NZTA M10 NOTES: 2020

NOTES TO THE SPECIFICATION FOR DENSE GRADED ASPHALTIC CONCRETE

New Zealand Government

1 GENERAL

1.1 Preliminary

These notes are for the guidance of the Engineer and Contractor and do not form part of the contract.

1.2 Scope

The specification has been prepared for the manufacture, supply and placing of dense graded asphaltic concrete mixes (also referred to as dense asphalt, hot mix asphalt or AC).

The specification contains two broad types of dense asphaltic concrete:

(a) "AC" grade mixes which tend to contain more coarse aggregate particles and less binder. These mixes should generally be used where deformation resistance and structural strength is required.

(b) "DG" grade mixes which tend to be finer, contain more binder and have a low surface texture. These mixes should generally be used in a low speed environment and where a good fatigue life is needed, such as over more flexible pavements.

The nominal maximum aggregate size and types of mixes to be used should be specified in the Schedule of Job Details. A guide to the selection of mixes is given in Table 3.3 and Table 3.4.

1.3 Quality Systems

It is a requirement that Contractors operate a quality system that complies with AS/NZS ISO 9001 and this quality system is certified by a JAS-ANZ registered agency. In addition, it is expected that Contractors will operate systems such as Civil Contractors New Zealand Asphalt Plant Accreditation Scheme (APAS), and other similar process control programmes.

1.4 Testing

It is expected that all laboratory and field testing will be carried out by, or under the control of, a laboratory accredited to NZS ISO/IEC 17025. However, it may be that, for reasons of practicality or availability that the laboratory may not be accredited for the specific test carried out. While this is not desirable, if the testing is carried out to the same standards of competence and traceability as fully accredited tests, then the non-accredited testing is acceptable.

2 MATERIALS

2.1 Aggregate

The relative density (specific gravity) of the combined aggregates is determined using ASTM C127 for coarse aggregate fractions and ASTM C128 for fine aggregate fractions. Determination of the relative density of the fine aggregates using ASTM C128 normally includes the portion of the fine aggregate passing the 0.075 mm test sieve. However, for some materials removing the portion of fine aggregate passing the 0.075 mm test sieve by washing prior to testing can improve the accuracy of the test result. Appendix X1 of ASTM C128 discusses this practice. Consequently, some testing agencies may choose to wash the fine aggregate when determining the relative density of the fine aggregates.

The use of uncrushed sands in significant volumes can reduce the deformation resistance of asphalt mixes. Hence a requirement to confirm the deformation of the asphalt using the Wheel Tracking test if volumes of uncrushed or natural sands greater than 10% of the total aggregate are used.

2.2 Mineral Filler

By strict definition, filler is that mineral matter passing the 0.075mm sieve and includes filler sized particles derived from aggregates as well as added fine materials such as lime, fly ash, etc. In practice, materials used as added filler are comprised predominantly of particles smaller than 0.075mm but can also contain a proportion of coarser particles. Tests applied to added filler materials apply to the complete sample, not just that portion passing the 0.075mm sieve.

2.3 Binder

The binder used in asphalt mixes is specified by NZTA M01-A specification. This is a performance-based asphalt binder specification based on AASHTO M 332.

NZTA M01-A uses advanced performance-based testing to link binder properties with site climatic conditions and traffic loading. It is expected that all asphalt mixes compliant with M10 will use M01-A compliant binders.

It is also a requirement that the appropriate binder grade from M01-A specification is used in the asphalt mix – not heavier duty grades unless specifically approved by the engineer. This is intended to limit the use of inappropriately stiff grades of bitumen where they are not needed.

3 MIX DESIGN

3.1 General

This specification is based on the performance-based design criteria described in Austroads AGPT04B *Guide to Pavement Technology Part 4B Asphalt*.

The Austroads mix design procedure has two main elements:

(a) Laboratory compaction using gyratory compaction in place of Marshall.

(b) Performance-related tests on compacted materials.

Gyratory compaction enables ready selection of different compaction levels to match expected service conditions as well as being able to simulate long term heavy traffic loadings by extended compaction. Gyratory compaction is also considered to achieve particle alignment that is a better representation of field compaction of asphalt. The specification does, however, provide for the use of Marshall compaction for the traditional “DG” grades of asphalt if that method of compaction is preferred. It is important that only one set of criteria is applied, either Marshall or gyratory compaction.

