



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 02:12 AM UTC

PDB ID : 4DGF / pdb_00004dgf
Title : Structure of SulP Transporter STAS Domain from Wolinella Succinogenes Refined to 1.6 Angstrom Resolution
Authors : Keller, J.P.; Chang, C.; Tesar, C.; Bearden, J.; Dallos, P.; Joachimiak, A.; Midwest Center for Structural Genomics (MCSG)
Deposited on : 2012-01-25
Resolution : 1.60 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

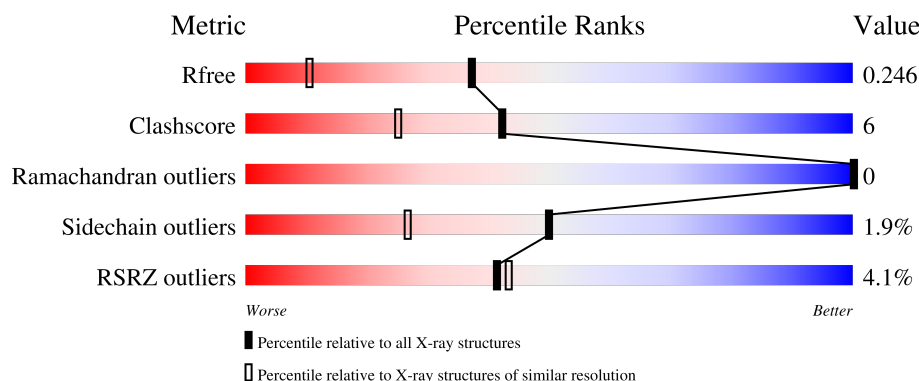
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.60 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	4673 (1.60-1.60)
Clashscore	190562	4931 (1.60-1.60)
Ramachandran outliers	187476	4831 (1.60-1.60)
Sidechain outliers	187428	4830 (1.60-1.60)
RSRZ outliers	180081	4672 (1.60-1.60)

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	135	
1	B	135	

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 2286 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 SULFATE TRANSPORTER SULFATE TRANSPORTER FAMILY PROTEIN.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	122	Total	C	N	O	S	Se	0	9	0
			1036	667	171	194	1	3			
1	B	125	Total	C	N	O	S	Se	0	12	0
			1080	694	176	204	1	5			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	431	SER	-	expression tag	UNP Q7M9V0
A	432	ASN	-	expression tag	UNP Q7M9V0
A	433	ALA	-	expression tag	UNP Q7M9V0
B	431	SER	-	expression tag	UNP Q7M9V0
B	432	ASN	-	expression tag	UNP Q7M9V0
B	433	ALA	-	expression tag	UNP Q7M9V0

- Molecule 2 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Cl	0	0
			1	1		
2	B	1	Total	Cl	0	0
			1	1		

- Molecule 3 is FORMIC ACID (CCD ID: FMT) (formula: CH₂O₂).



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

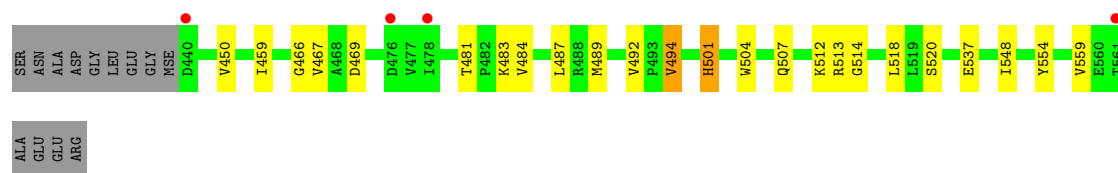
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	79	Total	O	0	0
			79	79		
4	B	83	Total	O	0	0
			83	83		

