



# Full wwPDB X-ray Structure Validation Report ⓘ

May 29, 2020 – 05:00 am BST

PDB ID : 2NVC  
Title : Human Aldose Reductase complexed with novel naphtho[1,2-d]isothiazole acetic acid derivative (3)  
Authors : Steuber, H.; Heine, A.; Klebe, G.  
Deposited on : 2006-11-12  
Resolution : 1.65 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](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

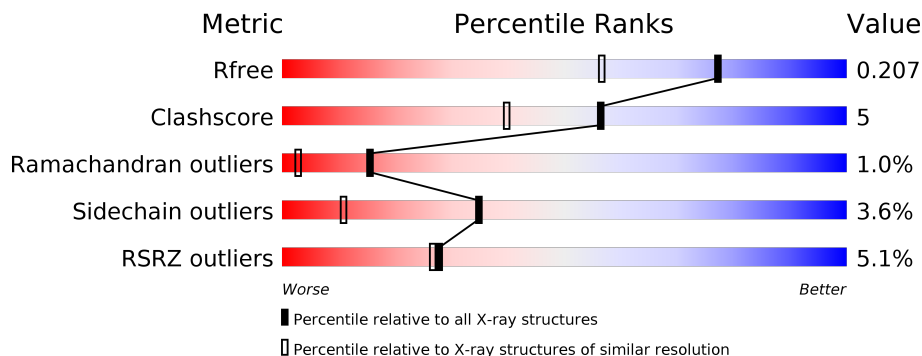
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.65 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	1827 (1.66-1.66)
Clashscore	141614	1931 (1.66-1.66)
Ramachandran outliers	138981	1891 (1.66-1.66)
Sidechain outliers	138945	1891 (1.66-1.66)
RSRZ outliers	127900	1791 (1.66-1.66)

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	316	

## 2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 2869 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.

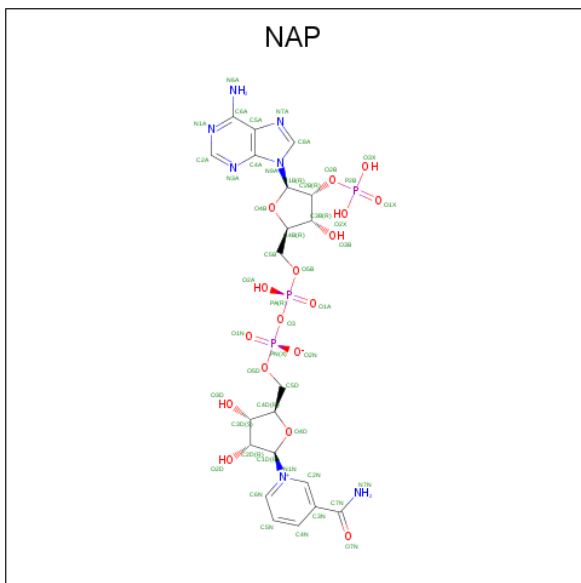
- Molecule 1 is a protein called Aldose reductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	315	2547	1635	430	470	12	0	7	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	4	ILE	LEU	SEE REMARK 999	UNP P15121

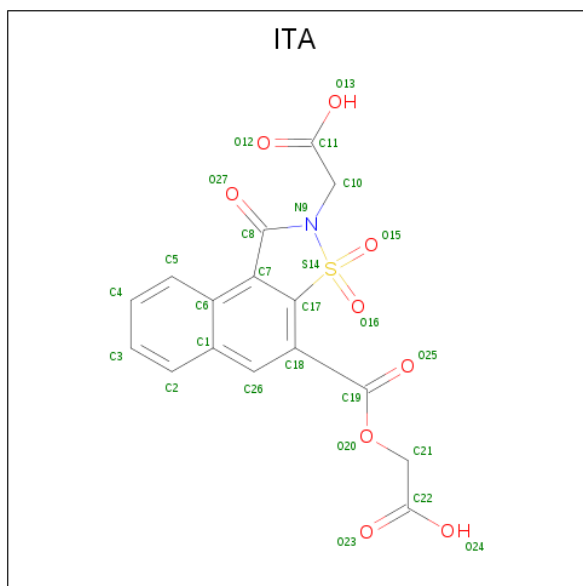
- Molecule 2 is NADP NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (three-letter code: NAP) (formula: C<sub>21</sub>H<sub>28</sub>N<sub>7</sub>O<sub>17</sub>P<sub>3</sub>).



