4.0 CHAPTER 4 – CHLORIDE TESTING (CHL2)

4.1 INTRODUCTION

The Level 2 Chloride Test is a field test to determine the chloride content of concrete. In bridge applications, it is most often performed on a deck or curb because these are the areas of the bridge that are commonly exposed to the application of de-icing salt.

Chlorides diffuse into concrete surfaces. Horizontal concrete surfaces are more likely to have higher chloride concentrations than vertical concrete surfaces since a horizontal surface allows the applied chloride build up and permeate into the concrete, while a vertical surface allows the chloride application to 'run-off'. The chloride test method can also be used on other concrete areas which are exposed to deicing salt, such as the splash zone of piers on underpasses, substructure elements exposed to leakage from the deck, or superstructure elements which project above the deck and may be exposed to road splash.

4.1.1 BACKGROUND - THE NEED TO DETERMINE CHLORIDE CONTENT

Concrete is a permeable material. It is also typical for concrete components to have some cracks. Therefore, two of the elements necessary for corrosion to occur, oxygen and water can readily penetrate into concrete and reach the embedded steel reinforcement. Water acts as the electrolyte in this corrosion process.

Concrete's alkalinity acts to protect the embedded steel from corroding. In new concrete, the pH is greater than 12. This highly alkaline environment causes a protective layer to form on the steel reinforcement and the rebar is said to be in a passivated state. When the concentration of chloride ions at the rebar is high enough or when the carbonation front reaches the rebar, this passive layer is destroyed and corrosion begins. The concentration of chloride ions necessary to initiate corrosion is about 0.030% by weight of concrete (or approximately 0.7 kg/m^3).

In non-marine environments, the primary source of chloride in concrete is in the form of applied de-icing salts. However, there are other sources such as calcium chloride used as dust control or as an admixture in concrete. Corrosion occurs in areas that are exposed to the application of chlorides - decks, curbs, splash zones and areas subjected to leakage.

There are also some chlorides that occur naturally in aggregates. These chlorides are considered 'locked in' and do not contribute to the corrosion process. However, during the sampling process the concrete is pulverized and the 'locked-in' chloride concentration in the aggregate is measured along with the chlorides in the surrounding paste. Although these are generally trace amounts of chlorides, the inspector should try to account for these background chlorides to determine the 'active' chloride concentration of the concrete whenever possible.

4.2 TEST METHOD

The extraction of the concrete powder samples has evolved from SHRP-S-328, Volume 6: 'Method for Field Determination of Total Chloride Content' and SHRP-S-330, Appendix F: 'Standard Test Method for Chloride Content in Concrete Using the Specific Ion Probe'. Although very thorough, the methods described in this procedure were not practical for a mobile field application. In Alberta, the samples are generally collected quickly such that the bridge site can be promptly reopened to traffic. The following outlines a practical test method:

4.2.1 MARK OUT THE TEST LOCATIONS

- Measure or reference test locations and mark the surface to be tested using temporary markers.
- Samples are taken *beside* the temporary mark so the mark itself does not contaminate the sample.
- Choose locations that will avoid cracks, delaminations, rebar, voids, and strands. Refer to Section 4.3.1 for more information.

4.2.2 PULVERIZE THE CONCRETE SAMPLE

- Drill into the concrete and create a pulverized sample.
- Use a 15-45 mm diameter drill bit. Smaller drill bits will not create sufficient powder to allow for rapid chloride tests, lab tests or any further duplicate tests. The powder from these smaller holes is also more difficult to collect than that from larger diameter holes. Larger drill bits generate a greater amount of powder sample that is easier to collect. Further, larger drill bits are less susceptible to local sampling errors that can be caused by drilling into concrete samples where the average aggregate diameter is larger than the diameter of the drill bit. However, a larger bit is more difficult to control during drilling.
- Measure the depth of the drill bit. Sample depth ranges should be accurate to 3-5 mm. The tip of the drill bit is cone shaped and accounts for the variance.

4.2.3 COLLECT THE CONCRETE SAMPLE

- After drilling down to the required depth, use the drill bit to bring the concrete powder out of the hole by allowing the drill bit to spin in the hole without applying any downward pressure. Scrape this powder into a container.
- Collect the powder that remains in the hole using a vacuum device or small scoop.
- Once the sample has been collected, seal the container and label the sample as described in Section 4.3.3.

4.2.4 PREVENT CROSS-CONTAMINATION

- Take care not to cross-contaminate the powder samples.

- Sources of cross contamination are :
    - Powder left in the test hole between samples
    - The drill bit
    - The powder collection vacuum or scoop
- Help prevent cross contamination by using compressed air to blow out the test hole, cleaning the drill bit, and cleaning the vacuum or scoop between samples.

