REPORT

Feb 28, 2013 File: 4026 -13

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Mark Louttit, PEng
Ministry of Transportation and Infrastructure
7818 6th St.
Burnaby, BC, V3N 4N8

Subject: **Massey Tunnel Lighting Improvement Options**

Dear Mark Louttit,

Executive Summary

The main purpose of this report is to explore the options, benefits, and costs for increasing the wall reflectance in the tunnel to improve driver visibility. A review of current lighting and conditions along with a review of current Tunnel Maintenance & Rehabilitation Manuals was undertaken as part of the work. DMD also consulted with Parson's Brinckerhoff (PB), a US engineering firm who specialize in tunnels.

Based on evaluation and lighting calculations considering various wall reflectance's and luminaire aiming angles, light level improvements for paint or tiling on the tunnel wall would be around 200% (based on existing luminaire aiming and the photometrics for the Valid Manufacturing Ltd fixture tunnel currently being used for the tunnel). Photometric files for fixtures used in 2004 were not available which is why the Valid photometry was used. It is important to note that the levels we calculated as part of this report were far lower than those calculated in 2004 (by a third party) as part of the Massey Tunnel fixture replacement work undertaken in 2005.

Even with paint or tiles on the walls the tunnel lighting levels would still be well below industry standards. However, the effect that tile or paint would have goes well beyond light levels. A painted or tiled surface would create a more open effect in the tunnel and improve driver visibility and comfort. To further explain this effect, imagine painting the walls dark grey or black in one's office space. The space may feel smaller and more confined by using black or grey colours. By creating a more open effect in the tunnel driver speed could increase which ultimately could reduce safety.

The order of magnitude costs for painting or tiling the tunnel walls would be as follows:

Option	Cost
Tile	$7,000,000
Paint	$484,000

A painted surface would require re-painting every seven years whereas the tile would only require replacement where damaged. Both surfaces would require ongoing cleaning of six-eight times a year.

The Ministry may also consider reviewing the use of LED lighting in the tunnel threshold to improve lighting levels. Tunnel lighting controls and their operation should also be reviewed.

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To:

Mark Louttit, PEng

Ministry of Transportation and Infrastructure

Regarding:

Massey Tunnel Lighting Improvement Options

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Introduction

The Ministry of Transportation and Infrastructure commissioned DMD to review possible improvements to the lighting levels in the Massey Tunnel. The main purpose of this report is to explore the options, benefits, and costs for increasing the wall reflectance in the tunnel to improve driver visibility.

This report is a follow-up to the 2001 George Massey Tunnel Lighting Report prepared by DMD. As per the scope, the main focus is on improving the tunnel wall reflectance. We have also included information on new LED lighting and tunnel lighting controls.

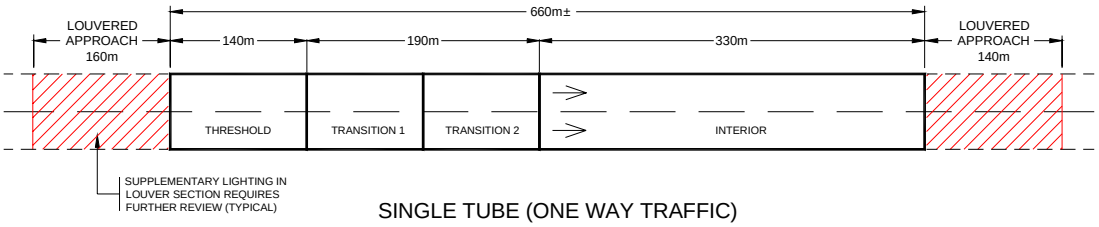
Our scope of work for this investigation is as follows:

- Provide details regarding available options (paints and tiles). This would include general requirements, issues, material types, installation, etc.
- Estimate the overall improvement in light levels.
- Provide the order of magnitude installation costs. Lane closure costs will be provided by others.
- Provide examples from other jurisdictions showing that a particular option was used successfully or that it had little (or negative) impact.
- Provide a summary of the current maintenance practice for the walls and a suggested best practice.

