

# Winnipeg Sewage Treatment Program Integrated Management System



## CHAIR Procedure

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## SAFETY IN DESIGN TOOL

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## Introduction

The Construction Hazard Assessment Implication Review, or CHAIR, is a tool to assist designers, constructors, clients and other key stakeholders to work together to reduce construction, maintenance, repair and demolition safety risks associated with design.

CHAIR provides a rigorous framework for a facilitated discussion that is stimulated by guidewords or prompts. These prompts assist the key stakeholders to collectively identify and reduce safety risks associated with a design. The risks are formally listed for action by the appropriate stakeholders.

CHAIR recognizes that a design involves key considerations such as operability, aesthetics and economics with the elements of safety. It also acknowledges that a design process may be determined by many different stakeholders and/or influences. The CHAIR methodology aims to involve these elements and influences.

This procedure will be applied to projects where the design or construction is unique, complex, or of sufficient inherent hazard that a formal detailed assessment is warranted.

There are three phases of CHAIR:

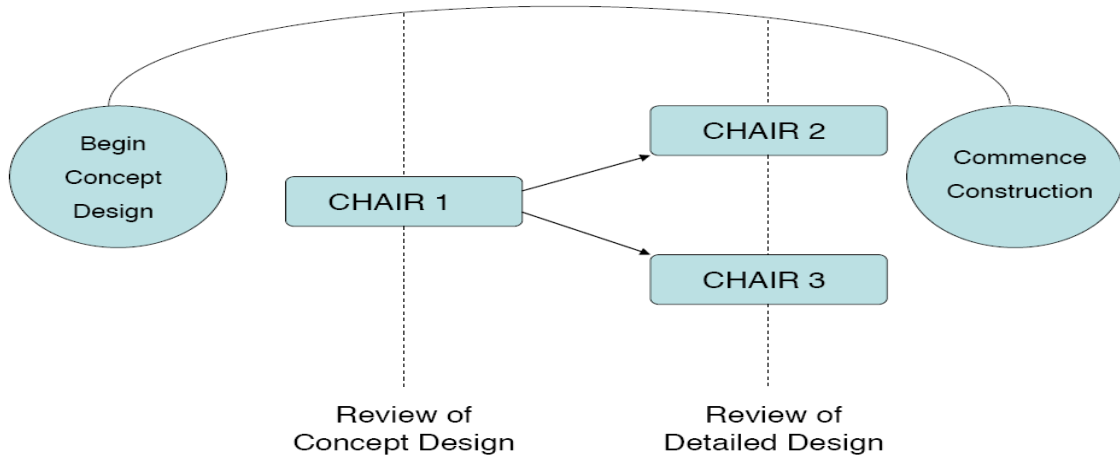
CHAIR ONE is performed at the conceptual stage of a design, which is the best opportunity to make fundamental change, even though much of the design is still to be determined.

CHAIR TWO focuses on construction and demolition issues and is performed well before construction, when the full detailed design is known.

CHAIR THREE focuses on maintenance and repair issues and is performed at the same time as the CHAIR 2 study.

This is illustrated in the following diagram:

### Project Phase



For example, a CHAIR study could be used during the design stage to improve safety during construction by:

- designing a multi-storey building such that the exterior wall covering (precast panels etc.) can be installed as soon as the framework is in place and most trades begin work on the floor;
- designing higher parapet walls or an integrated guardrail system along all roof edges thus eliminating the need for installing temporary barriers;
- designing permanent stairways and walkways to be constructed first and minimizing the use of temporary scaffolding.

By proactively considering construction, maintenance, repair and demolition issues, the CHAIR framework should not only help reduce the number of construction industry incidents, but also assist in improving constructability and reducing the life cycle costs associated with building and civil design projects.

## 1. Importance of safe design

The design process involves a range of participants and stakeholders. It includes designers, specialist consultants, clients, users, approval authorities and (at times) project managers and constructors. The art of design involves consideration of a range of issues such as aesthetics, function, safety and environment. Such considerations can arise due to experience, legislation, codes and standards, expertise, logic, checklists and any other means.

Previous experience greatly assists with identification of safety risks associated with a design. However, to learn from previous experience requires an incident to have occurred, be adequately documented and the information made available to the relevant parties involved in the design process.

