

## Hazard Identification and Risk Assessment for North America

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### Attachment(s):

- Electrical Hazards Checklist
- Environmental Checklist
- Gravitational and Acceleration Hazards Checklist
- Hazard and Operability Study (HAZOP) Initial Report
- Hazard and Risk Assessment Form Instructions
- Hazardous Substances Checklist
- Hazards and Risk Assessment Form
- Hazards and Risk Assessment Form Instructions
- HAZOP Revalidation Report
- Human Factors Checklist
- Layer of Protection Analysis (LOPA) Initial Report
- Leader Installer
- Mechanical Hazards Checklist
- Microbiological Hazards Checklist
- Pressure Hazards Checklist
- Quality/Production/Property/Security/Public Image Checklist
- Radiation Hazards Checklist
- Thermal Hazards Checklist
- Vibration and Noise Hazards Checklist

## Purpose and Scope

<b>Purpose</b>	This chapter contains the Linde Risk Assessment Tools and Templates designed to provide: <ul style="list-style-type: none"><li>• An understanding of the methodologies and terms used within the risk assessment process, and</li><li>• A consistent approach to conducting, documenting and reporting the results of Risk Assessments.</li></ul>
<b>Scope</b>	This chapter applies to all Linde personnel involved in the generation, use and maintenance of Hazard Identification and Risk Assessment Reports in Gases Americas.

## Responsibilities

<b>Senior, Regional and Location Managers</b>	The Senior, Regional and Location Manager is responsible for ensuring that current Risk Assessment Tools and Reports are used on all Gases America analyses.
<b>Risk Assessment Team Leader</b>	The Risk Assessment Team Leader is responsible for ensuring: <ul style="list-style-type: none"><li>• The analysis is performed utilizing the correct tool.</li><li>• The analysis is documented utilizing the correct template.</li><li>• A copy is maintained on file at the location.</li><li>• For OSHA Process Safety and/or EPA Risk Management covered processes, copies of completed reports are forwarded to the Manager, Process Safety, SHEQ.</li></ul>
<b>Risk Assessment Team Member</b>	Risk Assessment Team members are required to: <ul style="list-style-type: none"><li>• Take responsibility for ensuring the safety of personnel operating the plant or equipment reviewed</li><li>• Take into account all relevant data and information</li><li>• Make decisions using a risk-based approach</li><li>• Apply professional judgment and do not be influenced by resource or cost restraints</li><li>• Review in sufficient detail all significant risks</li><li>• Alert Senior Management of any unacceptable risks.</li></ul>

## About Risk Assessment

<b>Risk Assessment objectives</b>	<p>The objectives of a <i>Risk Assessment</i> are to:</p> <ul style="list-style-type: none"><li>• Enable management to identify and control <i>Hazard(s)</i> and <i>Risk(s)</i></li><li>• Assess and limit risk of fatality or injury to our employees and contractors</li><li>• Assess and control events that can lead to loss</li><li>• Identify and control potential risks to the public from Linde operations, products and services</li><li>• Ensure that the level of effort devoted to eliminating the risk is equal to the level of risk.</li></ul>
<b>Why perform a Risk Assessment?</b>	<p>Risk Assessments help Linde to understand the nature of risk involved in a process, and to help make decisions that improve business operations. Understanding the risks in a process allows Linde to:</p> <ul style="list-style-type: none"><li>• Manage the business</li><li>• Communicate the risks of activities to employees so they can gain a greater awareness of the hazards, and the knowledge to perform tasks safely</li><li>• Meet the increasing demand from regulatory authorities to perform those tasks</li><li>• Increase profits by reducing losses</li><li>• Provide a safe workplace for employees.</li></ul>
<b>Activities requiring a Risk Assessment</b>	<p>Following are some common activities within Linde that require a Risk Assessment (this list is not all-inclusive):</p> <ul style="list-style-type: none"><li>• Designing new plants or equipment</li><li>• Developing a new process</li><li>• Introducing a new product or service into the market place</li><li>• Performing hazardous activities</li><li>• Distributing hazardous chemicals</li><li>• Activities requiring a Permit to Work (Hazardous Work Permit)</li><li>• Dismantling or decommissioning equipment.</li></ul>