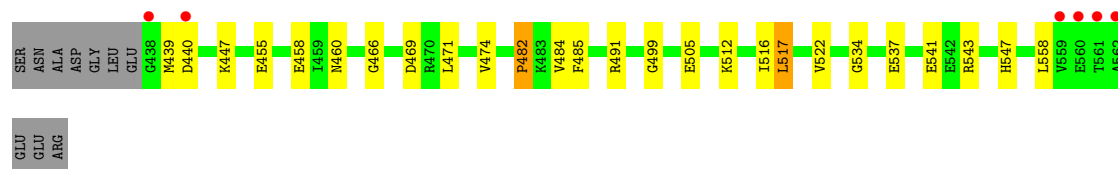
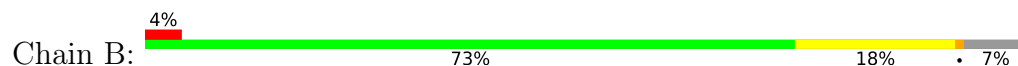
3 Residue-property plots

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: SULFATE TRANSPORTER SULFATE TRANSPORTER FAMILY PROTEIN



- Molecule 1: SULFATE TRANSPORTER SULFATE TRANSPORTER FAMILY PROTEIN



4 Data and refinement statistics

Property	Value	Source
Space group	P 2 21 21	Depositor
Cell constants a, b, c, α , β , γ	37.71Å 71.86Å 105.57Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	59.41 – 1.60 59.41 – 1.60	Depositor EDS
% Data completeness (in resolution range)	99.6 (59.41-1.60) 99.8 (59.41-1.60)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.62 (at 1.60Å)	Xtriage
Refinement program	REFMAC 5.6.0117	Depositor
R, R_{free}	0.206 , 0.244 0.209 , 0.246	Depositor DCC
R_{free} test set	1944 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å ²)	16.2	Xtriage
Anisotropy	0.378	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 35.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.44$, $\langle L^2 \rangle = 0.26$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	2286	wwPDB-VP
Average B, all atoms (Å ²)	20.0	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 23.65 % 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 4.4675e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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 [i](#)

5.1 Standard geometry [i](#)

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

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	1.56	11/1053 (1.0%)	1.29	2/1419 (0.1%)
1	B	1.51	8/1097 (0.7%)	1.25	2/1475 (0.1%)
All	All	1.53	19/2150 (0.9%)	1.27	4/2894 (0.1%)

All (19) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	501	HIS	ND1-CE1	9.59	1.42	1.32
1	A	466	GLY	N-CA	7.68	1.55	1.45
1	B	466	GLY	N-CA	7.28	1.55	1.45
1	A	467	VAL	CA-CB	-6.84	1.46	1.54
1	A	514	GLY	C-O	6.23	1.32	1.24
1	A	504	TRP	NE1-CE2	-6.21	1.30	1.37
1	B	512	LYS	N-CA	6.20	1.53	1.46
1	B	547	HIS	CG-CD2	6.06	1.42	1.35
1	B	517	LEU	C-O	5.93	1.31	1.24
1	B	482	PRO	C-O	5.72	1.30	1.23
1	A	487	LEU	C-O	5.58	1.30	1.24
1	A	450	VAL	CA-C	-5.51	1.48	1.53
1	B	522	VAL	CA-CB	5.47	1.60	1.54
1	A	484	VAL	N-CA	5.37	1.52	1.46
1	B	474	VAL	N-CA	5.34	1.52	1.46
1	A	492	VAL	CA-CB	-5.34	1.49	1.54
1	A	518	LEU	CA-C	5.12	1.58	1.52
1	A	494	VAL	CA-CB	5.02	1.62	1.55
1	B	485	PHE	C-O	-5.02	1.18	1.24

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	554	TYR	N-CA-C	6.61	118.14	111.07
1	A	504	TRP	CB-CA-C	-5.82	101.71	110.90
1	B	499	GLY	N-CA-C	-5.78	105.79	112.73
1	B	471	LEU	N-CA-C	-5.25	106.72	113.23

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	1036	0	1030	9	0
1	B	1080	0	1071	18	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
3	A	3	0	1	0	0
3	B	3	0	1	0	0
4	A	79	0	0	4	0
4	B	83	0	0	4	0
All	All	2286	0	2103	27	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 6.