Codes and standards tend to address the obvious risks and are less effective in identifying previously unforeseen hazards. When a design is no longer simple or straightforward, or involves unique, unusual or potentially hazardous design, sufficient experience or codes of practice may not exist to adequately consider all safety issues.

There is a balance of responsibilities between a designer, a constructor and other stakeholders, such as clients or specialist consultants. It is important that all participants highlight unusual safety risks associated with a design and required construction. Those involved in the design process should:

- ❖ identify the hazards presented by potential design solutions and consider the risks these hazards will generate for construction workers and others who may be affected by the construction work (e.g. members of the public);
- ❖ include health and safety considerations among the design options so that they can avoid the hazards, reduce their impact or introduce control measures to protect those at risk

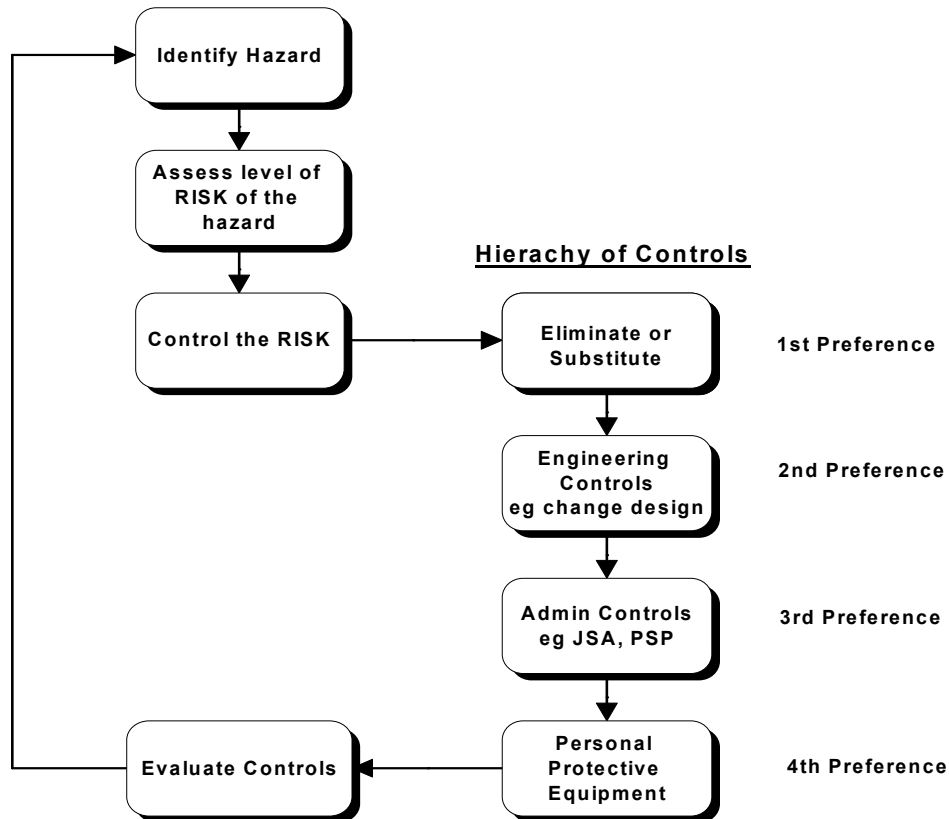
where it is reasonably practicable;

- ❖ forewarn the contractor of the residual hazards that have been identified within the design and the need to manage them during the construction work.

Eliminating the hazard is the first risk control that should be considered. If the hazard cannot be eliminated (for example eliminating risks associated with maintenance by using aluminum/stainless steel, that doesn't require regular painting), the risk can be minimized by using a series of steps known as the hierarchy of risk control:

- substituting the system of work or plant with something safer (e.g. pre-assembled equipment at ground level rather than height);
- modifying the system of work or plant to make it safer (e.g. ensure attachment points for lifting, window cleaning, safety lines, etc.);
- isolating the hazard (e.g. introduce restricted areas);
- introducing engineering controls (e.g. prevent falls from buildings during construction or maintenance by increasing wall/edge height).

These controls are represented in the following flow chart:



Note: A combination of 2 or more controls may be necessary to control the risk.

Only when the above risk control options have been exhausted should consideration (and more importantly reliance) be given to personal protective equipment (e.g. safety harnesses) or

adopting administrative controls such as hazard warning signs.

