



# wwPDB X-ray Structure Validation Summary Report

Feb 27, 2014 – 12:52 PM GMT

PDB ID : 2W2L  
Title : CRYSTAL STRUCTURE OF THE HOLO FORMS OF RHODOTORULA GRAMINIS D-MANDELATE DEHYDROGENASE AT 2.5Å.  
Authors : Vachieri, S.G.; Cole, A.R.; Bagneris, C.; Baker, D.P.; Fewson, C.A.; Basak, A.K.  
Deposited on : 2008-11-02  
Resolution : 2.50 Å(reported)

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A user guide is available at <http://wwpdb.org/ValidationPDFNotes.html>

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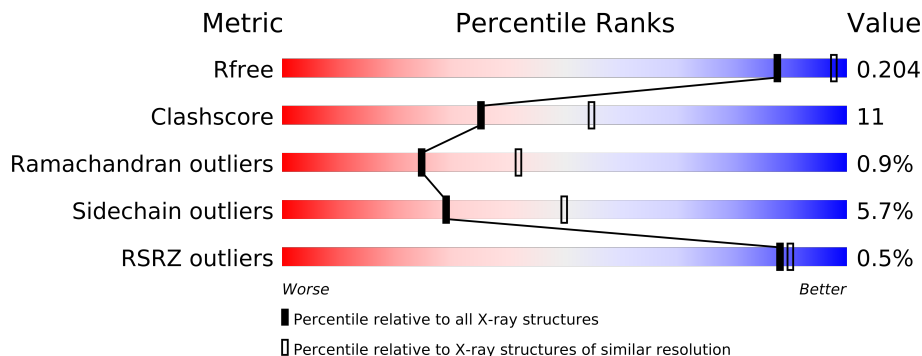
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.15 2013  
Xtriage (Phenix) : dev-1323  
EDS : stable22639  
Percentile statistics : 21963  
Refmac : 5.8.0049  
CCP4 : 6.3.0 (Settle)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)  
Validation Pipeline (wwPDB-VP) : stable22683

# 1 Overall quality at a glance

The reported resolution of this entry is 2.50 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))
$R_{free}$	66092	2784 (2.50-2.50)
Clashscore	79885	3562 (2.50-2.50)
Ramachandran outliers	78287	3480 (2.50-2.50)
Sidechain outliers	78261	3482 (2.50-2.50)
RSRZ outliers	66119	2785 (2.50-2.50)

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. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	348	
1	B	348	
1	C	348	
2	D	348	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
3	NAD	A	1347	-	X
3	NAD	B	1347	-	X
3	NAD	C	1346	-	X
3	NAD	D	1346	-	X

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 11321 atoms, of which 0 are hydrogen and 0 are deuterium.

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 D-MANDELATE DEHYDROGENASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	346	Total	C	N	O	S	22	0	0
			2664	1692	469	496	7			
1	B	345	Total	C	N	O	S	17	0	0
			2655	1686	468	495	6			
1	C	344	Total	C	N	O	S	34	0	0
			2650	1684	467	493	6			

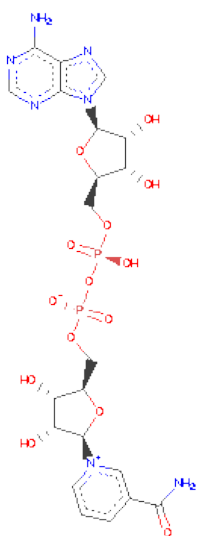
- Molecule 2 is a protein called D-MANDELATE DEHYDROGENASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	D	345	Total	C	N	O	S	23	1	0
			2665	1693	471	494	7			

There is a discrepancy between the modelled and reference sequences:

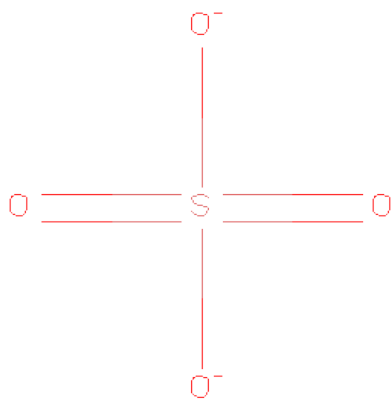
Chain	Residue	Modelled	Actual	Comment	Reference
D	73	ILE	LEU	CONFLICT	UNP Q7LLW9

- 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
3	A	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
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		

- Molecule 4 is SULFATE ION (three-letter code: SO<sub>4</sub>) (formula: O<sub>4</sub>S).



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

- Molecule 5 is water.

