



# wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 1, 2016 – 04:05 PM GMT

PDB ID : 4E5N  
Title : Thermostable phosphite dehydrogenase in complex with NAD  
Authors : Zou, Y.; Zhang, H.; Nair, S.K.  
Deposited on : 2012-03-14  
Resolution : 1.70 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  
<http://wwpdb.org/validation/2016/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 : 1.7 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Refmac : 5.8.0135  
CCP4 : 6.5.0  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : trunk26865

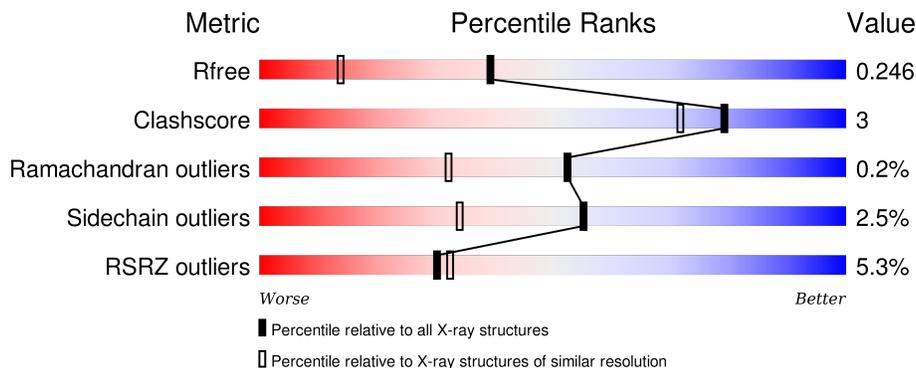
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.70 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))
$R_{free}$	91344	3190 (1.70-1.70)
Clashscore	102246	3585 (1.70-1.70)
Ramachandran outliers	100387	3527 (1.70-1.70)
Sidechain outliers	100360	3527 (1.70-1.70)
RSRZ outliers	91569	3200 (1.70-1.70)

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. 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	330	 3% 91% 8%
1	B	330	 3% 92% 6% •
1	C	330	 6% 92% 8%
1	D	330	 2% 93% 7%
1	E	330	 8% 89% 9% ••

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Mol	Chain	Length	Quality of chain
1	F	330	 2% 89% 9% ..
1	G	330	 3% 89% 9% ..
1	H	330	 15% 89% 10%

## 2 Entry composition

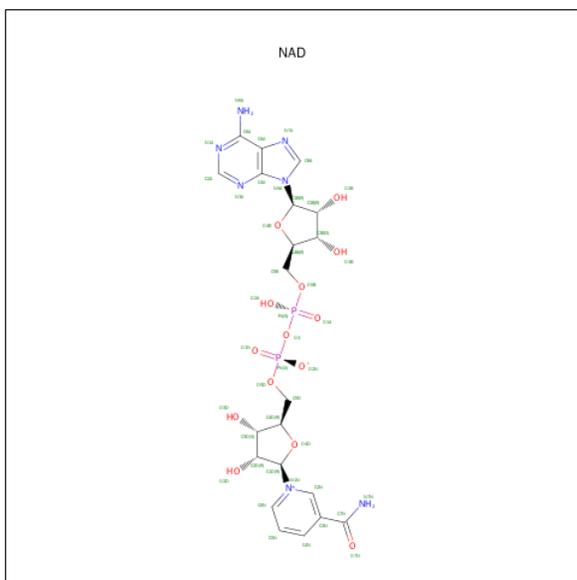
There are 3 unique types of molecules in this entry. The entry contains 22943 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Thermostable phosphite dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	329	2519	1591	456	457	15	0	0	0
1	B	329	2519	1591	456	457	15	0	0	0
1	C	330	2528	1597	458	458	15	0	0	0
1	D	330	2524	1595	457	457	15	0	0	0
1	E	328	2511	1586	455	456	14	0	0	0
1	F	327	2504	1581	454	455	14	0	0	0
1	G	328	2509	1584	455	456	14	0	0	0
1	H	329	2519	1591	456	457	15	0	0	0

