



Full wwPDB X-ray Structure Validation Report ⓘ

Apr 25, 2026 – 10:02 PM EDT

PDB ID : 5XDF / pdb_00005xdf
Title : Homoserine dehydrogenase from *Thermus thermophilus* HB8 complexed with HSE
Authors : Akai, S.; Miyahara, I.
Deposited on : 2017-03-28
Resolution : 2.00 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

A user guide is available at

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

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

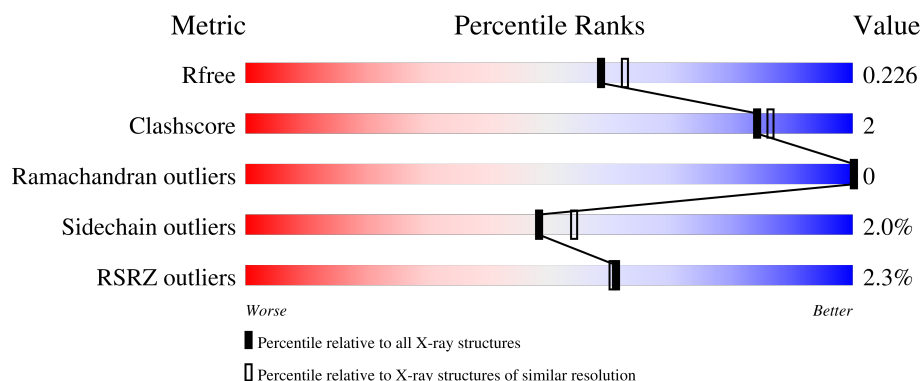
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

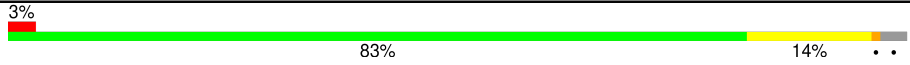
The reported resolution of this entry is 2.00 Å.

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}	180053	10052 (2.00-2.00)
Clashscore	190562	11152 (2.00-2.00)
Ramachandran outliers	187476	11031 (2.00-2.00)
Sidechain outliers	187428	11029 (2.00-2.00)
RSRZ outliers	180081	10067 (2.00-2.00)

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 of the lower bar indicate the fraction of residues that contain outliers for ≥ 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	332	
1	B	332	

2 Entry composition [i](#)

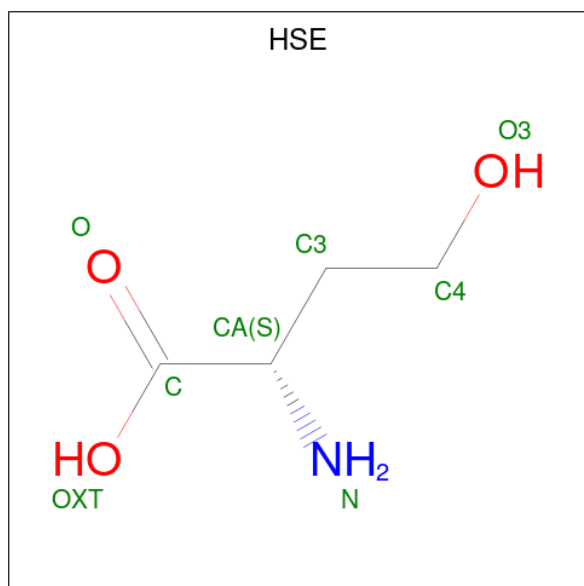
There are 5 unique types of molecules in this entry. The entry contains 5346 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Homoserine dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	323	Total	C	N	O	S	0	3	0
			2401	1543	413	441	4			
1	B	330	Total	C	N	O	S	0	2	0
			2422	1559	415	444	4			

- Molecule 2 is L-HOMOSERINE (CCD ID: HSE) (formula: $C_4H_9NO_3$).

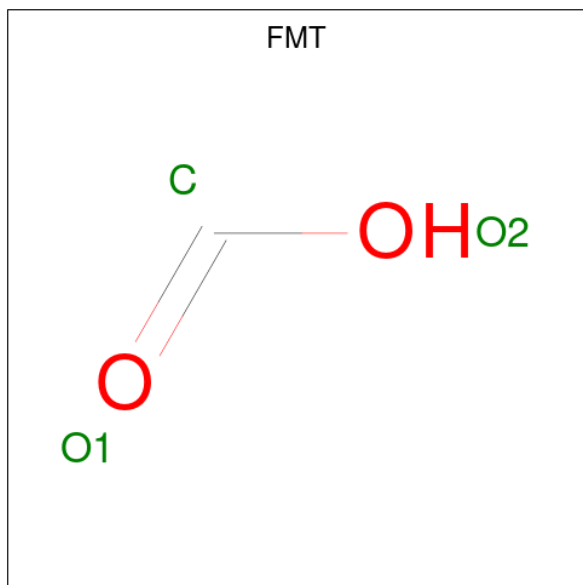


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			8	4	1	3		
2	B	1	Total	C	N	O	0	0
			8	4	1	3		