## Phases of a Risk Assessment

<b>Risk Assessment phases</b>	<p>Following are the phases of a Risk Assessment:</p> <ul style="list-style-type: none"><li>• <i>Phase One – Planning (Page 4)</i></li><li>• <i>Phase Two – Identifying Hazards (Page 4)</i></li><li>• <i>Phase Three – Evaluating Hazards (Page 5)</i></li><li>• <i>Phase Four – Assessing Risks (Page 5)</i></li><li>• <i>Phase Five – Managing Risks (Page 6)</i></li><li>• <i>Phase Six – Monitoring Risks (Page 7)</i></li></ul>
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Risk Assessment tool Several tools can be used to conduct a Risk Assessment, the most common being the *General Risk Assessment Tool (Page 7)*.

## Phase One – Planning

Initial Phase – Planning Following are the steps for completing the initial phase:

- State the objectives of the Risk Assessment
- Describe the activity to be evaluated
- Confirm the scope, or what will be included and excluded
- Select the personnel to perform the evaluation and assign responsibilities
- Nominate a Team Leader
- Identify how the results of the assessment will be communicated and to whom.

## Phase Two – Identifying Hazards

Identifying hazards Following are three common methods for identifying hazards:

**Checklist:** The following checklists can be used to identify hazards typically found within the gases industry:

- *Electrical Hazards Checklist (see attachment)*
- *Environmental Checklist (see attachment)*
- *Gravitational and Acceleration Hazards Checklist (see attachment)*
- *Hazardous Substances Checklist (see attachment)*
- *Human Factors Checklist (see attachment)*
- *Mechanical Hazards Checklist (see attachment)*
- *Microbiological Hazards Checklist (see attachment)*
- *Pressure Hazards Checklist (see attachment)*
- *Quality/Production/Property/Security/Public Image Checklist (see attachment)*
- *Radiation Hazards Checklist (see attachment)*
- *Thermal Hazards Checklist (see attachment)*
- *Vibration and Noise Hazards Checklist (see attachment)*

**Note:** These checklists are not all-inclusive. Be aware that it is necessary to add or delete items as applicable.

**HAZOP Study:** If a HAZOP Study is available, for the equipment or process, use the report to generate a list of hazards.

**Brainstorming Session:** Generate ideas in a meeting involving experienced employees.

**Note:** Record the details of the process used on the Hazard and Risk Assessment Form in the column “Describe The Hazard”. For complete details on using the form, see *General Risk Assessment Tool (Page 7)*.

## Phase Three – Evaluating Hazards

### Evaluating hazards

Select hazards that fall under the scope of the assessment, and which have significant consequences.

Describe what can go wrong and how:

- **People:** Injuries to employees, customers or the public, occupational diseases.
- **Environmental Impacts:** Off-site or on-site contamination.
- **Property Damage:** Building fires, equipment damage, transport incidents.
- **Business Interruption:** Production outage, lost market share.
- **Quality Impacts:** Poor product quality or yield, customer dissatisfaction.
- **Linde Image Impact:** Negative image.

**Note:** Record the details on the Hazard and Risk Assessment Form under “What Can Happen”. For complete details on using the form, see [General Risk Assessment Tool \(Page 7\)](#).

## Phase Four – Assessing Risks

### Assessing risks

Select hazards with consequences that have a “Likelihood of Failure”. Following are common types of failures that could occur at Linde facilities (the list is not all-inclusive):

- Human errors of omission, such as the operator failing to check equipment as required.
- Human errors of commission, such as the operator inadvertently tripping the system.
- Active equipment failures, such as pumps stopping or valves failing to close.
- Passive equipment failures, such as pipes rupturing or structural failures.

**Note:** Record the details on the Hazard and Risk Assessment Form under “How Can It Happen”. For complete details on using the form, see [General Risk Assessment Tool \(Page 7\)](#).