- 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	Total 44	C 21	N 7	O 14	P 2	0	0
2	B	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	C	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	D	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	E	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	F	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	G	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	H	1	Total 44	C 21	N 7	O 14	P 2	0	0

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	347	Total 347	O 347	0	0
3	B	368	Total 368	O 368	0	0
3	C	210	Total 210	O 210	0	0
3	D	390	Total 390	O 390	0	0

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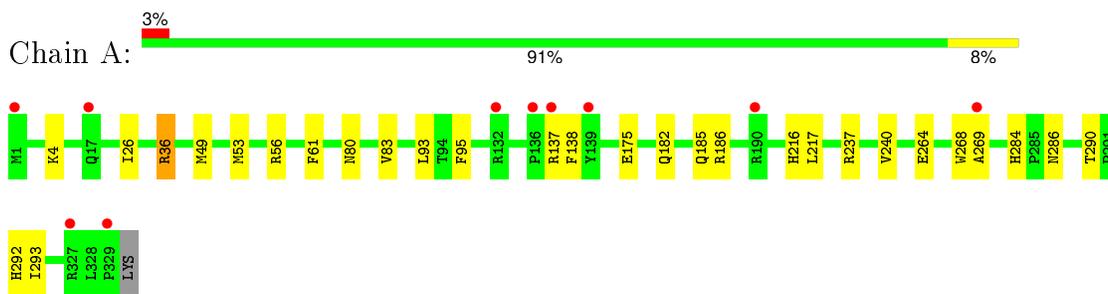
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<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
3	E	235	Total 235	O 235	0	0
3	F	370	Total 370	O 370	0	0
3	G	371	Total 371	O 371	0	0
3	H	167	Total 167	O 167	0	0

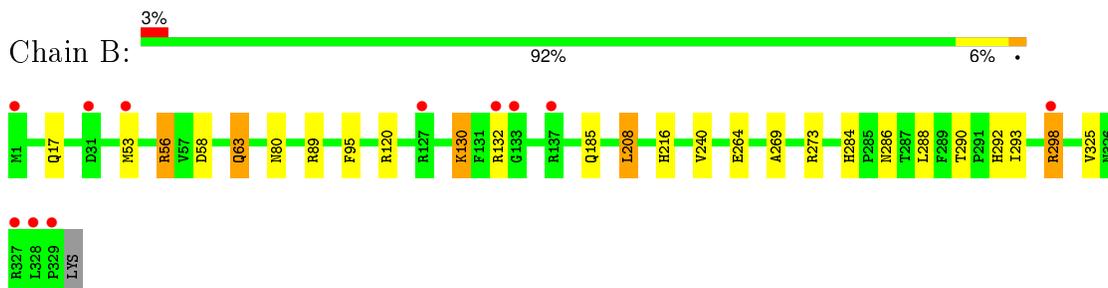
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of 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.

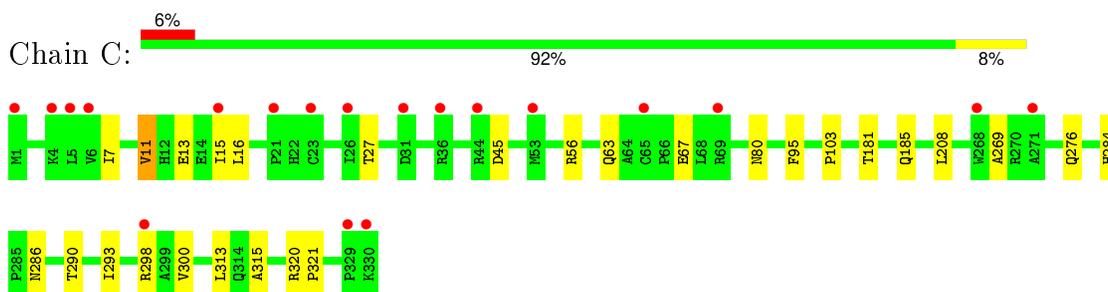
- Molecule 1: Thermostable phosphite dehydrogenase



