A guide to the use of Relevant Good Practice (RGP) for explosive demolition of structures

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Part 1 of this paper covers the client's and project team's SMS and aims to capture RGP as seen in industry that can help contractors and guide clients (including Nuclear Licensees) when considering resources, risk balance, management arrangements and control that need to be in place as part of an effective contractor-intelligent customer relationship.

Part 2 starts at the contractual process and follows through to the day of the blow-down and will appear in the December 2020 edition of Explosives Engineering.

The safety of a project does not just rely on a competent contractor but also requires an engaged and adequately resourced intelligent client with a competent project team

Demolition of the five coal-fired boilers on former chemical manufacturing site at Widnes. Copyright J Wolstenholme ©

Explosive demolition has safety benefits in reducing risks from conventional health and safety hazards by undertaking a single demolition event under controlled conditions. The technique provides a predicted collapse mechanism to induce a progressive collapse where the structure cannot support the applied loadings and fails under gravity.

This is the first part of a two-part paper presenting the author's opinion on what Relevant Good Practice (RGP) for undertaking explosive demolition of structures (including those on nuclear sites) looks like. It identifies those aspects of client and project team activities, preparation and planning, contractual arrangements, technical design and justification, safety management systems (SMS) and the supervision that experience has identified as being required to undertake a project safely. The safety of a project does not just rely on a competent contractor but also requires an engaged and adequately resourced intelligent client with a competent project team.

Differences in the regulatory framework

Although the regulatory regime on UK nuclear sites is different to that encountered on non-nuclear sites, the relevant good practice necessary to safely undertake the high hazard (and potentially high risk activity) of explosive demolition is common.

The Office of the Nuclear Regulator (ONR) regulates the UK nuclear industry (including demolition activity on nuclear sites) through a permissioning regime made against the Safety Assessment Principles (SAPS). Its principal focus is ensuring that the demolition activity is undertaken in a way that is compatible with the principles of nuclear safety. In comparison, demolition activities elsewhere within Great Britain are regulated by the Health and Safety Executive (HSE), principally acting in an enforcement rather than permissioning role and solely focussed on ensuring that risks to employees and others arising out of the demolition activity are subject to proportionate control.

Challenges

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As experienced shotfirers retire and commercial long-term demand for explosive demolition on nuclear and non-nuclear sites increases due to worldwide decommissioning and redevelopment programmes, our sector will be challenged in its ability to satisfy that demand safely. Most previous incidents during explosive demolition have led to property or commercial loss and not loss of life. However, there have been fatal and serious incidents such as Gorbals Tower Block Glasgow (1993)[1], Royal Canberra Hospital (1997)[2] , Bakersfield USA[3] and Didcot Power Station (2016)[4]. These have resulted in long-term consequences to individuals, businesses and society. These highlight the importance of the available learning from past incidents during explosive demolition and developing safe and robust systems of work.

General safety considerations

Safe and effective explosive demolition requires a detailed engineering analysis integrated with a robust SMS to produce a clear, coherent, conservative, justifiable fault-tolerant design and safe system of work. This is achieved through a series of robust engineering and process reviews that compare the design to RGP and seek to reduce the risk "So far as is Reasonably Practical"[5] (SFAIRP).

The SMS together with the selection of a competent contractor and appropriate contractual arrangements influence the engineering design and how the works are undertaken and supervised. The client's involvement is fundamental to providing the resources and setting the culture and expectations of this process.

Definitions

SFAIRP

The concept of reasonably practicability is fundamental to UK health and safety legislation as a key part of the general duties of the Health and Safety at Work etc. Act 1974 (HSWA).

"So Far As Is Reasonably Practicable" (SFAIRP) involves weighing a risk against the trouble, time and money needed to control it. SFAIRP describes the level to which we generally expect to see risks arising out of work activities to be controlled and is core to the consideration of RGP in the nuclear industry and elsewhere. Whether activities are taking place on a nuclear site or not, a proportionate identification and analysis of the hazards associated with a specific activity, as part of an overarching system of risk assessment, should be undertaken to demonstrate that the overall level of risk is acceptable.

Relevant Good Practice (RGP)

RGP is "an aid to making a judgement". The word "Relevant" is an important qualifier, because what may be good practice in one scenario may be less applicable to others. It allows a test of applicability in situations where there might be an alternate applicable standard.

RGP is defined[6] as "those standards for controlling risk which have been judged and recognised by HSE/ONR as satisfying the law when applied to a particular case in an appropriate manner."

Meeting RGP is therefore the starting point in demonstrating that risks are being appropriately controlled and an activity is SFAIRP safe.

Intelligent Customer

The concept of an Intelligent Customer (IC) has gained international acceptance in both the civil and nuclear industries. An IC is defined[7] as "an organisation" (rather than individual post holders) "that has the competence to specify the scope and standard of a required product or service and assess whether the supplied product or service meets the specified requirements".

