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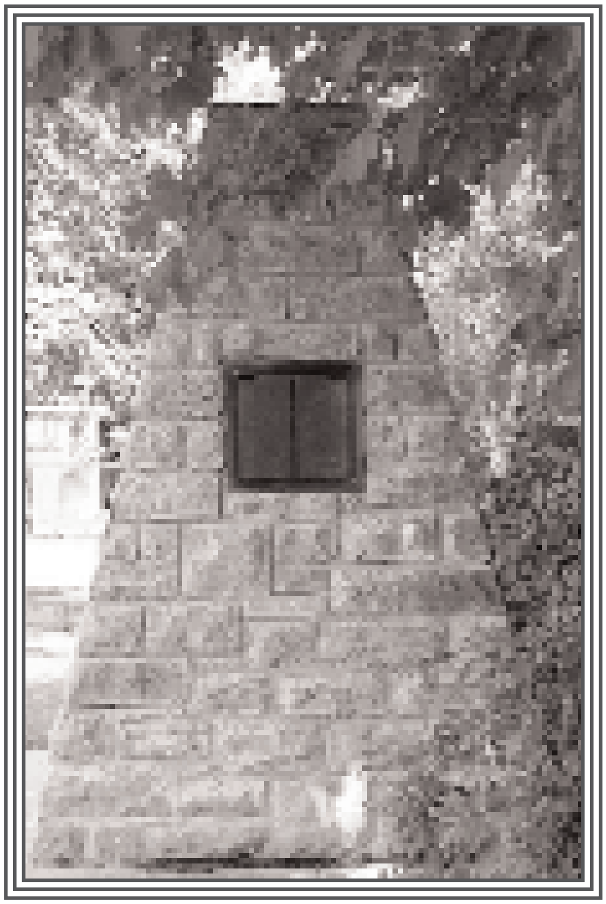
THE CENOTAPH/MONUMENT RESTORATION PROGRAM



CONSERVATION GUIDELINES

REVISED, October 26, 2005

Canada

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INTRODUCTION TO THE CONSERVATION GUIDELINES

The aim of 'conservation' is to safeguard an object of cultural value and extend its physical life for the benefit of future generations. In the context of the Cenotaph/Monument Restoration Program, the objects of cultural value are Cenotaphs and Military Monuments as defined by the Program. A fundamental principle of conservation is minimum intervention, which allows the safeguarding of the valued objects with the least physical change.

The primary purpose of these Conservation Guidelines for the Cenotaph/Monument Restoration Program is to provide sound, practical conservation advice appropriate to the repair and restoration of Cenotaphs and Monuments in Canada. These Guidelines are not intended to replace the role of conservation practitioners or professionals, or to provide detailed technical specifications appropriate for every situation. They are intended to provide guidance and direction to assist in investigating, planning, and completing the conservation of a Cenotaph/Monument.

The secondary purpose of these Guidelines is to assist the custodians of Cenotaphs and Monuments who intend to apply for funding support through the Veterans Affairs Canada Cenotaph/Monument Restoration Program, in determining a scope of work that is both necessary and appropriate. The Guidelines will form the basis for the technical criteria against which submissions for funding through this program will be evaluated.

The Guidelines are divided into five sections. The first section addresses the treatment of the Cenotaph/Monument as a whole. The remaining sections present guidelines for the treatment of the most common materials used in the construction of Cenotaphs/ Monuments: masonry, concrete, metal, and wood. Basic background information on these materials, including how they are formed or are fabricated, and a brief discussion on the most common types of deterioration that affect the materials is provided at the beginning of each Guideline section. A glossary of some specific terms is also included at the end of the Guidelines.

The Guidelines have been developed following the internationally accepted conservation principle of '*minimum intervention*', meaning, wherever possible, the conservation of the Cenotaph/Monument should be achieved through approaches that require the least amount of modification, alteration, or removal of the original fabric. For example, it is highly preferable that a cracked stone be repaired rather than replaced. Within the Guidelines, recommendations are presented in order from the lowest level of intervention to the highest.

These Guidelines have been developed, in part, using Parks Canada's *Cultural Resource Management Policy* and the *Standards and Guidelines for the Conservation of Historic Places in Canada*, to ensure that the guidance provided represents best practice in heritage conservation, and to ensure that it is relevant and appropriate, should a Cenotaph/Monument ever be listed on the *National Register of Historic Places in Canada*.

Conservation is inherently an interdisciplinary process, requiring many individuals with different types of expertise to work together towards a common goal of protecting the

Cenotaph/Monument. These guidelines should be shared with and referred to by all of the stakeholders in the conservation project: custodians, consultants, and contractors, to help ensure the success of the work.

GUIDELINES FOR OVERALL CENOTAPH/MONUMENT

GENERAL APPROACH

Recommended	Not Recommended
Preserve significant existing features of the Cenotaph/Monument.	Removing or radically changing existing features of the Cenotaph/Monument.
Document the form and the condition of the Cenotaph/Monument and its materials prior to beginning project work.	Undertaking project work on the Cenotaph/ Monument without first documenting their existing character and condition.
Evaluate the overall condition of the Cenotaph/Monument through investigation, analysis, monitoring or testing to determine the appropriate conservation actions.	Initiating a repair without understanding the cause of the problem being treated. Carrying out a repair that does not address the cause of the problem.
Review whether problems with one component or material of the Cenotaph/Monument are contributing to problems with another component or material.	
Ensure that all proposed conservation actions represent minimum interventions to solve identified problems.	Proposing excessive or uncalled for work on the Cenotaph/Monument because funding is available.
Record all conservation actions undertaken on a Cenotaph/Monument with the dates of the interventions. Maintain this record in a safe and accessible place for future custodians and conservators.	

CONSERVATION ACTIONS

Recommended	Not Recommended
Any conservation actions should not interfere with water drainage away from the base of the Cenotaph/Monument.	Implementing conservation actions that result in water accumulating at the base of the Cenotaph/Monument.
Clean the Cenotaph/Monument using the gentlest methods possible and only when necessary to halt deterioration or remove heavy soiling or graffiti.	Cleaning the Cenotaph/Monument when it is not heavily soiled to create a 'new' appearance, thus needlessly introducing chemicals or moisture into the materials.
Clean the Cenotaph/Monument from the bottom up to avoid streaking. Refer to the individual material guidelines for specific guidance on cleaning	Cleaning the Cenotaph/Monument more than is necessary.

Recommended	Not Recommended
Consideration should be given to evaluating tall or slender Cenotaphs/Monuments to determine their ability to resist forces from wind, seismic activity, and other ground vibrations. A Professional Engineer, licensed to practice in the Province in which the Cenotaph/Monument is located, must complete this evaluation. The National Building Code of Canada, though not directly applicable to monuments, should be followed as a basis for estimating the applied loading on the Cenotaph/Monument.	Ignoring the potential effects of local seismic activity on tall or slender Cenotaphs/Monuments.
Consider the potential effects from individuals climbing on the Cenotaph/Monument on its stability and strength.	
Develop a plan for the ongoing maintenance of the Cenotaph/Monument.	Initiating maintenance of the Cenotaph/ Monument only when a problem is evident.

MASONRY IN CENOTAPHS/MONUMENTS

The masonry used to construct Cenotaphs/Monuments is most often stone, though brick may also be present. The most common stone type used is granite, though sandstone, limestone and marble are also used. Brick types can include clay, terracotta or occasionally, cement. Each of these various types of masonry has unique physical properties, will perform differently, and will require specific techniques for conservation.

Granite, an igneous rock formed by the crystallization of magma, is relatively impervious to moisture and highly resistant to weathering. In heavily polluted environments, granite can be damaged by run-off from calcareous stones such as limestone. Small natural inclusions in granite, such as pyrite or iron sulphide are frequently present. These can react with precipitation causing local staining and occasionally the break down of the stone. Cracks or micro-cracks in the stone can accelerate this deterioration.