Design is the process of considering options and in developing and understanding these options, there is the ability to improve safety and reduce costs. For example, the costs associated with assembling large scale scaffolding may far exceed the costs associated with an alternate design and/or construction materials.

Essentially, given the opportunity to consider the design in a formal and systematic way, a smarter design results - and a smarter design invariably leads to a safer design.

## **2. The CHAIR Methodology**

### **2.1. The CHAIR process**

A CHAIR study is intended to help identify that a design needs to consider operability, aesthetics, and economics, with the elements of safety in constructability and maintainability. A CHAIR provides a structured forum to ensure there is opportunity to foresee construction, maintenance, repair and demolition safety issues, so they can be eliminated or modified as part of the design process.

The process for CHAIR is as follows:

- Assemble a CHAIR study team (include all stakeholders).
- Define the objectives and the scope of the study.
- Agree on a set of guidewords / prompts to assist brainstorming process.
- Partition the design (CHAIR-1, CHAIR-3) or the construction process (CHAIR-2) into logical blocks of appropriate size.
- For each logical block, use various guidewords to assist with the identification of safety aspects/issues.
- Discuss associated risks and determine if the safety risk can be eliminated.
- If the safety risk cannot be eliminated, determine how it might be reduced.
- Assess whether the proposed risk controls (i.e. expected safeguards, etc.) are appropriate (is the risk as low as reasonably practicable).
- Document comments, actions and recommendations - determine appropriate method for design issues still to be resolved.

### **2.2. CHAIR Guidewords**

A CHAIR study is a form of safety analysis similar to a technique used in Hazard and Operability (HAZOP) study.

One of the main elements of a HAZOP is the use of guidewords, applied to various sections of the design, to stimulate discussion and risk identification. Similarly, the methodology of a CHAIR study is to divide the proposed design into logic blocks and consider the implications of the guidewords for that element.

It is critical that the guidewords provided be used as a prompt to promote discussion of issues

and not as a checklist of issues to be considered.

As all CHAIR phases have their own specificity, a typical list of CHAIR guide words was developed for each phase and will be presented in the respective sections of this document.

### **2.2.1. The CHAIR Facilitator**

The success of a CHAIR study is dependent on the ability of a facilitator to select and use the experience and expertise of the study team to critically evaluate the design. Therefore, the selection of a facilitator is critical.

The facilitator should be sufficiently removed from the design process that he or she does not take the questions or suggestions coming from workshop participants as personal criticism, nor feel the need to defend the design concept. As the whole purpose of a workshop is to test the design concept from a safety-in-construction standpoint, the role of the facilitator is to encourage workshop participants to constructively challenge the design and explore whether issues have been overlooked or sufficiently thought through.

It is recommended that the facilitator should have the following attributes:

- an understanding of the principles of safety in construction;
- the respect, or potential to quickly gain the respect, of workshop participants;
- as a minimum, a broad understanding of the project;
- the ability to bring out the views of a diverse range of people participating in the workshop to constructively challenge the design concept;
- the ability to put forward their own views and thus provoke thought, but without dominating the workshop;
- the ability to keep the workshop on track and moving along (issues that can't be resolved relatively quickly should be listed for action outside the workshop).

## **2.3. CHAIR-1: conceptual design review**

### **2.3.1. Introduction to CHAIR 1**

The purpose of the CHAIR-1 study is to review the conceptual design and identify the significant construction, maintenance, repair and demolition safety risks associated with a project. By identifying and understanding these risks very early in the project phase, risk controls can be established to ensure that, if these risks cannot be eliminated, they are at least managed so they are as low as is reasonably practicable.

Organizations typically perform feasibility or conceptual operational design assessments which cover the various function and elements of a design, including safety. The focus of these assessments is at a fundamental level, where it is still possible to radically change the design concept and significantly improve safety and operability. The effectiveness of such studies is diminished when time is spent on less significant issues, which are more appropriately addressed as part of detailed design.

Those involved in the design process should have an informed view of the overall “constructability” and “maintainability” of the design, as not only do they influence safety, they also influence project and operability costs. Such influences may not necessarily be mutually



exclusive.

Only what is reasonable to foresee at the time a concept design is reviewed can be expected from any design review. It may be possible for risks which cannot be foreseen or addressed at the CHAIR-1 stage to be considered at the CHAIR-2 and CHAIR-3 stages.