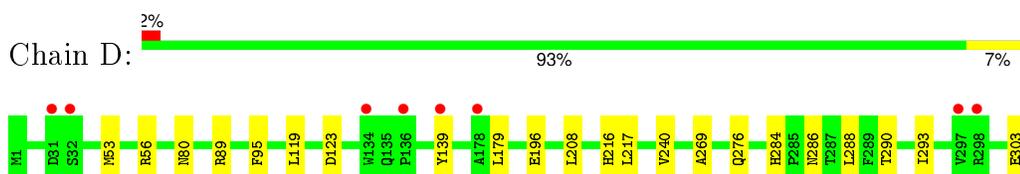
- Molecule 1: Thermostable phosphite dehydrogenase



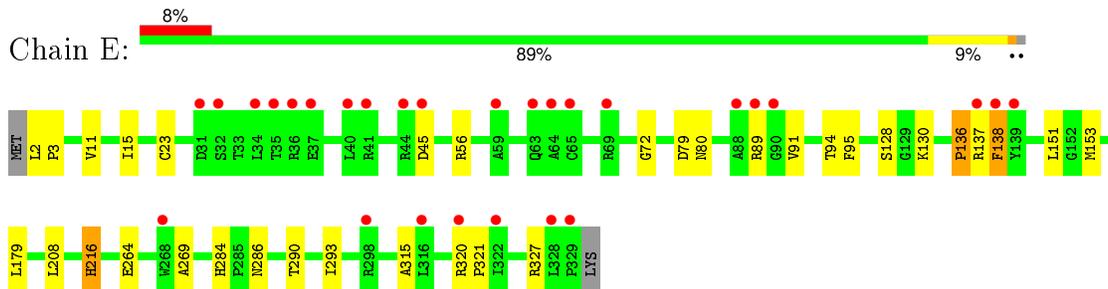
- Molecule 1: Thermostable phosphite dehydrogenase



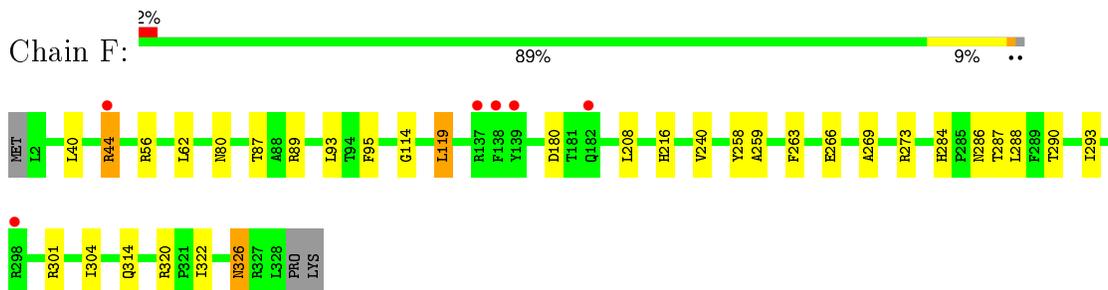
- Molecule 1: Thermostable phosphite dehydrogenase