Sandstone is a sedimentary rock composed of grains of sand held together by natural binders. Sandstone will gradually deteriorate when exposed to the elements, because the binders tend to weather more rapidly than the sand grains, resulting in erosion. Sandstone is also susceptible to exfoliation of its surface and swelling of its layers when exposed to moisture and freezing temperatures. If its layers are not properly oriented in a masonry assembly, exfoliation problems can be significant. If limestone or marble is placed above sandstones, the run-off of chemicals from these stones can react with acid rain to cause deterioration of the sandstone. Natural inclusions, such as deposits of minerals or clay, can also weaken the stone and produce staining. A common form of deterioration is contour scaling, in which a relatively impermeable, dense, brittle crust forms on the surface of the stone as a result of chemical reactions with airborne pollutants. Moisture trapped behind this crust will expand when frozen, forming blisters and causing spalling. The cycle is then repeated on the freshly exposed stone surface, and can lead to significant loss of detail.

Limestone, like sandstone, is sedimentary, relatively permeable, and susceptible to pollution damage which can result in the erosion of surface detail. Limestone may possess inclusions that weaken the stone. It can be susceptible to differential weathering of its bedding planes, which can result in the fracture or splitting of the stone.

Marble can include a wide variety of mineral compositions. Marble is relatively soft and can be readily carved. It is soluble in acids and not durable when exposed to moisture. Reactions with sulphuric acids from the atmosphere can cause marble surfaces to be converted to gypsum, which may combine with carbon or soot to form dark crusts which will expand, converting more marble to gypsum, eventually eroding the surface and any carved details or inscriptions.

Brick and *terracotta* are similar in that they are both fired clay products. However, each material has its own characteristics and uses. Brick is a solid or hollow masonry unit, made of clay, with sand and other materials added as binders before being moulded, dried and fired in a kiln. Brick is used for both cladding and structural work. Terracotta is also made of clay mixed with sand and moulded, but is fired at a higher temperature making it harder and more compact than brick. Terracotta is used for ornamental work, roof and floor tiles, and is not a load-bearing material.

Brickwork deterioration can result from: prolonged exposed to moisture and freeze-thaw cycles; crystallization of water-soluble salts which cause surfaces to crumble; acid rain causing lime or calcium carbonates in the brick to dissolve; masonry ties corroding and failing; mortar failure, resulting in water infiltration which, when frozen, displaces brick units.

Failure of terracotta can be attributed to: problems with the manufacture of the units; corrosion of abutting metal causing loss of oxides; and water infiltration. Resulting problems include crackling of the glaze surface, accumulation of organic growth causing glaze deterioration, and cracking and shattering of the terracotta units themselves.

The most common masonry assemblies for Cenotaph/Monuments use one massive stone, or a system of several large stones. Less common are assemblies of smaller stone or brick units. Assemblies using large stones will typically have mortar placed between the stones to evenly distribute their weight sometimes with shims for levelling purposes. Assemblies of smaller stones or brick are built with a lime or cement-based mortar to hold the units together and to evenly distribute their weight. The surface pointing for these is almost always mortar. It is possible that some assemblies may be dry laid, with no bedding mortar. A surface pointing of mortar may sometimes be applied to a dry laid masonry assembly. The surfaces of the joints are also sometimes filled or 'pointed' with putty, caulking, or lead.

Mortar is a mixture of a binder (lime and/or cement), aggregate (sand) and water, that acts to bind the masonry units together and evenly distribute the forces in the assembly. Mortar should always be slightly weaker than the masonry units in order to permit the units to expand or contract without damage in response to moisture and temperature variations. Mortar should also generally be more permeable than the stones, so water entering the masonry assembly can evaporate out through the joints. Portland cement based mortars are generally too hard and impermeable for historic masonry assemblies. The profile of a mortar joint is also an important factor in the mortar's performance. The joint should be designed to shed water away from the masonry.

Additional information on masonry conservation can be found in the following sources:

Weaver, Martin E., 1993. *Conserving Buildings: A Guide to Techniques and Materials.* New York: John Wiley and Sons, Inc.

De Teel, Paterson, and Tiller, 1979. *Preservation Briefs 7: The Preservation of Historic Glazed Architectural Terra Cotta.* U.S. Department of the Interior, National Park Service.

Ashurst, Nicola, 1994. *Cleaning Historic Buildings, Volumes 1 and 2.* London: Donhead Publishing.

Ashurst, John, and Ashurst, Nicola, 1988. *Brick, Terracotta and Earth (Practical Building Conservation, English Heritage Technical Handbook, Vol. 2).* UK: Gower Technical Press.

GUIDELINES FOR MASONRY COMPONENTS.

GENERAL APPROACH

Recommended	Not Recommended
Determine the cause of the distress, damage, or deterioration of the masonry component requiring repair through investigation, analysis, monitoring, and testing as required.	Initiating a repair without understanding the cause of the problem being treated. Carrying out a repair that does not address the cause of the problem.
Monitor the activity of significant cracks, bulges, tilting or other deformations in masonry assemblies to help determine if repairs are necessary, including checking for: seasonal opening and closing of cracks; growth in crack length or outward displacement of bulges, over time; the appearance of new cracks or deformations, and increased rate of growth in bulges or deformation.	Repairing cracks or deformations in masonry assemblies without first determining the cause or significance of the symptom of distress.
Prevent water from collecting within masonry assemblies by maintaining drainage at the base of the masonry, and by re-pointing deteriorated mortar joints.	Applying water-repellent coatings to masonry surfaces that could trap moisture within the assembly.

CONSERVATION ACTIONS

Cleaning Masonry

Recommended	Not Recommended
Clean using the gentlest methods possible and only when necessary to halt deterioration or remove heavy soiling or graffiti. Remove any vegetation or organic growths that are growing in or on the masonry using the gentlest means possible, such as soaking with low-pressure water (less than 350 kPa [50 psi]) followed by gentle scrubbing with natural bristle brushes, or scraping with soft plastic or wood spatulas.	Using tools that could damage the masonry to remove vegetative growth, including: steel wire brushes; metal spatulas, knives, or screwdrivers; abrasive pads such as steel wool; rotary grinders or sanders. Using biocides to kill off plants such as lichens, as chemicals in the biocide may adversely react with the materials on the Cenotaph/Monument, or be hazardous to non-target animals and plant life.

Recommended	Not Recommended
	Using flame cleaning to burn off plants such as lichens, as the excessive heat may damage the masonry or other materials on the Cenotaph/ Monument such as wood, lead, synthetic caulks.
Remove stains or accumulated dirt on masonry, using low pressure soaking with water (less than 350 kPa [50 psi]) followed by gentle scrubbing with natural bristle brushes.	Cleaning with water when there is any possibility of freezing temperatures. Using detergents or household cleaners with Sodium Hydroxide (NaOH) to remove stains, as they may adversely react with the masonry or be hazardous to animals and plant life. Using abrasive sandblasting techniques that can damage the masonry by eroding its surface, and can damage soft or delicate materials that form nearby parts of the Cenotaph/Monument. Using high-pressure water cleaning methods (greater than 2700 kPa [400 psi]) that could damage the masonry, the mortar joints, and other soft or delicate components of the Cenotaph/ Monument.
Clean granite using moderate-pressure water (maximum 2700 kPa [400 psi]) if soaking with water and scrubbing with natural bristle brushes does not provide an acceptable degree of removal. Use a fan type tip on the water pressure machine with minimum 375 mm [15 inch] spread. Do not hold the nozzle closer than 450 mm [18 inch] to the surface being cleaned. Hold the nozzle perpendicular to the surface.	Using moderate-pressure water cleaning techniques on granite that includes lead-filled inscriptions. Using moderate-pressure water cleaning techniques on granite masonry assemblies constructed with soft or poor condition mortars. Using moderate-pressure water cleaning techniques on softer, less durable stones and brick, such as sandstone, marble, or limestone. Adding detergents, acids, or other additives to the water when pressure washing.
Carry out cleaning tests to determine other approp-riate cleaning approaches, if cleaning using low-pressure water and brushes or moderate-pressure water does not provide a sufficient degree of removal. Cleaning tests should be observed over a sufficient period of time so that both the immediate and the long-range effects of the cleaning are known. The gentlest method possible should be selected to achieve an appropriate level of clean-liness.	Cleaning masonry surfaces with more aggressive methods, without testing or without sufficient time for the results and accompanying effects of the testing to be evaluated.
Protect adjacent materials during cleaning to avoid damage by abrasion or water infiltration.	Cleaning masonry without protecting surrounding materials.