The mix design procedures provide for a range of tests on performance-based properties that include:

(a) Moisture sensitivity of gyratory compacted samples;

(b) Modulus testing of laboratory moulded specimens;

(c) Fatigue testing and flexural stiffness of beams cut from laboratory compacted slabs;

(d) Wheel tracking of laboratory compacted slabs or field samples to assess deformation resistance.

Wheel tracking testing provides data on the deformation resistance of an asphalt mix. This testing is particularly relevant for heavily trafficked pavements (high wheel loadings, high traffic counts or both) or where trafficking is highly channelised.

In addition, the option to use the Superpave gyratory compactor is permitted, provided the Engineer agrees. The Servopac™ apparatus can be reconfigured to the Superpave compaction requirements as in of AASHTO T 312 or ASTM D6925.

3.2 Aggregate Particle Size Distribution and Binder Content

The aggregate particle size distribution (grading) and binder content ranges shown in Table 3.1 and Table 3.4 of the specification are targets for design purposes. Experience has shown that, for some aggregates, the design particle size distributions may need to be placed outside the specified ranges in order to achieve compliant volumetric properties. This is acceptable provided performance-related testing demonstrates the adequacy of the asphalt mix design. As a minimum Wheel Tracking testing should be done, and for more demanding sites, Flexural Stiffness and Fatigue testing should be considered.

Application of production tolerances to the asphalt design particle size distribution can result in production test results being outside the particle size distribution design limits. This is normal and acceptable.

The binder content ranges are in terms of total binder. The volume of effective binder is controlled, however, by the VMA and air void requirements. The effective binder volume is calculated from Vbe = VMA – Va.

3.3 Laboratory Mixing and Compaction temperatures

Table 1 contains very approximate estimates of binder mixing and asphalt compaction temperatures based on estimates of binder viscosities. They are based on a binder viscosity of 0.170 Pa.s for mixing with aggregates, and 0.280 Pa.s for compacting specimens in laboratory compaction apparatus. Please note that these are provided as a guide only to contextualise the NZTA M01-A performance-graded binders.

Table 1: Estimates of Performance-Graded Binder Mixing and Compaction Temperatures

Binder Grade	Climate Zone	Binder Grade Category	Approximate Temperatures °C	
			Mixing	Compaction
PG 52	Cool	S	145	133
		H	150	138
		V	155	143
		E	160	148
PG 58	Moderate	S	152	140
		H	158	146
		V	164	152
		E	170	158
PG 64	Warm	S	158	146
		H	165	153
		V	-	-
		E	-	-

Note: Binder performance-grades PG 64V and PG 64E will probably be modified binders. Mixing and compaction temperatures should be supplied by the binder manufacturer.

3.4 Mix Properties: Selection of Mix Type, Binder Type and Testing Requirements

The principle factors influencing the performance characteristics of asphalt mixes are the selection and quality of components, and the volumetric properties of the mix (nominal size, particle size distribution, binder grade and content and voids relationships). External factors such as traffic, appropriate treatment selection and pavement condition must also be considered.

Four traffic categories of Light, Medium, Heavy and Very Heavy have been chosen and a guide to their selection is shown in Table 3.2 below. The relevant traffic category should be nominated in the Schedule of Job Details.

The mix type, nominal mix size, mix design procedure and binder type should also be nominated in the Schedule of Job Details. For most wearing course and structural asphalt applications, dense graded asphalt mix types are used. Other mix types are used as wearing courses to provide particular surface characteristics for particular applications as follows:

(a) Open graded porous asphalt is used to provide texture and as a porous wearing course to reduce water spray and tyre noise levels on motorways and other high-speed roads. Note that open graded porous asphalt will be specified in accordance with NZTA P11 specification.

(b) Stone mastic asphalt (SMA) is used to provide good surface texture and good deformation resistance on heavily trafficked roads. SMA mixes are specified by NZTA M27 specification.

A detailed guide to selection of different wearing course types for particular surface characteristics is provided in the Austroads "*Guide to the Selection of Road Surfacings"* AGPT03-09. A treatment selection tool may be found on the NZTA web site https://www.nzta.govt.nz/resources/asphalt-surfacing-treatment-selection/ .