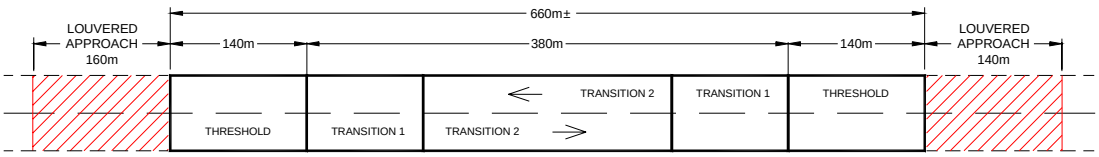
Background

An initial review of the lighting upgrade options and costs were identified in a 2001 report undertaken by DMD. The tunnel lighting was replaced in 2005-2006 as part of the tunnel seismic upgrade. However, due to a lack of available power lighting the tunnel was only upgraded to well below what is required for tunnels of this variety. One other factor contributing to low lighting was the very low tunnel wall reflectance. Other issues are tunnel lighting controls and cleaning of the existing lighting and tunnel walls.

A tunnel has various lighting zones which require varying light levels. A breakdown of the zones in the Massey Tunnel is shown in Figure 1.



SINGLE TUBE (ONE WAY TRAFFIC)



SINGLE TUBE - COUNTER FLOW (TWO WAY TRAFFIC)

Figure 1 - Tunnel Lighting Zones

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Zone	Required Level and per IESNA RP-22	Existing Design Levels (Calculated in 2004)
Threshold	150 cd/m²	63 cd/m²
Transition 1	50 cd/m²	21 cd/m²
Transition 2	15 cd/m²	16 cd/m²
Daytime interior	8 cd/m²	18 cd/m²
Night interior	2.5 cd/m²	18 cd/m²

Figure 2 - Tunnel Lighting Levels

The lighting zones have different light level requirements. Required levels (based on the 2001 DMD report) and lighting levels calculated as part the lighting retrofit in 2004 as part of the 2005-2006 tunnel seismic upgrade are shown in Figure 2.

The levels calculated in 2004 were based on Metrolux fixture with an aiming of 15° downward from vertical and a light loss factor of 0.78. Typically in a tunnel a light loss factor of 0.3 to 0.65 would be applied (ref IES RP22-11). The higher light loss factor requires additional cleaning of the luminaires (six-eight times a year), which is more than if a lower light loss factor was applied. As the tunnel fixtures are not cleaned on regular basis it is very doubtful the existing design light levels are being achieved.

The light level calculated in 2004 was based on the selected and installed Metrolux fixture. We understand that some of these fixtures have been replaced since the initial installation. However, because we are unsure whether or not the fixtures have been replaced, the existing design levels noted in Figure 2 are more than likely not accurate. In fact, the levels we have calculated are far less.

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Figure 3 - Existing Tunnel Lighting

The existing lighting in the tunnel as of 2006 is shown in the image in Figure 3. This image shows the very low wall reflectance's present.

Options / Considerations

Listed below are options and considerations aimed at improving the lighting levels in the Massey Tunnel by increasing wall reflectance. Although it was defined in the scope, we are unable to provide any examples from other jurisdictions that show whether a particular option (other than paint) was successfully retrofitted or if it had any impact.

Wall Finish Options

The following are options and considerations for improving lighting and driver visibility in the tunnel. The US Federal Highway Association's (FHWA) Rail Transit Tunnel Maintenance & Rehabilitation Manual (2005 edition) states that the interior finish of a tunnel as very important to the overall tunnel function. The finishes must meet the following standards to ensure tunnel safety and ease of maintenance. They must also:

- Be designed to enhance tunnel lighting and visibility
- Be fire resistant
- Be precluded from producing toxic fumes during a fire
- Be able to attenuate noise
- Be easy to clean
- Adhere well to the existing tunnel walls and ceiling
- Be robust – not damaged by high pressure washing

FHWA's Rail Transit Tunnel Maintenance & Rehabilitation Manual provides a description of the typical types of tunnel finishes that exist in highway tunnels. They are as follows:

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- **Ceramic Tile** - This type of finish is the most widely used by tunnel owners. Tunnels with a concrete or shotcrete inner lining are conducive to tile placement because of their smooth surface. Ceramic tiles are extremely fire resistant, economical, easily cleaned, and good reflectors of light due to the smooth, glazed exterior finish. They are not, however, good for sound attenuation (which in new tunnels has been addressed through other means). Typically, tiles are 106 mm (4-¼ in) square and are available in a wide variety of colors. They differ from conventional ceramic tile in that they require a more secure connection to the tunnel lining to prevent the tiles from falling onto the roadway below. Even with a more secure connection, tiles may need to be replaced eventually due to normal deterioration. Additional tiles are purchased at the time of original construction since they are specifically made for that tunnel. The additional amount purchased can be up to 10 percent of the total tiled surface.
- **Porcelain-Enameled Metal Panels** - Porcelain enamel is a combination of glass and inorganic color oxides that are fused to metal under extremely high temperatures. This method is used to coat most home appliances. The Porcelain Enamel Institute (PEI) has established guidelines for the performance of porcelain enamel through the following publications:
  1. Appearance Properties (PEI 501)
  2. Mechanical and Physical Properties (PEI 502)
  3. Resistance to Corrosion (PEI 503)
  4. High Temperature Properties (PEI 504)
  5. Electrical Properties (PEI 505).

  Porcelain enamel is typically applied to either cold-formed steel panels or extruded aluminum panels. For ceilings, the panels are often filled with a lightweight concrete; for walls, fiberglass boards are frequently used. The attributes of porcelain-enameled panels are similar to those for ceramic tile previously discussed. They are durable, easily washed, reflective, and come in a variety of colors. As with ceramic tile, these panels are not good for sound attenuation.
- **Epoxy-Coated Concrete** - Epoxy coatings have been used on many tunnels during construction to reduce costs. Durable paints have also been used. The epoxy is a thermosetting resin that is chemically formulated for its toughness, strong adhesion, reflectance, and low shrinkage. Experience has shown that these coatings do not withstand the harsh tunnel environmental conditions as well as the others, which ultimately requires repair or rehabilitation more often.

Wall Finish Recommendations

As part of the scope we have reviewed tile and painted tunnel finishes. Tile costs were considered by Parson's Brinckerhoff (PB), a US engineering firm who specialize in tunnels. PB defined tile costs for a tunnel at approximately $70 per sq/ft in US dollars. If we convert this into m², the cost would be approximately $750.00 per square metre. Based on 660m of tunnel length x 3.5m of height x 4 walls, the total area would be approximately 9,240 m² for the tunnel walls. At $750.00 per m² the cost of tiling the walls of the tunnel would be approximately $7,000,000. This cost should be confirmed with local tile supplier.

Discussions with PB confirmed that the only practical and cost effective solution of those discussed is paint. The other finishes listed above are typically applied as part of the original tunnel construction. On the other hand, paint has been used to improve the reflectance for walls and ceilings

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for existing tunnels and parking garages with concrete surfaces. PB noted that they have specified painted wall surfaces for a number of existing tunnels in the US.

In terms of paint, PB noted a waterborne breathable paint should be used to prevent peeling. A Tnemec™ paint was recommended based on past installations. In western Canada this paint is distributed by HDIM Protective Coatings in Edmonton, Alberta. This Acrylic Emulsion coating is a very suitable product for this type of service. Product information and product data sheets, as well as the performance criteria sheets for the Tnemec 180 Tneme-Crete products are attached.

In terms of the benefits of paint, lighting level calculations are required. In 2004 a lighting calculation model was set-up by Lighting Technologies using their Lumen Micro design software. The results are shown in Figure 2 – Tunnel Lighting Levels.

The lighting zones have different light level requirements. Required levels (based on the 2001 DMD report) and lighting levels calculated as part of the lighting retrofit in 2004 as part of the 2005-2006 tunnel seismic upgrade are shown in Figure 2.

The levels calculated in 2004 were based on Metrolux fixture with an aiming of 15° downward from a vertical and light loss factor of 0.78. Typically in a tunnel a light loss factor of 0.3 to 0.65 would be applied (ref IES RP22-11). The higher light loss factor requires additional cleaning of the luminaries (six-eight times a year), which is more than if a lower light loss factor was applied. As the tunnel fixtures are not cleaned on a regular basis, it is very doubtful the existing design light levels are being achieved.

The light level calculated in 2004 was based on the selected and installed Metrolux fixture, which we understand have been replaced since installation. Because we are unsure of the replacement of the fixture, existing design levels noted in Figure 2 are more than likely not accurate. In fact, the levels we have calculated are far less. The plan for this wall reflectance study was to go to Lighting Technologies and have the wall reflectance added and have the lighting recalculated. Lighting Technologies noted they no longer provide these calculation services and Lumen-Micro calculation software is no longer supported. In addition Lumen-Micro has no capability to include wall reflectance values in the calculations.