4.2.5 FILL TEST HOLES

- After all samples are collected and the holes blown out with compressed air, they are to be filled using an approved patching material, generally a rapid setting concrete.
- Avoid trapping voids or large air pockets when filling the test holes.
- Ensure that the patching material is mixed to the manufacturer's specifications. Do not add more water to an approved material to make it more fluid.

4.2.6 RAPID CHLORIDE TESTS

Rapid chloride tests are performed on all of the powder samples to determine the chloride content (percent chloride per unit weight of concrete). Currently only two rapid chloride test systems have been approved for use. They are:

- James Instruments CL-1000
- Germann Instruments Rapid Chloride Test (RCT), acid soluble test method

Each set of equipment will have its own specific test procedure for the samples. The inspector is to follow the manufacturer's instructions to test the samples accurately. The basic steps are to:

- Calibrate the rapid chloride test using calibration solutions of known chloride concentration. The results will be in mV. This will be used to correlate mV readings to chloride contents.
- Plot the calibration solution test results on the provided graph included in the RCT kit.
- Weigh or measure the necessary amount of concrete powder sample.
- Add the concrete powder sample to the known amount of test solution.
- Shake the powder mixed into the test solution for at least 5 minutes.
- Measure and record the mV reading of the test solution with the concrete powder.
- Plot the mV readings on the provided graph with the calibration results on it to convert the mV reading to a chloride concentration.
- Clean all of the test equipment prior to testing another sample.

4.3 TESTING LOCATIONS

Chloride testing is destructive because holes are drilled into the component that is being tested. This testing is also time-consuming as the samples must be extracted and tested and the holes re-patched. The destructive and time-consuming nature of the test means that only a limited number of samples can be gathered and tested. Testing on these samples will reveal the chloride content only at the locations where the samples were gathered. Therefore, it is essential that the test locations be representative of the entire component being tested.

4.3.1 REPRESENTATIVE TEST LOCATIONS

The chloride sample locations are to be taken from representative areas showing the average condition of the component. Do not take samples from delaminated areas, patched areas, birdbaths, the top of cracks, or from any other non-representative location. Chlorides will generally be higher in these deteriorated areas and will therefore not be representative of the entire component being tested.

Take special care to avoid reinforcing steel, prestressed tendons, or drilling completely through the deck or through box girders into the void as the sample will be lost.

On concrete decks, the standard practice is to obtain samples from 12 test locations for each span type. Therefore a bridge that has 5 spans, all of the same type, will only have a total of 12 test locations. A bridge that has a main span of one type, and approach spans of another type will have a total of 24 test locations or 12 test locations for each span type.

The sample locations for each span type are spread out across the deck in a diagonal line from one corner of the deck to the other opposite corner. The samples should be approximately equidistant from each other. This 'template' approach allows samples to be taken from the gutters, deck interior, and the wheel paths. Avoid deteriorated areas as described above. Figure 4.1 shows typical representative chloride testing sample locations.