- Molecule 3 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Na	0	0
			1	1		
3	B	1	Total	Na	0	0
			1	1		

- Molecule 4 is FORMIC ACID (CCD ID: FMT) (formula: CH₂O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			3	1	2		
4	B	1	Total	C	O	0	0
			3	1	2		

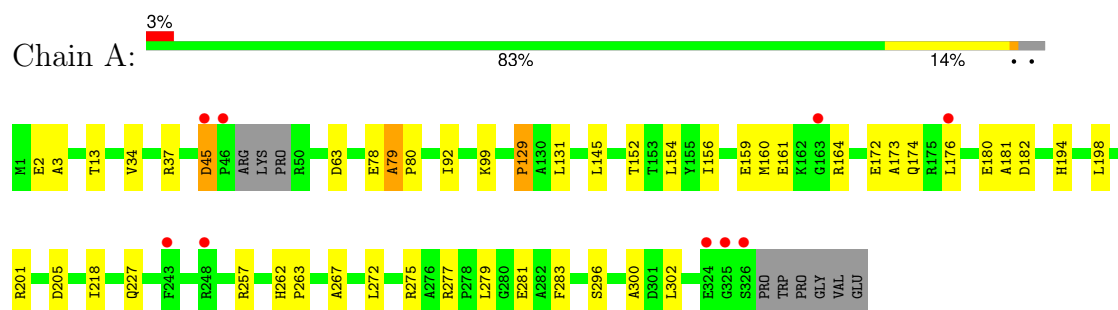
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	251	Total	O	0	0
			251	251		
5	B	248	Total	O	0	0
			248	248		

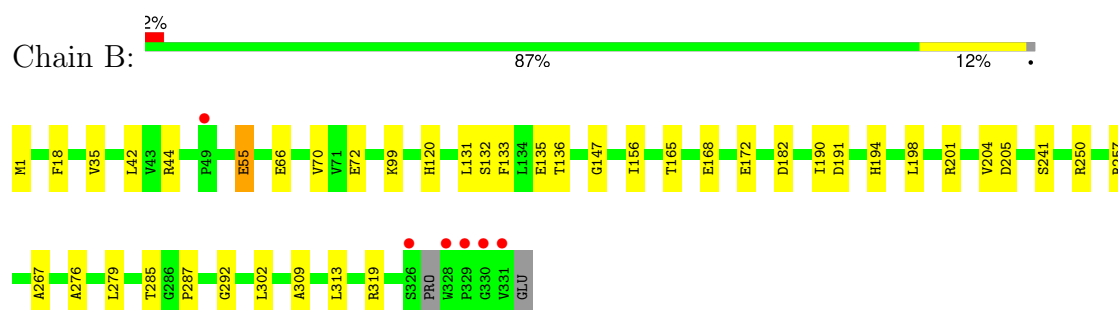
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide 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: Homoserine dehydrogenase



- Molecule 1: Homoserine dehydrogenase



4 Data and refinement statistics

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, α , β , γ	119.62Å 119.62Å 145.02Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.00 – 2.00 20.00 – 2.00	Depositor EDS
% Data completeness (in resolution range)	99.4 (20.00-2.00) 99.4 (20.00-2.00)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	5.48 (at 2.01Å)	Xtriage
Refinement program	REFMAC 5.8.0135	Depositor
R, R_{free}	0.185 , 0.219 0.195 , 0.226	Depositor DCC
R_{free} test set	4042 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å ²)	27.9	Xtriage
Anisotropy	0.040	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 47.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.35$	Xtriage
Estimated twinning fraction	0.018 for -h,-k,l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	5346	wwPDB-VP
Average B, all atoms (Å ²)	32.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.02% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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 ⓘ

5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: HSE, FMT, NA

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	1.68	25/2451 (1.0%)	1.29	5/3341 (0.1%)
1	B	1.62	22/2474 (0.9%)	1.25	9/3377 (0.3%)
All	All	1.65	47/4925 (1.0%)	1.27	14/6718 (0.2%)

