



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 24, 2020 – 04:44 am BST

PDB ID : 3FIU  
Title : Structure of NMN synthetase from Francisella tularensis  
Authors : Sorci, L.; Martynowski, D.; Eyobo, Y.; Osterman, A.L.; Zhang, H.  
Deposited on : 2008-12-12  
Resolution : 1.85 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

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.11  
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) : 2.11

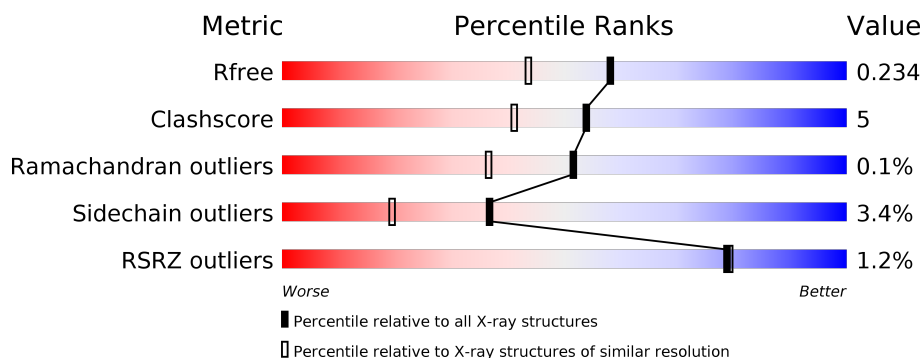
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 1.85 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))
$R_{free}$	130704	2469 (1.86-1.86)
Clashscore	141614	2625 (1.86-1.86)
Ramachandran outliers	138981	2592 (1.86-1.86)
Sidechain outliers	138945	2592 (1.86-1.86)
RSRZ outliers	127900	2436 (1.86-1.86)

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 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	249	 80% 14% . .
1	B	249	 86% 9% .
1	C	249	 86% 9% . .
1	D	249	 85% 10% .

## 2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 8516 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 NH(3)-dependent NAD(+) synthetase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	238	Total	C	N	O	S	0	3	0
			1896	1208	314	365	9			
1	B	238	Total	C	N	O	S	0	0	0
			1885	1203	312	361	9			
1	C	238	Total	C	N	O	S	0	4	0
			1898	1211	314	363	10			
1	D	238	Total	C	N	O	S	0	0	0
			1885	1203	312	361	9			

- Molecule 2 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

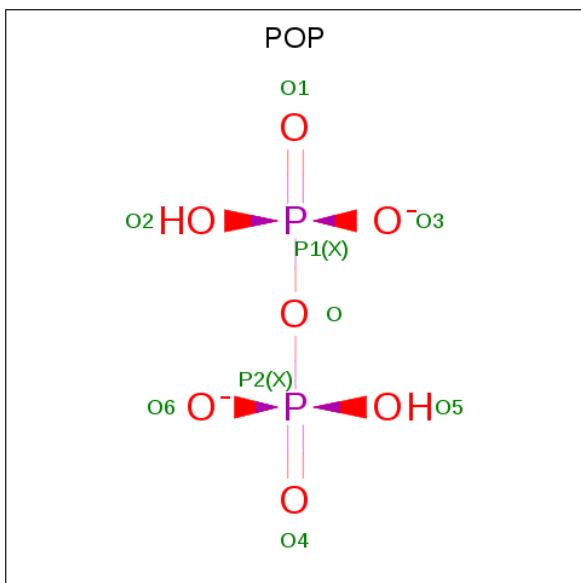
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	B	2	Total	Mg	0	0
			2	2		
2	A	2	Total	Mg	0	0
			2	2		
2	D	2	Total	Mg	0	0
			2	2		
2	C	2	Total	Mg	0	0
			2	2		

- Molecule 3 is ADENOSINE MONOPHOSPHATE (three-letter code: AMP) (formula: C<sub>10</sub>H<sub>14</sub>N<sub>5</sub>O<sub>7</sub>P).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			23	10	5	7	1		
3	B	1	Total	C	N	O	P	0	0
			23	10	5	7	1		
3	C	1	Total	C	N	O	P	0	0
			23	10	5	7	1		
3	D	1	Total	C	N	O	P	0	0
			23	10	5	7	1		