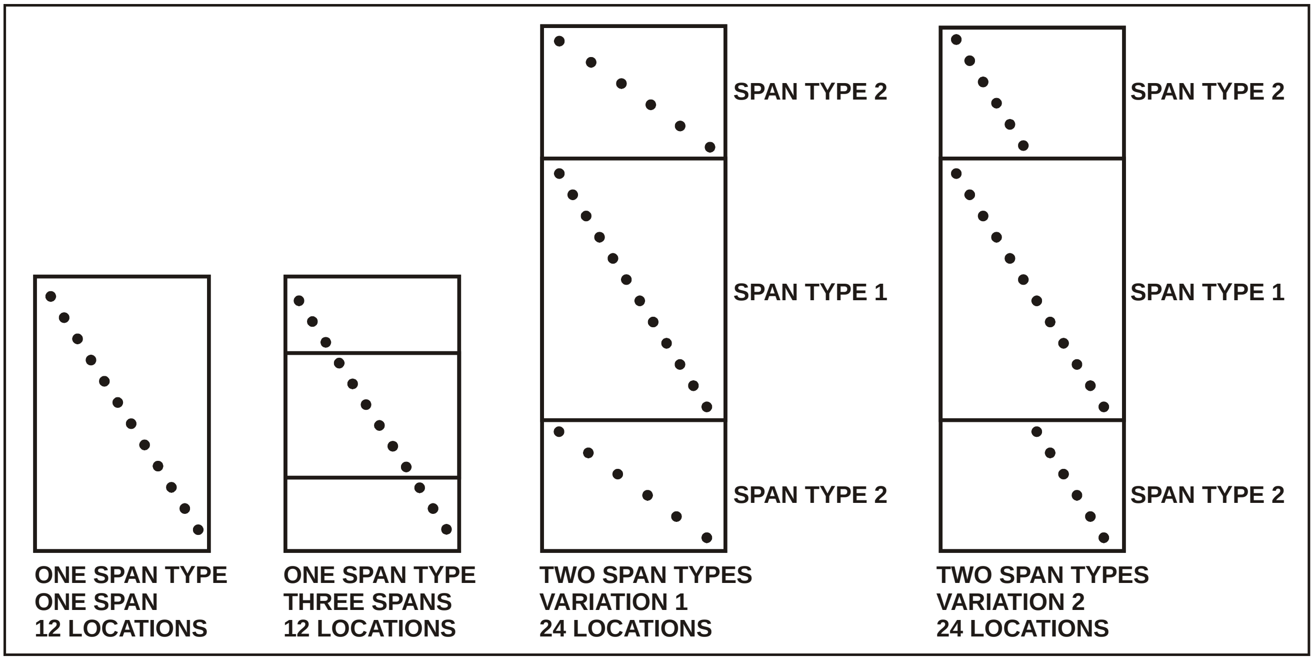

Figure 4.1 – Sample Chloride Test Locations for Various Span Configurations

4.3.1.1 Testing Through a Waterproof Membrane

Do not perform chloride testing on any bridge decks with a waterproof membrane under an asphalt wearing surface unless specifically directed by the Department. The destructive nature of the test will create several holes in the membrane and greatly reduce its functional life. If the presence of a waterproofing membrane is suspected or discovered unexpectedly on the first test hole, the inspector is to contact the appropriate Department representative for further instructions. When unsure, do not drill holes in the membrane.

It is acceptable to test through a polymer (epoxy) wearing surface as these are designed to be breathable. They are not watertight like membranes placed under the asphalt, and they contain pinholes throughout.

4.3.2 SAMPLING DEPTHS

Chlorides in contact with the exposed surface of the concrete can diffuse into the concrete. Over time, this produces a gradient of chloride concentration within the concrete. At the exterior of the concrete, the concentration of chlorides is highest. This concentration decreases with increasing depth towards the interior of the concrete.

It is currently accepted that there is a high probability of corrosion developing on uncoated reinforcing steel when there is a chloride concentration of 0.030% by unit weight in the concrete at the depth of the rebar. Therefore, it is desirable to know the concentration of chlorides at the surface of the concrete. This chloride concentration, when used in conjunction with chloride diffusion models, provides information as to when it is possible to reasonably expect the concentration of chloride at the rebar to reach the concentration necessary to initiate corrosion.

4.3.2.1 Typical Sample Depths

To develop a better understanding of the changing chloride concentration with depth in the concrete, chloride samples must be collected at various depths at the same test location.

In the field, chloride samples are typically taken at three depths: surface, mid-depth and the third or deepest sample depth. The top or surface sample depth should have the highest chloride concentration. This highest concentration compels the diffusion of chlorides into the concrete. The middle sample depth shows how the chlorides have penetrated into the deck over time. The third and deepest chloride sample depth can usually be used as an indication of the background or 'locked in' chloride concentration. However, it should be noted that chloride ions may have actually diffused to this third, deepest depth from the surface. Also, if chlorides were added to the concrete in the form of an admixture or with the mixing water used in making the concrete, they will be present throughout the concrete. Although chlorides from admixtures or the mixing water are not 'locked in' chlorides, they will nonetheless contribute to the corrosion of the reinforcing steel.

The three sample depths have been standardized by Alberta Transportation to allow for consistent test results that can be monitored at each particular site over time. The sample depths are referred to as nominal depths since the powder sample is actually taken from a range of depths. A depth of 0 mm is at the top of the concrete surface, below any ACP or polymer overlays. The standard sample depths taken at each test location are as shown in Table 4.1 below:

Sample	Nominal Depth	Actual Range of Sample Depth
A	12 mm	5 - 20 mm
B	50 mm	40 - 60 mm
C	100 mm	90 - 110 mm

Table 4.1 – Typical Chloride Sample Depths

Chloride sample depths and ranges other than those suggested in Table 4.1 may be requested by the Department in specific situations.

When obtaining the sample the inspector must ensure that the depth is measured accurately to 3-5 mm. The inspector must also ensure that the depths of powdered sample that are not required, such as from 0-5 mm, 20-40 mm and from 60-90 mm are not inadvertently collected. This added attention to detail when collecting powder samples will help prevent the sample from being cross-contaminated with powder from depths outside the intended range. Note that the top or surface 5 mm of the concrete surface is discarded because chlorides on the surface have not yet penetrated into the concrete.