The nominal size can be determined as a function of the layer thickness or the layer thickness selected on the basis of the nominal size required for a particular application. A guide to selection of layer thickness and nominal size is shown in Table 3.3 and Table 3.4.

The laboratory compaction levels for dense graded asphalt mixes differ depending on the traffic category and application. These differences are applied to both gyratory and Marshall compacted specimens. The contract will specify the traffic category and mix application on the basis of the field conditions. The Engineer should select the level of compaction (gyratory or Marshall) appropriate to the specified field conditions.

A minimum air void level of 2.0% at 250 cycles (or 160 cycles using the Superpave compaction apparatus) is specified as an indicator of the influence of long-term compaction under heavy traffic and potential for in-situ voids to reach critical levels.

Table 3.2 Guide to Traffic Category

Indicative Traffic Volume		Traffic Category	
Commercial vehicles/lane/day	Structural design level	Free flowing vehicles	Stop/start OR climbing lane OR slow moving
< 100	< $5x10^5$ ESAs	Light	Medium
100 - 500	$5x10^5$ - $5x10^6$ ESAs	Medium	Heavy
500 - 1000	$5x10^6$ - $2x10^7$ ESAs	Heavy	Very Heavy
> 1000	> $2x10^7$ ESAs	Very Heavy	Very Heavy

Note: Traffic category is based on Austroads vehicle classification system.

Table 3.3 Guide to Selection of Nominal Size of AC Mixes for Medium to Very Heavy Applications

Nominal Size (mm)	Designation	Typical Layer Thickness (mm)	Typical Use
10	AC 10	40 – 55	General purpose wearing course in medium traffic applications
14	AC 14	55 – 80	Wearing course mix for heavier traffic applications. Also, some intermediate course applications depending on layer thickness
20	AC 20	80 – 120	General purpose base and intermediate course mix for wide range of use
28	AC 28	110 - 170	Base mix for very heavy-duty applications.

Note: The minimum typical layer thicknesses above are based on 4 times the nominal size. Placement of mix layers at the minimum layer thickness will result in increased layer permeability.

Table 3.4 Guide to Selection of Nominal Size of DG Mixes for Light to Medium Applications

Nominal Size (mm)	Designation	Typical Layer Thickness (mm)	Typical Use
7	DG 7	25 – 40	General purpose wearing course in light traffic applications, where thin layers and fine surface texture are required
10	DG 10	35 – 55	General purpose wearing course for medium traffic applications
14	DG 14	50 – 80	Base and intermediate course applications

Note: The minimum typical layer thicknesses above are based on 3.5 times the nominal size. Placement of mixes at or less than the minimum layer thicknesses can result in increased layer permeability.

3.5 Performance-Related Properties

The specification requires several performance-related tests to be done, depending on the site traffic loadings.

Adhesion of binder to the aggregate is assessed using ASTM D4867, the “modified Lottman” procedure. The procedure of AGPT T232 may also be used, but test specimens are compacted to a higher voids content, so this test method may be more severe than ASTM D4867.

There is a new requirement to measure and report the modulus for all asphalt mixes. The modulus is an input criterion for pavement design algorithms. Where asphalt mixes are intended for very thin surfacings the requirement to determine modulus should be waived.

There are three methods that can be used to determine the modulus of an asphalt mix. The three test methods may return different modulus values, depending on the test temperature and the load pulse wave shape and duration (rise time). Normally the flexural modulus is used for the purposes of pavement design but the indirect tensile (resilient) modulus may be used to estimate the flexural modulus. Austroads AGPT Part 2 section 6.5.6 states that *“the indirect tensile modulus… is approximately equal to the flexural modulus at 15 Hz”*.

Determination of the flexural modulus and cycles to failure (fatigue life) may be required for Heavy and Very Heavy traffic categories. This testing is substantial and costly, so it is to be scheduled and paid for as a separate item. As an alternative, the engineer may accept the fatigue life calculated from the “Shell” equation (see Austroads AGPT02-17 equation 25).

The deformation resistance is normally measured using the Wheel Tracking apparatus as described by AGPT T231. Where loading is extreme (i.e. high axle loads, long durations) such as at intersections or industrial pavements, then alternative means such as Repeat Load Triaxial testing may be necessary to determine the deformation resistance of the asphalt mix.