### **2.3.2. CHAIR-1 Study Team**

A designer should be well informed but is not expected to know everything, especially with regard to detailed construction techniques. Therefore, the designer, or a single third party, in isolation should not perform a CHAIR-1 study. What is required is essentially a systematic and formalized “brainstorming” workshop, which involves the appropriate stakeholders (designers, construction, maintenance, safety representatives, etc.), and is led by a facilitator who is a “third party” to the design (but could belong to one of the stakeholder organizations).

As the CHAIR-1 study is undertaken at the conceptual stage of the design process, it is difficult to indicate who should attend a CHAIR-1 meeting. The appropriate participants will depend on the type of project being considered. Participants may include: architect, design manager, construction manager, safety specialist, client, construction foreperson, project managers, engineers and service consultants. A CHAIR-1 study provides an opportunity for people to contribute to improving safety using their specialized knowledge. By using a diverse group of people and a systematic methodology, the chance of overlooking a major problem is significantly reduced.

### **2.3.3. CHAIR 1 Guidewords**

A list of CHAIR-1 keywords is provided in [CHAIR 1 & 2 - Record Template](#). The development of the CHAIR-1 guidewords was based on the assumption that the CHAIR-1 study would be structured on the design (and not a proposed construction method) being divided into logical blocks.

As occurs in all such methods, there is a tendency for the number of guidewords to be increased, until eventually the method begins to lose its value. Therefore, non-specific guidewords have been selected to provide prompts to the discussions.

The guidewords have been organized into two types: “generic” (applicable in most cases regardless of the type of design to each element) and “overview” (used at the end of a CHAIR-1 study to review issues that relate to the whole design concept).

A CHAIR-1 facilitator should review the applicability of guidewords (including additional words that may be required) as part of the preparation for the CHAIR-1 workshop. If additional guidewords are suggested during a CHAIR-1 meeting, then they should be used (and recorded) by the designer.

### **2.3.4. CHAIR-1 Procedure**

The other difficulty is that there remains a tendency to use “add-on” safety measures as the first solution. The object of a CHAIR-1 study is to promote a full exchange of ideas in an enthusiastic environment.

A CHAIR-1 methodology follows that of most safety analysis in that:

- the design is divided into logical components for analysis;
- for each component of the design, sources of risks or other factors related to the risks of

- accidents are identified;
- an assessment is carried out as to the appropriateness of the risk and its controls.

The critical examination of a system requires careful chairing to stop the meeting getting bogged down or rambling too widely. Given good guidance and common sense, it is possible to obtain sensible and useful results.

### **2.3.5. CHAIR-1 Documentation**

It is important to document the findings, attendees, methodology, guidewords and findings of a CHAIR-1 study. A layout for recording the minutes of a CHAIR-1 meeting is provided in [CHAIR 1 & 2 - Record Template](#). A major component of an effective CHAIR-1 study is the recording of the meeting minutes. These are best recorded by someone who has a good understanding of the project, to ensure records are taken accurately and efficiently.

The minutes typically only record those identified risks that require action or follow up, or to justify where, after a detailed decision is made by the CHAIR-1 team, the existing design element is retained.

## **2.4. CHAIR-2: detailed design construction or demolition review**

### **2.4.1. Introduction**

A CHAIR-2 study is performed as the detailed design is approaching completion, but well before commencement of construction. In some cases, it may be possible to identify a constructor to assist in performing the study.

CHAIR-2 is a specific type of study, in that it is focused on ways in which a design can be modified to eliminate or reduce construction and/or demolition hazards. It does not replace Job Safety Analysis or Safework Method Statements which are performed by the construction organization and outline all the safety controls to be employed to control the risk during construction. The primary focus of a CHAIR-2 study is to ensure that, from a design perspective, as much as practical has been contemplated and incorporated into the design to minimize construction or demolition hazards.

### **2.4.2. CHAIR-2 Study Team**

As with a CHAIR-1 study, a CHAIR-2 study is performed by a group of people who are involved in the design and construction of the project, the composition of the team being dependent on the scope and nature of the design under examination. The critical elements being: an appropriate CHAIR-2 facilitator, appropriate selection of CHAIR-2 workshop attendees, application of specific CHAIR-2 guidewords, and clear recording and follow-up of the minutes from the CHAIR-2 meeting.