4.3.2.2 Additional Sample Depths

There are cases when the Department requests a fourth chloride sample depth at each test location. This fourth sample typically has a nominal depth of 120 mm or an actual range of sample depth of 115 to125 mm. This forth sample depth is generally taken from bridge decks where the depth of the top mat of reinforcing steel is approximately 100 mm. This can occur when a concrete overlay has been placed on top of the existing concrete wearing surface without removing any, or very little of the original concrete first. The fourth depth in this case, would be used to collect ‘background’ chloride content readings.

4.3.3 LABELING OF SAMPLES

The samples are to be labeled with the bridge file number, sample number (location), sample depth, and the date the test sample was taken, as shown in Figure 4.2.

If the inspector chooses to number the test location of their sample as shown in Figure 4.2, the inspector must also record the actual location on the bridge that the test sample number corresponds to. The actual location of the sample is required and will be recorded on page 2 of the CHL2 inspection form. Refer to Section 4.7.2.1 for more details.

BRIDGE FILE:	**12345W**
TEST SAMPLE:	**1B**
SAMPLE DEPTH:	**50 mm (40 – 60 mm)**
TEST DATE:	**July 15, 2003**

Figure 4.2 – Sample Label for a Chloride Test Sample

4.4 QUALITY ASSURANCE

When the rapid chloride tests are completed, the results should be reviewed to determine if re-testing is necessary due to irregularities in results. When results are not in a typical pattern of the higher chloride concentrations nearer the surface and the lower chloride concentrations from the deeper samples, determine the reason for these irregularities. A typical cause of deviation from the expected results is when a concrete overlay was placed on the original deck and the 50 mm samples contain more chlorides than the newly placed concrete at the 12 mm depth.

Outliers that do not follow the pattern for the specific site should be re-tested. Perform an additional rapid chloride test on the remaining powder sample obtained from that location. If the results are the same, an additional sample may have to be collected from a new test location beside the previous location.

4.4.1 LABORATORY TESTING

It is also desirable to provide an independent check on the field testing procedure. Therefore, a minimum of 1 in 6 sample locations, selected at random, is to be sent to an independent, Department approved, laboratory for further tests. All sample depths collected at the location are to be sent to the lab. Therefore, if sample locations 2 and 8 were selected for lab testing, the 12, 50, and 100 mm samples would be sent from each location. Lab results are later recorded on page 2 of the CHL2 form as described in Section 4.7.3.

The lab samples are to be tested in accordance with the Department's test procedure TLT-520, 'Alberta Test Procedure for Total Chloride Content in Cement, Mortar and Concrete'. TLT-520 is a titration method that determines the chloride content of a dry powder concrete sample by a potentiometric titration of chloride with silver nitrate. This method is included in the supplemental information at the end of this chapter, Section 4.10.

TLT-520 is similar to AASHTO Method T-260, but TLT-520 requires duplicate testing of all chloride samples. Both results must be within 0.007% chloride per unit weight of concrete of each other. If the two test results from a single sample are apart by more than 0.007% chloride, a 3rd test is required. If the 3rd test is within the +/-0.007% chloride tolerance with one of the previous tests, then these two are considered to be correct and the outlier result is discarded. Ensure that sufficient sample, a minimum of 6 g, has been collected at each test location to accommodate two rapid tests and three lab tests.

4.4.2 PERIODIC CHECKS WITH KNOWN CHLORIDE CONCENTRATIONS

Rapid chloride tests should be performed on powder samples of known chloride concentrations after every 2-3 months of use or whenever problems are suspected with the test equipment. These samples of known concentration can be purchased from the RCT kit suppliers. These known samples should also be sent to the lab for quality assurance testing at least once per test season or if problems are suspected with the lab.

4.5 THE CHL2 FORM – STRUCTURE INVENTORY INFORMATION

The inventory information found at the top of the Level 2 Chloride Inspection form (CHL2) contains the same inventory data found on the typical Level 1 and other Level 2 bridge and culvert inspection forms. Descriptions of these fields may be found in Section 1.3.2 of the Level 2 Inspection Manual or Section 4 of the Level 1 BIM Inspection Manual.

Ensure the date of the Level 2 inspection is recorded in the header information on the first page. This date will be echoed onto the last page of the CHL2 form.

4.5.1 ADDITIONAL STRUCTURE INVENTORY INFORMATION

In addition to the inventory data in the header of the form, the CHL2 form provides additional information about the bridge structure. This section is located immediately below the header information on page one of the CHL2 form, and is shown in Figure 4.3. Refer to Section 1.4 for a complete description of the Structure Information fields.

```
STRUCTURE INFORMATION:

No. of spans: ..    Span Types: .../...  Substructure Types: .../...
Span Lengths: ....-....-....-....-.....m    Total Length: .....m
```

Figure 4.3 – CHL2, Additional Structure Information

4.6 LEVEL 2 CHLORIDE TESTING SUMMARY – PAGE 1

The chloride test results are summarized on page one of the CHL2 form, as shown in Figure 4.4.