3.6 Design and Manufacture of Asphalt Mixes Incorporating Reclaimed Asphalt Pavement (RAP)

As a general rule, no special requirements need apply to the use of RAP in asphalt mixes where the percentage of RAP does not exceed 15% of the total mix.

RAP should be of consistent quality, i.e. binder viscosity, aggregate density and particle size distribution so that finished asphalt quality is similarly consistent.

Useful reviews of RAP practices may be found in:

- Austroads AP-R517-16 *“Maximising the use of Reclaimed Asphalt in Mix design: Field Validation”*, found at https://austroads.com.au/publications/pavement/ap-r517-16 and;
- NAPA *“Best Practices for RAP and RAS Management”* found at https://www.asphaltpavement.org/PDFs/EngineeringPubs/QIP129_RAP_-_RAS_Best_Practices_lr.pdf

Where RAP is added in proportions greater than 15%, evidence is required to demonstrate that the performance of these mixes is not compromised. Such testing includes, but is not limited to:

(a) Fatigue testing and flexural stiffness using the four-point beam apparatus comparing the RAP mix to the same mix made using virgin materials. Such testing should provide evidence that the fatigue life of the RAP mix is equal to or better than the virgin mix, or;

(b) Binder rheology testing that shows how the effect of the age-hardened binders in the RAP is compensated for by the use of softer virgin binder grades, rejuvenating additives or other treatments.

A guide to blending of binders or rejuvenating agents to achieve a target binder viscosity is provided in Austroads AGPT/T193 “*Design of Bituminous Binder Blends to a Specified Viscosity Value”* at https://austroads.com.au/publications/pavement/agpt-t193-15. Caution must be used in determining targets for blending of binders as fresh binder or rejuvenator may not be fully combined with the aged binder during the asphalt manufacture process. Consequently, mix performance characteristics imparted by binder stiffness, particularly fatigue and rutting resistance, may fall between that of the fresh binder and that predicted from the stiffness or viscosity calculated or determined by extraction and testing of the blended binder.

3.7 Approval of Job-Mix Formula

The Engineer may allow the use of asphalt mixes with properties outside the specified ranges where it can be shown that all the other performance requirements can be adequately met. Such departures would normally involve discussions with the client.

A production trial is required to confirm the laboratory mix design and also to identify any necessary adjustments to the mix formulation arising from the scale-up to plant manufacture. It is normal and expected that scaling up to plant manufacture affects mix volumetrics and the blend formulation should be adjusted to compensate for this effect. Changes to the proportion of any once component should not exceed 20% of proportion of that component (i.e. a component which comprises 20% of the total asphalt mix should not be varied by more than ±4% of the total mix). Where changes greater than 20% are needed, calibration or the operation of the asphalt plant should be checked and validated. If adjustments to the asphalt plant do not correct the mix volumetrics then the mix design should be revalidated in the laboratory.

4 MANUFACTURE AND STORAGE

It is expected that asphalt plants should be modern, properly calibrated and ideally computer-controlled. Aggregate raw materials should be stored in well-managed stockpiles and kept as dry as reasonably possible.

Binders should be stored in tanks compliant with CCNZ BPG 01 the *Safe Handling of Bituminous Materials used for Roading*. Storage temperatures should be as low as practically possible to minimise damage to the binder by oxidative hardening. Asphalt plant operational documentation should describe how binders are stored, the means taken to maintain their quality and associated binder testing to demonstrate continued compliance.

Asphalt production temperatures may require adjustment upwards for cold conditions or long distance transportation. Production temperature is limited to 185°C to minimise damage to the binder by oxidation. The Engineer can allow higher production temperatures where specific job conditions, lengthy transport distances or the use of highly specialised binders require this. This should be in writing (for example by email) so that a record is kept of this decision.

Effective compaction can be obtained for mixes at temperatures well below the compaction temperatures of Table 1 above. Advances in asphalt manufacture such as “Warm Mix Asphalt” (WMA) technology can also allow significantly reduced mixing and compaction temperatures.

5 SAMPLING AND TESTING OF ASPHALT PRODUCTION

5.1 General

The purpose of inspection and testing is to provide reasonable assurance to the purchaser that the quality of component materials comply with the standards specified, and that the manufactured asphalt is in accordance with the designated job-mix formula.