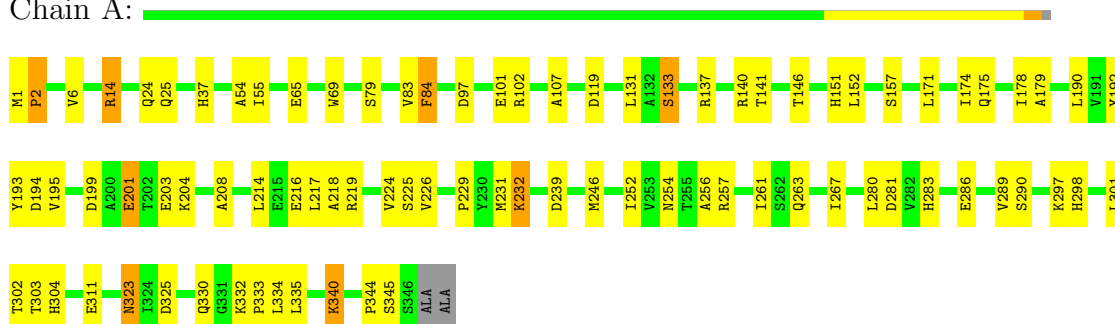
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	128	Total O 128 128	0	0
5	B	93	Total O 93 93	0	0
5	C	146	Total O 146 146	0	0
5	D	124	Total O 124 124	0	0

### 3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ( $RSRZ > 2$ ). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

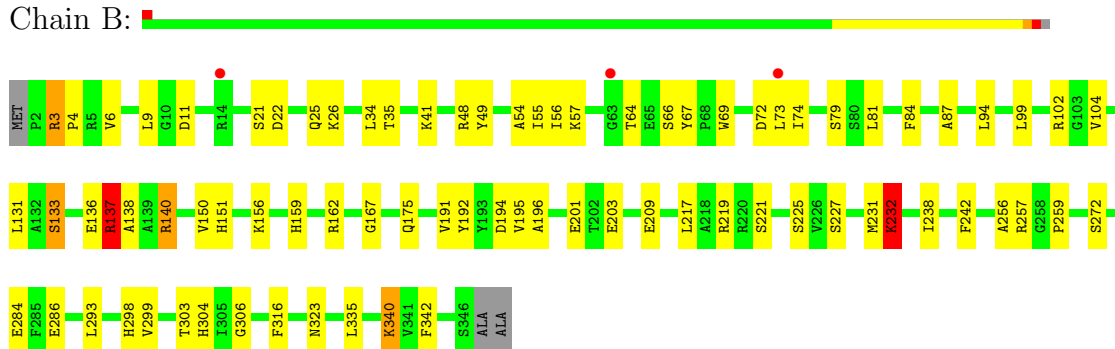
#### • Molecule 1: D-MANDELATE DEHYDROGENASE

Chain A:



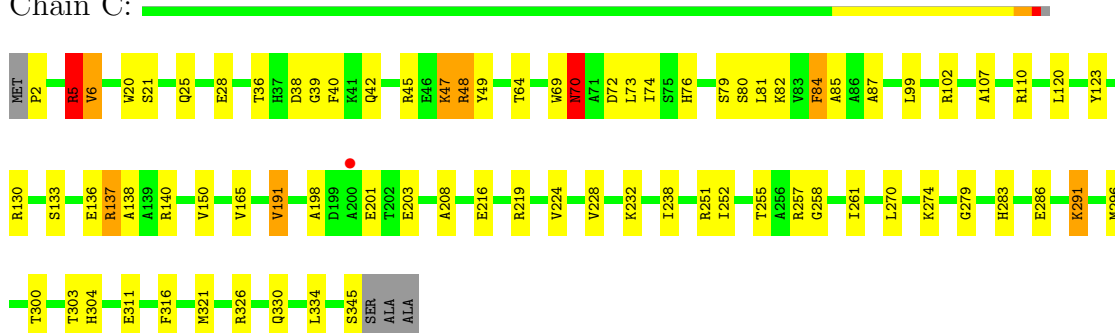
#### • Molecule 1: D-MANDELATE DEHYDROGENASE

Chain B:



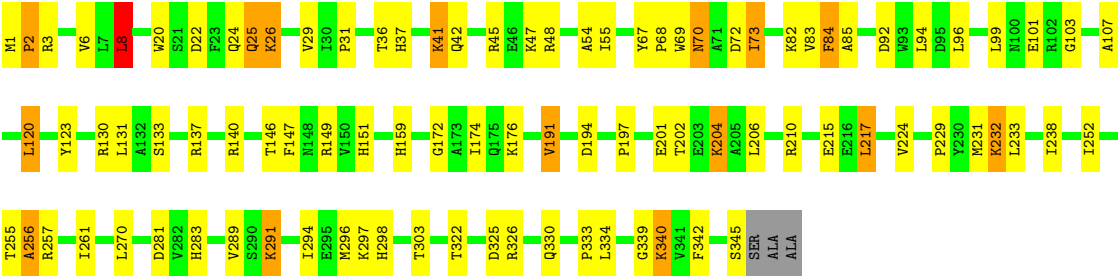
#### • Molecule 1: D-MANDELATE DEHYDROGENASE