CHLORIDE TESTING SUMMARY INFORMATION:

Test equipment make and model:____

Number of components tested: __

Comp No.	Comp Type	Component Description	Depth (mm)	Avg. % Cl	Depth (mm)	Avg. % Cl	Depth (mm)	Avg. % Cl	Depth (mm)	Avg. % Cl
__	_____	___________	_____	_____	_____	_____	_____	_____	_____	_____
__	_____	___________	_____	_____	_____	_____	_____	_____	_____	_____
__	_____	___________	_____	_____	_____	_____	_____	_____	_____	_____

Figure 4.4 – CHL2, Chloride Testing Summary Information

4.6.1 TEST EQUIPMENT MAKE AND MODEL

This text field is used to describe the test equipment used in obtaining the Rapid Chloride Test results. Additional information on Rapid Chloride Tests is found in Section 4.2.6.

4.6.2 NUMBER OF COMPONENTS TESTED

This is a numeric field for the total number of components tested. A maximum of three components can be summarized on this page.

4.6.3 COMPONENT NUMBER (COMP NO.), TYPE (COMP TYPE), AND DESCRIPTION

These fields are brought forward from the inspection data pages that follow. List the component number, type and description for each row. Detailed information regarding bridge components is found in Section 4.7.1.

4.6.4 SAMPLE DEPTHS AND AVERAGE CHLORIDE CONCENTRATIONS (DEPTH (MM) AND AVG. % CL)

These numeric columns are for the inspector to summarize the chloride test results. There are four columns in this summary, each column has a Depth and Average Percent Chloride

(Avg. % Cl) field. The leftmost column is for the shallowest depth, and the depths increase with each column to the right.

The Average Percent Chloride column is the average of all of the test results at a specific depth, for each component type. These values are the same as calculated at the bottom of page 2 of the CHL2 form as described in Section 4.7.4.

4.6.5 COMMENTS

At the bottom of the page there are four lines provided for the inspector to make any additional comments that relate to the testing or the results.

4.7 REPORTING CHLORIDE TEST RESULTS – PAGE 2

The second page of the CHL2 form is for the inspector to record all information regarding the chloride test results. Field test results, quality assurance results and summary information are all shown on this data page.

A separate data page is to be used for each different component that is tested. Note that different span types are considered to be different components. More than one data page may be used for a particular component if required.

4.7.1 CHLORIDE TEST DATA – HEADER INFORMATION:

The following header information shown in Figure 4.5 appears at the top of each page of inspection data. It serves as a summary for the component that is being tested for chlorides.

```
CHLORIDE TEST DATA:

Component No. __   Component Type: ______   Component Description: _______________
```

Figure 4.5 – CHL2, Chloride Test Data Component Information

4.7.1.1 Component Number (Component No.)

If chloride tests are performed on multiple bridge components at a particular site, a separate CHL2 page is used to record the test results for each component. Assign a number to each of the different components and record the component number in this field. Begin numbering with component 1.

4.7.1.2 Component Type

Identify the name of the component category that is being tested in this field. Examples of some different component types are deck, curbs, piers, and abutments. Only record one component type per page. Different span types are considered to be separate components and require their own page.

4.7.1.3 Component Description

The component description is a text description of the component being tested. This field should describe the Component Type in more detail. For example, if the Component Type was ‘deck’ then the Component Description would be the span type and the span numbers if there was more than one span type.

4.7.2 RAPID CHLORIDE TEST RESULTS

The main body of the form as shown in Figure 4.6 is where the inspector records the location and the results of the chloride tests for each component. Rapid Chloride Test (RCT) results are presented first near the top of the form. Quality Assurance (laboratory test results) follow the RCT results, and average results are at the bottom of the page.

On the CHL2 form there is the Test Location column, followed by four sets of three columns across the page. The three columns are the Sample Number, the Sample Depth, and the Chloride Concentrations, and they are repeated four times across the page.

Each row on the CHL2 data page is only used for samples that are taken at the same location and include the different depth samples taken at the location. The leftmost column is for the test sample that is closest to the surface. The samples become deeper with each set of columns to the right.

There are 24 rows for rapid chloride tests on each inspection data page. Only show results from a single component on a data page. The inspector may use additional pages for a single component if required.

TEST LOCATION	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL
RAPID (RCT) RESULTS												

ROWS CONTINUE…

Figure 4.6 – CHL2, Rapid Chloride Test Data

4.7.2.1 Recording Chloride Test Location (Test Location)

Record the chloride test location in the far-left column to the nearest 0.1 m.

In order to describe where the samples were taken from, the inspector may want to reference the chloride test locations to obvious reference points at the site. For example, ‘5.0 m N of S abut, 2.3 m W of E curb’.