All (27) 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:507:GLN:HG2	4:A:772:HOH:O	1.44	1.12
1:B:516[B]:ILE:HD11	1:B:543:ARG:NH1	1.67	1.06
1:B:516[B]:ILE:HD11	1:B:543:ARG:CZ	2.13	0.79
1:B:505[B]:GLU:OE1	4:B:783:HOH:O	2.03	0.77
1:B:516[B]:ILE:O	1:B:516[B]:ILE:CG2	2.37	0.73
1:B:516[B]:ILE:O	1:B:516[B]:ILE:HG22	1.95	0.66
1:B:458:GLU:OE2	1:B:491:ARG:NH1	2.31	0.64
1:B:484:VAL:HG13	1:B:516[B]:ILE:HG22	1.78	0.64

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:484:VAL:HG13	1:B:516[B]:ILE:CG2	2.34	0.57
1:A:459:ILE:HD12	1:A:489[B]:MSE:SE	2.58	0.53
1:B:455[B]:GLU:HG3	1:B:482:PRO:HG3	1.91	0.51
1:B:455[B]:GLU:HG3	1:B:482:PRO:CG	2.42	0.50
1:B:537[A]:GLU:HG3	4:B:752:HOH:O	2.13	0.49
1:A:494:VAL:HB	4:B:742:HOH:O	2.11	0.48
1:A:501:HIS:HD2	4:A:774:HOH:O	1.97	0.48
1:B:537[A]:GLU:CG	4:B:752:HOH:O	2.63	0.47
1:A:481:THR:HG21	1:A:513:ARG:HB3	1.99	0.44
1:A:483:LYS:HD2	1:A:559:VAL:HG22	1.98	0.44
1:A:520[B]:SER:OG	1:A:548:ILE:HA	2.18	0.44
1:B:534:GLY:O	1:B:537[A]:GLU:HG2	2.18	0.44
1:B:516[B]:ILE:HD12	1:B:517:LEU:N	2.33	0.42
1:B:440:ASP:HB3	1:B:447:LYS:HE2	2.01	0.42
1:A:537[A]:GLU:HG2	4:A:744:HOH:O	2.20	0.41
1:B:516[B]:ILE:HG21	1:B:558:LEU:HD13	2.03	0.41
1:B:439[A]:MSE:HB3	1:B:439[A]:MSE:HE3	1.61	0.40
1:A:512:LYS:HE3	4:A:766:HOH:O	2.21	0.40

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	129/135 (96%)	127 (98%)	2 (2%)	0	100	100
1	B	135/135 (100%)	130 (96%)	5 (4%)	0	100	100
All	All	264/270 (98%)	257 (97%)	7 (3%)	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	111/109 (102%)	110 (99%)	1 (1%)	70	55
1	B	116/109 (106%)	113 (97%)	3 (3%)	40	17
All	All	227/218 (104%)	223 (98%)	4 (2%)	50	28

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	469	ASP
1	B	460	ASN
1	B	469	ASP
1	B	541	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	460	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 4 ligands modelled in this entry, 2 are monoatomic - leaving 2 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	$\# Z > 2$
3	FMT	A	602	-	2,2,2	0.37	0	1,1,1	1.20	0
3	FMT	B	602	-	2,2,2	0.55	0	1,1,1	0.87	0

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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, 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	120/135 (88%)	0.13	4 (3%)	49	52	5, 17, 33, 55	9 (7%)
1	B	122/135 (90%)	0.14	6 (4%)	35	36	5, 17, 30, 78	10 (8%)
All	All	242/270 (89%)	0.14	10 (4%)	41	43	5, 17, 33, 78	19 (7%)

All (10) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	562	ALA	6.2
1	A	561	THR	3.8
1	B	561	THR	3.8
1	B	438	GLY	3.2
1	A	440	ASP	3.0
1	B	560[A]	GLU	3.0
1	A	478	ILE	2.7
1	B	440	ASP	2.6
1	A	476	ASP	2.4
1	B	559	VAL	2.3

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(Å ²)	Q<0.9
3	FMT	A	602	3/3	0.97	0.07	12,12,13,15	0
3	FMT	B	602	3/3	0.97	0.06	13,13,16,18	0
2	CL	A	601	1/1	0.99	0.02	15,15,15,15	0
2	CL	B	601	1/1	1.00	0.01	13,13,13,13	0

6.5 Other polymers [i](#)

There are no such residues in this entry.