Chain C:



#### • Molecule 2: D-MANDELATE DEHYDROGENASE

Chain D: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	100.10Å 110.15Å 79.84Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.28 – 2.50 48.25 – 2.50	Depositor EDS
% Data completeness (in resolution range)	98.7 (48.28-2.50) 94.4 (48.25-2.50)	Depositor EDS
$R_{merge}$	0.15	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.30 (at 2.51Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.182 , 0.265 0.164 , 0.204	Depositor DCC
$R_{free}$ test set	2901 reflections (5.40%)	DCC
Wilson B-factor (Å <sup>2</sup> )	21.9	Xtriage
Anisotropy	0.137	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.36 , 10.7	EDS
Estimated twinning fraction	0.189 for -h,-k,l	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.46$ , $\langle L^2 \rangle = 0.29$	Xtriage
Outliers	0 of 56652 reflections	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	11321	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	21.0	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 22.31 % 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 5.8560e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

<sup>1</sup>Intensities estimated from amplitudes.

## 5 Model quality ⓘ

### 5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: SO4, NAD

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 5$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\# Z  > 5$	RMSZ	$\# Z  > 5$
1	A	0.95	5/2721 (0.2%)	1.25	9/3687 (0.2%)
1	B	0.94	3/2712 (0.1%)	0.86	1/3674 (0.0%)
1	C	1.01	3/2707 (0.1%)	0.98	9/3668 (0.2%)
2	D	1.19	6/2725 (0.2%)	0.93	4/3691 (0.1%)
All	All	1.03	17/10865 (0.2%)	1.02	23/14720 (0.2%)

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	2
1	C	0	3
2	D	0	1
All	All	0	6

The worst 5 of 17 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	D	48	ARG	NE-CZ	29.58	1.71	1.33
2	D	291	LYS	CB-CG	18.18	2.01	1.52
1	C	48	ARG	CG-CD	-16.68	1.10	1.51
1	A	14	ARG	NE-CZ	15.67	1.53	1.33
2	D	201	GLU	CB-CG	15.48	1.81	1.52

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	14	ARG	NE-CZ-NH1	-35.86	102.37	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	14	ARG	NE-CZ-NH2	34.54	137.57	120.30
2	D	291	LYS	CA-CB-CG	-14.98	80.44	113.40
1	C	201	GLU	N-CA-CB	-13.59	86.15	110.60
1	A	14	ARG	CD-NE-CZ	11.62	139.87	123.60

There are no chirality outliers.

5 of 6 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	14	ARG	Sidechain
1	A	24	GLN	Peptide
1	C	48	ARG	Sidechain
1	C	5	ARG	Peptide
1	C	79	SER	Peptide

## 5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2664	0	2664	66	0
1	B	2655	0	2649	48	0
1	C	2650	0	2648	49	0
2	D	2665	0	2668	78	0
3	A	44	0	26	4	0
3	B	44	0	26	4	0
3	C	44	0	26	2	0
3	D	44	0	26	8	0
4	A	5	0	0	0	0
4	B	5	0	0	1	0
4	C	5	0	0	0	0
4	D	5	0	0	0	0
5	A	128	0	0	6	0
5	B	93	0	0	1	0
5	C	146	0	0	4	0
5	D	124	0	0	12	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	11321	0	10733	226	0

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 11.

The worst 5 of 226 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
3:D:1346:NAD:H2D	5:D:2035:HOH:O	1.42	1.14
2:D:1:MET:HB3	2:D:2:PRO:HA	1.33	1.05
1:A:37:HIS:HE1	5:A:2042:HOH:O	1.36	1.05
1:C:270:LEU:HB3	1:C:296:MET:HE1	1.36	1.02
2:D:107:ALA:HB2	2:D:334:LEU:HD13	1.42	1.01

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	344/348 (99%)	318 (92%)	22 (6%)	4 (1%)	19	32
1	B	343/348 (99%)	321 (94%)	18 (5%)	4 (1%)	19	32
1	C	342/348 (98%)	322 (94%)	17 (5%)	3 (1%)	25	42
2	D	344/348 (99%)	326 (95%)	16 (5%)	2 (1%)	33	55
All	All	1373/1392 (99%)	1287 (94%)	73 (5%)	13 (1%)	25	42

5 of 13 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	25	GLN
1	C	6	VAL
1	C	80	SER
1	B	3	ARG
1	B	303	THR