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

- Molecule 3 is {4-[(CARBOXYMETHOXY)CARBONYL]-3,3-DIOXIDO-1-OXONAPHTHO[1,2-D]ISOTHIAZOL-2(1H)-YL}ACETIC ACID (three-letter code: ITA) (formula:

C<sub>16</sub>H<sub>11</sub>NO<sub>9</sub>S).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	S		
3	A	1	27	16	1	9	1	0	0

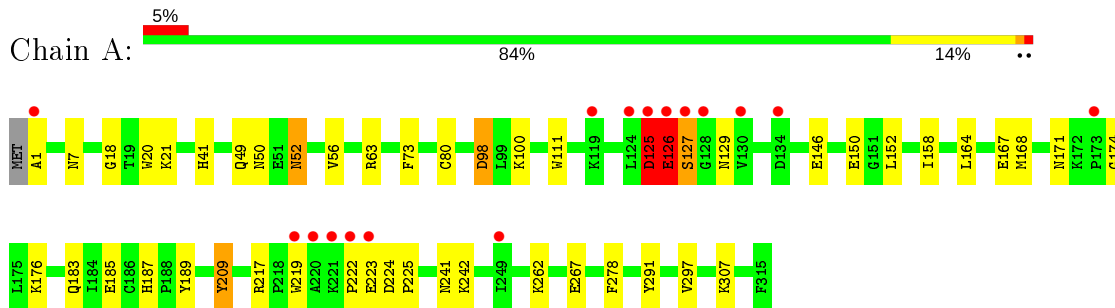
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	247	247	247	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 the various outlier classes 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: Aldose reductase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	39.95Å 47.09Å 46.87Å 76.24° 77.16° 67.82°	Depositor
Resolution (Å)	19.55 – 1.65 19.55 – 1.65	Depositor EDS
% Data completeness (in resolution range)	98.3 (19.55-1.65) 87.7 (19.55-1.65)	Depositor EDS
$R_{merge}$	0.03	Depositor
$R_{sym}$	0.03	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.54 (at 1.65Å)	Xtrriage
Refinement program	SHELXL-97	Depositor
R, $R_{free}$	0.158 , 0.214 0.162 , 0.207	Depositor DCC
$R_{free}$ test set	1596 reflections (4.95%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	17.1	Xtrriage
Anisotropy	0.256	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.29 , 49.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	2869	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	22.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.16% of the height of the origin peak. No significant pseudotranslation is detected.*

<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: NAP, ITA

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	0.45	0/2637	1.16	9/3579 (0.3%)

There are no bond length outliers.

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	209	TYR	CA-CB-CG	8.20	128.99	113.40
1	A	125	ASP	CA-CB-CG	7.85	130.68	113.40
1	A	125	ASP	CB-CG-OD1	7.75	125.27	118.30
1	A	209	TYR	CB-CG-CD1	7.20	125.32	121.00
1	A	224	ASP	CB-CG-OD1	6.07	123.76	118.30
1	A	98	ASP	CB-CG-OD2	5.57	123.31	118.30
1	A	209	TYR	CB-CG-CD2	-5.15	117.91	121.00
1	A	217	ARG	NE-CZ-NH1	5.14	122.87	120.30
1	A	291	TYR	CB-CG-CD1	5.08	124.05	121.00

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	2547	0	2557	26	0
2	A	48	0	25	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	27	0	9	1	0
4	A	247	0	0	5	0
All	All	2869	0	2591	26	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.