Other Surface Treatments

Recommended	Not Recommended
Remove damaged or deteriorated paint or other coatings only to the next sound layer using the gentlest method possible, such as hand scraping, prior to recoating.	Removing paint or other coatings that are firmly adhering to, and thus protecting, masonry surfaces. Using methods of removing coatings that are destructive to masonry, such as sandblasting, application of caustic solutions or high-pressure water-blasting. Using tools that could damage the masonry, such as rotary grinders or sanders.
Apply compatible paint or stucco following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting masonry. Applying paint or stucco to masonry that has been historically unpainted or uncoated. Removing paint from historically painted masonry, unless it is causing damage to the underlying masonry. Removing stucco from masonry that was historically never exposed, or radically changing the type of paint or coating or its colour.
Repaint or re-stucco with colours that are historically appropriate.	Using new paint or stucco colours that are inappropriate to the Cenotaph/Monument.

Repairing Masonry Elements

Recommended	Not Recommended
Repair deteriorated masonry elements by the most appropriate minimum intervention method available, including: - re-pointing; - re-setting loose masonry units; - pin and glue repairs; - dutchman repairs; - stone consolidation; - local replacement of masonry units; or - dismantling and rebuilding.	Replacing masonry that can be repaired. Removing deteriorated masonry elements that could be stabilized, repaired and conserved.

Recommended	Not Recommended
Create a mock-up of each type of masonry repair involved in the conservation project as part of the repair contract in order to refine repair techniques, mortar mixes, replacement materials, and establish the acceptable quality of workmanship for each repair type. It is important to prepare the mock-ups far enough in advance of the repair work to allow them to fully cure before they are evaluated.	

Re-pointing

Recommended	Not Recommended
Re-point mortar joints where there is evidence of deterioration such as disintegrating mortar, cracks in mortar joints, or loose masonry units.	Removing non-deteriorated or acceptable mortar from sound joints, then re-pointing the entire Cenotaph/Monument to achieve a uniform appearance.
Create new weep or drainage holes at the base of a masonry assembly to assist in the drainage and drying out of the masonry assembly when moisture infiltration into the assembly is an ongoing problem.	Damaging the stone or brick units to create the drainage holes by drilling holes that are wider than the mortar joints.
Remove deteriorated or inappropriate mortar by carefully raking the joints using properly sized hand tools to avoid damaging the masonry.	Using rotary grinders or electric saws to remove mortar from joints. Failing to remove deteriorated mortar prior to repointing or not removing enough mortar to produce a proper depth of new mortar. The depth of new mortar pointing should equal at least twice the width of the mortar joint being re-pointed.
Match the aesthetic properties of the re-pointing mortars with the original mortar, including: colour, texture, aggregate, width, and, joint profile.	Using a "scrub" coating technique to repoint instead of traditional repointing methods. Re-pointing mortar joints with a synthetic caulking compound.
Use mortars that will ensure the long-term preservation of the masonry assembly. Mortar should be compatible with the properties of existing masonry units, including: strength, porosity, absorption, and vapor permeability.	Re-pointing with mortar of too high a Portland cement content. This can create a bond that is stronger than the masonry units and can cause damage as a result of the differing coefficients of expansion and the differing porosity of the materials.
Carry out a comparison of the existing and proposed mortar mixes to determine their mechanical	

Recommended	Not Recommended
and aesthetic properties for comparison. Carry out the comparison far enough in advanceof the repair work to allow sufficient time to identify and source appropriate replacement materials.	
Replace failed or deteriorated joint sealants including caulk, putty and lead, in kind, unless the type of material used is adversely affecting the surrounding materials of the Cenotaph/ Monument. Replacement sealants should match the original in colour, texture, and finish.	Failing to follow manufacturers' product and application instructions when applying sealants or caulks. Using sealants which can discolour as a result of absorbing soil or dirt particles from atmospheric pollutants. Using sealants or caulk in joints that were originally pointed with mortar.

Re-setting Loose Masonry Units

Recommended	Not Recommended
Reset loose or displaced masonry units by removing all deteriorated mortar around the masonry unit, and resetting the unit fully bedded in new mortar.	

Pin and Glue Repairs

Recommended	Not Recommended
Re-attach fragments of stone that have broken off by pinning and gluing where the fractured piece of stone is intact and to be retained. Use adhesives that are compatible with the stones' coefficient of thermal expansion to bond the fragment back onto the stone. Bonding larger fragments may require the addition of reinforcement using non-corroding materials for the pins, such as stainless steel, to mechanically attach the fragment to the stone. Important properties of the adhesive should include the ability to: harden without shrinkage; bond well with the stone; not adversely react chemically with the stone; be reversible or removable; remain stable with age, not becoming brittle with exposure to ultraviolet radiation, for example; and not be wicked out by moisture. Keep the adhesive 6mm [1/4 inch] to 12mm [1/2 inch] back from the visible faces of the stone so that the remaining crack can be filled with a cementitous material.	Replacing a stone, when a re-attaching a broken off fragment is possible. Using hard or rigid adhesives on materials with significant coefficients of expansion such as slate or sandstone. Permitting the adhesive to drip, be smeared or otherwise exposed on the stone surface as they can change the colour of the stone, and can react with ultraviolet radiation, becoming brittle and very dark in color.

Dutchman Repairs

Recommended	Not Recommended
Repair chipped or locally deteriorated parts of larger stone units with dutchman repairs when the fractured piece of stone is lost. Dutchman repairs involve carefully fitting a new piece of stone into a pocket cut into the existing stone and finishing the new piece to match the surrounding existing stone.	Replacing a stone, when a partial repair using a dutchman is possible.
When using a dutchman repair, carefully match the physical, mechanical, and aesthetic properties of the replacement stone to the existing stone. Use non-corroding materials for pins, such as stainless steel to improve the degree of attachment between the repair stone and the original stone.	
Use adhesives that are compatible with the stones' coefficient of thermal expansion to bond the repair stone to the original stone. Refer to the guidelines for pinning and gluing stone fragments, for other recommended properties of the adhesive. Keep the adhesive 6mm [1/4"] to 12mm [1/2"] back from the visible faces of the stone so that the joint between the repair stone and original stone can be filled with a cementitous material. Match the colour of the cementitous material used to fill the joint between the repair and original stone to the colour of the stone.	