Based on this DMD have set up a lighting calculation model and have undertaken calculations with paint finishes on tunnel walls in the threshold and interior areas. We have assumed an 84% wall reflectance for the paint (based on the supplier's info) and 10% for the existing concrete walls and ceiling. We used our lighting calculation software, AGI32, and undertook the required calculations in the interior and threshold zones. If we consider a 15° downward aiming angle and a 0.72 light loss factor our results calculated were as follows:

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Element: Reflectance	Interior Zone Lighting and Uniformity			Threshold Zone Lighting and Uniformity		
Walls and Ceiling: 10% (existing concrete)	4.9	Luminance (Cd/m²).		11.5	Luminance (Cd/m²).	
			Improvement			Improvement
Walls: 84% (paint) Ceiling: 10% (existing concrete)	12.6	Luminance (Cd/m²).	157.14%	35.8	Luminance (Cd/m²).	211.30%

Figure 4 - Lighting Calculations with Wall Reflectance

The existing levels (10% reflectance's) calculated by DMD are far less than those calculated by Lighting Technologies in 2004. Lighting Technologies defined the threshold level of 63 cd/m², whereas our calculations show 11.5 cd/m² for the existing conditions. As the Software is not longer supported and Lighting Technologies no longer provided a calculation service it is not possible to determine why the difference in calculated levels exists. We would however recommend that on site light level measurements be undertaken in the tunnel to verify existing lighting.

Based on a 15° downward luminaire aiming angle, improvements to the wall reflectance through the application of paint would result in significant light level improvement (shown in Figure 4).

One issue with respect to applying any finish to the tunnel walls will be the short lane closure period (approximately 6 hour closures per lane) in the tunnel required to apply the coating. This product has a listed three hour minimum re-coat window at 24°C. This means that at that temperature, the coating will be resistant to atmospheric moisture at the three hour point, meaning traffic would be able to continue flowing through the tunnel after the paint has dried for three hours.

For the painting of corroded doors and piping, Tnemec has a host of products that should be considered.

According to Ken Poon of HDIM, most of the existing tunnel walls are coated with water based Acrylic. However, there are some areas coated with Methyl Methacrylate, which require an abrasive blast in order to create a good bonding to the existing coating. Ken also noted that an inspection will be required to confirm that the proper coating thickness and adhesion requirements are met.

Cost provided by HDIM for water jet cleaning, repair of voids, cost of Tnemec 180, and installation are listed below. Not included are traffic control equipment/personnel, engineering, and inspections.

- WJ 4 Cleaning $9.80 per sq. Meter

- Application of one coat $10.00 per sq. Meter
- Filling voids $38.00 per sq. Meter
- Tnemec 180 Acrylic $6.00 per sq. Meter

Based on 660m of tunnel length x 3.5m of height x 4 walls, the total area would be approximately 9,240 m² for the tunnel walls. If we assume 10% of the walls will require filling of voids, the area would be approximately 924 m². This is a best guess. Estimated costs would be as follows:

- 9,240 m² x $26.80 (includes additional dollar as noted below) = $247,632.00
- 924 m² x $38.00 = $35,112.00
- Total cost = $282,744.00 (traffic control and lane closures extra). We would however suggest a 1.5 factor be added to this cost to compensate for limited working period and night-time work premiums. That would bring the cost to **$484,115.00**. This will require further investigation.

Information provided by HDMI show the best reflective properties of 84% are provided with their white finish. Since light reflectance is critical, HDIM and Tnemec are developing a system that will enhance the incident light from vehicle headlight. An acrylic coating alone is not enough to maintain the reflective values, particularly in the wet weather in Metro Vancouver. The extra step of the HDIM system should not increase the application cost by more than $1.00 per m². This cost has been added in the above total.

Prior to painting the entire tunnel, it is recommended that a small test section be undertaken in the threshold areas. This would allow for review of any installation issues and some monitoring of the performance of the paint finish over a short time period. This would also allow for field measurements of the luminance levels to confirm the effectiveness.

