



# wwPDB X-ray Structure Validation Summary Report i

Feb 28, 2014 – 12:51 AM GMT

PDB ID : 2YQ5  
Title : Crystal Structure of D-isomer specific 2-hydroxyacid dehydrogenase from *Lactobacillus delbrueckii* ssp. *bulgaricus*: NAD complexed form  
Authors : Holton, S.J.; Anandhakrishnan, M.; Geerlof, A.; Wilmanns, M.  
Deposited on : 2012-11-05  
Resolution : 2.75 Å (reported)

This is a wwPDB 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 <http://wwpdb.org/ValidationPDFNotes.html>

---

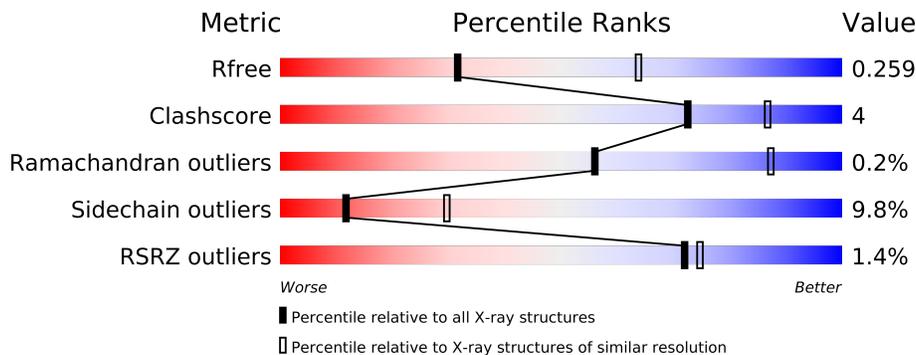
The following versions of software and data (see [references](#)) were used in the production of this report:

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 2.75 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	2406 (2.80-2.72)
Clashscore	79885	2995 (2.80-2.72)
Ramachandran outliers	78287	2941 (2.80-2.72)
Sidechain outliers	78261	2944 (2.80-2.72)
RSRZ outliers	66119	2409 (2.80-2.72)

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	343	
1	B	343	
1	C	343	
1	D	343	

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 10369 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-ISOMER SPECIFIC 2-HYDROXYACID DEHYDROGENASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	328	2545	1628	410	494	13	0	0	0
1	B	328	2544	1626	410	495	13	0	0	0
1	C	331	2573	1645	415	500	13	0	0	0
1	D	321	2492	1593	399	487	13	0	0	0

There are 40 discrepancies between the modelled and reference sequences:

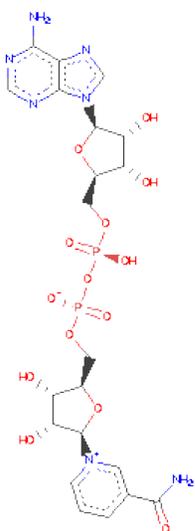
Chain	Residue	Modelled	Actual	Comment	Reference
A	334	THR	-	EXPRESSION TAG	UNP Q1GAA2
A	335	ALA	-	EXPRESSION TAG	UNP Q1GAA2
A	336	SER	-	EXPRESSION TAG	UNP Q1GAA2
A	337	GLY	-	EXPRESSION TAG	UNP Q1GAA2
A	338	HIS	-	EXPRESSION TAG	UNP Q1GAA2
A	339	HIS	-	EXPRESSION TAG	UNP Q1GAA2
A	340	HIS	-	EXPRESSION TAG	UNP Q1GAA2
A	341	HIS	-	EXPRESSION TAG	UNP Q1GAA2
A	342	HIS	-	EXPRESSION TAG	UNP Q1GAA2
A	343	HIS	-	EXPRESSION TAG	UNP Q1GAA2
B	334	THR	-	EXPRESSION TAG	UNP Q1GAA2
B	335	ALA	-	EXPRESSION TAG	UNP Q1GAA2
B	336	SER	-	EXPRESSION TAG	UNP Q1GAA2
B	337	GLY	-	EXPRESSION TAG	UNP Q1GAA2
B	338	HIS	-	EXPRESSION TAG	UNP Q1GAA2
B	339	HIS	-	EXPRESSION TAG	UNP Q1GAA2
B	340	HIS	-	EXPRESSION TAG	UNP Q1GAA2
B	341	HIS	-	EXPRESSION TAG	UNP Q1GAA2
B	342	HIS	-	EXPRESSION TAG	UNP Q1GAA2
B	343	HIS	-	EXPRESSION TAG	UNP Q1GAA2

*Continued on next page...*

Continued from previous page...