Stone Consolidation

Recommended	Not Recommended
Use synthetic consolidants to return structural integrity to a carving or statue where the naturally occurring binders and cements have been lost and the stone is beginning to disintegrate.	Using untrained personnel to return structural integrity to a carving or statue, thus causing further damage to fragile historic materials.
Determine if consolidating is the most appropriate method of treatment by evaluating this method against other methods of conservation, such as dutchman repair, plastic mortar repair or replacement.	Using untested consolidants, thus causing further damage to fragile historic materials.
Consolidants should be able to deeply penetrate	

Recommended

the stone, harden without shrinkage, and bond well with the stone. In addition they should not adversely react chemically with the stone, be reversible or removable, remain stable with age, neither changing colour nor becoming brittle with exposure to ultraviolet radiation. They should not be wicked out by moisture, not migrate to the surface of the stone over time; and, not alter the surface appearance of the stone.

Not Recommended

Local Replacement of Masonry Units

Recommended

Replace extensively deteriorated or missing parts of masonry elements, in kind with new stone or brick. The new work should match the old in form and detailing.

Match the physical and mechanical properties of new stone used in repairs and replacements as closely as possible with the existing stone:
- stone type;
- compressive strength (ASTM C170-90, wet and dry);
- modulus of rupture (ASTM C99-87, wet and dry);
- absorption (ASTM C97-02);
- bulk specific gravity (ASTM C97-02).

Match the aesthetic properties of the new stone, used in repairs and replacements, with the existing stone, including color, texture, density of grain or bedding planes, number and size of inclusions, and finish.

Match the physical and mechanical properties of the new brick, used in replacements, as closely as possible with the existing brick, including:
- brick material type;
- compressive strength;
- modulus of rupture;
- absorption;
- bulk specific gravity.

Reference ASTM standard C67-03 for testing procedures.

Not Recommended

Replacing an entire masonry element, such as a column, when limited replacement of deteriorated and missing components is appropriate.

Using replacement material that does not match the existing masonry element.

Recommended	Not Recommended
Match the aesthetic properties of the new brick, used in replacements, with the existing brick, including size, colour, and texture.	
Carry out testing and comparison of the existing and replacement stones or bricks to determine their physical, mechanical, and aesthetic properties for comparison. Carry out testing far enough in advance of the repair work to allow sufficient time to identify and source appropriate new materials. Carry out comparisons under both wet and dry conditions and under natural light at the Cenotaph/Monument.	Tasking the Contractor with the responsibility of sourcing the replacement material.

Dismantling and Rebuilding

Recommended	Not Recommended
Dismantle and rebuild the entire Cenotaph/ Monument or large parts of it, when the integrity of the assembly of the masonry, or its supporting foundation, is badly deteriorated, putting the security of the Cenotaph/Monument at risk. Decide if dismantling and rebuilding is appropriate by evaluating it against other less intrusive methods.	Dismantling a masonry assembly that can be repaired by other less intrusive means.
When dismantling, number and record each stone prior to removal to ensure accurate reconstruction in the original order and stone location. Record the thickness of typical joints at critical locations in the assembly to permit an accurate reconstruction. When rebuilding, replace ferrous dowels or cramps with new dowels or cramps fabricated from non-corroding material such as stainless steel.	

CONCRETE AS A CONSTRUCTION MATERIAL

Concrete is a human-made material composed primarily of sand, stone aggregate (gravel), Portland cement and water. The ratio of these materials dictates the strength and performance of the concrete. Because concrete lacks significant tensile strength, reinforcement, often in the form of a cage of deformed metal bars or metal wire mesh, is encased within the concrete mass to allow the concrete to carry loadings while spanning across supports. This reinforcement will also allow the concrete mass to undergo thermal expansions and contractions without developing excessive cracking.

Cracking of concrete, corrosion of reinforcement, spalling of the concrete cover, and surface scaling are the four most common and important types of deterioration of reinforced concrete. Deterioration of concrete can result from:

- environmental factors including moisture levels, temperature levels, the presence of chlorides, and carbon dioxide;
- the original materials and workmanship, including aggregate material, level of con solidation of the concrete during placement, amount of reinforcement, presence of cold joints, location and number of crack control joints; and
- improper maintenance such as prolonged exposure to moisture, application of water proofing coatings that inadvertently trap moisture, saturation with chlorides due to the spreading of road de-icing salts on or nearby the concrete.

Concrete dating from the early part of the 20^{th} century was often built to low construction standards relative to the standards common today. Designers and fabricators from that period often had little knowledge of the properties and characteristics of the concrete. Early instances of concrete construction are thus often in poor condition and can require a significant degree of conservation work.

Virtually all concrete will crack with time. Cracks can be a result of natural shrinkage of the concrete during curing, thermal expansion and contraction, flexure or shear from overloading, and adverse reactions between the alkalis in the cement and some aggregates known as alkali-silica reactivity. Proper design and placement of the reinforcement can provide the necessary tensile strength to counteract the shrinkage, thermal, and overload cracking. Crack control joints can also be introduced at regular intervals, to force the concrete to crack at predetermined locations to accommodate shrinkage. Shrinkage cracks are dormant and will not change with time. Thermal cracks will tend to widen and narrow with the cycles of the ambient temperature. Structural cracks are active only if the overload condition is continued or if settlement is occurring. Cracking due to alkali-silica reactivity has the appearance of lines on a road map and over time will develop a white crust on the surface.

Concrete is a porous material and absorbs water. To protect the reinforcement metal from corrosion, it is typically buried within the concrete mass and covered by some minimum thickness of concrete. The thickness of the concrete cover provides a physical barrier to moisture to protect the metal, while the high alkalinity of the concrete also provides a degree protection. Cracking of the concrete can expose the reinforcement resulting in the premature corrosion of the metal. Insufficient concrete cover over the reinforcement also often results in the premature corrosion. Corrosion of the reinforcement metal resulting from contact with moisture will result in a reduction in the strength of the concrete structure, the loss of the concrete cover material, and possible staining of the concrete. Exposure of the concrete to carbon dioxide can also neutralizeits alkalinity, thereby eliminating the chemical protection afforded the metal. This is known as carbonation.

In the 1970s, the use of steel reinforcement that was coated with an epoxy to increase its resistance to corrosion became relatively common in high exposure situations.

Spalling is the loss of the surface concrete material and is typically a symptom of the corrosion of the underlying metal reinforcement. As the metal corrodes, rust is produced which occupies significantly more space than the original metal and causes expansive forces within the concrete cover which can produce the spalls. Spalls can reduce the strength of the concrete structure due to the loss of concrete, and the loss of bond between the concrete and reinforcing, and can expose the reinforcement to an even greater risk of corrosion.

Surface scaling can result from freeze-thaw actions of moisture trapped within the concrete surface. As the moisture expands when it freezes, it can break off layers of the concrete, resulting in a pitted uneven surface. Scaling can also result from the introduction of high stresses in the concrete produced by thermal expansion forces acting in a concentrated manner on a small area of concrete.

Additional information can be obtained in the United States National Park Service's preservation brief, *Preservation of Historic Concrete Problems and General Approaches*, published by the United States National Park Service, Technical Preservation Services. This document is available online at:

http://www.cr.nps.gov/hps/tps/briefs/brief15.htm

GUIDELINES FOR CONCRETE COMPONENTS.

GENERAL APPROACH

Recommended	Not Recommended
Determine the cause of the distress, damage, or deterioration of the concrete component requiring repair through investigation, analysis, monitoring, and testing as required.	Initiating a repair without understanding the cause of the problem being treated. Carrying out a repair that does not address the cause of the problem.
Prevent water from collecting on or around concrete components by ensuring adequate drainage off of, and away from, the concrete and the Cenotaph/ Monument as a whole.	Applying membranes or coatings to act as 'waterproofing' for concrete features as the coatings can inadvertently trap water leading to deterioration of the concrete. Applying either penetrating or film-forming sealers to minimize moisture absorption, as these sealers are often not removable, and both types typically change the appearance of the surface of the concrete by making it more reflective.