## Phase Five – Managing Risks

**Managing risks** Managing risks requires answering two fundamental questions:

### What controls are in place?

Identifying the safeguards in place and determining their adequacy is imperative to the Risk Assessment process. Safeguards that do not fully prevent or mitigate the hazards to an acceptable level cannot be considered a true safeguard.

When the current safeguards in place do not prevent or mitigate a hazard to an acceptable level, recommend alternative safeguards within the “Potential Safeguards” section of the Hazard and Risk Assessment Form.

Choose the safeguards that will best control the risk of the hazard and list them under the ‘Adopted Safeguards’ section of the Hazard and Risk Assessment Form.

**Note:** For details on using the Hazard and Risk Assessment Form, see [General Risk Assessment Tool \(Page 7\)](#).

### How safe is it?

Considering the new/additional safeguards put into place, use the [Risk Assessment Matrix \(Page 7\)](#) to determine the Frequency, Consequence/Severity, and appropriate Risk Category for each item listed:

- If the new/additional safeguard has reduced the risk to an acceptable level, move on to the next item.
- If the risk is not adequately reduced, consider additional safeguards.

### Risk control measures

There are two primary categories for controlling risk: Design and Administrative. Below is a table that lists some generic risk *Control* Measures in each category.

Design	Administrative
Eliminate hazard	Task procedures
Substitute for less hazardous product/situation	Training
Reduce hazard:	Permit to work
• magnitude	Signs, tags and lockout
• volume	Maintenance systems:
• intensity	• preventative maintenance
• rate of change	• condition monitoring
• complexity	Health and hygiene programs
Enclose or isolate hazard	Personal Protective Equipment (PPE)

## Phase Six – Monitoring Risks

**Monitoring risks** Ensure there are methods in place to monitor risks. This can include daily inspections, readings, alarms, operating procedures, group policies, periodic audits, or other administrative/engineering methodologies to ensure risks are properly controlled.

Record the Team’s recommendations for monitoring the risks, along with the frequency, under the “Design or Controlling Standards” section of the Hazard and Risk Assessment Form. For details on using the Hazard and Risk Assessment Form, see [General Risk Assessment Tool \(Page 7\)](#).

**Monitoring system** The Risk Assessment must include systems to monitor the risks on an on-going basis. Inspections and audits are the most common methods to monitor risks and control measures. The level of risk will dictate the frequency of monitoring.

The Risk Assessment must be revisited at an appropriate frequency to confirm that the Risk Assessment remains valid and that no changes have occurred that would change the associated risks. The Risk Assessment should include a frequency of reviews.