- Molecule 4 is PYROPHOSPHATE 2- (three-letter code: POP) (formula:  $\text{H}_2\text{O}_7\text{P}_2$ ).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total O P 9 7 2	0	0
4	B	1	Total O P 9 7 2	0	0
4	C	1	Total O P 9 7 2	0	0
4	D	1	Total O P 9 7 2	0	0

- Molecule 5 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	B	1	Total Na 1 1	0	0
5	A	1	Total Na 1 1	0	0
5	D	1	Total Na 1 1	0	0
5	C	1	Total Na 1 1	0	0

- Molecule 6 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	205	Total O 205 205	0	0
6	B	214	Total O 214 214	0	0
6	C	196	Total O 196 196	0	0
6	D	197	Total O 197 197	0	0



- Molecule 1: NH(3)-dependent NAD(+) synthetase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	50.43Å 126.44Å 152.53Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	40.00 – 1.85 47.88 – 1.85	Depositor EDS
% Data completeness (in resolution range)	93.9 (40.00-1.85) 93.6 (47.88-1.85)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.04	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.01 (at 1.84Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, $R_{free}$	0.184 , 0.233 0.184 , 0.234	Depositor DCC
$R_{free}$ test set	3939 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	24.5	Xtriage
Anisotropy	0.195	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.36 , 47.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.51$ , $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	8516	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	26.0	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 66.51 % 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 5.9771e-06. 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, 0.333 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: NA, MG, POP, AMP

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	0.66	0/1953	0.64	0/2645
1	B	0.67	0/1927	0.64	0/2610
1	C	0.65	0/1959	0.62	0/2651
1	D	0.67	0/1927	0.67	0/2610
All	All	0.66	0/7766	0.64	0/10516

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 [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	1896	0	1844	33	0
1	B	1885	0	1836	16	0
1	C	1898	0	1855	19	0
1	D	1885	0	1836	24	0
2	A	2	0	0	0	0
2	B	2	0	0	0	0
2	C	2	0	0	0	0
2	D	2	0	0	0	0
3	A	23	0	12	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	23	0	12	0	0
3	C	23	0	12	0	0
3	D	23	0	12	0	0
4	A	9	0	0	0	0
4	B	9	0	0	0	0
4	C	9	0	0	0	0
4	D	9	0	0	0	0
5	A	1	0	0	0	0
5	B	1	0	0	0	0
5	C	1	0	0	0	0
5	D	1	0	0	0	0
6	A	205	0	0	10	0
6	B	214	0	0	3	0
6	C	196	0	0	3	0
6	D	197	0	0	6	0
All	All	8516	0	7419	80	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 5.

The worst 5 of 80 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:A:231:ASN:HB2	6:A:824:HOH:O	1.58	1.03
1:C:236:ARG:HB3	6:C:732:HOH:O	1.71	0.90
1:A:63:SER:H	1:A:66:ASN:HD22	1.17	0.89
1:D:68:HIS:CD2	1:D:72:GLN:NE2	2.47	0.82
1:A:221:GLN:HB2	1:C:71:MET:HE1	1.60	0.81

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	237/249 (95%)	237 (100%)	0	0	100	100
1	B	234/249 (94%)	232 (99%)	1 (0%)	1 (0%)	34	19
1	C	238/249 (96%)	237 (100%)	1 (0%)	0	100	100
1	D	234/249 (94%)	234 (100%)	0	0	100	100
All	All	943/996 (95%)	940 (100%)	2 (0%)	1 (0%)	51	36

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	7	PHE

### 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	204/212 (96%)	196 (96%)	8 (4%)	32	15
1	B	201/212 (95%)	194 (96%)	7 (4%)	36	18
1	C	205/212 (97%)	196 (96%)	9 (4%)	28	12
1	D	201/212 (95%)	197 (98%)	4 (2%)	55	40
All	All	811/848 (96%)	783 (96%)	28 (4%)	37	18

5 of 28 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	205	GLU
1	C	6	ASP
1	D	75	LEU
1	B	221	GLN
1	B	248	ASN

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 34 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	221	GLN
1	C	26	ASN
1	D	120	GLN
1	B	239	HIS
1	B	26	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 carbohydrates in this entry.

