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OPERATOR PROTECTIVE STRUCTURES ON EARTHMOVING MACHINERY

The aim of this paper is to clarify the technical standards applicable to operator protective structures on different earthmoving machinery classes.

It is understood that earthmoving machinery operate in a variety of environmental conditions and applications. Operator protective structure technical standards are intended to assure operators of reasonable protection when operating in a normal condition. Risk assessment and/or job safety analysis should be conducted to identify any additional risks outside normal operating conditions.

The technical standards below may apply to other types of earthmoving equipment that are not listed in the table. Please refer to the relevant standards for detailed inclusions and exclusions on machine type and application.

Structures which have been altered or repaired without the authorisation of the OEM are no longer in compliance with the original OEM's certification.

Certain protective structures information (e.g. name and address of the manufacturer or constructor of the structure, machine make, model(s), identification numbers, international standard number(s), a specific level within the standard being met, year of construction etc.) are typically identified on the structure.

Table 1 and Table 2 provide summaries of the technical standards applicable to operator protective structures on different earthmoving machinery classes, and a summary of related Australian standards.

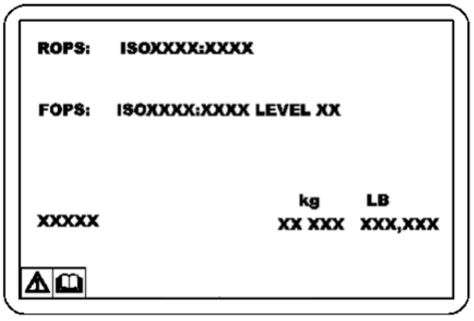

Figure 1 - An operator protective structure and an example of an operator protective structures label

Contact your operator protective structure manufacturer or constructor for more details.

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Table 1 – Summary of operator protective structures standards for different types of earthmoving machinery[1]

Category of Structure	Standard Designation and Title ISO – International Standard AS – Australian Standard SAE – Society of Automotive Engineering Standard	Excavators			Dozer	Loader	Backhoe Loader	Dumper/Scraper	Grader	Skid-steer	Compactor/Roller	Forestry[2]	Comments
		1-6 t	>6 - <50 t	>50t									
Tip-over Protective Structure (TOPS)	**ISO 12117** Earth-moving machinery - Tip-over protection structure (TOPS) for compact excavators - Laboratory tests and performance requirements	✓											Compact excavators (1-6t) are generally fitted with TOPS in lieu of ROPS. 'TOPS compliance' instead of 'ROPS compliance' is more appropriate for excavators 1-6t since the ROPS standard does not cover these machines.
Roll-over Protective Structure (ROPS)	**ISO 12117-2** Earth-moving machinery – Laboratory tests and performance requirements for protective structures of excavators – Part 2: Roll-over protective structures (ROPS) for excavators of over 6 t	*	✓	**									* Compact excavators (1-6t) are generally fitted with TOPS in lieu of ROPS. 'TOPS compliance' instead of 'ROPS compliance' is more appropriate for excavators 1-6t since the ROPS standard does not cover these machines. ** This part of ISO 12117 is intended to be applied to excavators having a gross operating mass up to 50t due to the limitation of the experimental and statistical data set used to derive acceptance criteria.
	ISO 3471 Earth-moving machinery – Roll-over protective structures – Laboratory tests and performance requirements	*	*	*	✓	✓	✓	✓	✓	✓	✓		* Excavators are not in scope of ISO 3471 – refer to ISO 12117 and ISO 12117-2 depending on the operating mass
	AS 2294.1 Earth-moving machinery – Protective structures General	*	*	*	✓	✓	✓	✓	✓	✓	✓		Equivalent to ISO 3471 for ROPS * AS 2294.1 defers to AS 2294.2 which does not apply to excavators. AS 2294.1 itself makes no reference to excavators.
	AS 2294.2 Earth-moving machinery - Protective structures Laboratory tests and performance requirements for roll-over protective structures												Withdrawn, was identical to ISO 3471:1994
	SAE J1040 Performance Criteria for Rollover Protective Structures (ROPS) for Construction, Earthmoving, Forestry, and Mining Machines												Cancelled, superseded by ISO 3471
	ISO 8082 (2 Parts) Self-propelled machinery for forestry – Laboratory tests and performance requirements for roll-over protective structures											✓	ISO 8082 Part 1 includes requirement levels and testing procedures identical to ISO 3471. Part 2 for machines having a rotating platform including a cab and boom. Earthmoving excavators used in cross-over applications involving sites with trees, but excluding forestry applications, are covered by ISO 12117-2.

[1] Refer to the listed standards for a full list of machinery in scope, and/or specifically excluded from scope. In addition, note that certain machines which are designed to travel slowly on relatively flat, stable supporting surfaces may not require ROPS if conditions of use prevent the risk of a rollover. These may include Paving machines, Profilers, Stabilisers, Material transfer vehicles, Stand up loaders

[2] 'Forestry' in this, and subsequent tables refers to purpose-built forestry machinery rather than earthmoving machines that may be used in forestry applications