Threshold Lighting

New LED lighting continues to evolve in higher wattages and specialized applications. One new product for high wattage tunnel applications has been developed by Schreder Lighting and is currently going through photometric testing. The main focus of the lighting improvements would be in the threshold areas. The threshold area is very critical and requires very high luminance level for eye adaptation. To improve these lighting levels we have reviewed replacing the 100 existing 250W high pressure luminaires with more energy efficient 200W LED luminaries. The estimated cost of the new 200W LED luminaires is approximately $1600.00 each. No additional power would be required as the existing would be replaced one for one.

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Figure 5 - LED Tunnel Luminaire

An example of a tunnel lighting luminaire is shown in Figure 5. The actual luminaire would be twice the length as what is shown.

To date LED tunnel luminaires have lacked the light output to provide the require threshold lighting levels required. Therefore, this product may be worthy of further review.

The benefits of retrofitting to these luminaires may be worth pursuing for the $200K to $250K cost.

Controls

A tunnel will have multiple lighting levels for maximum efficiency. This is achieved by controls that measure the luminance outside the tunnel and are aimed at the tunnel entrance. The luminance meter records the actual luminance levels and then adjusts the levels inside the tunnel through controls to coincide with the actual levels outside the tunnel. Because the full lighting level is only required during limited daytime periods, an intricate lighting control system is required to adjust the levels inside the tunnel based on exterior luminance.

Lighting controls at the tunnel are the PLC Multipoint system. Sensors are placed outside the tunnel so levels can be automatically adjusted inside the tunnel. Some minor relocation of the existing sensors was undertaken in 2006 as part of the seismic upgrade project. It is not known if the system operates correctly. We understand that the lights are most often controlled by the tunnel operators, thus resulting in levels which don't correspond to lighting level outside the tunnel.

These controls have a direct effect on the visibility in the tunnel. As previously mentioned, we are unsure if the controls operate correctly as DMD were not involved with the set-up, testing, and commissioning of these systems.

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We recommend these controls be reviewed and inspected to ensure they are operating properly. The supplier PLC Multi-point (in Everett, Washington) should be contacted and required to review the operations of the control system. Upgrades required shall be made so the system is operating at the optimal level. This review should also be considered for the Cassiar Tunnel which uses the same lighting controls.

Maintenance

We are unsure how often the tunnel walls, ceiling, and luminaires are cleaned or how that work takes place. It does not appear to be completed on a regular basis.

According to Best Practices for Roadway Tunnel Design, Construction, Maintenance, Inspection, And Operations NCHRP Project 20-68A, Scan 09-05 tunnels are typically washed at least four times a year, and more as needed depending on weather and traffic. Some urban tunnels are washed every week or two during overnight hours. Washington DOT washes its tunnels once a month or as needed. The tendency is to wash the tunnel walls more often in the winter.

Figure 6 - Tunnel Cleaning Equipment

Ken Poon from HDIM noted an Auto Sprayer system was proposed approximately 10 years ago for regular power-washing to deal with the continuous diesel fumes and airborne dirt. The routine power-wash would be at 5,000 psi.

The 2001 DMD Massey Tunnel Lighting Report recommended 8 cleanings a year (monthly in the winter and every 2 months in the summer). This is the result of the high light loss factor of 0.72 applied to the lighting design. Typically in tunnels a lower light loss factor would be between 0.3 and 0.65 as defined in IES-RP-22 Recommended Practice for Tunnel Lighting. This higher light loss factor was applied to maximize light levels. In order to maintain these levels an aggressive cleaning schedule is required.

We recommend the wall and luminaires be power washed at least four-six times a year in order to maintain wall reflectance's and light levels. The

durability of the paint coating should not be affected by the frequent washing.

The paint will require refinishing every seven years (as stated by the supplier). The repainting will not be as extensive, since we anticipate that the basic repair of the defective substrate is done and that the auto-sprayers will reduce the heavy build-up from the last 10+ years. We are unsure of the lesser % of the initial cost to repaint.

If you have any questions please call.

Yours sincerely,

Don McLean

To:

Mark Louttit, PEng

Ministry of Transportation and Infrastructure

Regarding:

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TNEMEC

W.B. TNEME-CRETE® 180 & 181

PRODUCT DATA SHEET

PRODUCT PROFILE

GENERIC DESCRIPTION Acrylic Emulsion

COMMON USAGE Decorative, high-build protection against weather, driving rain, industrial fumes and alternate freezing-thawing. Formulated to resist mildew growth on the paint film. Available in smooth and sand-texture finishes for concrete, CMU and properly primed steel. Spray application "dry-falls" under certain conditions.