Another method to describe chloride test locations on a bridge deck is to define a corner of the bridge as the origin for an X-Y coordinate system of length and width in the Comments section at the bottom of the page. Any corner could be selected as the origin, but for consistency, the origin from CSE testing should be used whenever possible. Refer to Section 3.3.1 for additional information.

Once the origin is clearly defined in the comments, then the inspector can record the two coordinates of length and width in the Test Location field for each row on the CHL2 form, as shown in Figure 4.7.

4.7.2.2 Sample Number and Chloride Concentration (No., Depth (mm), % CL)

The Sample Number columns simply provide a numbering system to label the samples. The samples at different locations are numbered down the page with a different row for each different location. Number the locations using integers such as 1, 2, 3, and so on.

Samples that are taken from different depths at the same location are labeled alphanumerically, as in A, B, C, and so forth, with ‘A’ being the most shallow depth at that location.

Therefore the columns across the page for four depths are sample numbers 1A, 1B, 1C, and 1D. The next row would be the second location and the samples would be labeled 2A, 2B, 2C, and 2D across the page. Refer to Figure 4.7 for a detailed example.

4.7.2.3 Sample Depth (Depth (mm))

The Depth columns are for the inspector to record the nominal depths of all of the test samples. Again the depths are recorded across the page with one test location per row from shallowest to deepest. Therefore if there were four chloride depths at the sample location, they would be 12 mm, 50 mm, 100 mm, and 120 mm, as shown in Figure 4.7.

4.7.2.4 Chloride Concentration (% CL)

The Chloride Concentration (% CL) column is where the rapid chloride test results are recorded for each sample. It is recorded as a percent of chloride per unit weight of concrete to 3 decimal places.

TEST LOCATION	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL
RAPID (RCT) RESULTS												
(5.2 m, 0.7 m)	**1A**	**12**	**0.126**	**1B**	**50**	**0.032**	**1C**	**100**	**0.022**	**1D**	**120**	**0.004**
(25.4 m, 1.8 m)	**2A**	**12**	**0.112**	**2B**	**50**	**0.025**	**2C**	**100**	**0.021**	**2D**	**120**	**0.009**
(41.3 m, 2.9 m)	**3A**	**12**	**0.096**	**3B**	**50**	**0.029**	**3C**	**100**	**0.015**	**3D**	**120**	**0.007**
Comments:												
The origin (0,0) used to locate sample locations is the SE corner of the deck, same as the CSE origin.												
The format is (length, width) away from the origin in metres.												

Figure 4.7 – CHL2, Sample of Completed Section, Page 2

4.7.3 RECORDING LABORATORY CHLORIDE TEST RESULTS

The inspector records the laboratory chloride test results in this section, as shown in Figure 4.8. All of the same fields and formatting are used as in the Rapid Chloride Test Results section as described in Section 4.7.2.

The samples from 1 of every 6 test locations are sent to an approved laboratory for further testing. All sample depths collected at the test location are sent to the lab, for example the 12, 50, and 100 mm samples from the same location would be sent to the lab. The laboratory performs 2 tests on these samples, and the results from both of these tests are recorded in the Laboratory Results section of the CHL2 form.

If a third laboratory test is required to verify results only record the two confirmed results in this section. The third result, the outlier, is not recorded on the Level 2 form. Refer to Section 4.4.1 or TLT-520 for more information on using a third laboratory test to verify results.

TEST LOCATION	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL
LABORATORY RESULTS												

Figure 4.8 – CHL2, Laboratory Chloride Test Results

4.7.4 AVERAGE OF CHLORIDE TEST RESULTS

Calculate the average rapid chloride test results for each test depth and record them at the bottom of the CHL2 form, as shown in Figure 4.9. Repeat the process with the lab results. All of the same fields and formatting are used as described in Section 4.7.2, Rapid Chloride Test Results.

TEST LOCATION	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL
AVERAGES												
LAB AVERAGES	***		***			***			***			
RCT AVERAGES	***		***			***			***			

Figure 4.9 – CHL2, Average Chloride Test Results

4.8 OTHER CHL2 DATA – LAST PAGE

Refer to Section 1.5 for instructions on completing the last page of the CHL2 form. The last page shares a common format with the other Level 2 forms.

4.9 ADDITIONAL INFORMATION TO PROVIDE TO THE DEPARTMENT

The inspector is required to submit a copy of the rapid chloride test field worksheet with the Level 2 CHL2 form. This is the sheet that has the calibration chart that was used as well as the field results in mV. The inspector should also consider submitting the following:

- A visual record of sample locations such as a plan view of the bridge with sample locations marked.
- A bar chart showing the chloride concentration at the various locations and depths.