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Category of Structure	Standard Designation and Title ISO – International Standard AS – Australian Standard SAE – Society of Automotive Engineering Standard	Excavators			Dozer	Loader	Backhoe Loader	Dumper/Scraper	Grader	Skid-steer	Compactor/Roller	Forestry	Comments
		1-6 t	>6 - <50 t	>50t									
Falling Object Protective Structure (FOPS)	**ISO 3449** Earth-moving machinery – Falling-object protective structures – Laboratory tests and performance requirements	*	*	*	✓	✓	✓	✓	✓	✓	✓		Note there are two levels of protection referenced in this standard: **Level I** describes protection from small falling objects (e.g. bricks, small concrete blocks, hand tools) encountered in operations such as highway maintenance, landscaping and other construction site services. **Level II** describes protection from heavy falling objects (e.g. trees, rocks) for machines involved in site clearing, overhead demolition or forestry * ISO 10262 OPG/FOGS applies to excavators in lieu of ISO 3449 FOPS
	AS 2294.1 Earth-moving machinery – Protective structures				✓	✓	✓	✓	✓	✓	✓		Equivalent to ISO 3449 for FOPS
	AS 2294.3 Earth-moving machinery - Protective structures Laboratory tests and performance requirements for falling-object protective structures												Withdrawn, was identical to ISO 3449:1992
	SAE J1356 Minimum Performance Criteria for Falling Object Guards for Excavators	✓	✓	✓									Equivalent to ISO 3449 Level II FOPS
	SAE J1043 Performance Criteria for Falling object Protective Structure (FOPS) for Industrial Machines												Cancelled, superseded by ISO 3449
	SAE J231 Minimum Performance Criteria for Falling Object Protective Structure (FOPS)												Cancelled
	ISO 8083 Machinery for forestry – Falling-object protective structures (FOPS) – Laboratory tests and performance requirements											✓	Note there are two levels of protection referenced in this standard: **Level I** describes protection from small objects, e.g. small rocks, small debris and other small objects encountered in operations such as highway maintenance, landscaping and other construction site services. **Level II** describes protection from large objects, e.g. large rocks, large debris and other large objects encountered in applications such as construction and demolition

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Category of Structure	Standard Designation and Title ISO – International Standard AS – Australian Standard SAE – Society of Automotive Engineering Standard	Excavators			Dozer	Loader	Backhoe Loader	Dumper/Scraper	Grader	Skid-steer	Compactor/Roller	Forestry	Comments
		1-6 t	>6 - <50 t	>50t									
Front and Top Operator Protective Guards (OPG) *(The top Guard is sometimes referred to as a Falling Object Guarding System - FOGS)*	**ISO 10262** Earth-moving machinery – Hydraulic excavators – Laboratory tests and performance requirements for operator protective guards	✓* **	✓*	✓*									Describes an arrangement of a front guard or a top guard, or a combination of front and top guards equipped accordingly with respect to the use of the machine and against risk of falling and/or approaching objects. Note there are two levels of protection referenced in this standard: **Level I** acceptance is intended for protection from small objects, e.g. small rocks, small debris and other small objects encountered in operations such as highway maintenance, landscaping and other construction site services; **Level II** acceptance is intended for protection from large objects, e.g. large rocks, large debris and other large objects encountered in applications such as construction and demolition. Compact excavators having a mass of 6 000 kg or less are excluded from acceptance Level II. * ISO 10262 OPG applies to excavators in lieu of ISO 3449 FOPS ** Compact excavators having a mass of 6,000 kg or less are excluded from acceptance Level II
	SAE J1356 Minimum Performance Criteria for Falling Object Guards for Excavators	✓	✓	✓									Equivalent to ISO 10262 Level II FOGS
Operator Protective Structures for Forestry (OPS)	**ISO 8084** Machinery for forestry – Operator protective structures – Laboratory tests and performance requirements	*	*	*	*	*	*	*	*	*	*	✓	Describes testing and validation requirements for OPS on forestry machines. The OPS are designed to provide reasonable protection from penetrating objects such as saplings, branches, broken winch lines and poking hazards in forestry work, but not from small, thrown objects such as chain teeth (i.e. chainshot). Currently, there is ongoing ISO development work related to thrown object guards (ISO 11839), and chainshot protection (ISO 21876). * ISO 8084 FOPS may also be applied to other earthmoving machinery used in forestry and when brush-guards are required
	AS 2294.1 SUPPLEMENT 1 Earth-moving machinery - Protective structures - General - Operator protective structures fitted to plant used in timber industry (forest operations) (Supplement to AS 2294.1-1997)												Withdrawn, replaced by ISO 8084

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Table 2 – Summary of topical Australian Standards and their current status

Designation	Title	Current Status
AS 2294:1991	Earth-moving machinery - Protective structures	Superseded by AS 2294 Parts 1-4
AS 2294.1:1997	Earth-moving machinery - Protective structures General	Pending revision/withdrawal Technically equivalent to ISO 3471 for ROPS Technically equivalent to ISO 3449 for FOPS
AS 2294.1 SUPPLEMENT 1:2003	Earth-moving machinery - Protective structures - General - Operator protective structures fitted to plant used in timber industry (forest operations) (Supplement to AS 2294.1-1997)	Withdrawn, replaced by ISO 8084
AS 2294.2:1997	Earth-moving machinery - Protective structures Laboratory tests and performance requirements for roll-over protective structures	Withdrawn, refer to ISO 3471
AS 2294.3:1997	Earth-moving machinery - Protective structures Laboratory tests and performance requirements for falling-object protective structures	Withdrawn, refer to ISO 3449
AS 2294.4:1997	Earth-moving machinery - Protective structures Specifications for deflection-limiting volume	Withdrawn, refer to ISO 3164
AS 4988:2002	Earth-moving machinery - Hydraulic excavators - Laboratory tests and performance requirements for operator protective guards	Withdrawn, identical to ISO 10262:1998 (See Table 1 OPG)
AS 4987:2002	Earth-moving machinery - Tip-over protection structure (TOPS) for compact excavators - Laboratory tests and performance requirements	Withdrawn, identical to ISO 12117:1997 (See Table 1 TOPS)