COLORS Refer to Tnemec Color Guide.

FINISH Series 180: Flat, smooth Series 181: Flat, sand texture

PERFORMANCE CRITERIA Extensive test data available. Contact your Tnemec representative for specific test results.

COATING SYSTEM

PRIMERS Self-priming on concrete, masonry, brick, stucco and lightweight block.
Split-Face & Split-Fluted CMU: Series 130, 54-562
Steel: 10-99, 37H, 66, N69, 90E-92, N140, 161

TOPCOATS Prepare surfaces by method suitable for exposure and service. Refer to the primer data sheet.

SURFACE PREPARATION

Prepare surfaces by method suitable for exposure and service. Refer to the primer data sheet.

PAINTED SURFACES Remove chalk and old paint not tightly bonded to the surface. Patch cracks

ALL SURFACES Must be clean, dry and free of oil, grease, form release agents and other contaminants. Allow new concrete, masonry and stucco to cure 7 days. Level protrusions and mortar spatter.

TECHNICAL DATA

VOLUME SOLIDS 44.0 ± 2.0% †

RECOMMENDED DFT 4.0 to 10.0 mils (100 to 255 microns) per coat. **Note:** Number of coats and thickness requirements will vary with substrate, application method and exposure. See APPLICATION and/or contact your Tnemec representative.

CURING TIME

Temperature	To Touch	To Recoat
75°F (24°C)	1 hour	3 hours

Curing time varies with surface temperature, air movement, humidity and film thickness.

VOLATILE ORGANIC COMPOUNDS **Unthinned:** 0.82 lbs/gallon (98 grams/litre)
Thinned 5%: 0.82 lbs/gallon (98 grams/litre) †

THEORETICAL COVERAGE 705 mil sq ft/gal (17.3 m²/L at 25 microns). See APPLICATION for coverage rates. †

NUMBER OF COMPONENTS One

PACKAGING 5 gallon (18.9L) pails and 1 gallon (3.79L) cans.

NET WEIGHT PER GALLON 11.50 ± 0.25 lbs (5.22 ± .11 kg) †

STORAGE TEMPERATURE Minimum 35°F (2°C) Maximum 110°F (43°C)

TEMPERATURE RESISTANCE (Dry) Continuous 170°F (77°C) Intermittent 200°F (93°C)

SHELF LIFE 24 months at recommended storage temperature.

FLASH POINT - SETA N/A

HEALTH & SAFETY Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product.
Keep out of the reach of children.

W.B. TNEME-CRETE® | 180 & 181

APPLICATION

COVERAGE RATES

Dense Concrete, Masonry and Filled CMU

	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m²/Gal)
Minimum	4.0 (100)	9.5 (240)	176 (16.3)
Maximum	8.0 (205)	19.0 (485)	88 (8.2)

CMU (First Coat)

Minimum	8.0 (205)	19.0 (485)	88 (8.2)
Maximum	10.0 (255)	24.0 (610)	71 (6.5)

Primed Steel

Minimum	4.0 (100)	9.5 (240)	176 (16.3)
Maximum	6.0 (150)	14.5 (370)	118 (10.9)

Allow for application losses and surface irregularities. Spreading rates are approximate and variable based on the roughness and porosity of substrates; also the method of application. Film thickness is rounded to the nearest 0.5 mil or 5 microns. Wet and dry film thicknesses are calculated from the sq ft/gal figures. There is no method for accurately measuring the applied film thickness of texture coatings. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.
Important: Protection against weather, driving rain and alternate freezing and thawing is obtained when coating is applied to form a continuous, void-free film. The coating must be brushed, rolled or sprayed and back-rolled onto block. Grooves in scored and fluted block must be brushed. Two coats are normally recommended for lightweight block. Split-face and split-fluted block must be filled. Contact your Tnemec representative for specific coating system recommendations. †

MIXING

Stir thoroughly with a power mixer, making sure no pigment remains on the bottom of the can.

THINNING

Normally none required. Can be thinned up to 5% or 1/4 pint (190 mL) per gallon with clean water.