Manufacturing compliance is assessed by:

(a) Verifying that the job-mix formula has been replicated, i.e. the use of conforming components and combination in the design proportions to achieve the job-mix formula grading and binder content, and;

(b) Verification that the mix as produced has compliant volumetric properties.

The manufacturer should not rely solely on the sampling and testing done for compliance purposes as the measures of process quality control. The specification provides an incentive to the manufacturer to undertake suitable measures to improve the level of conformity and consistency of manufactured product by reducing the frequency of testing for compliance purposes where the manufacturer is using a suitable statistical process control system and where the results of compliance tests show an appropriate level of consistency in meeting the specification requirements. A guide to statistical process control systems is provided in AAPA Implementation Guide IG-3: *“Asphalt Plant Process Control Guide”*.

The use of statistical process control and other measures, such as the Civil Contractors New Zealand Asphalt Plant Accreditation Scheme (APAS), are strongly encouraged.

5.2 Volumetric testing

This version of the specification has included the mandatory testing of asphalt air voids at manufacture. This is best practice and ensures that field compaction can achieve compliant air voids.

The intention of the specification is that the asphalt mix as produced by the asphalt plant will have laboratory air voids at, or close to, the design target. Hence the requirement that the mix production trial should return laboratory air voids at the design target ±1%. It is expected that, if the air voids results fall outside of this criterion, that the mix design job-mix formula (i.e. the mix recipe) will be adjusted such that compliant air voids are achieved.

Where routine quality control testing returns volumetric test results that fall outside of the specified limits careful consideration should be given to the degree of non-compliance and the consequent effect on the volumetric properties of the mix in the field; i.e. the in-situ air voids. The breadth of the allowable limits for production air voids (+2.0, -1.0) is relatively wide, so it is expected that if replicable non-compliances are reported then a non-conformance report should be raised, and appropriate corrective actions taken.

Where there is dispute over the effect of a volumetric non-compliance and the appropriate corrective actions the advice and guidance of the NZTA Principal Surfacings Engineer should be sought.

6 PLACING

6.1 Preparation of Surface

Road surfaces must be clean to ensure a good bond between new asphalt and the existing surface.

6.2 Tack Coating and Membrane Sealing

Tack coating for normal asphalt applications comprises a light application of bitumen emulsion to ensure adequate adhesion between layers. Residual binder application rate is normally between 0.1 and 0.2 L/m². The type of bitumen emulsion for normal applications should suit the conditions of use. Generally, rapid setting cationic emulsion is used in cooler regions where damp conditions may be encountered. In warmer or drier conditions, slower setting cationic emulsions may combine easier handling with satisfactory performance.

In cases where the surface has questionable water resistance New Zealand practice has been to apply a waterproofing chip seal first.

6.3 Spreading

The specification provides for asphalt to be placed when pavement surface temperatures are as low as 5°C. Placing in cool conditions increases the difficulty in obtaining good standards of work and, where practicable, work involving thin layers (40 mm or less) should be programmed to be done when such conditions are less likely to occur.

The selection and use of automatic level control for asphalt paving should normally be determined by the Contractor, taking into account the applicability to site conditions and the geometric requirements of the finished result. The Schedule of Job Details provides for specification of particular level control devices, if required.

Typical applications of automatic controls are as follows:

(a) *Joint Matcher*. Suitable for use on most classes of work to reduce manual effort.

(b) *Travelling Beam (Generally 9.0 m)*. Assists in removing minor irregularities within the length of the beam. Suitable for a wide range of work, except for short runs and restricted working space. Improved shape correction may involve increased quantities of asphalt.

(c) *Cross-fall*. Limited applications where a set cross-fall is desired from a reference on one side of the paver.

(d) *Computerised Electronic Control* (e.g. "Paveset"). Enables paver to operate to predetermined profile. Needs accurate survey and well-maintained equipment.

(e) *Fixed Stringline*. Enables paver to operate to set profile. Requires accurate survey and additional personnel for setting up and maintaining lines. Presence of stringlines can severely restrict movement of spreading vehicles.

6.4 Joints

Joints are the weakest part of the pavement. Cold joints should be minimised by planning of works to achieve a minimum number of construction joints and, where practicable, maximum use of hot or warm joints.

7 CONSTRUCTION TRIAL

A construction trial is usually only applicable to major projects. A separate schedule item should be included for payment for construction trials.