All (26) 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:146:GLU:O	1:A:150:GLU:HG3	1.88	0.74
1:A:222:PRO:HD2	1:A:223:GLU:OE1	1.95	0.67
1:A:20:TRP:CE3	1:A:21:LYS:HE3	2.33	0.64
1:A:185:GLU:OE2	1:A:187:HIS:HE1	1.86	0.59
1:A:189:TYR:CE2	1:A:225:PRO:HB2	2.38	0.58
1:A:164:LEU:O	1:A:168:MET:HG2	2.05	0.57
1:A:242:LYS:HE2	1:A:278:PHE:CE1	2.40	0.56
1:A:242:LYS:HE2	1:A:278:PHE:CD1	2.42	0.54
1:A:307:LYS:HD2	4:A:1224:HOH:O	2.08	0.53
1:A:219:TRP:HH2	3:A:600:ITA:O15	1.92	0.53
1:A:126:GLU:O	1:A:127:SER:HB2	2.10	0.52
1:A:267:GLU:HG2	4:A:1129:HOH:O	2.10	0.52
1:A:185:GLU:CD	1:A:297:VAL:HG22	2.32	0.49
1:A:49:GLN:HG2	4:A:1209:HOH:O	2.12	0.49
1:A:125:ASP:O	1:A:126:GLU:OE2	2.30	0.49
1:A:167:GLU:HG3	1:A:171:ASN:ND2	2.29	0.48
1:A:262:LYS:O	2:A:500:NAP:H8A	2.13	0.48
1:A:174:GLY:O	1:A:176[B]:LYS:HE3	2.13	0.48
1:A:152:LEU:HD23	4:A:1201:HOH:O	2.15	0.47
1:A:41:HIS:HA	1:A:73:PHE:O	2.15	0.46
1:A:183:GLN:OE1	2:A:500:NAP:H2N	2.16	0.46
1:A:1:ALA:N	4:A:1085:HOH:O	2.50	0.45
1:A:98:ASP:O	1:A:100:LYS:NZ	2.50	0.45
1:A:80:CYS:SG	1:A:111:TRP:HB2	2.61	0.41
1:A:18:GLY:HA3	2:A:500:NAP:H4D	2.03	0.40
1:A:52:ASN:O	1:A:56:VAL:HG23	2.22	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	320/316 (101%)	313 (98%)	4 (1%)	3 (1%)	17 4

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	127	SER
1	A	126	GLU
1	A	125	ASP

### 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	287/281 (102%)	276 (96%)	11 (4%)	33 10

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	7	ASN
1	A	50	ASN
1	A	52	ASN
1	A	63	ARG
1	A	125	ASP
1	A	126	GLU
1	A	129	ASN
1	A	158	ILE

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Mol	Chain	Res	Type
1	A	209	TYR
1	A	241[A]	ASN
1	A	241[B]	ASN

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	7	ASN
1	A	50	ASN
1	A	136	ASN
1	A	182	ASN
1	A	187	HIS

### 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](#)

2 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 2$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z  > 2$	Counts	RMSZ	$\# Z  > 2$
2	NAP	A	500	-	45,52,52	1.91	11 (24%)	56,80,80	1.77	13 (23%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
3	ITA	A	600	-	20,29,29	2.79	5 (25%)	31,44,44	3.93	13 (41%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	NAP	A	500	-	-	4/31/67/67	0/5/5/5
3	ITA	A	600	-	-	0/9/33/33	0/3/3/3

All (16) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	600	ITA	S14-N9	-10.54	1.53	1.66
2	A	500	NAP	C2N-N1N	5.81	1.42	1.35
2	A	500	NAP	C2A-N3A	4.53	1.39	1.32
2	A	500	NAP	C3N-C7N	3.80	1.56	1.50
2	A	500	NAP	C6N-N1N	3.57	1.44	1.35
2	A	500	NAP	C4A-N3A	3.54	1.40	1.35
2	A	500	NAP	O4D-C1D	3.32	1.45	1.41
3	A	600	ITA	C8-N9	-3.04	1.34	1.39
2	A	500	NAP	C2A-N1A	2.69	1.38	1.33
3	A	600	ITA	C26-C18	2.52	1.41	1.37
2	A	500	NAP	P2B-O2B	2.51	1.64	1.59
3	A	600	ITA	O16-S14	2.22	1.46	1.43
2	A	500	NAP	C2D-C1D	-2.12	1.50	1.53
3	A	600	ITA	C7-C6	-2.08	1.40	1.43
2	A	500	NAP	C6N-C5N	2.07	1.43	1.38
2	A	500	NAP	C2N-C3N	2.00	1.42	1.39

All (26) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	600	ITA	C10-N9-C8	-13.28	113.26	122.59
3	A	600	ITA	C10-N9-S14	10.01	127.97	121.53
3	A	600	ITA	O27-C8-C7	-6.92	120.87	129.02
3	A	600	ITA	C17-C7-C8	-6.68	107.31	111.69
2	A	500	NAP	C3N-C7N-N7N	-5.02	111.73	117.75
3	A	600	ITA	O16-S14-N9	-4.44	106.15	109.98
2	A	500	NAP	O7N-C7N-N7N	4.30	128.68	122.58
2	A	500	NAP	C5A-C6A-N6A	3.91	126.30	120.35