APPLICATION EQUIPMENT

Series 180 or 181
Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss (1)	D AC	64HD 62HD	5/16" or 3/8" (7.9 or 9.5 mm)	1/2" (12.7 mm)	50-70 psi (3.4-4.8 bar)	30-40 psi (2) (2.1-2.8 bar)

(1) With heavy duty spring (JGA 191K2).
(2) Series 181 air spray. An alternative to using a pressure pot for air spray of texture coatings that should increase production time is using a low pressure transfer pump designed for texture coatings, such as Graco 987-429 10:1 president pump rubber packed (up to 1,000 psi with 3 gpm max fluid delivery) equipped with an air evenflo control with pump and atomizing air regulators. Contact Tnemec Technical Service for more information.

Series 180 only
Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.023"-0.031" (585-785 microns)	2000-2800 psi (138-193 bar)	3/8" (9.5 mm)	30 mesh (600 microns)

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.
Roller: Use a synthetic cover. For smooth surfaces use 3/8" to 3/4" (9.5 mm to 19.0 mm) nap. For rough surfaces use 3/4" (19.0 mm) or longer nap. To obtain proper penetration for rough or porous surfaces, thin up to 5% or 1/4 pint (190 mL) per gallon. Force material into voids and hairline cracks with a brush or squeegee. Smooth out build-up at laps. Multiple coats may be required to achieve recommended film thickness, depending on applicator technique and roller nap size.
Brush: Use a stiff nylon brush. Work material into voids and avoid brushing out too thin.

SURFACE TEMPERATURE

Minimum 40°F (4°C) Maximum 90°F (32°C)
The surface should be dry and at least 5°F (3°C) above the dew point.

CLEANUP

Flush and clean all equipment immediately after use water.

CAUTION

Dry overspray can be wiped or washed from most surfaces. Satisfactory dry-fall performance depends upon height of work, weather conditions, equipment adjustment and proper thinning. Low temperature and high humidity are of particular concern. Test for each application as follows: Spray from 15 to 25 feet towards paint container. The material then should readily wipe off. **Note:** Heat can fuse-dry overspray to surfaces. Always clean dry overspray from hot surfaces before fusing occurs. Be aware that exterior surface temperatures can be higher than air temperature.

† Values may vary with color.

TNEMEC

W.B. Tneme-Crete® 180 & 181

Performance Criteria

ADHESION

METHOD: ASTM D 3359, (Method B, 5 mm Crosshatch).

SYSTEM: Two coats Series 180 or 181 W.B. Tneme-Crete applied to concrete block, or to concrete block coated with Series 130 Envirofill and cured 10 days.

The following coatings/primers applied to SSPC-SP10/NACE No. 2 Near-White Metal Blast Cleaned steel, topcoated with Series 180 or 181 W.B. Tneme-Crete and cured 10 days: Series 10 Tnemec Primer, 37H Chem-Prime H.S., Series N69 Hi-Build Epoxoline II, Series 135 Chembuild.

REQUIREMENT: No less than a rating of 5. (TR3147)

METHOD: ASTM D 7234.

SYSTEM: Series 1254 EpoxoBlock WB/Series 180 W.B. Tneme-Crete applied to SSPC-SP13/NACE No. 6, ICRI-CSP5 Surface Preparation of Concrete and cured 14 days at 75°F (24°C).

REQUIREMENT: Exceeds the cohesive strength of the concrete, average of three tests. (TR6353)

FREEZE-THAW

METHOD: TTM-058 - Cyclic testing with each cycle consisting of 24 hours at 100% R.H. and 100°F (38°C), 20 hours at 5°F (-15°C), and four hours at 75°F (24°C).

SYSTEM: Two coats Series 180 or 181 W.B. Tneme-Crete applied to concrete block and cured 14 days.

REQUIREMENT: No cracking after 30 cycles. (TR2469-A, TR2470-A)

FUNGAL/MOLD/MILDEW RESISTANCE

METHOD: ASTM D 3273, 90°F (32°C) and 95% R.H. environment of aureobasidium pullulans, aspergillus niger and species of penicillium.

SYSTEM: Two coats Series 180 or 181 W.B. Tneme-Crete on filter paper cured 24 hours.

REQUIREMENT: No microorganism growth after four weeks exposure. (TR3315)

HUMIDITY

METHOD: ASTM D 4585.