Chain	Residue	Modelled	Actual	Comment	Reference
C	334	THR	-	EXPRESSION TAG	UNP Q1GAA2
C	335	ALA	-	EXPRESSION TAG	UNP Q1GAA2
C	336	SER	-	EXPRESSION TAG	UNP Q1GAA2
C	337	GLY	-	EXPRESSION TAG	UNP Q1GAA2
C	338	HIS	-	EXPRESSION TAG	UNP Q1GAA2
C	339	HIS	-	EXPRESSION TAG	UNP Q1GAA2
C	340	HIS	-	EXPRESSION TAG	UNP Q1GAA2
C	341	HIS	-	EXPRESSION TAG	UNP Q1GAA2
C	342	HIS	-	EXPRESSION TAG	UNP Q1GAA2
C	343	HIS	-	EXPRESSION TAG	UNP Q1GAA2
D	334	THR	-	EXPRESSION TAG	UNP Q1GAA2
D	335	ALA	-	EXPRESSION TAG	UNP Q1GAA2
D	336	SER	-	EXPRESSION TAG	UNP Q1GAA2
D	337	GLY	-	EXPRESSION TAG	UNP Q1GAA2
D	338	HIS	-	EXPRESSION TAG	UNP Q1GAA2
D	339	HIS	-	EXPRESSION TAG	UNP Q1GAA2
D	340	HIS	-	EXPRESSION TAG	UNP Q1GAA2
D	341	HIS	-	EXPRESSION TAG	UNP Q1GAA2
D	342	HIS	-	EXPRESSION TAG	UNP Q1GAA2
D	343	HIS	-	EXPRESSION TAG	UNP Q1GAA2

- Molecule 2 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
2	A	1	44	21	7	14	2	0	0

Continued on next page...

*Continued from previous page...*

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	
2	B	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
2	C	1	Total	C	N	O	P	0	0
			44	21	7	14	2		
2	D	1	Total	C	N	O	P	0	0
			44	21	7	14	2		

- Molecule 3 is water.

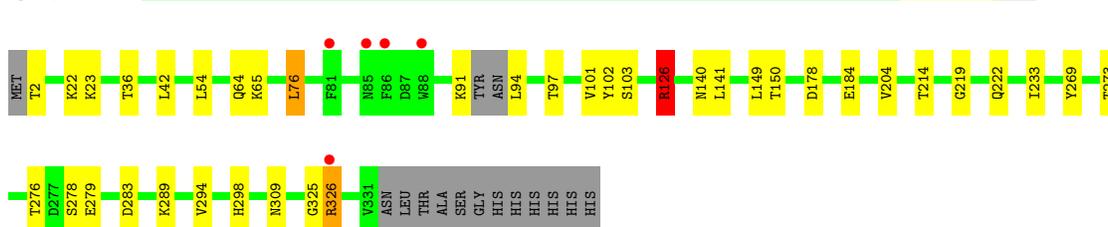
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	10	Total	O	0	0
			10	10		
3	B	11	Total	O	0	0
			11	11		
3	C	9	Total	O	0	0
			9	9		
3	D	9	Total	O	0	0
			9	9		

### 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.

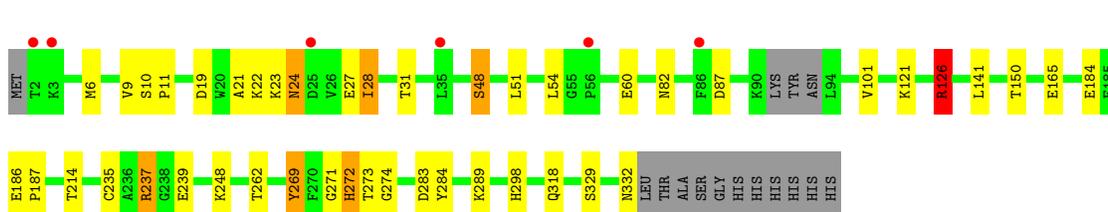
- Molecule 1: D-ISOMER SPECIFIC 2-HYDROXYACID DEHYDROGENASE

Chain A:



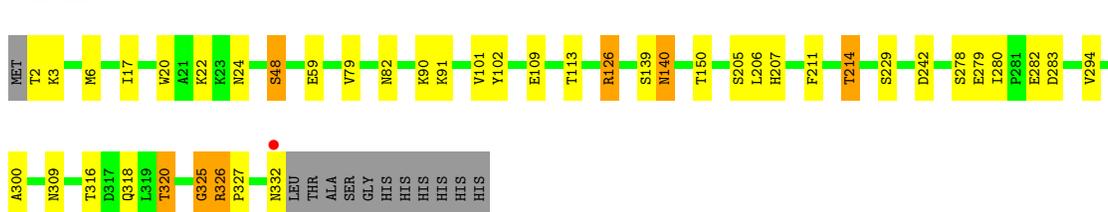
- Molecule 1: D-ISOMER SPECIFIC 2-HYDROXYACID DEHYDROGENASE

Chain B:



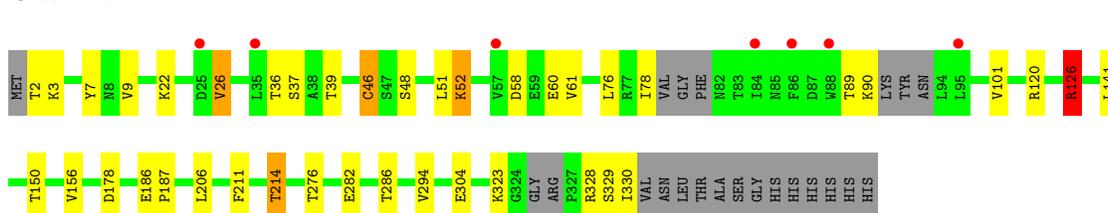
- Molecule 1: D-ISOMER SPECIFIC 2-HYDROXYACID DEHYDROGENASE

Chain C:



- Molecule 1: D-ISOMER SPECIFIC 2-HYDROXYACID DEHYDROGENASE

Chain D:



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	92.72Å 110.01Å 147.74Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	44.99 – 2.75 44.95 – 2.75	Depositor EDS
% Data completeness (in resolution range)	99.1 (44.99-2.75) 99.1 (44.95-2.75)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.42 (at 2.77Å)	Xtrriage
Refinement program	REFMAC 5.7.0029	Depositor
R, $R_{free}$	0.188 , 0.259 0.189 , 0.259	Depositor DCC
$R_{free}$ test set	1953 reflections (5.18%)	DCC
Wilson B-factor (Å <sup>2</sup> )	45.6	Xtrriage
Anisotropy	0.507	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.31 , 14.5	EDS
Estimated twinning fraction	No twinning to report.	Xtrriage
L-test for twinning	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtrriage
Outliers	0 of 39677 reflections	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	10369	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	47.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.92% of the height of the origin peak. No significant pseudotranslation is detected.*

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

## 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

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	0/2596	0.79	6/3528 (0.2%)
1	B	0.71	1/2595 (0.0%)	0.82	4/3528 (0.1%)
1	C	0.72	0/2626	0.86	5/3571 (0.1%)
1	D	0.63	0/2540	0.77	1/3450 (0.0%)
All	All	0.68	1/10357 (0.0%)	0.81	16/14077 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	165	GLU	CD-OE2	5.34	1.31	1.25

The worst 5 of 16 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	126	ARG	NE-CZ-NH1	8.56	124.58	120.30
1	B	274	GLY	N-CA-C	-8.31	92.33	113.10
1	C	325	GLY	N-CA-C	7.50	131.85	113.10
1	B	273	THR	N-CA-C	-7.02	92.05	111.00
1	A	126	ARG	NE-CZ-NH1	6.76	123.68	120.30

There are no chirality outliers.

There are no planarity outliers.

### 5.2 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 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	2545	0	20	9	0
1	B	2544	0	14	14	0
1	C	2573	0	41	12	0
1	D	2492	0	0	10	0
2	A	44	0	26	1	0
2	B	44	0	26	0	0
2	C	44	0	26	1	0
2	D	44	0	26	1	0
3	A	10	0	0	0	0
3	B	11	0	0	1	0
3	C	9	0	0	0	0
3	D	9	0	0	0	0
All	All	10369	0	179	45	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 4.