### **2.4.3. CHAIR-2 Guidewords**

A critical difference between CHAIR-1 and CHAIR-2 studies is that analysis for a CHAIR-2 study is structured towards the proposed construction (or demolition) sequence, rather than using a logical breakdown of the specific design. The reason for this is that at the detailed design stage, there is less opportunity to fundamentally change the design. However, the possibility exists to

modify the design with regard to the intended construction or demolition method, the details of which would not have been available at a CHAIR-1 study stage. It also provides a different assessment perspective from a CHAIR-1 study for identifying safety risks.

Therefore, the guidewords to be used for a CHAIR-2 study are different to reflect the task oriented approach of the construction sequence. The aim of a CHAIR-2 methodology is to acknowledge that the basic design will be built, but also to identify design modifications that would result in safer construction or demolition techniques.

As the number of construction sequences may be large, the number of guidewords available is limited to ensure that a CHAIR-2 study does not become laborious. A list of the CHAIR 2 guidewords is provided in [CHAIR 1 & 2 - Record Template](#).

The guidewords have been based on the approach of critical examination of system and are applied in the sequence presented. Thus the first aim is to eliminate or substitute a dangerous construction or demolition step or the main causes of accidents. In some cases, it might be best to combine certain construction processes to make them safer. To avoid is a less stringent action and means that it may be possible to evade certain conditions or actions deemed to be undesirable. The final guideword contains some basic suggestions that might prompt other construction or demolition safety issues.

#### **2.4.4. CHAIR-2 Procedure**

The purpose of the CHAIR-2 study is not to identify every single construction or demolition step or risk, as a majority of them should be well known to competent constructors. However, it is likely that there will be some risks which would not be expected in the context of normal construction, and it is these that are intended to be identified and assessed.

It should be noted that as part of the input prior to a CHAIR-2 meeting, it is expected that the design team would provide documentation, in broad terms, as to how it is expected the particular design would be constructed.

A CHAIR-2 methodology involves:

- the construction sequence divided into defined logical steps for analysis;
- each construction step, sources of risks or other factors related to the risks of accidents being identified;
- an assessment carried out as to the appropriateness of the risk and its controls to improve the design and clarify a preferred construction method and sequence.

#### **2.4.5. CHAIR-2 Documentation**

As with a CHAIR-1 study, it is important to adequately document the findings, attendees, methodology, guidewords and findings of a CHAIR-2 Study. A layout for recording the minutes of a CHAIR-2 meeting is provided in [CHAIR 1 & 2 - Record Template](#).

### **2.5. CHAIR-3: detailed design maintenance & repair review**

A CHAIR-3 study is more a document that demonstrates the appropriateness of maintenance and repair of items and plant and equipment.

A CHAIR-3 study is performed as the detailed design is approaching completion, but well before construction commences. It is essentially performed at the same time as a CHAIR-2. In some

cases, it may be possible to identify the owner's maintenance and repair personnel who could contribute information to the study.

Depending on the size and complexity of a design, a CHAIR-3 could be performed by a single person or a small team, provided they have:

- a knowledge of hazard identification techniques and an understanding of how to rate the importance (risk or level of danger) of the problems identified;
- a thorough knowledge of the current design to the extent of understanding the function of every plant and equipment item and knowledge of the way/s each item can fail (the failure modes);
- extensive practical experience.

It would be expected that the format of the study could be flexible, with an example format provided in CHAIR-3 section, [CHAIR 3 Worksheet](#).

## 2.6. CHAIR action closing

CHAIR actions close-out are to be controlled by the Design Manager and reported individually using the [HAZOP and CHAIR Closing Form](#). The design manager needs to update the action status [HAZOP and CHAIR Recommendations Register](#).

The [HAZOP and CHAIR Closing Form](#) is updated with enough design information to demonstrate that the design has incorporated the changes / elements agreed for closing the CHAIR recommendations. The Design Manager is to sign the document as a verifier.

**Filing of document is to be as per record management.**

## Appendices

[CD-PD-TO-04 HAZOP and CHAIR Workshop Register](#)

[CD-PD-TO-05 HAZOP and CHAIR Recommendations Register](#)

[CD-PD-TO-06 HAZOP and CHAIR Closing Form](#)

[CD-PD-TO-07 CHAIR 1 & 2 - Record Template](#)

[CD-PD-TO-08 CHAIR 3 Worksheet](#)