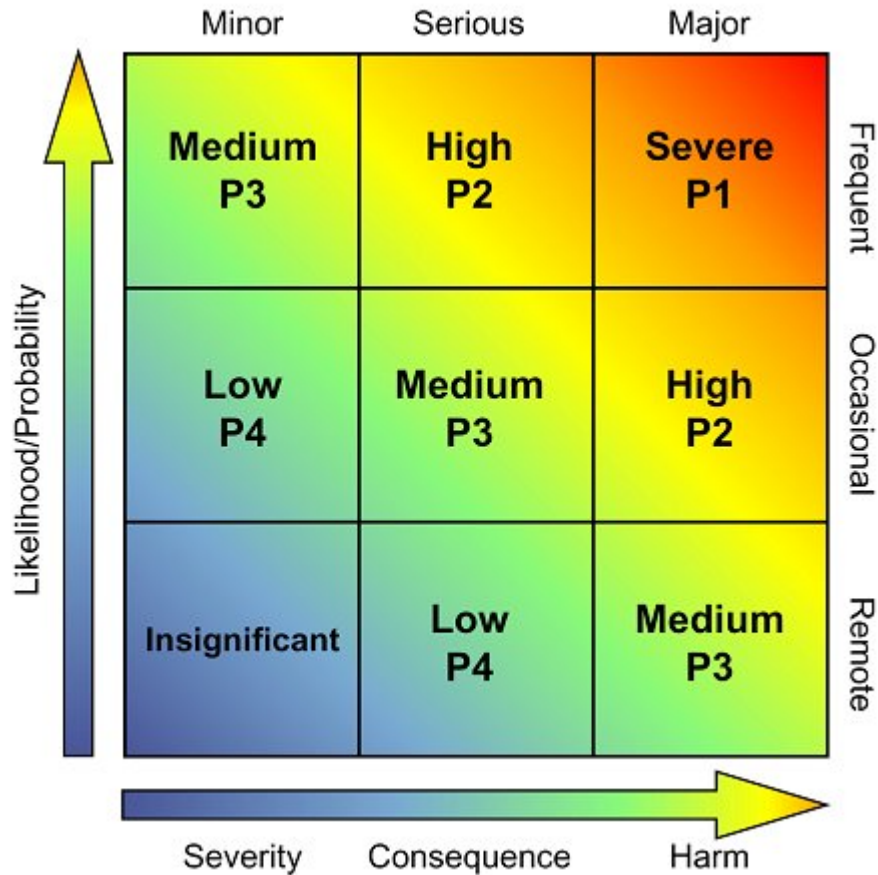
## General Risk Assessment Tool

**Documenting the Risk Assessment** The basic [Hazards and Risk Assessment Form \(see attachment\)](#) can be used to document the results of the Risk Assessment. For instructions on using the form, see [Hazard and Risk Assessment Form Instructions \(see attachment\)](#).

**Note:** The form has been designed to follow the [Phases of a Risk Assessment \(Page 3\)](#).

## Risk Assessment Matrix

**Risk Matrix** The Risk Assessment Matrix is a useful tool for evaluating risk and prioritizing risk reduction measures. It compares one risk with another so that they can be ranked in order of increasing risk.



Frequency ratings For a description of the Frequency ratings, click here:

Rating	Description
Frequent	<p>Occurrence expected</p> <p>For example, likely to occur during the life of an individual item or system, or repeatedly during the operation of a large number of similar items.</p> <p><b>Typically more than once per year for a business unit operating several sites.</b></p>
Occasional	<p>Occurrence could happen</p> <p>For example, likely to occur sometime in the life of an individual item or system, or several times in the life of a large number of similar components.</p> <p><b>Typically more than once every 5 years for a business unit operating several sites.</b></p>

<b>Remote</b>	<p>Occurrence not expected</p> <p>For example, not expected to occur in the life of an individual item or system, and unlikely to occur in the life of a large number of similar components.</p> <p><b>Typically no more than once in about 30 years for a business unit operating several sites.</b></p>
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**Consequence/  
Severity ratings** For a description of the Consequence/Severity ratings, click here:

Rating	Description
<b>Major</b>	<ul style="list-style-type: none"> <li>• employee fatalities or serious injuries while at work, on or off Linde premises</li> <li>• contractor fatalities or serious injuries while at work, on or off Linde premises</li> <li>• explosion, fire, or other acute incidents resulting in significant damage to Linde or third-party property and/or third-party injury</li> <li>• third-party fatalities in incidents involving Linde vehicles</li> <li>• major transportation accidents involving Linde products (for example, vehicle rollover and/or product release)</li> <li>• noteworthy cases of product contamination (for example, contaminated oxygen intended for medical use)</li> <li>• property damage or business interruption likely to cost \$1million or more</li> <li>• major incidents involving Linde people, product, or property likely to receive significant media attention</li> <li>• significant chemical spills that could pose a threat to the environment</li> </ul>
<b>Serious</b>	<ul style="list-style-type: none"> <li>• lost time injury or severe injury without permanent disability</li> <li>• on-site release contained with assistance</li> <li>• off-site release with only minor detrimental effects</li> <li>• statutory offence</li> <li>• financial loss between \$10k and \$1million</li> <li>• media attention (local coverage)</li> </ul>