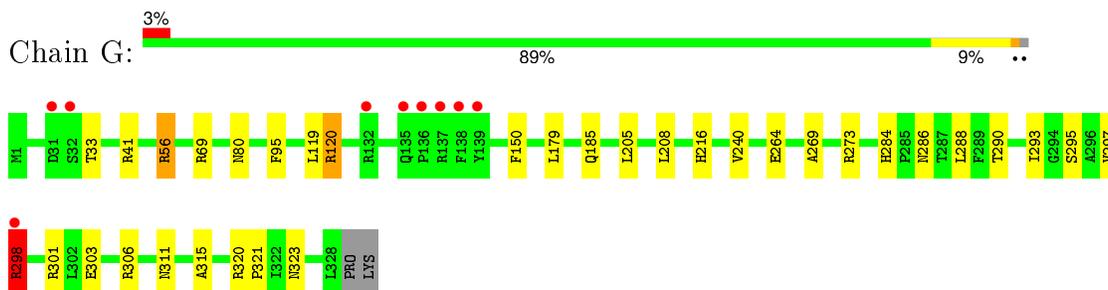
- Molecule 1: Thermostable phosphite dehydrogenase



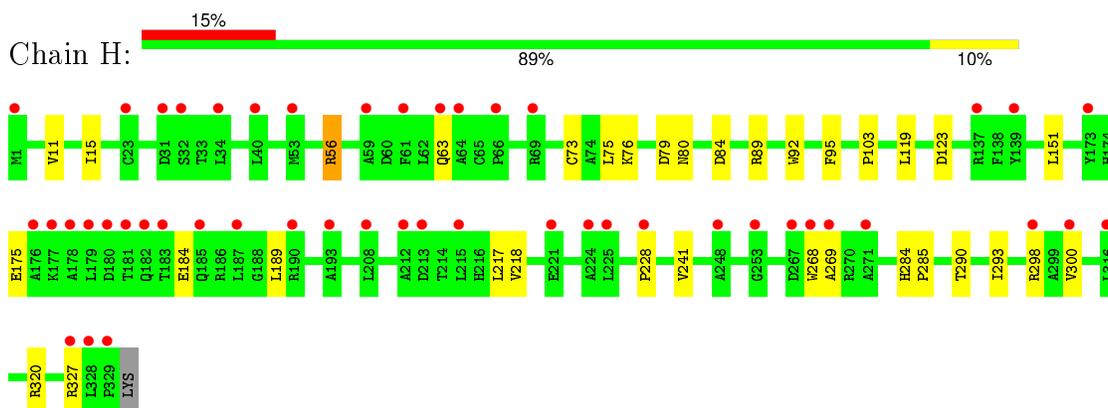
- Molecule 1: Thermostable phosphite dehydrogenase



- Molecule 1: Thermostable phosphite dehydrogenase



- Molecule 1: Thermostable phosphite dehydrogenase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	90.71Å 113.54Å 130.19Å 90.00° 100.16° 90.00°	Depositor
Resolution (Å)	25.00 – 1.70 80.19 – 1.70	Depositor EDS
% Data completeness (in resolution range)	100.0 (25.00-1.70) 95.1 (80.19-1.70)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.00 (at 1.70Å)	Xtrriage
Refinement program	REFMAC 5.5.0109	Depositor
R, $R_{free}$	0.210 , 0.247 0.210 , 0.246	Depositor DCC
$R_{free}$ test set	13623 reflections (5.31%)	DCC
Wilson B-factor (Å <sup>2</sup> )	22.0	Xtrriage
Anisotropy	0.273	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 49.5	EDS
Estimated twinning fraction	No twinning to report.	Xtrriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtrriage
Outliers	0 of 270433 reflections	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	22943	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	29.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 32.45 % 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 9.3755e-04.*

<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, 0.375 respectively for untwinned datasets, and 0.333, 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

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	0.38	0/2566	0.56	0/3490
1	B	0.40	0/2566	0.58	0/3490
1	C	0.36	0/2575	0.53	0/3501
1	D	0.41	0/2571	0.57	0/3496
1	E	0.37	0/2558	0.56	0/3480
1	F	0.40	0/2550	0.57	0/3468
1	G	0.41	0/2555	0.57	1/3475 (0.0%)
1	H	0.34	0/2566	0.51	0/3490
All	All	0.38	0/20507	0.56	1/27890 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	G	120	ARG	NE-CZ-NH2	-5.21	117.69	120.30