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	600	ITA	C21-O20-C19	-3.56	109.62	115.91
3	A	600	ITA	O20-C19-C18	3.43	118.99	112.21
2	A	500	NAP	C5N-C6N-N1N	-3.29	115.68	120.40
2	A	500	NAP	C6N-N1N-C2N	3.29	124.98	121.97
2	A	500	NAP	O7N-C7N-C3N	-3.19	115.82	119.63
3	A	600	ITA	C5-C6-C1	3.10	121.91	117.89
2	A	500	NAP	N3A-C2A-N1A	-3.07	123.88	128.68
2	A	500	NAP	C3N-C2N-N1N	-3.04	117.46	120.43
3	A	600	ITA	C8-N9-S14	3.01	116.91	115.16
3	A	600	ITA	C17-S14-N9	2.81	94.40	92.53
3	A	600	ITA	O27-C8-N9	2.70	127.35	123.34
2	A	500	NAP	C5A-C6A-N1A	-2.60	114.45	120.35
3	A	600	ITA	C7-C8-N9	2.51	111.79	108.57
2	A	500	NAP	C2N-N1N-C1D	-2.30	114.01	119.14
2	A	500	NAP	C1B-N9A-C4A	-2.28	122.64	126.64
2	A	500	NAP	C2D-C3D-C4D	-2.09	98.58	102.64
2	A	500	NAP	O2A-PA-O1A	2.08	122.50	112.24
3	A	600	ITA	O16-S14-O15	2.05	119.21	116.30

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	500	NAP	PA-O3-PN-O5D
2	A	500	NAP	C4D-C5D-O5D-PN
2	A	500	NAP	C2B-O2B-P2B-O3X
2	A	500	NAP	PN-O3-PA-O1A

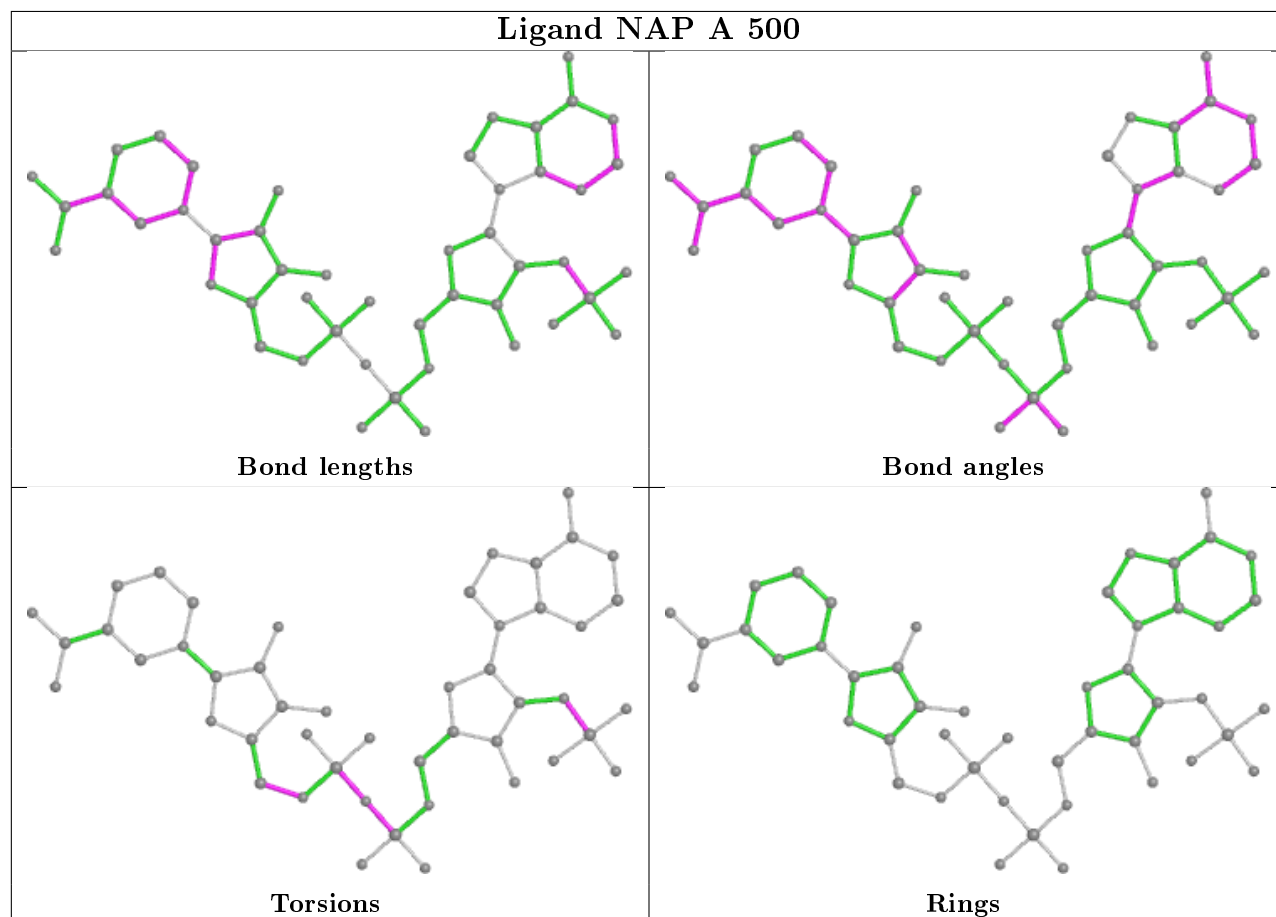
There are no ring outliers.