### 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	278/279 (100%)	262 (94%)	16 (6%)	28	49
1	B	277/279 (99%)	261 (94%)	16 (6%)	28	49
1	C	276/279 (99%)	264 (96%)	12 (4%)	40	65
2	D	278/279 (100%)	259 (93%)	19 (7%)	22	39
All	All	1109/1116 (99%)	1046 (94%)	63 (6%)	29	50

5 of 63 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	219	ARG
1	C	25	GLN
2	D	231	MET
1	B	232	LYS
1	B	340	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 30 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	323	ASN
1	C	151	HIS
2	D	283	HIS
1	C	76	HIS
1	C	159	HIS

### 5.3.3 RNA ⓘ

There are no RNA chains 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 carbohydrates in this entry.

## 5.6 Ligand geometry

8 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	1347	-	48,48,48	1.49	5 (10%)	73,73,73	2.49	14 (19%)
4	SO4	A	1348	-	4,4,4	0.16	0	6,6,6	0.10	0
3	NAD	B	1347	-	48,48,48	1.38	3 (6%)	73,73,73	1.99	12 (16%)
4	SO4	B	1348	-	4,4,4	0.16	0	6,6,6	0.84	0
3	NAD	C	1346	-	48,48,48	1.51	4 (8%)	73,73,73	2.26	15 (20%)
4	SO4	C	1347	-	4,4,4	0.16	0	6,6,6	0.15	0
3	NAD	D	1346	-	48,48,48	1.55	5 (10%)	73,73,73	2.29	13 (17%)
4	SO4	D	1347	-	4,4,4	0.26	0	6,6,6	0.31	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	A	1347	-	-	0/30/62/62	0/3/5/5
4	SO4	A	1348	-	-	0/0/0/0	0/0/0/0
3	NAD	B	1347	-	-	0/30/62/62	0/3/5/5
4	SO4	B	1348	-	-	0/0/0/0	0/0/0/0
3	NAD	C	1346	-	-	0/30/62/62	0/3/5/5
4	SO4	C	1347	-	-	0/0/0/0	0/0/0/0
3	NAD	D	1346	-	-	0/30/62/62	0/3/5/5
4	SO4	D	1347	-	-	0/0/0/0	0/0/0/0

The worst 5 of 17 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	D	1346	NAD	O7N-C7N	7.75	1.42	1.24
3	A	1347	NAD	O7N-C7N	7.40	1.41	1.24
3	C	1346	NAD	O7N-C7N	7.15	1.40	1.24
3	B	1347	NAD	O7N-C7N	6.84	1.40	1.24
3	D	1346	NAD	C2A-N3A	3.57	1.39	1.32

The worst 5 of 54 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	1347	NAD	N3A-C2A-N1A	-12.47	118.29	128.71
3	D	1346	NAD	O4D-C1D-N1N	11.08	119.29	107.95
3	A	1347	NAD	O4D-C1D-N1N	11.07	119.28	107.95
3	B	1347	NAD	N3A-C2A-N1A	-10.79	119.69	128.71
3	C	1346	NAD	N3A-C2A-N1A	-10.35	120.06	128.71

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

## 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 ⓘ

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	346/348 (99%)	-0.24	0 100 100	8, 20, 38, 57	5 (1%)
1	B	345/348 (99%)	-0.11	3 (0%) 81 82	7, 21, 42, 52	3 (0%)
1	C	344/348 (98%)	-0.34	1 (0%) 91 93	6, 17, 31, 39	7 (2%)
2	D	345/348 (99%)	-0.33	0 100 100	7, 18, 31, 42	6 (1%)
All	All	1380/1392 (99%)	-0.26	4 (0%) 88 93	6, 19, 38, 57	21 (1%)

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	73	LEU	2.5
1	B	63	GLY	2.2
1	C	200	ALA	2.1
1	B	14	ARG	2.0

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

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

### 6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

### 6.4 Ligands ⓘ

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. The B-factors column lists the minimum, median, 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	RSR	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
3	NAD	D	1346	44/44	0.35	10.64	19,27,30,31	44
3	NAD	C	1346	44/44	0.30	6.36	16,23,25,26	44
3	NAD	B	1347	44/44	0.23	4.46	10,14,17,19	44
3	NAD	A	1347	44/44	0.29	4.30	12,21,22,24	44
4	SO4	A	1348	5/5	0.11	-0.62	51,52,53,54	0
4	SO4	C	1347	5/5	0.13	-0.65	60,61,61,62	0
4	SO4	B	1348	5/5	0.11	-1.26	53,53,55,56	0
4	SO4	D	1347	5/5	0.10	-1.95	61,62,63,63	0

## 6.5 Other polymers ⓘ

There are no such residues in this entry.