CONSERVATION ACTIONS

Cleaning Concrete Components

Recommended	Not Recommended
Clean using the gentlest methods possible and only when necessary to halt deterioration or remove heavy soiling or graffiti.	
Clean concrete components using low-pressure (less than 350 kPa [50 psi]) soaking with water followed by gentle scrubbing with natural bristle brushes.	Cleaning concrete components with water when there is any possibility of freezing temperatures. Using detergents or household cleaners with Sodium Hydroxide ($NaOH$) to remove stains on the concrete, as they may adversely react with other materials or be hazardous to animals and plant life. Blasting concrete components with abrasives, as this can damage the concrete by eroding its surface, and can damage soft or delicate materials such as wood, lead, sandstone, or marble, adjacent to the concrete of the Cenotaph/Monument. Using biocides to kill off plants such as lichens, as chemicals in the biocide may adversely react with other materials on the Cenotaph/Monument,

Recommended	Not Recommended
	or be hazardous to non-target animals and plant life. Using flame cleaning to burn off plants such as lichens, as the excessive heat may damage other materials on the Cenotaph/ Monument, such as wood, lead, synthetic caulks. Applying coatings or paint over the concrete to present a "clean appearance" as these coatings can inadvertently trap water, leading to premature failure of the coating and the accelerated deterioration of the concrete.
When cleaning using low-pressure soaking and brushes is not sufficient, soaking with low pressure water (less than 350 kPa [50 psi]) followed by spraying with moderate-pressure water jets (maximum 2700 kPa [400 psi]) is generally safe for use <u>on good quality concrete only</u>.	Pressure washing poor quality or low strength concrete. Pressure washing concrete with an exposed aggregate finish. Pressure washing concrete where soft or delicate materials, such as wood, lead, sandstone, marble, lead lettering, or carvings, form nearby parts of the Cenotaph/Monument, as the pressure of the water may damage these materials. Adding detergents, acids, or other additives to the water when pressure washing.
Carry out cleaning tests to determine other appropriate cleaning approaches, if cleaning using low or moderate-pressure water and brushes does not provide a sufficient degree of cleanliness. Cleaning tests should be observed over a sufficient period of time so that both the immediate and the long-range effects of the cleaning are known, the gentlest method possible is selected, and an appropriate level of cleanliness achieved.	Cleaning concrete surfaces with more aggressive methods, without testing or without sufficient time for the testing results to be known.
Protect adjacent materials during the cleaning of concrete components to avoid damage by abrasion or water infiltration	

Repairing Concrete Components

Recommended	Not Recommended
Monitor the activity of significant cracks in the concrete before determining if repairs are necessary, including checking for: - seasonal opening and closing of cracks;	Repairing cracks in concrete without first determining the cause or significance of the crack.

Recommended	Not Recommended
- growth in crack length over time; and, - the appearance of new cracks.	
Match the physical and mechanical properties of the repair concrete as closely as possible with the existing, including: - modulus of elasticity (ASTM C469-02); - cement to aggregate ratio; - aggregate gradation (ASTM C136-05); - compressive and shear strength (ASTM C39/C39M-04a); and, - coefficient of thermal expansion. ASTM is the acronym for the American Society for Testing and Materials. ASTM publishes standards for testing procedures and material and construction quality that are referenced by Building Codes in Canada including the National and Provincial building codes.	Using off-the-shelf pre-packaged concrete patching compounds.
Where concrete is exposed and forms an important visual element of the Cenotaph/Monumnet, match the physical appearance of the exposed repair concrete with the existing, including: color; texture; and finish. In some cases, using aggregates from the original sources and reproducing the original construction methods, such as formwork, finishing techniques, should be considered.	Using new coatings or finishes, not historically accurate for the Cenotaph/Monument, to cover and hide surface repairs. Re-creating architectural features after forming by sculpting with plastic concrete. Re-creating form finish details such as form lines, wood grain, or knots with grinders or trowels.
Create a mock-up of an exposed concrete repair as part of the repair contract to determine the suitability of the proposed repair materials and techniques in matching the physical appearance of the existing exposed concrete. It is important to prepare the mock-ups far enough in advance of the repair work to allow them to fully cure before they are evaluated (e.g. minimum 28 days), and to prepare them under the same conditions as the eventual repairs. For example, if the repair is on a vertical surface, the mock-up should be created in a vertical orientation.	
Clean exposed concrete to remove contaminants, dirt, and soil, before initiating repairs, so that the new concrete patches match a cleaned surface.	

Recommended	Not Recommended
Carry out testing of the existing concrete to determine its physical and mechanical properties, including its level of air content (percentage of voids), the presence of any impuritiesor contamination, and evidence of carbonation. Carry out testing far enough in advance of the repair work to allow sufficient time to identify source appropriate replacement materials.	
Ensure the freeze-thaw durability of the repair concrete by including an appropriate level of air entrainment as recommended by the Canadian Standard *CSA A23.1 Concrete Materials and Methods of Concrete Construction*.	
Use non-corroding reinforcement, such as stainless steel, epoxy coated steel, or glass fibre reinforced polymer [GFRP] rods, in repairs to replace or supplement existing corroded reinforcement.	
Match the amount of reinforcement to the existing, unless the repair is treating a case of damage resulting from overloading of the concrete.	Over or under reinforcing the repair location.
Remove and replace all unsound concrete. It may be necessary to limit the size of the chipping equipment used on early concrete features to better control the degree of removal, as the compressive strength of the concrete may be much lower than modern concrete.	Replacing entire concrete features, when selective replacement and repair is possible.
Remove all corrosion from existing exposed reinforcement that is to remain using wire brushes or sandblasting.	
Ensure proper concrete mixing, placement, and curing procedures by following the recommendations of the Canadian Standard *CSA A23.1 Concrete Materials and Methods of Concrete Construction*.	
Ensure good chemical and mechanical bonds between the repair material and original concrete by: - sandblasting the exposed concrete in the patch area; - air-blasting the patch area to remove any dirt, debris or contaminants;	

Recommended	Not Recommended
- pre-wetting the patch area before adding the patch material; - brushing a slurry made from the repair conc-rete onto the exposed concrete of the patch area to act as a bonding agent; - undercutting the edges of patches and cutting the patches square to develop a good mechani cal bond; - introducing supplemental anchors (e.g. stain less steel dowels) to tie the patch to the exist ing concrete; - insuring an appropriate minimum thickness of the patch material is applied (i.e. do not feather the edges of the patch); and, - chipping around all existing rebar a distance at least equal to the size of the largest aggregate used in the repair concrete.	
Seal inactive cracks by pointing with a cementi-tous mortar or injecting epoxies to prevent the ingress of moisture into the concrete mass through the crack.	Pointing cracks with mortar or other hard mate-rials without first determining if the crack is active or not. Sealing active cracks with hard mortars or other hard materials, which could prevent the seasonal movements at the crack.
Control the propagation of thermal expansion/contraction cracks by saw-cutting crack control joints into the concrete at strategic locations to force the concrete to crack at that specific location.	
Maintain a record of the date and extent of the conservation actions to guide future research and treatment.	

METALS ON CENOTAPH/MONUMENTS

A variety of metals have been used in the fabrication of Cenotaph/Monuments including: iron, tin, copper, zinc, aluminium, lead, with the most common being bronze. Typically, metals are featured as decorative elements such as plaques, sculpture, or lettering. Bronze is an alloy or fusion of the ores, tin and copper. Wrought iron, cast iron, and steel tend to be simple to identify, but alloys are more complicated, and their identification may require assistance from a conservator or conservation professional.

Most metals are chemically unstable, reacting with the atmosphere to form oxides over varying periods of time. Some metals, such as aluminum and stainless steel, form a protective oxide coating on their surface which cannot be penetrated by further oxygen molecules, permitting them to retain their shiny appearance with little or no maintenance for years. However, most metals require a coating or anodizing to prevent corrosion.