<b>Minor</b>	<ul style="list-style-type: none"> <li>• first aid or medical attention required</li> <li>• on-site release immediately contained</li> <li>• financial loss between \$1k and \$10k</li> </ul>
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**Risk category** A risk assessment must include the appropriate risk category. For simplification, Linde uses four categories to classify risk:

- P1 – Serious Risk
- P2 – High Risk
- P3 – Medium Risk
- P4 – Low Risk

## Prioritizing and Timelines

**Prioritizing actions** When each risk has been assigned an appropriate risk reduction measure, the next step is to prioritize the actions. The system for prioritizing and setting target dates for hazards and risks can be found in the IMSS Audit Manager Tool. The table below describes the system.

Action Rating	Action Timing
Priority 1	Immediate risk control required, closeout within one month.
Priority 2	Agreed plan within one month; complete within six months.
Priority 3	Complete within one year.
Priority 4	Action to be considered.
Satisfactory	No action required.

**Risk priorities and extensions** The priority rating should correspond to the level of risk. That is, the higher the risk, the higher the priority. Other factors may influence the decision that requires a thorough review and documentation on the decisions.

Only the Executive Management can approve extensions to P1 and P2 non-conformances. Some non-conformances are large in scope where the corrective actions can not be physically completed within the scheduled timelines as outlined above. Extensions can be granted provided a documented Corrective Action Plan, with amended timelines for completion is developed.

## Other Types of Risk Assessment Methodologies

<b>Further Risk Assessment tools</b>	<p>The Risk Assessment process outlined in this chapter is sufficient for many activities within our facilities. However, for more complex situations, additional hazard/risk tools may be required. There are several tools available in IMSS to supplement the process. Additional tools include:</p> <ul style="list-style-type: none"><li>• Hazard and Operability Study (HAZOP)</li><li>• Failure Mode and Effects Analysis (FMEA)</li><li>• Fault Tree Analysis</li><li>• Logic Diagrams</li><li>• Other specialized tools for specific assessments</li></ul> <p><b>Note:</b> Contact the local SHEQ Group for further guidance and assistance when a specialized Risk Assessment is recommended.</p>
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## Instructions for Completing Reports

<b>User friendly reports</b>	<p>The reports are simplified and designed as templates for the user to fill-in the blanks. For example, wherever “example information” is indicated, replace the text with similar information gathered during the analysis. Most instructions and examples found within the templates have been depicted within <i>(parenthesis, and have been bolded and italicized)</i> for easy recognition.</p> <p><b>Note:</b> Ensure that all instructions and examples have been deleted and replaced with the specific report information.</p>
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## Types of Reports

<b>HAZOP (initial)</b>	A <i>Hazard and Operability Study (HAZOP) Initial Report (see attachment)</i> template is used for the initial analysis of new or current systems, tasks or procedures.
<b>HAZOP (revalidation)</b>	A <i>HAZOP Revalidation Report (see attachment)</i> template is used for processes that are being currently analyzed and require revalidation due to process changes or statutory requirements.
<b>LOPA (initial)</b>	A <i>Layer of Protection Analysis (LOPA) Initial Report (see attachment)</i> template is used for the initial analysis of a new or current management system, engineering and administrative safeguards.
<b>LOPA (revalidation)</b>	A LOPA Revalidation template is used for processes that are currently being analyzed and require revalidation due to process changes or statutory requirements.

**Off-Site Consequence Analysis (OCA)** An OCA Report template is used for processes covered by the EPA Risk Management Rule.

## Software Programs and Evaluation Tools

**Hazard Review Leader 4.0 Software Tool** Hazard Review Leader 4.0 is Gases America's only approved software program to document and report findings from HAZOP and Layer of Protection Analysis. For information on downloading the software program, see [Hazard Review Leader 4.0 Software \(Page 12\)](#).

**Software Validation and Risk Assessment Protocol** A Software Validation and Risk Assessment Protocol and Report template for software that requires inspection, testing and validation prior to service.

