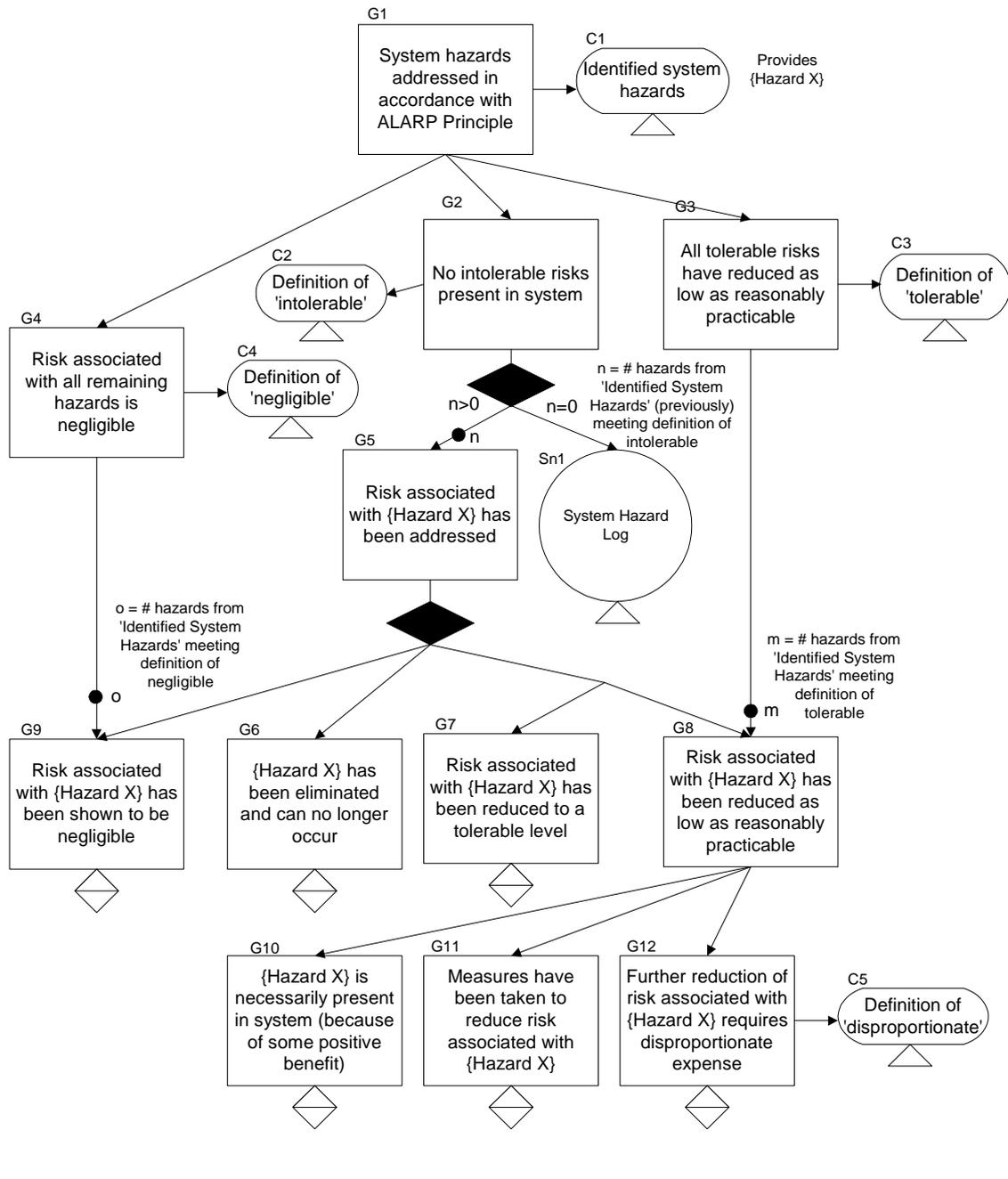


ALARP (As-Low-As-Reasonably-Practicable) Pattern

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Intent	This pattern provides a framework for arguing that identified risks in a system have been sufficiently addressed in accordance with the ALARP principle.
Also Known As	<ul style="list-style-type: none"> • Risk Reduction Argument Pattern
Motivation	<p>This pattern was developed for two reasons:</p> <ul style="list-style-type: none"> • To argue compliance with the ALARP principle at the highest level when addressing system level hazards. • To provide a more structured approach to presenting a 'Hazard Avoidance' argument (See Hazard Avoidance Pattern) by showing differing treatment of hazards according to their associated risk.

