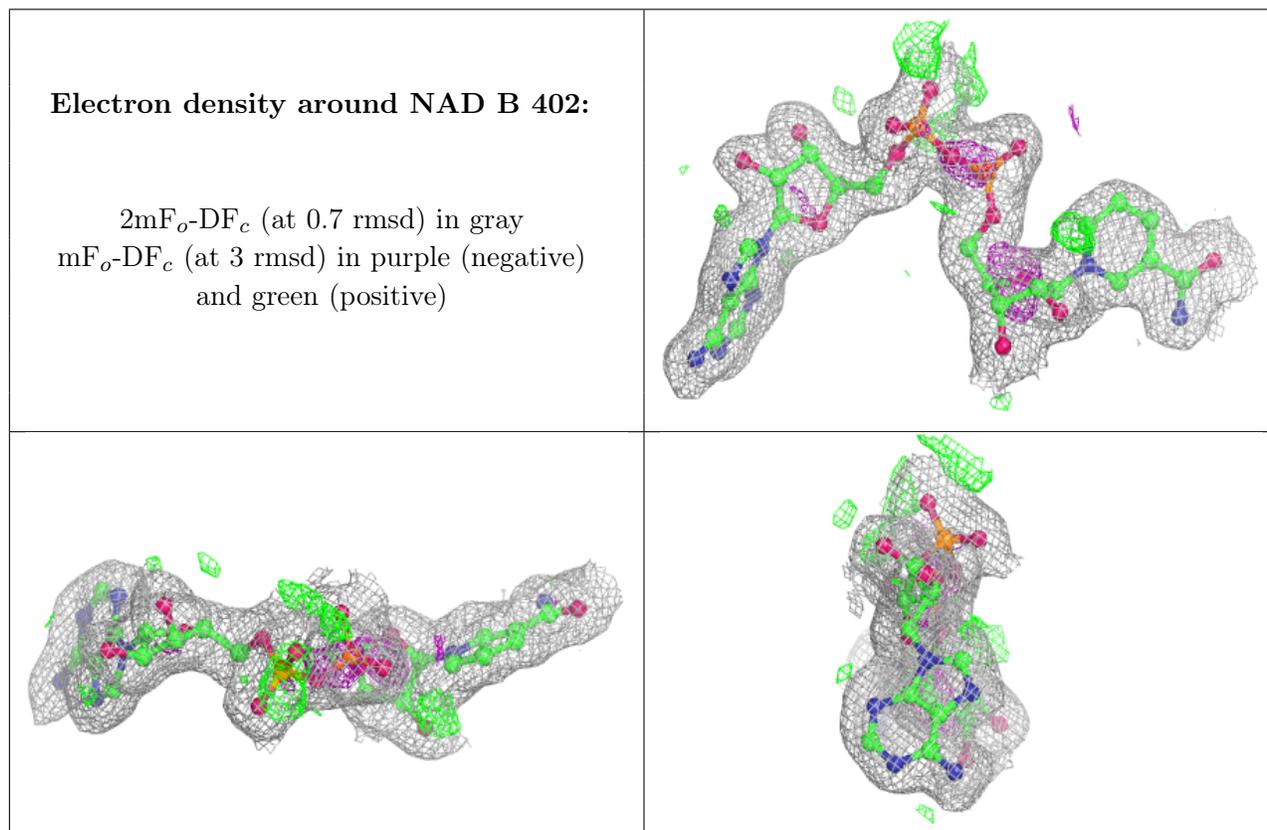
Electron density around NAD C 404:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)
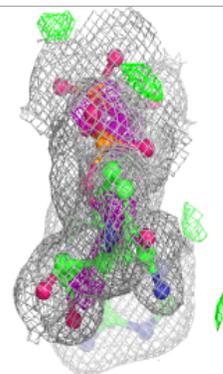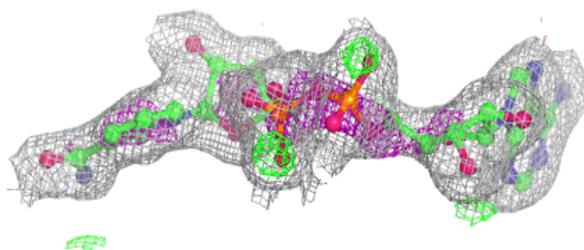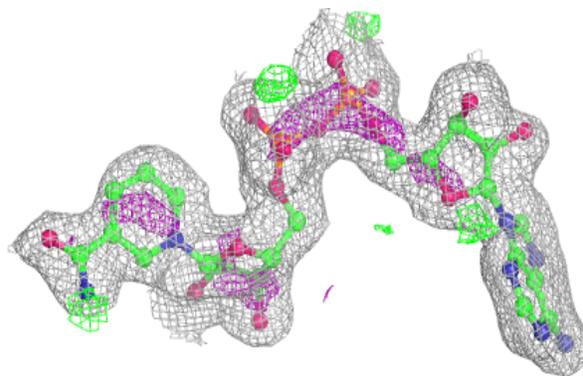
Electron density around NAD D 402:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)

Electron density around NAD A 402:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)

6.5 Other polymers ⓘ

Unable to reproduce the depositors R factor - this section is therefore empty.