**EPA-RMP Level II Hazard Review checklist** An EPA-RMP Level II Hazard Review Checklist is the template designed to identify and document hazards associated with processes covered under the EPA RMP Level II Risk Management Program.

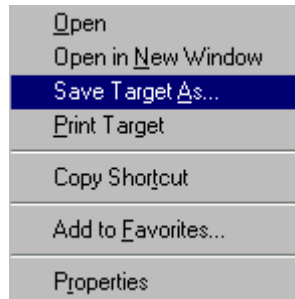
**Product Quality Risk Analysis** A Product Quality Risk Analysis Protocol for processes requiring an analysis to evaluate and determine Control Points (CP) and Critical Controls Points (CCP) within a process.

## Hazard Review Leader 4.0 Software

**Close other applications** Before installing Hazard Review Leader, close all applications other than Windows Explorer.

**Download files from the Intranet** You can download files directly from this chapter or obtain the program on a CD through the Manager of Process Safety. Click on this link to download *Leader Installer (see attachment)* **CAUTION 33.1 MB download!**

If downloading, **DO NOT** run the file from the source but save it to disk and then run from there (this will also save on Intranet traffic). Your browser may give you access to this function from the left mouse click, but it is recommended you use the right mouse click option to bring up this list of options and select **Save Target As** to copy the file to your nominated location.