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

Of 20 ligands modelled in this entry, 12 are monoatomic - leaving 8 for Mogul analysis.

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	AMP	A	3001	2,5	22,25,25	1.12	2 (9%)	25,38,38	1.50	5 (20%)
3	AMP	C	3001	2,5	22,25,25	1.10	2 (9%)	25,38,38	1.56	5 (20%)
3	AMP	B	3001	2,5	22,25,25	1.07	1 (4%)	25,38,38	1.33	4 (16%)
4	POP	C	4001	2,5	6,8,8	0.79	0	13,13,13	1.08	1 (7%)
4	POP	D	4001	2,5	6,8,8	0.74	0	13,13,13	1.07	1 (7%)
4	POP	A	4001	2,5	6,8,8	0.81	0	13,13,13	1.24	2 (15%)
4	POP	B	4001	2,5	6,8,8	0.68	0	13,13,13	1.07	0
3	AMP	D	3001	2,5	22,25,25	0.94	1 (4%)	25,38,38	1.57	5 (20%)

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	AMP	A	3001	2,5	-	0/6/26/26	0/3/3/3
3	AMP	C	3001	2,5	-	0/6/26/26	0/3/3/3
3	AMP	B	3001	2,5	-	0/6/26/26	0/3/3/3
4	POP	C	4001	2,5	-	0/6/6/6	-
4	POP	D	4001	2,5	-	0/6/6/6	-
4	POP	A	4001	2,5	-	0/6/6/6	-
4	POP	B	4001	2,5	-	0/6/6/6	-
3	AMP	D	3001	2,5	-	2/6/26/26	0/3/3/3

The worst 5 of 6 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	3001	AMP	C2-N3	2.86	1.36	1.32
3	B	3001	AMP	C5-C4	2.79	1.48	1.40
3	A	3001	AMP	C5-C4	2.55	1.47	1.40
3	C	3001	AMP	C5-C4	2.47	1.47	1.40
3	D	3001	AMP	C5-C4	2.17	1.46	1.40

The worst 5 of 23 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	3001	AMP	N3-C2-N1	-4.45	121.72	128.68
3	D	3001	AMP	N3-C2-N1	-3.75	122.81	128.68
3	A	3001	AMP	N3-C2-N1	-3.56	123.12	128.68
3	B	3001	AMP	N3-C2-N1	-3.48	123.24	128.68
3	A	3001	AMP	C2-N1-C6	3.46	124.67	118.75

There are no chirality outliers.

All (2) torsion outliers are listed below:

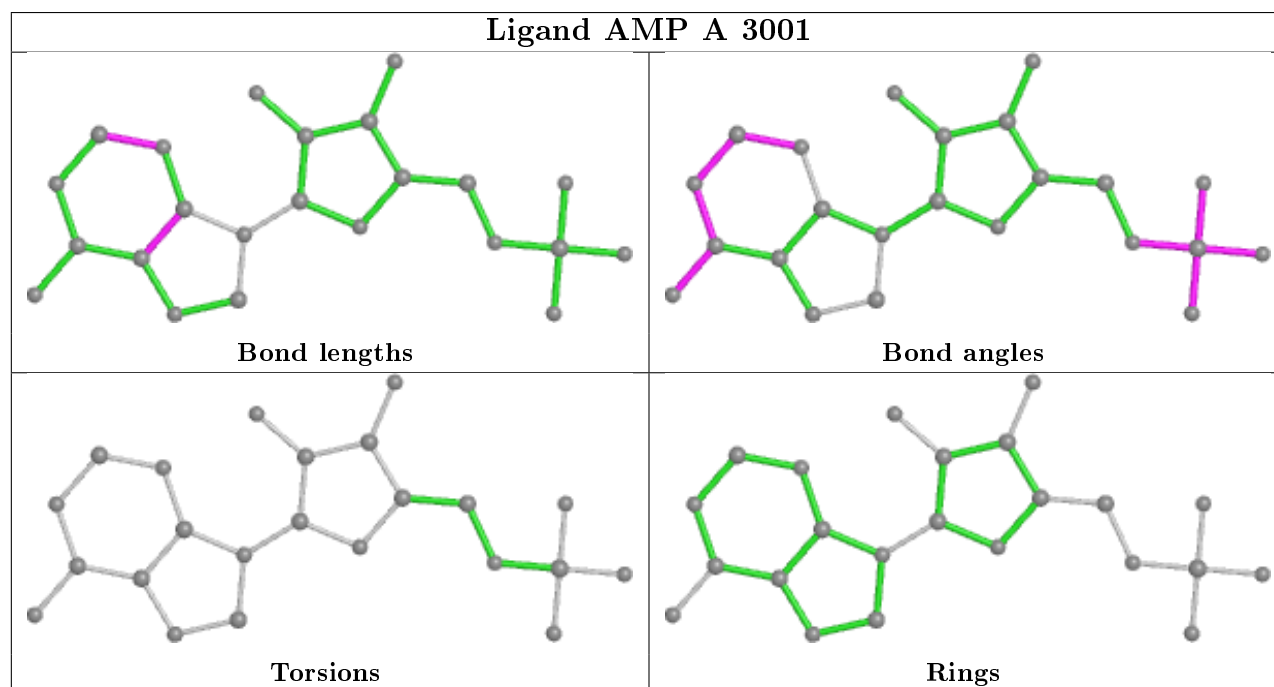
Mol	Chain	Res	Type	Atoms
3	D	3001	AMP	C3'-C4'-C5'-O5'
3	D	3001	AMP	O4'-C4'-C5'-O5'

There are no ring outliers.

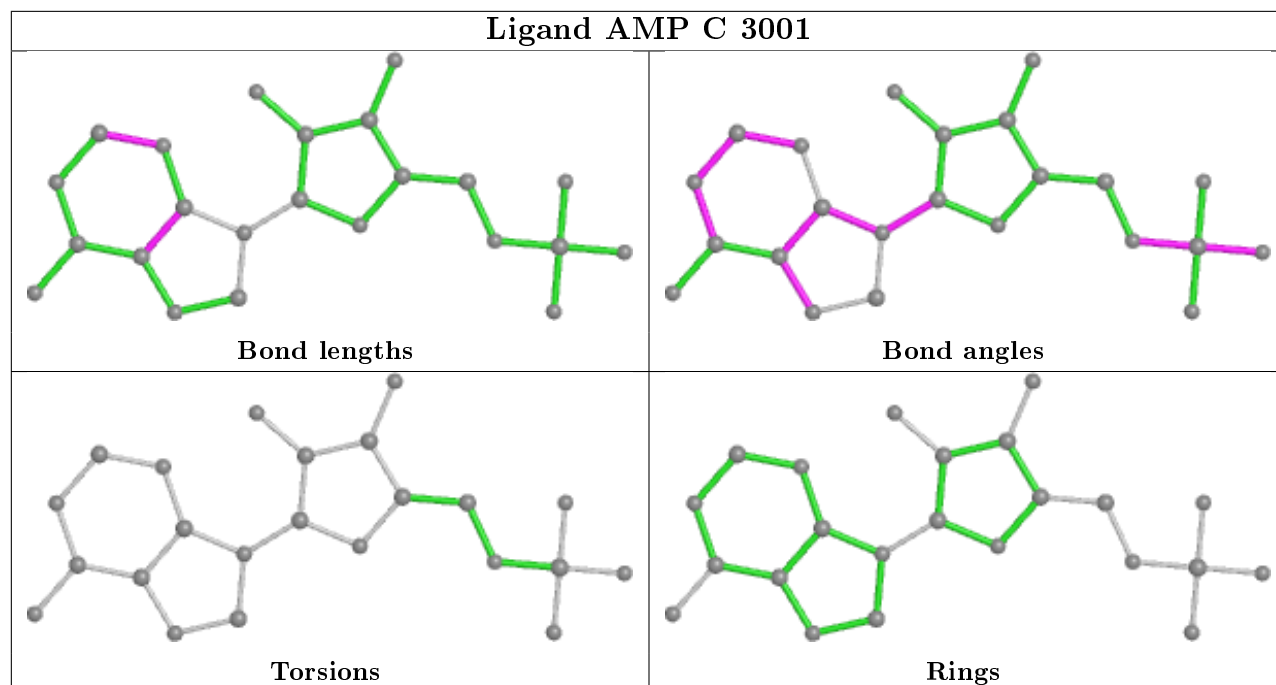
No monomer is involved in short contacts.