The worst 5 of 45 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:B:6:MET:CE	1:B:28:ILE:CG2	2.66	0.73
1:A:178:ASP:OD1	2:A:0:NAD:O2B	2.09	0.70
1:C:48:SER:OG	1:C:318:GLN:NE2	2.28	0.66
1:A:91:LYS:O	1:A:94:LEU:N	2.30	0.64
1:D:2:THR:O	1:D:26:VAL:CG1	2.45	0.64

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	324/343 (94%)	311 (96%)	13 (4%)	0	100 100
1	B	324/343 (94%)	313 (97%)	9 (3%)	2 (1%)	33 70

*Continued on next page...*

Continued from previous page...

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	C	329/343 (96%)	322 (98%)	7 (2%)	0	100	100
1	D	313/343 (91%)	296 (95%)	17 (5%)	0	100	100
All	All	1290/1372 (94%)	1242 (96%)	46 (4%)	2 (0%)	56	87

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	184	GLU
1	B	239	GLU

### 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	281/294 (96%)	257 (92%)	24 (8%)	15	38
1	B	281/294 (96%)	252 (90%)	29 (10%)	10	27
1	C	284/294 (97%)	259 (91%)	25 (9%)	14	36
1	D	276/294 (94%)	244 (88%)	32 (12%)	8	21
All	All	1122/1176 (95%)	1012 (90%)	110 (10%)	12	30

5 of 110 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	289	LYS
1	C	91	LYS
1	D	276	THR
1	B	329	SER
1	C	22	LYS

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

### 5.3.3 RNA [i](#)

There are no RNA chains 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)

4 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	NAD	A	0	-	48,48,48	2.14	14 (29%)	73,73,73	2.14	16 (21%)
2	NAD	B	0	-	48,48,48	2.50	21 (43%)	73,73,73	1.98	16 (21%)
2	NAD	C	0	-	48,48,48	1.52	8 (16%)	73,73,73	1.87	14 (19%)
2	NAD	D	0	-	48,48,48	1.41	7 (14%)	73,73,73	1.89	13 (17%)

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	NAD	A	0	-	-	0/30/62/62	0/3/5/5
2	NAD	B	0	-	-	0/30/62/62	0/3/5/5
2	NAD	C	0	-	-	0/30/62/62	0/3/5/5
2	NAD	D	0	-	-	0/30/62/62	0/3/5/5

The worst 5 of 50 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	0	NAD	PN-O3	-6.19	1.47	1.60
2	A	0	NAD	O4B-C1B	-6.06	1.32	1.41

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	0	NAD	O4D-C1D	5.98	1.50	1.41
2	B	0	NAD	C4A-N9A	-5.15	1.30	1.37
2	B	0	NAD	PN-O5D	-5.14	1.43	1.60

The worst 5 of 59 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	0	NAD	N3A-C2A-N1A	-8.96	121.21	128.71
2	B	0	NAD	N3A-C2A-N1A	-8.12	121.92	128.71
2	C	0	NAD	N3A-C2A-N1A	-7.74	122.23	128.71
2	A	0	NAD	O4B-C1B-N9A	-7.65	101.33	108.44
2	A	0	NAD	N3A-C2A-N1A	-6.51	123.27	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 [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	328/343 (95%)	-0.14	5 (1%) 70 73	25, 45, 90, 116	0
1	B	328/343 (95%)	-0.08	6 (1%) 65 68	19, 38, 94, 109	0
1	C	331/343 (96%)	-0.36	1 (0%) 91 94	21, 35, 60, 77	0
1	D	321/343 (93%)	0.06	7 (2%) 59 62	23, 49, 93, 113	0
All	All	1308/1372 (95%)	-0.13	19 (1%) 72 73	19, 42, 89, 116	0

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	57	VAL	5.1
1	D	86	PHE	4.1
1	B	25	ASP	3.3
1	B	3	LYS	3.3
1	B	2	THR	3.2

### 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. 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(Å <sup>2</sup> )	Q<0.9
2	NAD	A	0	44/44	0.16	0.41	48,58,67,69	0
2	NAD	C	0	44/44	0.12	-0.31	30,38,46,50	0
2	NAD	D	0	44/44	0.15	-0.32	47,59,65,67	0
2	NAD	B	0	44/44	0.11	-1.22	31,38,41,45	0

## 6.5 Other polymers

There are no such residues in this entry.