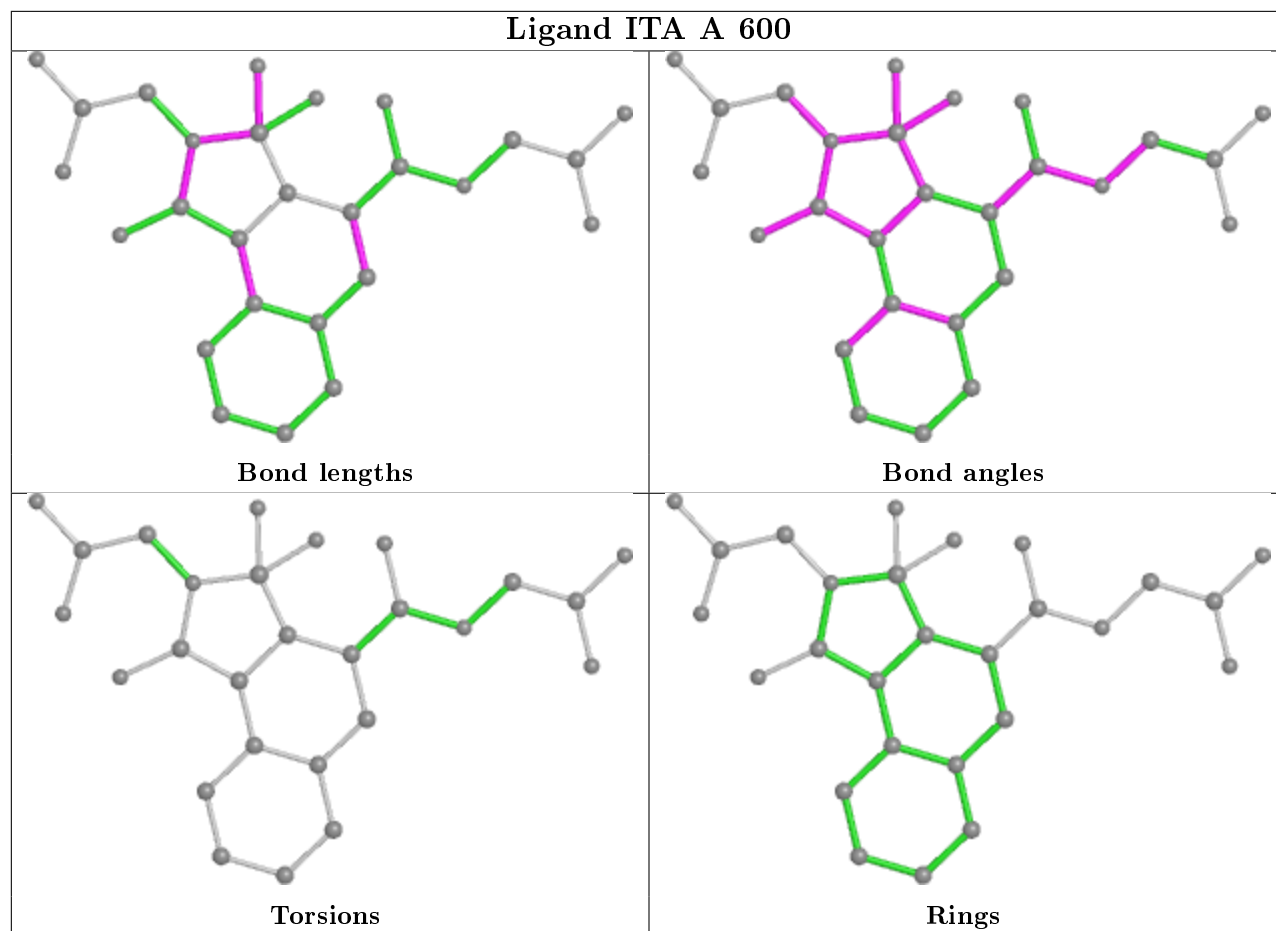
2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	500	NAP	3	0
3	A	600	ITA	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 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.