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths,

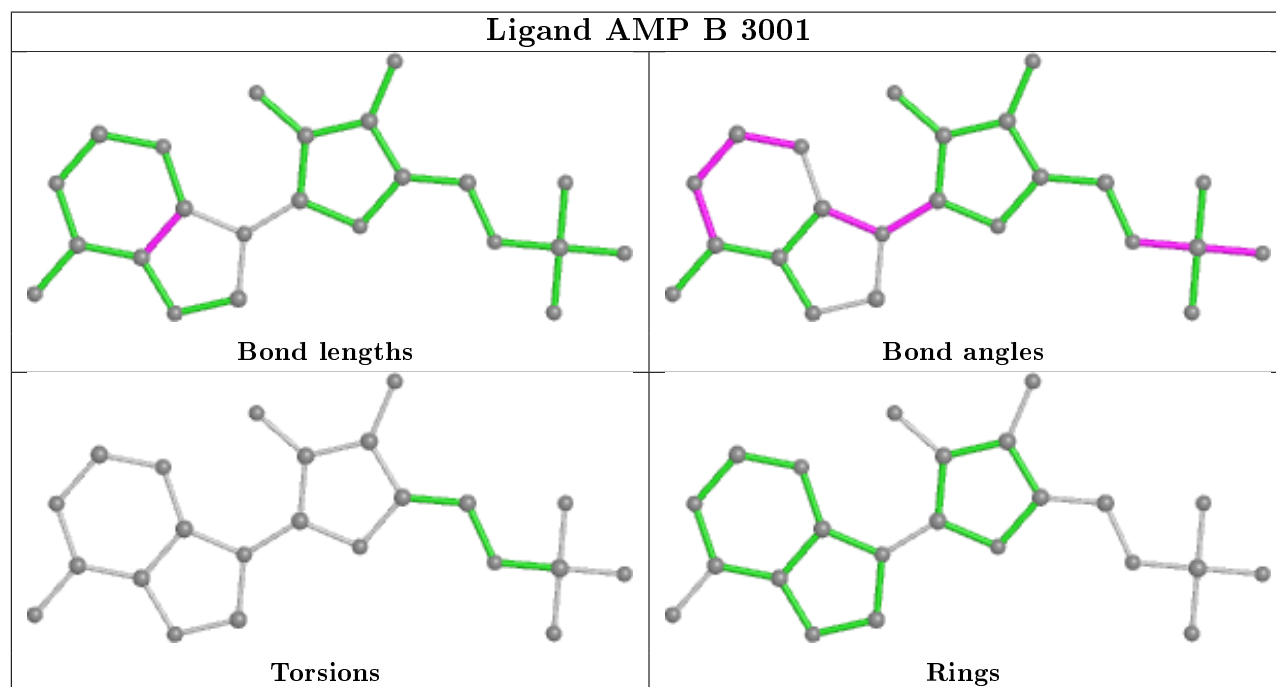
bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 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.