Structure



Participants

G1

Defines the overall objective of the pattern

G2, G3, G4

Defines targets for three classes of identified risks: negligible, tolerable, and intolerable

Sn1

Provided at this point to support the claim that no intolerable risks have (ever) been identified with the system

	<p>G6 or G7 and G8</p> <p>G8</p> <p>G10, G11, G12</p> <p>G9</p> <p>C1</p> <p>C2, C3, C4</p> <p>C5</p>	<p>Claims either that hazard has been eliminated or associated risk reduced to a tolerable level and dealt with as a tolerable risk.</p> <p>Defines ALARP target for each identified tolerable risk</p> <p>Claims required to support ALARP target:</p> <ul style="list-style-type: none"> • Hazard only acceptable if positive benefit achieved • Risk reduction measures have been taken up to the point where further measures would be disproportionate to benefit gained. <p>Claims for each remaining hazard that associated risk shown to be negligible</p> <p>A context identifying all system hazards, including indication of associated risks (e.g. Risk Category from A, B, C, D).</p> <p>A workable definition of ‘intolerable’/ ‘tolerable’/ ‘negligible’ risks that can be used as a basis for selection from the list of hazards(e.g. Intolerable = Risk Category A, Tolerable = Risk Category B or C, Negligible = D).</p> <p>The ALARP principle relies on some understanding of when it is no longer cost-effective to spend further money on risk reduction. This element, a definition of cost-effectiveness, is therefore required.</p>
Collaborations	<p>An important aspect of this pattern is that it divides and conquers the goal of hazard mitigation / elimination according to the level of risk associated with each hazard. There are three strands to the safety argument: one tackling intolerable risks, one tackling tolerable risk and one discounting negligible risks. To support</p>	

	<p>the top-level goal (G1) satisfactorily it is important that these three strands address all identified risks. The definitions of tolerable, intolerable and negligible (C3, C2 and C4 respectively) should therefore be so defined as to cover and classify the range of possible levels of risks.</p> <p>It should also be noted that the definitions of negligibility (C4) and disproportionate (C5) cannot be considered entirely independently. It would not make sense, for example, to force risk reduction to a level below that identified elsewhere as negligible.</p> <p>As the goal structure shows, if the means of addressing a previously identified intolerable risk is to reduce it to a tolerable level, then the remaining risk must be tackled as for all tolerable risks. If the level of risk has been reduced to a negligible level, then the hazard must be tackled as a negligible risk.</p> <p>It is important that the source of Identified System Hazards (C1) identifies the level of risk posed by a hazard in a way that permits sub-division into the classes of risk defined by C2, C3 and C4.</p>
<p>Applicability</p>	<p>This pattern is applicable in contexts where the ALARP principle is accepted as the device for reasoning about the relative importance of risks and the cost-effectiveness of risk reduction.</p> <p>In order to apply this pattern it is necessary to have access to the following contextual information:</p> <ul style="list-style-type: none"> • C1: Identified System Hazards (See <i>Participants</i> section) • C2, C3, C4: Definition of Intolerable / Tolerable / Negligible Risk (See <i>Participants</i> section) <p>These definitions are typically provided by the appropriate regulatory authority, standards or through investigations by safety engineers, including discussions with customers.</p>

	<ul style="list-style-type: none"> • C5: Definition of Disproportionate (See <i>Participants</i> section)
Consequences	<p>After applying this pattern, there will be a number of undeveloped goals of the form:</p> <ul style="list-style-type: none"> • G7: Risk associated with {Hazard X} has been reduced to a tolerable level • G9: Risk associated with {Hazard X} has been shown to be negligible • G6: {Hazard X} has been eliminated and can no longer occur • G10: {Hazard X} is necessarily present in the system • G11: Measures have been taken to reduce risk associated with {Hazard X} • G12: Further reduction of risk associated with {Hazard X} requires disproportionate expense
Implementation	<p>Implementation of this pattern involves first instantiating the contexts C1, C2, C3, C4. In the context of the list of hazards referenced by C1, the solutions to goals G2, G3 and G4 can be provided. If no tolerable risks were ever present in the system, then reference to the system hazard log (Sn1) is sufficient to support the claim G2. However, if any intolerable risks have been identified, it is necessary to claim (G5) that these have been resolved through complete elimination of the hazard (G6), or reduction to a tolerable (G7, G8) or negligible (G9) level.</p> <p>For each tolerable risk identified an argument must be constructed (G6, G10, G11, G12) to demonstrate that it has been addressed in accordance with the ALARP principles. Measures taken in risk reduction must be stated in support of G11. Some evidence / argument of the non cost-effectiveness of further risk reduction measures must be supplied in support of G12, in accordance with the definition given by C5.</p>

	<p>Evidence of risk analysis (probably based upon consideration of probability of occurrence) is required in support of each claim of hazards posing negligible risk (G9).</p> <p>Possible Pitfalls</p> <ul style="list-style-type: none"> • Not providing complete coverage of levels of risk through definitions C2, C3, C4 • Expressing definitions C2, C3, C4 in a way that is difficult to apply to the information provided by C1 (and vice versa) • Not having a commonly agreed concept of when to stop attempting further risk reduction (C1) - this can result in a non-uniform approach to tackling risks where significantly different levels of effort are committed to risks at the same level.
Examples	Not available at this time
Known Uses	See <i>Industrial Press Safety Argument</i>
Related Patterns	<ul style="list-style-type: none"> • Hazard Mitigation Argument