The long-term performance of metal components will depend on the their physical and chemical properties, the climate to which they are exposed, design details, and their proximity to other metallic and non-metallic components. In order to correct damage to a metal component, the cause of its deterioration must be understood. If the properties of the metal are not understood, inappropriate treatment may result in an adverse reaction that causes further deterioration. Generally, metal components tend to be durable, but components that are not suited for a particular location and function, or not receiving adequate maintenance, may become fragile.

The following describes typical forms of metal deterioration:

Corrosion occurs in most metals in reaction to oxygen, water, and other elements in the environment. As metals corrode, a chemical compound forms on their surfaces creating first a film, and later a crust. The expansion caused by the formation of this crust can break masonry where metal is bolted or embedded. In certain cases where the film of corrosion is stable and uniform, it actually forms a finish called a *patina* that protects the metal. Bronze statuary will turn a reddish-brown, but in the presence of pollutants, the surfaces may turn green and/or black. The end colour and period of time it takes the change to occur will depend on the atmosphere and the chemical pollutants present. Artificial patinas may be applied to metals for aesthetic reasons to achieve a particular colour.*Pitting* occurs when a patina has ceased to be a stable layer, and corrosion is attacking the metal at deeper levels creating deep holes. Protective patinas can be made porous by acid rain, which then results in pitting and selective corrosion.

Selective corrosion take place when only some of the metals in an alloy begin to corrode. A common example is when the zinc from a brass alloy corrodes, leaving white patches on the surface of the metal.

Galvanic corrosion occurs when dissimilar metals are in contact with each other causing an electrochemical reaction. The metal that is less resistant to corrosion will deteriorate at a faster rate. In the case of a bronze-clad aluminium door, the aluminium components will break down from corrosion while the bronze will remain intact.

Erosion or abrasion is the physical process whereby metal slowly wears away. This can be caused by natural factors such as water, wind or wind-driven sand, or by repeated human actions such as pushing doors open, or by acts of vandalism.

Plastic deformation or creep often affects lead components subjected to loads or high temperatures. This condition can occur with heavy statuary that sags under its own weight. Lead lettering, which is the most comon use of lead on Cenotaphs, will not be affected by this problem.

Casting flaws in ironwork can be mistaken for corrosion. These flaws usually take the form of bubbles, holes, or cinders. Cracks may also form due to uneven cooling or flaws in the molten metal pour. The resulting flaws may become corrosion sites.

Cracks in metal can occur for a number of reasons: expansion of ice trapped between sections of metal; flaws in metal castings or extrusions; metal fatigue; no provision for thermal expansion and contraction of metal; and accidental impact or vandalism. How these cracks are repaired will depend largely on the cause of the damage and the type of metal. Some metals can be welded or brazed, while others, such as cast iron, have limited repair options.

Additional information can be found in the following sources:

Gayle, Margot, Look, David W., and Waite, John G. 1992. *Metals in America's Historic Buildings. Uses and Preservation Treatments.* U.S. Department of the Interior, National Park Service, Cultural Resources, Preservation Assistance. Washington, D.C.

Anson-Cartwright, Tamara. 1997. *Landscapes of Memories: a guide for conserving historic cemeteries, repairing tombstones.* Toronto: Ministry of Citizenship, Culture and Recreation. ISBN 0-7778-6339-1

Weaver, Martin E. 1993. *Conserving Buildings: A Guide to Techniques and Materials.* New York: John Wiley and Sons, Inc. ISBN 0-471-50945-0

Ashurst, John, Ashurst, Nicola, Wallis, Geoff, and Toner, Dennis. 1988. *Metals (Practical Building Conservation, English Heritage Technical Handbook, Vol. 4)*. UK: Gower Technical Press. ISBN: 0470211075

GUIDELINES FOR METAL COMPONENTS.

GENERAL APPROACH

Recommended	Not Recommended
Identify the types of metal that make up the Cenotaph/Monument component requiring repair.	Undertaking repairs to metal components without knowing the type of metal being treated.
Determine the cause of deterioration of the metal components requiring repair, through investigation, analysis, monitoring, or testing as required.	Initiating a repair without understanding the cause of the problem being treated. Carrying out a repair that does not address the cause of the problem.
Document the form, materials and existing condition of the Cenotaph/Monument before and after conservation begins.	Undertaking project work that will have an impact on metal components without first undertaking a survey of existing conditions.
Ensure that all proposed conservation actions for metal components represent minimum interventions to solve identified problems.	Removing or radically changing significant metal components and finishes.
Retain as much of the original material as possible by repairing or replacing only the deteriorated portions.	Removing major portions of the metal component and replacing with a replica.

CONSERVATION ACTIONS

Recommended	Not Recommended
Protect metals from corrosion by providing proper drainage so that water or organic matter does not stand on horizontal surfaces or accumulate in decorative or curved features.	Failing to identify, evaluate, and treat causes of corrosion.
Ensure that all metals in direct contact with each other are of types that will not cause galvanic corrosion.	Placing incompatible metals together without providing a reliable separation material to prevent galvanic corrosion.

Cleaning Metal Components

Recommended	Not Recommended
Clean metals, when appropriate, to remove corrosion prior to refinishing.	Failing to recognize when cleaning is inappropriate for the particular metal.
Identify the particular types of metal prior to any cleaning procedure to ensure that the gen-	Using cleaning methods that alter or damage the original patina, colour, texture, and finish of the

Recommended	Not Recommended
tlest cleaning method possible and the appropriate level of cleanliness are selected.	metal; or cleaning when it is inappropriate for the metal. Removing the original patina of the metal, which may be a protective coating on some metals, such as bronze or copper.
Clean soft metals such as lead, tin, copper, terneplate, aluminium and zinc with appropriate chemicals methods because blasting methods can easily abrade their finishes.	Cleaning soft metals such as lead, tin, copper, terneplate, aluminium and zinc, with grit blasting or other abrasive methods, or using tools such as wire brushing, which will abrade the surface of the metal.
Use the gentlest cleaning methods for hard irons: cast iron, wrought iron, and steel, in order to remove paint build-up and corrosion. If hand-scraping and wire brushing have proven ineffective, low pressure dry grit blasting may be used as long as it does not abrade or damage the metal surface.	Failing to employ gentler methods prior to abrasively cleaning cast iron, wrought iron or steel; or using high pressure grit blasting.
Protect adjacent materials during cleaning so as to avoid damage by abrasion or chemical reaction.	Failing to mask or otherwise protect adjacent masonry, wood or other metal surfaces during metal cleaning.
Re-apply an appropriate paint or coating system after cleaning in order to decrease the corrosion rate of metals or alloys.	Failing to re-apply protective coating systems to metals or alloys that require them after cleaning so that accelerated corrosion occurs.
After cleaning, leave metal surfaces meant to be exposed without further treatment.	Applying paint, lacquer, or other coatings to metal surfaces meant to be exposed.