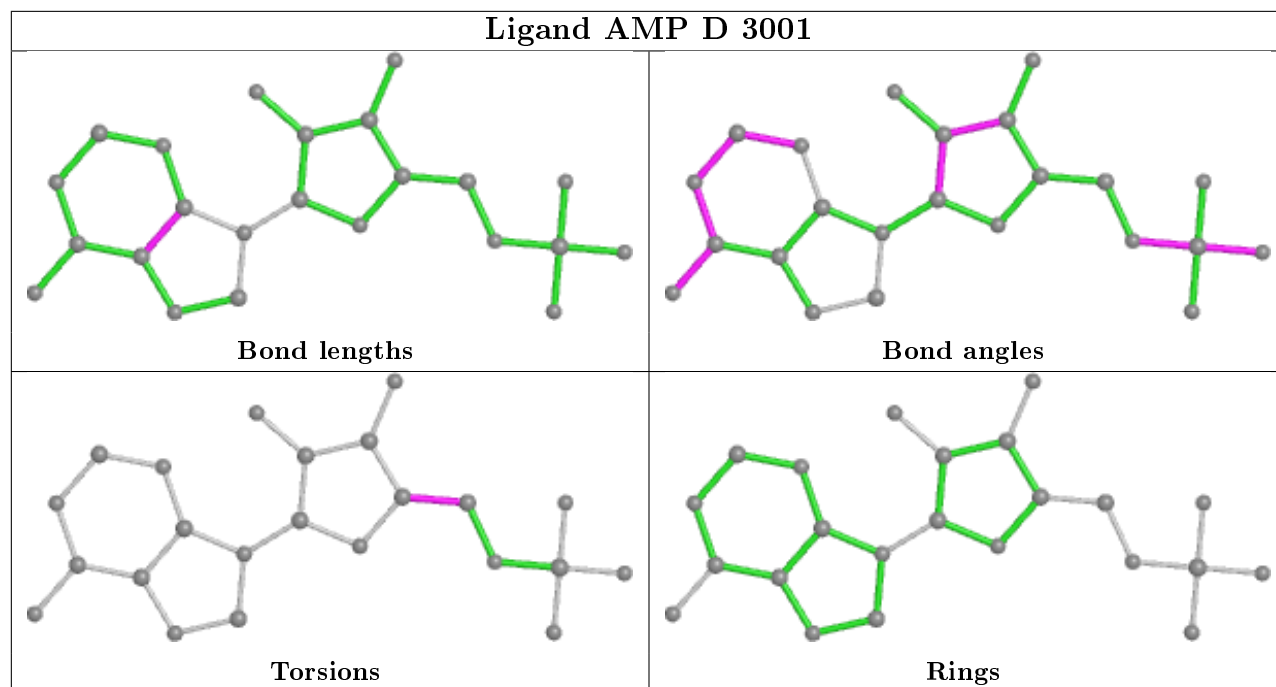


## Ligand AMP C 3001



## Ligand AMP B 3001





## 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	238/249 (95%)	-0.14	3 (1%) 77 78	15, 25, 40, 60	0
1	B	238/249 (95%)	-0.24	1 (0%) 92 92	14, 23, 36, 56	0
1	C	238/249 (95%)	-0.13	4 (1%) 70 70	15, 23, 37, 59	0
1	D	238/249 (95%)	-0.19	3 (1%) 77 78	15, 24, 38, 58	0
All	All	952/996 (95%)	-0.17	11 (1%) 79 79	14, 23, 38, 60	0

The worst 5 of 11 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	6	ASP	5.9
1	D	6	ASP	3.8
1	A	6	ASP	3.5
1	B	6	ASP	3.3
1	A	248	ASN	2.9

### 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. 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.

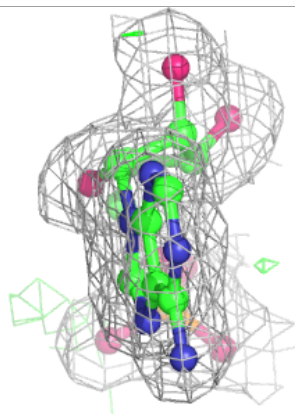
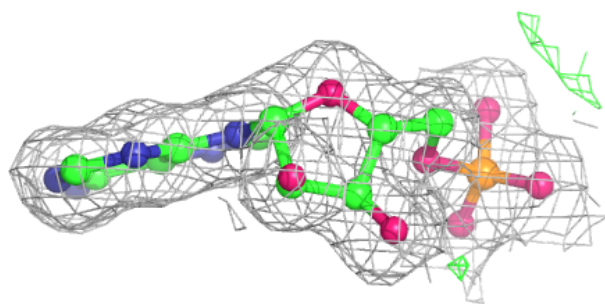
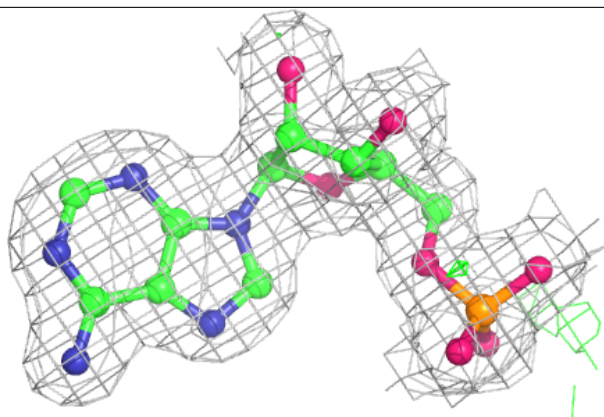


Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
5	NA	A	250	1/1	0.97	0.09	19,19,19,19	0
2	MG	A	5001	1/1	0.97	0.10	20,20,20,20	0
3	AMP	A	3001	23/23	0.97	0.07	13,21,23,26	0
3	AMP	D	3001	23/23	0.97	0.08	16,19,22,23	0
3	AMP	C	3001	23/23	0.98	0.08	13,18,21,23	0
4	POP	D	4001	9/9	0.98	0.07	15,17,19,20	0
4	POP	A	4001	9/9	0.98	0.07	17,18,19,19	0
2	MG	B	5001	1/1	0.98	0.10	19,19,19,19	0
2	MG	D	5001	1/1	0.98	0.08	16,16,16,16	0
3	AMP	B	3001	23/23	0.98	0.07	14,18,21,22	0
5	NA	B	250	1/1	0.99	0.13	18,18,18,18	0
2	MG	C	5001	1/1	0.99	0.08	18,18,18,18	0
4	POP	B	4001	9/9	0.99	0.07	14,16,19,20	0
2	MG	C	5002	1/1	0.99	0.05	20,20,20,20	0
2	MG	D	5002	1/1	0.99	0.05	20,20,20,20	0
2	MG	A	5002	1/1	0.99	0.04	20,20,20,20	0
5	NA	D	250	1/1	0.99	0.10	19,19,19,19	0
2	MG	B	5002	1/1	0.99	0.05	20,20,20,20	0
4	POP	C	4001	9/9	0.99	0.08	16,17,18,19	0
5	NA	C	250	1/1	0.99	0.13	18,18,18,18	0

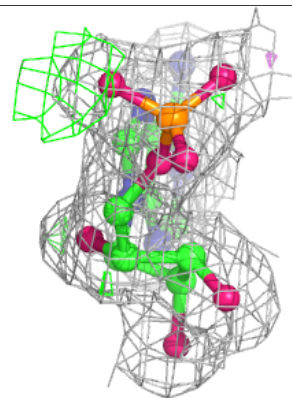
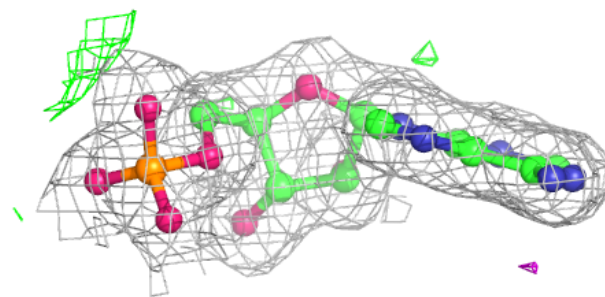
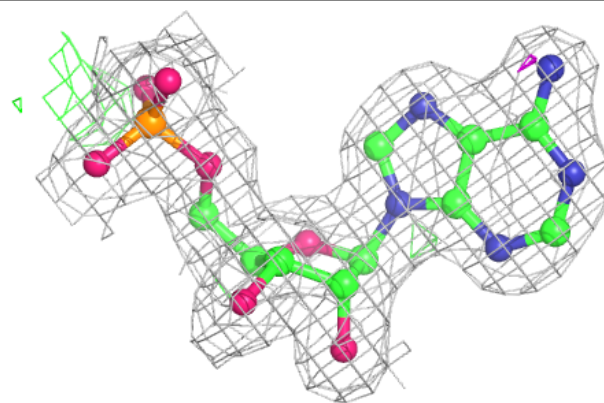
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