4.10 ALBERTA TRANSPORTATION TLT-520 TEST PROCEDURE

The following two pages contain the Alberta Transportation test procedure for chloride content in cement, mortar, and concrete (TLT-520). These are the guidelines that the approved laboratory must follow to determine the chloride content of the test samples.

GOVERNMENT OF THE PROVINCE OF ALBERTA
ALBERTA TRANSPORTATION

TECHNICAL STANDARDS BRANCH

TEST PROCEDURE TLT-520

ALBERTA TEST PROCEDURE FOR TOTAL CHLORIDE CONTENT IN CEMENT, MORTAR AND CONCRETE

1.0 SCOPE

1.1 This method describes the procedure for the determination of the total chloride content of dry hydrated portland cement, mortar or concrete. The method is limited to materials that do not contain sulfide, but the extraction procedure may be used for all such materials.

1.2 Total chloride content is determined by the potentiometric titration of chloride with silver nitrate.

2.0 APPLICABLE DOCUMENTS

2.1 ASTM C114 Standard Test Methods for Chemical Analysis of Hydraulic Cement, Section 19, Chloride.

2.2 H. A. Berman, Research Chemist, FHA, DOT Wash. D.C., "Determination of Chloride in Hardened Portland Cement Paste, Mortar and Concrete."
(This paper is based on Report FHWA-RD-72-12)

3.0 APPARATUS

3.1 Chloride Ion Selective Electrode with appropriate reference electrode.
Note: Carefully follow the instruction manual for set up, storage and maintenance of the electrodes as described by the manufacturer.

3.2 Potentiometer with millivolt scale readable to 1 mV or better.

3.3 Buret with 0.1 mL divisions.

3.4 Magnetic stirrer and Teflon stirring bars.

3.5 # 41 Filter Paper.

4.0 REAGENTS

4.1 Concentrated HNO_3 (specific gravity 1.42, Nitric Acid)

4.2 Standard 0.01 Normality NaCl (Sodium Chloride) solution; Oven dry reagent grade NaCl at 105 ºC for 1 hour, air cool, weigh out 0.5844 g, dissolve in distilled water and transfer to a 1 litre volumetric flask. Fill up to the mark with distilled water and mix.

4.3 Standard 0.01 Normality $AgNO_3$ (Silver Nitrate) solution; weigh 1.7000 g of reagent grade Silver Nitrate into a 250 mL beaker. Add about 50 mL distilled water to dissolve the Silver Nitrate, stir with glass rod until crystals dissolve. Add the mixture to a 1 litre volumetric flask, wash contents of beaker with distilled water into 1 litre flask. Fill flask to mark, stopper and mix to make homogenous.

To standardize the Silver Nitrate, titrate against 20 mL of 0.01 N NaCl prepared in 4.2 using millivoltmeter as described in procedure and calculate using the following formula:

$$N_1V_1 = N_2V_2$$

N_1 - Normality of Sodium Chloride
V_1 - Volume of Sodium Chloride Titrated
N_2 - Normality of Silver Nitrate

V_2 - Volume of Silver Nitrate needed to reach end point of Titration

$N_2 = 0.2 / V_2$
for 20 mL 0.01 N NaCl .

4.4 Fill Buret with $AgNO_3$ (Silver Nitrate).

5.0 PROCEDURE

5.1 Weigh duplicate 1 gram representative samples of powdered material under test into tared 250 mL beakers. Record exact weights to nearest 0.0001 g.

5.2 Add 10 mL of distilled water, swirling to bring powder into suspension.

5.3 Add 3 mL of 70% HNO_3 (Nitric Acid). Use a glass stir rod to mix and break up any lumps to form a slurry.

5.4 Heat the slurry rapidly to boiling. Do not allow to boil for more than a few seconds. Remove from heat.

5.5 Filter slurry into a 250 mL beaker using filter paper. Wash residue from beaker and stir rod through filter using hot distilled water. Wash contents of filter paper thoroughly with hot distilled water letting it drain. Repeat washing until a volume of about 75 mL is obtained. Allow filtrate to air cool to room temperature.

5.6 Fill the electrode(s) with the solutions recommended by the manufacturer. Connect electrodes to the millivoltmeter and determine the approximate reading of the equivalence point by immersing the electrode(s) in a beaker of distilled water. Allow to stabilize and record. Remove the beaker and wipe electrodes with absorbent paper.

5.7 Rinse with distilled water a magnetic stirring bar and add to the sample prepared in 5.5. Place the beaker on the magnetic stirrer. Immerse the electrodes into the solution taking care that the stirring bar does not strike the electrodes; begin gently stirring.