Repairing Metal Components

Recommended	Not Recommended
Use only personnel experienced in the metal being repaired.	Using untrained personnel for repairs to metal components, thus causing further damage to fragile elements.
Test all chemicals and consolidants for their interactions with the particular metals with which they will be in contact, as part of planning for the repairs.	Using untested chemicals and consolidants thus causing further damage to fragile metal elements.
Retain sound metal elements, or deteriorated metal elements that can be repaired.	Replacing metal elements that can be repaired.
Stabilize deteriorated metal elements by struc-	Removing deteriorated metal elements that could

Recommended	Not Recommended
tural reinforcement, weather protection, or by correcting unsafe conditions as required, until final repairs are undertaken. Repairs should be physically and visually compatible.	be stabilized on site, or leaving metal components in precarious states for long periods of time while waiting for repairs to be implemented.
Follow recognized conservation methods when repairing metal features by welding, patching, splicing, or otherwise reinforcing the metal.	Using metal repair techniques common to auto body shops or other commercial situations when treating the metal elements of a Cenotaph/ Monument.
Repairs may include limited replacement, in kind or with a compatible substitute material, for those extensively deteriorated or missing components.	Replacing an entire metal element when repair of the metal and limited replacement of deteriorated or missing components are appropriate.
When replacing an entire metal component too deteriorated to repair, use the remaining physical evidence as a model to reproduce the substitute part. If the same kind of material is not technically or economically feasible, then a compatible substitute may be considered.	Removing a metal element that is irreparable and not replacing it.
When replacement of a metal component is required, use a new metal element that conveys the same visual appearance, and is physically and visually compatible with the other parts of the Cenotaph/Monument.	Using a substitute material for the replacement part that neither conveys the visual appearance of the surviving parts of the metal feature, or that is physically or chemically incompatible.
Re-paint metal components, if warranted, with colours that are appropriate to the Cenotaph/ Monument.	Using new colours that are inappropriate to the Cenotaph/Monument.

WOOD AS A CONSTRUCTION MATERIAL

Wood is an organic material, and has a wide range of physical properties that can vary significantly from species to species or even within species depending on the conditions under which the wood was grown. Degradation of wood can be grouped into two broad categories: biological deterioration from fungal decay or insect attack, and mechanical deterioration.

Biological Deterioration

Fungi are classified into three categories depending on the nature of the degradation they cause: molds grow on the surface of wood with little effect and can be easily removed; staining fungi penetrate the cellular structure damaging cell contents and walls, reducing strength and stiffness; and decaying fungi can significantly reduce wood's strength by penetrating its cellular structure, and can destroy its chemical composition by consuming cell contents.

In order to grow and propagate, decaying fungi require adequate supplies of oxygen, food and moisture, and temperatures between 20 and 30 degrees Celsius. Areas prone to fungal decay include situations on which water can collect, such as horizontal surfaces, or checks and splits in the wood. Wood that is in direct contact with the ground, with water, or with concrete or asphalt, is also vulnerable, as are locations where two or more wood members butt tightly together, and where debris, bird or animal droppings accumulate.

Wood affected by some decaying fungi will lose structural strength before the decay is even visibly evident. Active advanced decay can be detected and identified by looking for damage to the wood, including cross cracks, stringy and fibrous appearance, staining, brown cubical deterioration, and change of colour and odour. Symptoms of decay can also include staining on paint coatings, local crushing of the wood, and paint failure. The presence of fungal fruiting bodies on the surface of wood is also a clue.

If the spores from fungal fruiting bodies fall on a moist wood surface and meet other favorable growth conditions, they are capable of developing and producing new fungal plants. Thus, disease can be spread from one piece of wood to another without direct contact between sound and infected material.

A number of insect species (such as beetles, carpenter ants, termites, wood wasps, and carpenter bees) can significantly damage wood and reduce its strength. The typical process is initiated when a female insect lays eggs in or on the surface of the wood. The eggs hatch into larvae which then tunnel through and feed on the wood. Upon maturity, the adults emerge, leaving the wood surface perforated with small, round 'flight holes'. The feeding actions of the insects create voids in the wood and can severely degrade the structural integrity of the wooden element. Detecting infestations of some insects can be difficult as their flight holes are very small, and determining if a flight hole is from an active or past infestation is almost impossible. Frass from the flight holes, which looks like fine sawdust, can indicate activity.

Conditions that are favorable to insect infestation (such as damp or wet wood and accumulations of rotting organic debris) can be eliminated. Preventive measures using insecticide and proper maintenance of the wood elements to deny suitable habitat and access, are usually the most effective approaches to preventing insect damage. When an infestation is present, the first step is to find the location of the colony, and then to determine why it is there. When it is time to eradicate the colony, use a 'poisoned' bait that the insects will carry back, pass around, and eventually destroy the colony.

Mechanical Degradation

Mechanical degradation of wood can include weathering, mechanical wear, and structural failure. The deg-radation process of wood can be influenced by the presence of naturally occurring growth defects with in the wood, by problems related to the conversion process from logs to dimension lumber, or by defects introduced into the wood by the seasoning or drying processes used in preparing the wood. The use of wooden members with spiral or diagonal cross grains is undesirable for flagpoles, frames, crosses and plaques because those types of grains generate twisting of the material and reduce strength and stiffness along the long axis of the wooden component.

Weathering is a generic term for degradation from exposure to atmospheric elements including ultraviolet radiation, moisture, temperature, chemical gasses, and windborne grit. Cracking and splitting of wooden components can result from various processes initiated by extended exposure to ultraviolet radiation, moisture, temperature changes, and temperature extremes. Protective coating can be damaged by atmospheric gasses that accelerate natural oxidation. Weathering often results from combinations of these factors. The application and maintenance of paint, stain or other protective finishes will prevent weathering.

Mechanical wear results in the loss of material. It can by caused by human traffic, windborne grit, sand or dust, impacts from maintenance equipment, deliberate vandalism, cables and ropes swinging in the wind, and animals or birds chewing or tearing at the wood. Protection against mechanical wear can include the application and maintenance of protective coatings, and the restriction or control of damaging activities.

Structural failure occurs when wood is subjected to stress levels that exceed its strength. The natural strength of wood can be reduced by any of the wood degradation processes discussed above. Indicators of structural failure include: sagging, splitting, or crushing of wooden members; leaning structures; and the appearance of new openings or gaps between different parts of a structure.

Additional information can be found in the following sources:

> *Canadian Building Digest*, published by the National Research Council of Canada. Of particular interest are: CBD-85, Some Basic Characteristics of Wood; and CBD-111, Decay of Wood. These documents are available online at: www.irc.nrc-cnrc.gc.ca/cbd/cbd-e.html
>
> *Building Performance Series*, published by Canadian Wood Council. These documents are available online at: www.cwc.ca
>
> *Wood Durability*, published by Forintek Canada Corp. This document is available online at: www.durable-wood.com

GUIDELINES FOR WOODEN COMPONENTS

GENERAL APPROACH

Recommended	Not Recommended
Inspect the damaged element to determine the level and extent of damage.	Intervening without properly identifying if repairs are necessary.
Determine the cause of the damage or deterioration requiring repair, through investigation, analysis, monitoring, and testing as required.	Initiating a repair without understanding the cause of the problem being treated. Carrying out a repair that does not address the cause of the problem.
Document the existing location, function, form and type of assembly, dimensions of the wooden element, and type of wood; the type and colour of the coating; and, the condition of the wooden element prior to beginning any conservation activity.	Beginning conservation activity without properly identifying the physical characteristics, functional requirements and condition of the wooden element.

CONSERVATION ACTIONS

Cleaning Wooden Components

Recommended	Not Recommended
Clean using the gentlest methods possible and only when necessary to halt deterioration or remove heavy soiling or graffiti.	Using detergents or household cleaners with Sodium Hydroxide (NaOH) to remove stains, as they may adversely react with other materials or be hazardous to animals and plant life.
Clean using low pressure soaking with water (less than 350 kPa [50 psi]) followed by gentle scrubbing with natural bristle brushes.	Using tools that could damage the wood, including: steel wire brushes; metal tools such as spatulas, knives, or screwdrivers; abrasive pads such as steel wool; and rotary grinders or sanders. Using biocides to kill off plants such as lichens, as chemicals in the biocide may adversely react with other materials on the Cenotaph/ Monument, or be hazardous to non-target animals and plant life. Using high-pressure water cleaning methods that could damage the wood.