## 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	315/316 (99%)	0.47	16 (5%) <b>28</b> <b>27</b>	11, 19, 39, 65	0

All (16) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	128	GLY	5.5
1	A	127	SER	4.3
1	A	1	ALA	4.0
1	A	222	PRO	3.8
1	A	221	LYS	2.9
1	A	173	PRO	2.9
1	A	119	LYS	2.9
1	A	126	GLU	2.7
1	A	124	LEU	2.6
1	A	220	ALA	2.4
1	A	219	TRP	2.4
1	A	125	ASP	2.3
1	A	249	ILE	2.2
1	A	223	GLU	2.1
1	A	130	VAL	2.0
1	A	134	ASP	2.0

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

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

### 6.3 Carbohydrates [i](#)

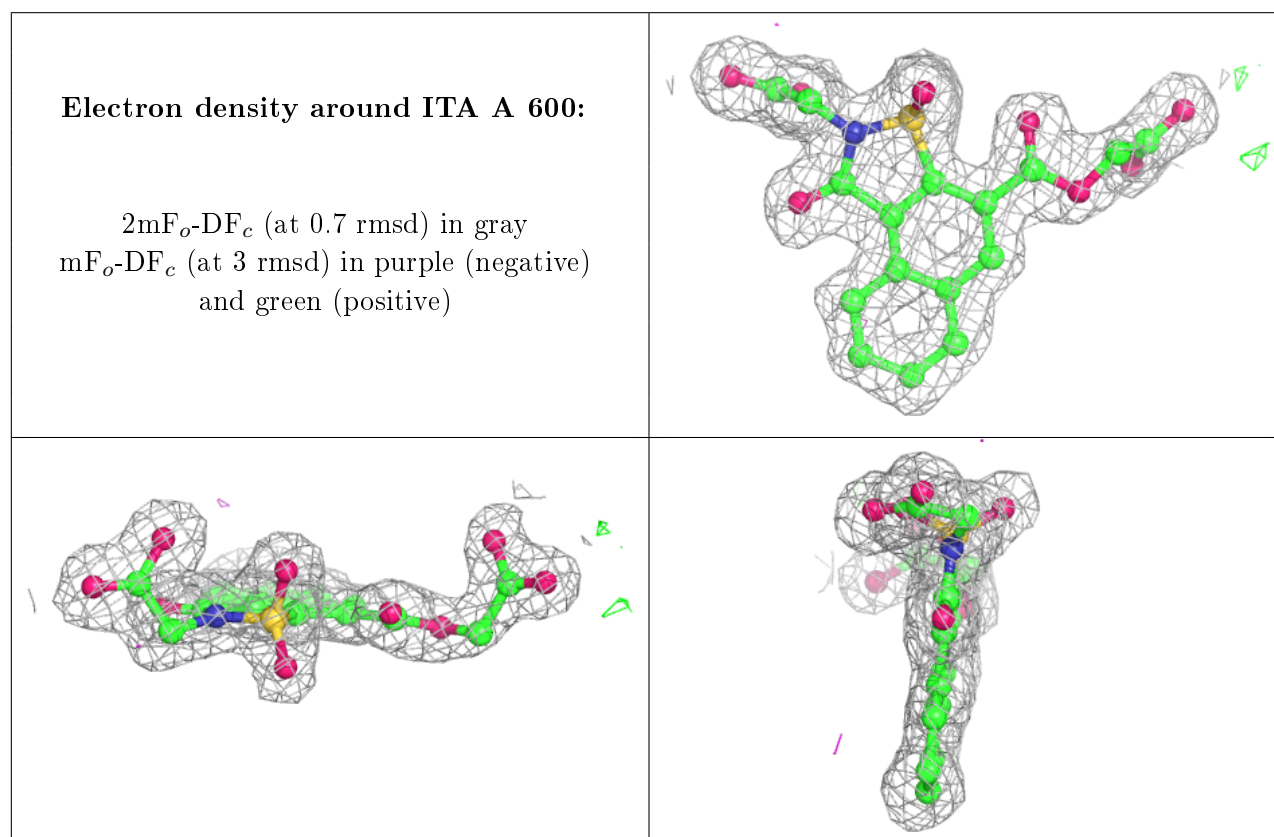
There are no carbohydrates in this entry.