**Electron density around AMP A 3001:**

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

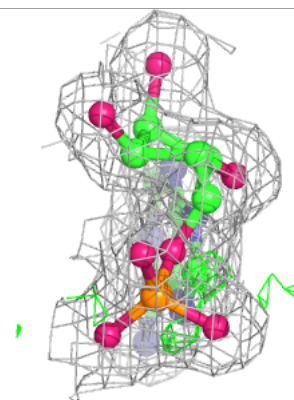
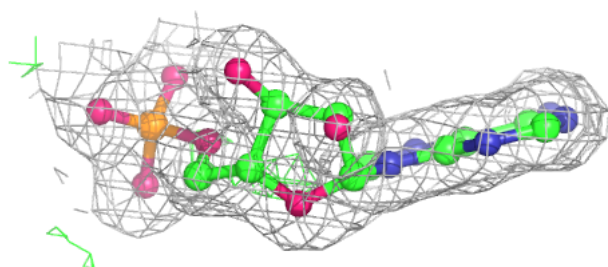
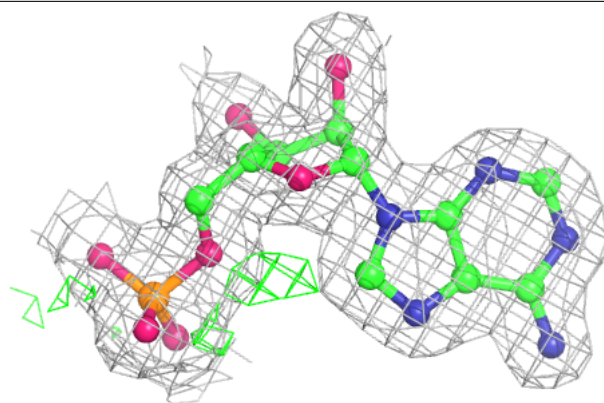
**Electron density around AMP D 3001:**

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

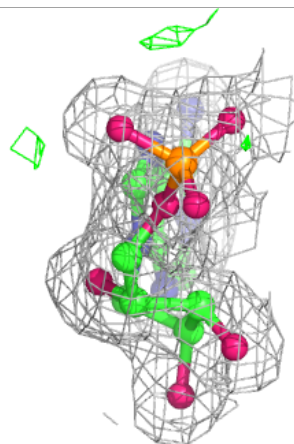
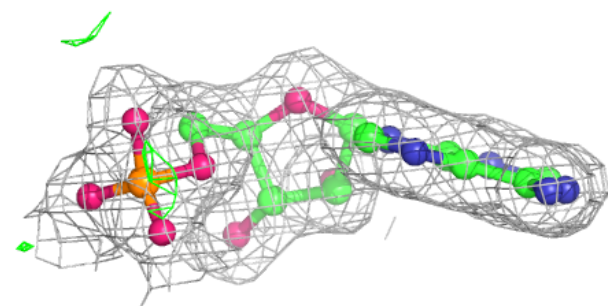
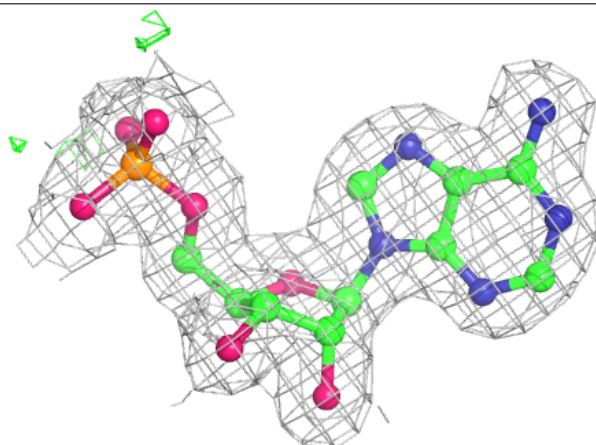


**Electron density around AMP C 3001:**

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

**Electron density around AMP B 3001:**

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



## 6.5 Other polymers [i](#)

There are no such residues in this entry.