Re-coating Wooden Components

Recommended	Not Recommended
Inspect coated wooden surfaces to determine	Removing paint or other coatings that are firmly

Recommended	Not Recommended
whether re-coating or re-painting is necessary, or if cleaning is all that is required.	adhering to and thus protecting wooden surfaces. Re-coating or repainting a wooden feature that is stained, without first determining whether or not the stain is the result of fungal decay.
Retain coatings, such as paint, that help protect the wood from moisture and ultraviolet light. Removal of a coating should be considered only where there is surface deterioration of the coating and where re-coating will occur.	Stripping paint or other coatings to reveal bare wood, thus exposing historically coated surfaces to the effects of accelerated weathering. Stripping coated wooden surfaces to bare wood, and then applying clear finishes or stains in order to create a 'natural' look.
Remove damaged or deteriorated coatings to the next sound layer using the gentlest methods possible, scraping and sanding by hand, then recoating in kind.	Using destructive removal methods such as propane or butane torches, sandblasting or water-blasting. These methods can irreversibly damage woodwork or other delicate parts of the Cenotaph/Monument, or cause fires.
Use electric hot-air guns carefully on decorative wooden features. Use electric heat plates on flat wooden surfaces when paint is so deteriorated or so thick that total removal is necessary prior to repainting.	Using thermal devices improperly so that the woodwork is scorched. Failing to have a fire extinguisher nearby when using thermal devices.
Use chemical strippers primarily to supplement other methods such as hand scraping, hand sanding and the thermal devices recommended above. Detachable wooden features may be chemically dip-stripped if proper safeguards are taken.	Failing to neutralize the wood thoroughly after using chemicals so that new paint does not adhere. Allowing detachable wooden features to soak too long in a caustic solution so that the wood grain is raised and the surface roughened
Apply compatible paint coating systems following proper surface preparation, such as washing with trisodium phosphate.	Failing to follow the manufacturer's product and application instructions when re-painting woodwork. Applying paint over deteriorated wood.
Re-painting with colours that are historically appropriate.	Using new colours that are historically inappropriate.
Apply a chemical preservative treatment, if required, using recognized preservation methods.	Using chemical preservatives such as creosote or copper napthanate, because if they have not been used historically, they can change the appearance of wood features.
Apply chemical preservatives to traditionally	Using preservatives that leave or form harmful

Recommended	Not Recommended
unpainted wooden features that are exposed to decay hazards.	residues, injure non-target animals or plant life, or corrode or damage other materials of the Cenotaph/Monument and its surroundings.

Eliminating Insect Infestations

Recommended	Not Recommended
Treat active infestations of insects by first identifying the type of insect, and then implementing a program of elimination appropriate to that insect. If using pesticides, confirm that the chemical is registered for the intended purpose with Agriculture and Agri-Food Canada, and follow the manufacturer's product and application instructions.	Using pesticides that leave or form harmful residues, injure non-target animals or plant life, or corrode or damage other materials of the Cenotaph/Monument and its surroundings.

Treating Deteriorated Elements

Recommended	Not Recommended
Repair deteriorated wooden features by the most appropriate minimum interventions available such as: patching, piecing-in, consolidating, structural reinforcement, or otherwise reinforcing the wood.	Removing or replacing an entire wooden element when repair of the wood or limited replacement of deteriorated or missing parts are appropriate. Unnecessarily removing sound wood.
Select replacement wood used for repairs, to match the existing wood as closely as possible as to: species; grade; quality (first growth, second growth); cut (quarter sawn, flat sawn, etc.); grain direction and pattern; and, moisture content.	Using replacement material that does not match the existing wooden elements.
Use a compatible substitute material if matching existing wood is not technically or economically feasible.	Using a substitute material for the replacement part that neither conveys the same appearance as the surviving parts of the wooden element, nor is physically or chemically compatible.
Repair of deteriorated wood may include consolidation, where synthetic resins are used to bond together the deteriorated wood fibres. Consolidants should be able to: deeply penetrate the wood; harden without shrinkage; bond well with the wood; not adversely react chemically with the wood; be reversible or removable; remain stable with age,for example not changing colour or becoming brittle with exposure to ultraviolet radiation; not be wicked out by mois-	Using untested consolidants that could cause further damage to fragile historic materials.

Recommended	Not Recommended
ture; and, not alter the surface appearance of the wood.	
Use surviving prototypes upon which to base the design of in kind replacement when repairing extensively deteriorated or missing wooden parts.	Replacing wooden elements with forms lacking any previous association with the Cenotaph/Monument.
Create connections between the new and existing wood that will accommodate natural shrinking and expansion; maintain load paths and stress distributions within the original structure; and are appropriate for the original framing techniques used.	Creating connections between replacement and existing wood that detract from the appearance of the wooden feature. Using metal fasteners that react chemically with the wood or any preservative treatments applied to the wood.
Design and install a complete wooden component when the existing one is entirely damaged or missing. New design should be compatible with the style and character of the Cenotaph/Monument, and should be based on physical and documentary evidence.	Changing the original style and character of the Cenotaph/Monument by adding newly designed replacements.
Maintain a record of the date and extent of the conservation actions to guide future research and treatment.	

GLOSSARY

Air entrainment: Minute bubbles of air are introduced into concrete to improve its durability under freezing conditions: the bubbles provide room for moisture to expand into when it freezes, thereby reducing the stresses generated in the concrete.

Anodized: A process in which a metal object is placed in an acid bath and an electrical current is passed through the tank. The process gives the metal a thin protective and lustrous film. The process is commonly used on aluminum.

Bedding mortar: The mortar in which the stone or brick is set. The bedding mortar may be physically different than the pointing mortar, especially in terms of its colour.

Brazing: A form of soldering that utilizes alloys to join metals. The melting point of the alloy is lower than the metal.

Check: A lengthwise separation of the wood that usually extends across the annual growth rings and commonly results from stresses set up in wood during seasoning.

Cold joint: A joint or discontinuity formed when a concrete surface hardens before the next batch of concrete is placed against it. The cold joint will be a weak point in the concrete casting.

Consolidant: A product that is introduced into a crumbling or deteriorating material to make up for the loss of naturally occurring binding agents.

Crack control joint: A joint created in the concrete casting, often by cutting a groove in the concrete, that is intended to encourage cracking due to shrinkage at that specific location.

Cross crack: Cracking in a direction that is across the grain of the wood.

Exfoliation: A process in which the surface material of a stone or brick sheds or sloughs off as a result of an ongoing deterioration in the integrity of the stone or brick.

Exposed aggregate finish: A special finish for concrete, where an aggregate is deliberately exposed on the surface of the concrete casting. The aggregate is most often a pea-stone or small sized stone.

Fruiting body: The visible organ of fungi in which the spores are produced, commonly seen as bracket fungi, which grow like shelves on trees, or molds.

Joint profile: The shape of the mortar joint. The joint profile can be flush or recessed and can vary depending on the shape of the tool used to finish it. The ability of the mortar joint to shed water away from the masonry (rather than directing it into the masonry) is an important design consideration.

Mock-up: A full size model of a repair or replacement used for testing and reference during work for quality assurance purposes. Mock-ups are prepared at the start of work and can often form part of the finished project.

Oxidation: A reaction of a metal with oxygen, usually resulting in the degradation of the metal. Oxidation can result in the formation of a protective layer, such as a patina or tarnish.

Permeability: A measure of a material's ability to transmit fluids.

Pointing mortar: The mortar that is used to finish the face of the exposed mortar joint. Pointing mortar will often have a different colour and texture than the bedding mortar for aesthetic reasons.

Slurry: A thin watery mixture of concrete paste applied to a concrete surface to improve bonding between the existing and new concrete.