8 FINISHED PAVEMENT PROPERTIES

Finished Pavement Properties requirements are to be specified in contract documents. To date the guidelines specified in the Austroads guide have not been used in New Zealand. NZTA Technical Memorandum TM7003 specifies roughness requirements for finished pavement construction for New Zealand highway pavements.

Compaction of the asphalt pavements is normally measured by determining the pavement air voids by testing core specimens. Locations for testing should be randomly selected, using ASTM D5361 or a similar randomised process, which requires locations to be selected on a stratified random basis. The Engineer may be present during the location selection and sampling process.

If the pavement lot is found to be non-compliant the Engineer should carry out further investigations to confirm the non-compliance. If the non-compliance is confirmed, then the Engineer may direct that:

(a) A reduction in payment proportional to the percent defective, or;
(b) If the actual quality level is significantly outside prescribed limits and is hence unacceptable the lot should be replaced.

8.1 Testing of Cores

The determination of asphalt thickness and compaction is by measurement of core specimen thicknesses and air voids respectively. The compliance of thickness and air voids is determined by a statistical process based on a proportion defective of 10% (consumer's risk) and a probability of acceptance of 90% (producer's risk).

Core air voids are calculated from the core Bulk Specific Gravity (relative density) and the Maximum Theoretical Specific Gravity (relative density) using ASTM D3203.

There are four test methods generally used to measure core specific gravity, but they return different bulk specific gravities, and consequently air voids, depending on core surface texture and amount of interconnected voids, if any. These methods are ASTM D2726 (water displacement), ASTM D6752 (vacuum sealing), ASTM D1188 (coated specimens) and ASTM D3549 (mensuration).

The default method for determining core density is ASTM D2726. However, this test method requires the use of alternative methods for determining specimen volume if core water absorption exceeds the maximum specified level. These alternative methods can return different values for specimen volumes depending on the specimen surface texture. Consequently, the air voids results may include some or all of the specimen surface texture and return higher values than would have been obtained using ASTM D2726 (water displacement).

It is required that testing laboratories report the voids derived from water displacement even if water absorption exceeds the maximum level. This requirement is due to the air voids acceptance criteria being based around voids derived from water displacement. The use of other methods introduces bias into the voids results and could cause compliant asphalt to be inappropriately rejected.

Air voids results from cores that exceed the maximum water absorption should be suitably annotated. All the core specimens in a set of cores (i.e. including those with water absorptions greater than 2%) must be used when calculating the lot characteristic values and compliance.

Air voids results for core specimens with high absorptions will be biased down as the water can access internal voids within the specimen. Thus, if the Upper Characteristic Value for a set of core air voids results exceeds the maximum allowable value then there is good evidence that the lot is non-compliant and appropriate remedial actions should be taken.

Maximum specific gravity values used to calculate specimen air voids should be derived from the testing of mix from the production lot rather than using values obtained during the mix design process. If there are several tests over the production lot, then the average maximum specific gravity should be calculated and used.

Engineers must carefully review and understand the basis of core specimen air voids and if necessary, seek advice from qualified and experienced asphalt technologists so that asphalt pavements are not inappropriately accepted or rejected due to test method effects.

It is recommended that core specimens are individually photographed beside a scale rule.

8.2 Ride Quality

The ride quality requirements at roundabouts and intersections shall take into account the design and pre-existing pavement shape and geometrics. Such areas shall be excluded from post-construction roughness testing.

The use of the straight edge is designed mainly for the control of joints on the finished pavement surface, but it can also be used where a roughness meter cannot be used due to geometry or length restraints. In these cases, where the Engineer considers that the ride quality is poor, then the straight edge can be used as a more objective measure of poor ride.

9 SPECIAL JOB REQUIREMENTS

If specific job conditions require changes to this specification, special clauses can be prepared and inserted in the Schedule of Job Details for the following:

(a) Any special design requirements, if applicable (specification clause 3);

(b) Any special requirements for use of automatic paver control, if applicable (specification clause 9.5.3);

(c) Requirements for a construction trial, if applicable. A separate schedule item is also required for the cost of such trial (specification clause 7);

(d) Special requirements for measurement of ride quality, if applicable. A separate schedule item shall be provided for the cost of testing, where testing is to be provided by the Contractor (specification clause 10.4);

(e) Special requirements for payment for non-complying materials, if applicable (specification clause 11.1).