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	2519	0	2540	18	0
1	B	2519	0	2540	21	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	C	2528	0	2553	13	0
1	D	2524	0	2547	15	0
1	E	2511	0	2528	17	0
1	F	2504	0	2521	24	0
1	G	2509	0	2526	28	0
1	H	2519	0	2540	17	0
2	A	44	0	26	0	0
2	B	44	0	26	0	0
2	C	44	0	26	1	0
2	D	44	0	26	0	0
2	E	44	0	26	0	0
2	F	44	0	26	0	0
2	G	44	0	26	1	0
2	H	44	0	26	0	0
3	A	347	0	0	0	0
3	B	368	0	0	2	0
3	C	210	0	0	1	0
3	D	390	0	0	5	1
3	E	235	0	0	0	1
3	F	370	0	0	1	1
3	G	371	0	0	4	0
3	H	167	0	0	2	0
All	All	22943	0	20503	143	2

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.

The worst 5 of 143 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:G:56:ARG:NH1	3:G:1263:HOH:O	2.05	0.82
1:G:311:ASN:HD21	1:G:323:ASN:H	1.30	0.79
1:B:298:ARG:O	3:B:1264:HOH:O	2.10	0.70
1:A:290:THR:HB	1:A:293:ILE:HG12	1.77	0.66
1:F:284:HIS:HD2	1:F:286:ASN:H	1.42	0.66

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:F:997:HOH:O	3:F:1270:HOH:O[2_645]	2.13	0.07
3:D:1230:HOH:O	3:E:987:HOH:O[1_545]	2.15	0.05

### 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	327/330 (99%)	319 (98%)	8 (2%)	0	100	100
1	B	327/330 (99%)	318 (97%)	9 (3%)	0	100	100
1	C	328/330 (99%)	317 (97%)	11 (3%)	0	100	100
1	D	328/330 (99%)	321 (98%)	7 (2%)	0	100	100
1	E	326/330 (99%)	313 (96%)	11 (3%)	2 (1%)	30	12
1	F	325/330 (98%)	318 (98%)	7 (2%)	0	100	100
1	G	326/330 (99%)	315 (97%)	9 (3%)	2 (1%)	30	12
1	H	327/330 (99%)	315 (96%)	11 (3%)	1 (0%)	46	26
All	All	2614/2640 (99%)	2536 (97%)	73 (3%)	5 (0%)	52	32

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	G	298	ARG
1	E	137	ARG
1	G	33	THR
1	E	136	PRO
1	H	228	PRO

#### 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	259/260 (100%)	255 (98%)	4 (2%)	72	56
1	B	259/260 (100%)	251 (97%)	8 (3%)	47	25
1	C	260/260 (100%)	254 (98%)	6 (2%)	58	37
1	D	259/260 (100%)	253 (98%)	6 (2%)	58	37
1	E	258/260 (99%)	252 (98%)	6 (2%)	58	37
1	F	257/260 (99%)	249 (97%)	8 (3%)	47	25
1	G	257/260 (99%)	251 (98%)	6 (2%)	58	37
1	H	259/260 (100%)	251 (97%)	8 (3%)	47	25
All	All	2068/2080 (99%)	2016 (98%)	52 (2%)	55	34

5 of 52 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	276	GLN
1	E	216	HIS
1	H	84	ASP
1	E	45	ASP
1	E	79	ASP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 53 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	276	GLN
1	D	275	GLN
1	G	284	HIS
1	C	284	HIS
1	D	80	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](#)

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
2	NAD	A	800	-	38,48,48	0.72	1 (2%)	47,73,73	1.92	5 (10%)
2	NAD	B	800	-	38,48,48	0.75	1 (2%)	47,73,73	2.00	6 (12%)
2	NAD	C	800	-	38,48,48	0.72	1 (2%)	47,73,73	1.89	5 (10%)
2	NAD	D	800	-	38,48,48	0.63	0	47,73,73	1.89	5 (10%)
2	NAD	E	800	-	38,48,48	0.71	0	47,73,73	1.87	6 (12%)
2	NAD	F	800	-	38,48,48	0.76	1 (2%)	47,73,73	1.85	6 (12%)
2	NAD	G	800	-	38,48,48	0.72	1 (2%)	47,73,73	1.96	6 (12%)
2	NAD	H	800	-	38,48,48	0.71	1 (2%)	47,73,73	1.81	5 (10%)