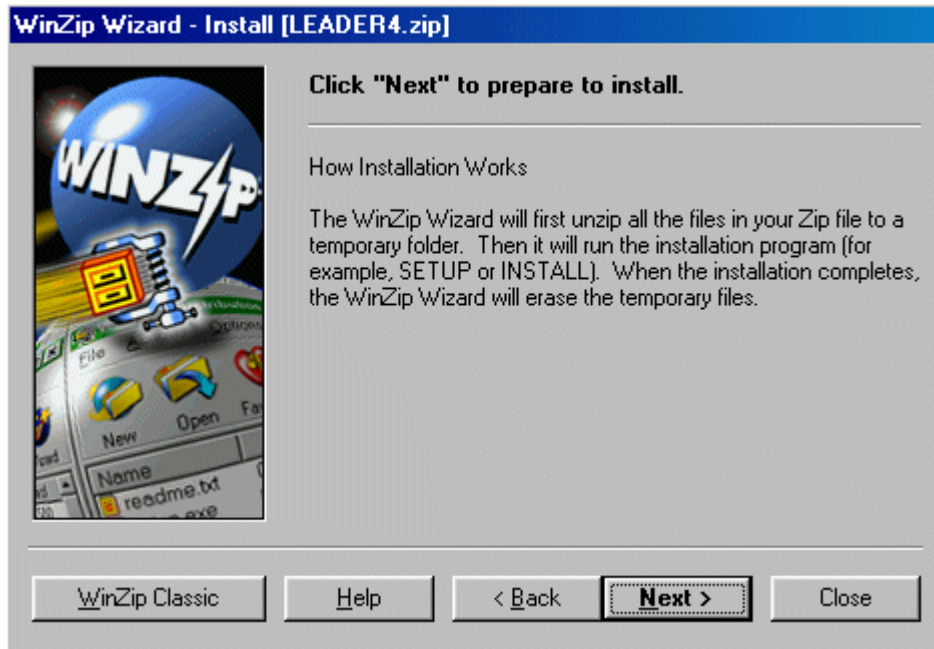


**WinZip Welcome** After downloading the file, open the Leader4.zip. The following screen will appear:

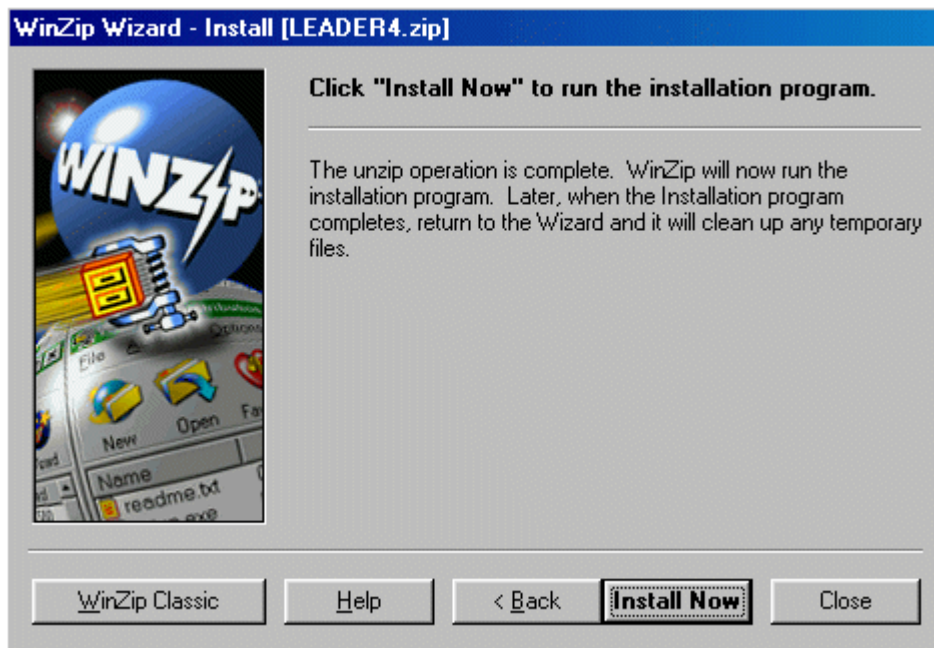


**WinZip Install** Click **Next**. A screen asking if you want to save the folder to your Favorite Zip Folders will appear. Click either **Yes** or **No** depending on preference.

The following screen will appear:



**WinZip extract** After selecting **Next**, WinZip will extract the necessary folders and prepare to install Leader 4 on your PC. The final WinZip screen is the following:



**Installing Leader 4.0** The setup routine for the program will now start. Below is a summary of the screens that will appear:

**Select destination folder** The default destination folder for the program is C:\Program Files\LEADER4. If desired, choose a different destination folder using the Browse radio button.

Backup replaced files	Backup files can be used if a rollback is requested. Retaining backup copies is recommended. Choose a different Destination Directory if desired.
Select program group	The setup routine will install an icon on your desktop and add the software to your program group, which will be available under the Start Menu. Edit the name if desired.
Installation and exit	After clicking <b>Next</b> , a number of files will be installed on your PC. The progress of this is shown on the screen. When all the files are installed, setup is complete. Click the <b>Back</b> button to change any information.  <i>Note:</i> You will need to reboot your computer before using the program.

## Recordkeeping

Retention	The location manager must retain the two most current Risk Assessment Reports for <i>each type</i> of analysis performed, involving each process, task or procedure at the site for the life of the process.
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## Forms and Attachments

Forms	<p>The following forms are used in this chapter:</p> <ul style="list-style-type: none"><li>• <i>Hazards and Risk Assessment Form (see attachment)</i></li><li>• <i>Hazards and Risk Assessment Form Instructions (see attachment)</i></li><li>• <i>Electrical Hazards Checklist (see attachment)</i></li><li>• <i>Environmental Checklist (see attachment)</i></li><li>• <i>Gravitational and Acceleration Hazards Checklist (see attachment)</i></li><li>• <i>Hazardous Substances Checklist (see attachment)</i></li><li>• <i>Human Factors Checklist (see attachment)</i></li><li>• <i>Mechanical Hazards Checklist (see attachment)</i></li><li>• <i>Microbiological Hazards Checklist (see attachment)</i></li><li>• <i>Pressure Hazards Checklist (see attachment)</i></li><li>• <i>Quality/Production/Property/Security/Public Image Checklist (see attachment)</i></li><li>• <i>Radiation Hazards Checklist (see attachment)</i></li><li>• <i>Thermal Hazards Checklist (see attachment)</i></li><li>• <i>Vibration and Noise Hazards Checklist (see attachment)</i></li></ul>
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