All (47) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	132	SER	N-CA	8.78	1.57	1.46
1	A	164	ARG	CA-C	7.93	1.62	1.52
1	B	42	LEU	CA-C	-7.75	1.42	1.52
1	A	131	LEU	CA-C	7.57	1.62	1.52
1	A	194	HIS	CA-C	7.17	1.61	1.52
1	A	92	ILE	N-CA	-6.81	1.39	1.46
1	B	250	ARG	CA-C	6.70	1.60	1.52
1	B	267	ALA	C-O	6.58	1.31	1.23
1	A	45	ASP	CA-C	6.51	1.60	1.52
1	B	287	PRO	N-CA	6.50	1.55	1.47
1	A	78	GLU	C-O	-6.48	1.16	1.24
1	B	70	VAL	CA-C	-6.24	1.45	1.52
1	B	190	ILE	N-CA	-6.23	1.38	1.46
1	A	159	GLU	CA-C	-6.16	1.44	1.52
1	A	257	ARG	C-O	-6.13	1.16	1.24
1	A	180	GLU	CA-C	6.09	1.60	1.52
1	A	174	GLN	CA-C	6.08	1.60	1.52
1	A	173	ALA	CA-C	-6.05	1.45	1.52
1	B	156	ILE	CA-CB	6.03	1.61	1.54
1	A	152	THR	CA-CB	5.93	1.62	1.53
1	A	300	ALA	N-CA	5.85	1.53	1.46
1	B	147	GLY	N-CA	5.74	1.51	1.45
1	B	182	ASP	CA-C	5.70	1.60	1.52
1	A	161	GLU	C-O	-5.63	1.17	1.24

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	182	ASP	N-CA	5.56	1.52	1.45
1	B	194	HIS	CA-C	5.52	1.60	1.52
1	B	42	LEU	N-CA	5.48	1.53	1.46
1	B	257	ARG	CA-CB	5.45	1.60	1.53
1	B	172	GLU	N-CA	5.43	1.52	1.46
1	A	79	ALA	CA-CB	-5.37	1.46	1.53
1	B	279	LEU	C-O	-5.34	1.18	1.24
1	A	296	SER	N-CA	5.33	1.52	1.46
1	A	129	PRO	CA-C	5.24	1.57	1.52
1	B	135	GLU	CA-C	5.23	1.59	1.52
1	A	181	ALA	N-CA	5.20	1.52	1.46
1	B	18	PHE	C-O	5.19	1.30	1.24
1	B	182	ASP	C-O	-5.16	1.17	1.24
1	B	72	GLU	CA-C	-5.14	1.46	1.52
1	A	63	ASP	CA-C	5.14	1.59	1.52
1	A	3	ALA	CA-CB	-5.11	1.45	1.53
1	A	262	HIS	C-O	5.11	1.30	1.24
1	B	292	GLY	CA-C	5.09	1.57	1.52
1	A	277	ARG	CD-NE	5.08	1.53	1.46
1	A	279	LEU	CA-C	-5.08	1.46	1.52
1	A	154	LEU	N-CA	5.04	1.52	1.46
1	B	276	ALA	CA-C	5.02	1.58	1.52
1	B	241	SER	N-CA	5.02	1.52	1.46

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	120	HIS	N-CA-C	6.83	119.15	110.61
1	B	204	VAL	N-CA-C	6.00	119.41	113.71
1	A	267	ALA	N-CA-C	5.67	118.57	110.24
1	B	319	ARG	CA-C-N	-5.51	114.70	120.38
1	B	319	ARG	C-N-CA	-5.51	114.70	120.38
1	B	309	ALA	CA-C-N	5.46	125.45	120.21
1	B	309	ALA	C-N-CA	5.46	125.45	120.21
1	A	172	GLU	N-CA-C	-5.31	105.49	111.28
1	B	133	PHE	N-CA-C	-5.29	105.59	111.36
1	B	313	LEU	CA-C-N	-5.19	114.89	120.03
1	B	313	LEU	C-N-CA	-5.19	114.89	120.03
1	A	218	ILE	N-CA-C	5.12	116.47	111.91
1	A	13	THR	O-C-N	5.10	127.52	122.12
1	A	37	ARG	NE-CZ-NH2	5.03	123.73	119.20

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-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 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	2401	0	2400	12	0
1	B	2422	0	2410	13	0
2	A	8	0	3	0	0
2	B	8	0	3	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	3	0	1	0	0
4	B	3	0	1	0	0
5	A	251	0	0	0	0
5	B	248	0	0	3	0
All	All	5346	0	4818	22	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 2.