SYSTEM: Two coats Series 180 or 181 W.B. Tneme-Crete applied to concrete block and cured 14 days.

REQUIREMENT: No blistering, cracking, loss of adhesion or change in color after 2,000 hours. (TR2467-B, TR2468-B)

MOISTURE VAPOR TRANSMISSION

METHOD: ASTM D 1653 (Method B), Wet Cup, Condition C at 100°F (38°C).

SYSTEM: Two coats Series 180 or 181 W.B. Tneme-Crete at 16 mils (406 microns) DFT cured 14 days at 75°F (24°C).

REQUIREMENT: Series 180: Average of 206 g/m² per 24 hours moisture vapor transmission and no more than 6.36 perms (4.18 metric perms) water vapor permeability. (TR2463-B)
Series 181: Average of 436 g/m² per 24 hours moisture vapor transmission and no more than 13.48 perms (8.87 metric perms) water vapor permeability. (TR2464-B)

SALT SPRAY (FOG)

METHOD: ASTM B 117.

SYSTEM: Two coats Series 180 or 181 W.B. Tneme-Crete applied to concrete block and cured 14 days.

REQUIREMENT: No blistering, cracking, delamination or color change after 2,000 hours. (TR2465-A, TR2466-A)

WIND DRIVEN RAIN RESISTANCE

METHOD: TT-C-555B, Section 4.4.7.3.

SYSTEM: Two coats Series 180 or 181 W.B. Tneme-Crete applied to concrete block and cured 14 days.

REQUIREMENT: No water damage or dampness visible on back of lightweight block after 48 hours.

NOTE: Unless otherwise specified, coating systems for the above tests were roller applied and cured at 75°F (24°C) and 50% R.H.

PROJECT PROFILE

Featured Products

Series 180 W.B. Tneme-Crete
Series 90-97 Tneme-Zinc
Series 73 Endura-Shield
Series 1070 Fluoronar

The Employee Parking Garage at the Bellagio Resort in Las Vegas is protected with nearly 34,000 gallons of Series 180 W.B. Tneme-Crete.

Bellagio Resort Employee Parking Garage

Although Las Vegas is known for its gambling, was the last thing developers wanted to do when it came to selecting protective coatings for the new 10-story, 5,300 space employee parking structure at the elegant Bellagio Resort and Casino.

That's why proven protective coatings from Tnemec were applied on the parking structure's interior concrete, exterior concrete columns and shop primed steel located on the tenth floor, as well as the decorative ornamental steel. The new construction replaces an employee parking lot located on the site of the $11 billion Project CityCenter, a 66-acre mixed-use development described as the largest privately financed development in the U.S.

Nearly 34,000 gallons of Series 180 W.B. Tneme-Crete, an acrylic emulsion coating, were applied to the concrete in the parking structure, according to Eric Brackman, Tnemec coating consultant for the project. "The interior of the structure was a little more than two million square feet," Brackman noted. "Being a dry-fall material, we didn't have to worry about overspray of the product on employee or customer vehicles."

Concrete substrates were pressure washed to provide a clean, dry and sound surface prior to the application. Afterwards, the interior coating was applied by airless spray equipment. "They first started applying the material in December 2005 when the temperature can get cold, so the ability to apply the coating in cooler weather was critical," Brackman acknowledged.

"The fact that the coating can be applied as soon as seven days after the concrete is poured was another important factor," Brackman said.

Series 90-97 Tnemec-Zinc, a two-component, zinc-rich aromatic urethane primer, was shop-applied to the decorative ornamental steel prominently displayed on the side of the parking structure. Once on the project site, the shop-applied primer was touched up using the same material. One coat of Series 73 Endura-Shield, an aliphathic acrylic polyurethane, and a finish coat of Series 1071 Fluoronar, a fluoropolymer, both in gray, were brush- and roller-applied.

"For this high-end type of property, the owner chose a system that would stand the test of time by providing outstanding corrosion resistance and exceptional long term color and gloss retention," Brackman added.

Project Name
Bellagio Resort Employee Parking Garage

Project Location
Project CityCenter, Las Vegas

Project Completion Date
Fall 2006

Owner
MGM Mirage, Las Vegas, NV

Architect/Engineer
HKS, Dallas, TX

Field Applicator
Tiffiny Decorating, Las Vegas, NV