5.8 Begin titration, recording the volume of standard $AgNO_3$ (Silver Nitrate) verses the millivolt readings to bring the readings to about 40 mV below the equivalence point. Continue the titration with smaller increments (0.2 mL). As you reach the equivalence point, reduce increments to 0.1 mL, recording all mV readings after each addition. As the titration proceeds, equal additions of $AgNO_3$ will cause larger changes in the mV readings. When the titration passes the equivalence point the change per increment will then decrease. Continue titration long enough to the establish that the meter readings are progressively decreasing. The endpoint of the titration is reached when the maximum difference in the mV readings occurs for equal volumes of $AgNO_3$. This can usually be determined without plotting a curve and occurs at the approximate equivalence point of the electrode(s) in distilled water. (In practice, with Alberta Transportation equipment, distilled water reads somewhere between 230 to 250 mV).

6.0 CALCULATIONS AND REPORT

6.1 Calculate and report the percent chloride to the nearest 0.001 % as follows:

Cl, % = (3.5453 * V * N) / W
Where:
V = millilitres of 0.01 N $AgNO_3$ solution used for titration of the sample (equivalence point).
N = exact normality of 0.01 N $AgNO_3$ solution.
W = weight of sample, grams.

6.2 The results of two properly conducted tests by the same operator on the same sample shall not differ by more than 0.007 percent chloride.

Bridge File Number : ....
Legal Land Location: ...-..-...-..-.
Latitude/Longitude : ..../.........
Road Auth./Region : .../R.
Bridge or Town Name: ....
Stream Name : ....
Highway #:Cntrl Sec: ....:...
Road Classification: ....-...
AADT/Year : .-....../..
Detour Length : ...km

Structure Usage : ..
Year Built : ../..
Clear Roadway/Skew: ....m/...Deg

Prev. Insp. Date : ____/__/__ (YMD)
Insp. Req'd Date : ____/__/__ (YMD)
(based on ___________________)

Current Insp. Date: ____/__/__ (YMD)
Inspector's Code : ____

STRUCTURE INFORMATION:

No. of Spans: .. Span Types: .../... Substructure Types: .../...
Span Lengths: ....-....-....-....-.....m Total Length: .....m

CHLORIDE TESTING SUMMARY INFORMATION:

Test equipment make and model:____

Number of components tested: __

Comp No.	Comp Type	Component Description	Depth (mm)	Avg. % Cl	Depth (mm)	Avg. % Cl	Depth (mm)	Avg. % Cl	Depth (mm)	Avg. % Cl
__	_____	___________	_____	_____	_____	_____	_____	_____	_____	_____
__	_____	___________	_____	_____	_____	_____	_____	_____	_____	_____
__	_____	___________	_____	_____	_____	_____	_____	_____	_____	_____

Comments:

ALBERTA TRANSPORTATION

BIM LEVEL 2 REPORT - 2004
CHLORIDE TESTING

FORM ID: CHL2
Bridge File: .....
Page: 2

CHLORIDE TEST DATA:

Component No. __ Component Type: ______ Component Description: ________________

TEST LOCATION	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL	No.	DEPTH (mm)	% CL
RAPID (RCT) RESULTS												
LABORATORY RESULTS												
AVERAGES												
LAB AVERAGES	***			***			***			***		
RCT AVERAGES	***			***			***			***		

Comments:

* For deck chloride samples, different span types are considered to be different components. Therefore each span type requires a separate page.

LEVEL 1 INSPECTION (INFORMATION ONLY)   Level 1 date: ____/__/__

Structural Condition Rating: __%   Sufficiency Rating: __% Estimated Remaining Life of Structure: __ years Special Comments for Next Inspection:
Next Scheduled Level 1 inspection: ____/__/__   Current Cycle: __months

ITEMS REQUIRING IMMEDIATE ATTENTION:

LEVEL 2 INSPECTION SPECIAL REQUIREMENTS:

Y => Snooper: __   Lift: __   Traffic control: __   Boat: __   Ladder: __ Other: ____

INSPECTOR:

Recommended Cycle __ months OR Next Insp. Date ____/__/__ (blank for default) Recommended Additional Cycles: _ (blank for default, 0 for discontinue)		
Inspector’s Code: ___	Inspector’s Name: __________________________	Class: _
Assistant’s Code: ___ Assistant’s Code: ___	Assistant’s Name: __________________________ Assistant’s Name: __________________________	Class: _ Class: _
Comments: ____ ____		

REVIEWER: Review Date: ____/__/__

Approved Cycle __ months OR Next Insp. Date ____/__/__ (blank for default) Approved Additional Cycle: _ (blank for default, 0 for discontinue)\		
Reviewer’s Code: ___	Reviewer’s Name:____________________________	Class: _
Comments: ____ ____		
Default No. of Inspections: _ Default Cycle: __ months	Number completed to date: __ Next Inspection Required Date ____/__/__	