All (22) 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:275[A]:ARG:HG2	1:A:281[A]:GLU:HG2	1.82	0.62
1:B:1:MET:HG3	1:B:35:VAL:HG23	1.84	0.60
1:A:283[B]:PHE:CE2	1:B:285:THR:HG21	2.41	0.56
1:B:165:THR:OG1	1:B:168:GLU:HG3	2.07	0.54
1:B:99:LYS:HD3	1:B:99:LYS:H	1.72	0.53
1:A:79:ALA:HB3	1:A:80:PRO:CD	2.38	0.53
1:A:302:LEU:C	1:A:302:LEU:HD23	2.36	0.51
1:B:99:LYS:HE2	1:B:191:ASP:OD2	2.12	0.50
1:A:145:LEU:HD11	1:A:272:LEU:HD11	1.95	0.49
1:A:156:ILE:HG22	1:A:160:MET:HE2	1.95	0.48
1:B:55:GLU:CD	1:B:55:GLU:H	2.21	0.48
1:B:302:LEU:C	1:B:302:LEU:HD23	2.39	0.48
1:B:44:ARG:NH1	5:B:506:HOH:O	2.48	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:275[A]:ARG:CG	1:A:281[A]:GLU:HG2	2.45	0.46
1:A:2:GLU:O	1:A:34:VAL:HA	2.17	0.44
1:B:99:LYS:NZ	5:B:503:HOH:O	2.39	0.44
1:B:201:ARG:HA	1:B:205:ASP:O	2.19	0.42
1:A:129:PRO:HG3	1:B:136:THR:HB	2.02	0.41
1:A:201:ARG:HA	1:A:205:ASP:O	2.19	0.41
1:A:283[B]:PHE:CE2	1:B:285:THR:CG2	3.03	0.41
1:B:66:GLU:HB2	5:B:510:HOH:O	2.20	0.41
1:A:145:LEU:HD23	1:A:145:LEU:C	2.46	0.41

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	322/332 (97%)	309 (96%)	13 (4%)	0	100	100
1	B	328/332 (99%)	318 (97%)	10 (3%)	0	100	100
All	All	650/664 (98%)	627 (96%)	23 (4%)	0	100	100

There are no Ramachandran outliers to report.

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	231/248 (93%)	225 (97%)	6 (3%)	40	44
1	B	231/248 (93%)	228 (99%)	3 (1%)	61	68
All	All	462/496 (93%)	453 (98%)	9 (2%)	48	56

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	45	ASP
1	A	99	LYS
1	A	176	LEU
1	A	198	LEU
1	A	227	GLN
1	A	263	PRO
1	B	55	GLU
1	B	131	LEU
1	B	198	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	54	GLN
1	B	158	GLN
1	B	174	GLN

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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 6 ligands modelled in this entry, 2 are monoatomic - leaving 4 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$
4	FMT	A	1303	-	2,2,2	1.18	0	1,1,1	0.04	0
2	HSE	A	1301	-	6,7,7	1.47	1 (16%)	5,8,8	1.27	0
2	HSE	B	401	-	6,7,7	0.69	0	5,8,8	1.77	1 (20%)
4	FMT	B	403	-	2,2,2	1.04	0	1,1,1	0.77	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
2	HSE	A	1301	-	-	1/7/7/7	-
2	HSE	B	401	-	-	0/7/7/7	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	1301	HSE	O-C	2.59	1.29	1.22

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	401	HSE	C4-C3-CA	3.66	119.67	113.27

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	1301	HSE	CA-C3-C4-O3

There are no ring outliers.

No monomer is involved in short contacts.

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, 95th 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 ²)	Q<0.9
1	A	323/332 (97%)	-0.06	9 (2%) 55 54	11, 28, 51, 68	3 (0%)
1	B	330/332 (99%)	-0.04	6 (1%) 67 67	11, 29, 51, 69	2 (0%)
All	All	653/664 (98%)	-0.05	15 (2%) 61 60	11, 28, 51, 69	5 (0%)

All (15) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	328	TRP	5.5
1	A	46	PRO	4.6
1	A	326	SER	4.1
1	A	45	ASP	4.0
1	A	163	GLY	3.6
1	B	326	SER	3.6
1	A	176	LEU	3.3
1	B	330	GLY	3.2
1	A	243	PHE	3.2
1	B	329	PRO	2.9
1	B	331	VAL	2.6
1	A	324	GLU	2.5
1	A	248	ARG	2.3
1	A	325	GLY	2.1
1	B	49	PRO	2.1

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 oligosaccharides 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, 95th 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
4	FMT	A	1303	3/3	0.91	0.15	38,38,43,48	0
2	HSE	A	1301	8/8	0.92	0.09	28,32,33,36	0
4	FMT	B	403	3/3	0.92	0.11	47,47,50,55	0
2	HSE	B	401	8/8	0.97	0.06	26,27,30,31	0
3	NA	B	402	1/1	0.99	0.08	20,20,20,20	0
3	NA	A	1302	1/1	1.00	0.02	22,22,22,22	0

6.5 Other polymers [i](#)

There are no such residues in this entry.