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	800	-	-	0/22/62/62	0/5/5/5
2	NAD	B	800	-	-	0/22/62/62	0/5/5/5
2	NAD	C	800	-	-	0/22/62/62	0/5/5/5
2	NAD	D	800	-	-	0/22/62/62	0/5/5/5
2	NAD	E	800	-	-	0/22/62/62	0/5/5/5
2	NAD	F	800	-	-	0/22/62/62	0/5/5/5
2	NAD	G	800	-	-	0/22/62/62	0/5/5/5
2	NAD	H	800	-	-	0/22/62/62	0/5/5/5

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	F	800	NAD	O4B-C1B	2.07	1.43	1.41
2	H	800	NAD	O4B-C1B	2.07	1.43	1.41
2	G	800	NAD	O4B-C1B	2.09	1.43	1.41
2	C	800	NAD	O4D-C1D	2.10	1.43	1.41
2	A	800	NAD	O4D-C1D	2.57	1.44	1.41

The worst 5 of 44 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	800	NAD	N3A-C2A-N1A	-10.93	120.52	128.89
2	B	800	NAD	N3A-C2A-N1A	-10.84	120.60	128.89
2	G	800	NAD	N3A-C2A-N1A	-10.79	120.63	128.89
2	D	800	NAD	N3A-C2A-N1A	-10.76	120.66	128.89
2	E	800	NAD	N3A-C2A-N1A	-10.57	120.80	128.89

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	800	NAD	1	0
2	G	800	NAD	1	0

## 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	329/330 (99%)	0.06	10 (3%) 54 58	17, 24, 37, 47	0
1	B	329/330 (99%)	0.11	11 (3%) 50 54	15, 23, 39, 52	0
1	C	330/330 (100%)	0.35	19 (5%) 26 28	19, 31, 55, 61	0
1	D	330/330 (100%)	-0.10	8 (2%) 62 66	14, 21, 36, 45	0
1	E	328/330 (99%)	0.42	28 (8%) 13 14	17, 29, 53, 64	0
1	F	327/330 (99%)	-0.05	6 (1%) 71 76	16, 24, 37, 46	0
1	G	328/330 (99%)	0.02	9 (2%) 58 62	14, 22, 38, 43	0
1	H	329/330 (99%)	0.97	48 (14%) 3 4	24, 40, 60, 65	0
All	All	2630/2640 (99%)	0.22	139 (5%) 30 32	14, 26, 50, 65	0

The worst 5 of 139 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	1	MET	6.1
1	E	137	ARG	5.9
1	H	1	MET	5.5
1	E	88	ALA	5.2
1	E	63	GLN	5.2

### 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	RSCC	RSR	LLDF	B-factors(Å <sup>2</sup> )	Q<0.9
2	NAD	F	800	44/44	0.98	0.08	-0.05	18,19,23,24	0
2	NAD	C	800	44/44	0.97	0.08	-0.34	21,24,33,34	0
2	NAD	D	800	44/44	0.98	0.07	-0.36	16,18,22,23	0
2	NAD	G	800	44/44	0.97	0.07	-0.38	15,18,21,22	0
2	NAD	H	800	44/44	0.90	0.12	-0.38	35,38,47,47	0
2	NAD	A	800	44/44	0.98	0.08	-0.57	18,22,25,25	0
2	NAD	E	800	44/44	0.97	0.07	-0.93	21,24,27,29	0
2	NAD	B	800	44/44	0.98	0.07	-0.93	13,16,18,21	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.