## 6.4 Ligands [i](#)

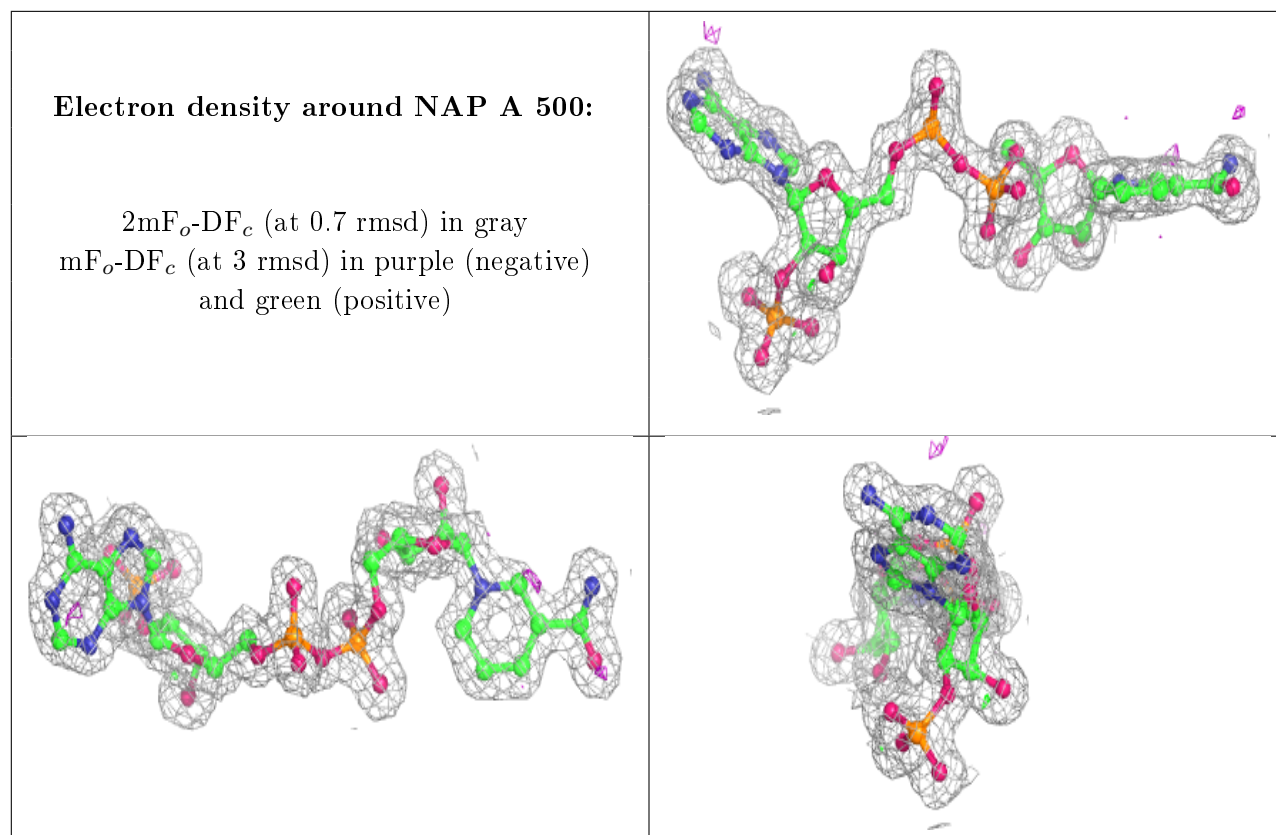
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
3	ITA	A	600	27/27	0.92	0.13	17,26,32,34	0
2	NAP	A	500	48/48	0.96	0.08	9,15,18,22	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.







## 6.5 Other polymers [i](#)

There are no such residues in this entry.