It is the summation of the capability of an organisation to understand what work is needed, the hazards involved, to specify what needs to be done; to set suitable standards; to supervise and control the work, to review, assess and evaluate whether relevant standards and legal requirements have been met. Most importantly, the client or Nuclear Licensee is responsible for the overall control of site activities. This includes any work commissioned from consultants and subcontractors.

Explosives demolition contractor

Depending upon the scale, complexity and contractual arrangements of the project, the Principal Contractor (PC) as defined in the Construction Design and Management Regulations 2015 (CDM 2015), may be the explosives demolition contractor, or the explosives specialism may be subcontracted out. Whatever the arrangements, in this paper both are referred to as the "contractor".

Project team

The project team comprises the client and their internal engineering and project management resource advised in some cases by competent external consultants. Those consultants should be selected by the client based on a judgement of their demonstrated competence in specialist areas of expertise for the specific project under consideration. The basis of that judgement should be documented to allow audit.

Independent Structural Assessment (ISA)

In the nuclear industry, ISA provides an independent third-party review of the adequacy of the contractor's structural engineer's design proposal including any temporary works. This check would be independent from any Category 3 (CAT 3) check referred to in BS5975:2019 undertaken by the contractor.

In the civil industry, an ISA may be disproportionate to the scale and scope of the project however its role and use should not be precluded. The client should record the basis for that decision and keep it under review should circumstances change. Requirements for ISAs should be included in the contract specification and documentation.

Safety case

Safety cases for a nuclear site should include the Construction Phase Plan (CPP) required under CDM 2015. Irrespective of the format it should be:

- understandable and useable by those with direct responsibility for safety
- communicate a clear and comprehensive argument and evidence that an activity such as explosive demolition, can be undertaken safely
- demonstrate that the risks and hazards have been assessed, an adequate and detailed engineered design has been undertaken, appropriate limits and conditions defined and adequate safety measures identified with clear arrangements to implement and supervise them.

UK Regulatory environment

This is designed to deliver a proportionate, accountable, consistent, transparent and targeted approach

All parties should comply with the legal requirements and regulations of the country in which they are working. These may differ from the UK and how those requirements are to be met. In GB, the primary legislation is the Health and Safety at Work etc. Act 1974 (HSWA), and in Northern Ireland the Health and Safety at Work (Northern Ireland) Order 1978 fulfils a similar function. A number of further Acts and Statutory Instruments support these key pieces of legislation.

The UK regulatory regime is a "goal-setting" regime rather than a more prescriptive standards-based regulatory regime. Such a principle is flexible and supports goals and principles underpinned by codes of practice and guidance. This is designed to deliver a proportionate, accountable, consistent, transparent and targeted approach. This encourages continuous improvement and the adoption of RGP as a mechanism for demonstrating compliance with the goal setting requirements of the law.

Construction activities in GB are largely regulated by CDM 2015. Standards for what compliance looks like under these regulations can be found in recognised standards such as BS5975:2019 on Temporary Works, BS6187:2011 Code of Practice for Full and Partial Demolition, BS5607:2017 Code of Practice for the Safe Use of Explosive in the Construction Industry. The Project Team and contractor(s) should be able to demonstrate compliance with those regulations and relevant guidance throughout their undertaking.

The legal requirements for the acquisition, manufacture and storage and security including tracking tracing and recording of explosives

in GB are found in the Explosives Regulations 2014. HSE's website www.hse.gov.uk and the overarching guidance supporting those regulations identifies relevant standards and industry guidance on how to deliver those requirements.

Clients or contractors undertaking works in the UK should be conversant with and are expected to comply with the requirements of UK legislation and regulations for those working overseas, the expectation would be that they should comply with the highest requirement be that of the host nation or the UK.

Key elements to demonstrate compliance with RGP

The key elements that will demonstrate that RGP is being followed are:

- An Intelligent Customer complying with legal requirements and providing the finance and information to deliver a safe project. The client should set high expectations with respect to behaviours and recognition of human factors.
- A competent project team assembled by the client to:
  - collect together all obtainable, relevant information on the structure[8] and its environment
  - produce the CDM2015 Pre-Construction Information (PCI) and any required Safety Case
  - advise the client on the choice of the most appropriate risk balanced form of contract
  - support the client in procuring a competent contractors(s)
  - manage, control and supervise the works through a SMS; and
- Detailed planning to identify and control the demolition risks. A detailed plan provides focus to assure the production of a safe design and site works whilst providing commercial certainty with a reduced risk of increased costs and time.
- An adequate Safety Case and CPP that demonstrates that risks are controlled and the demolition activities are SFAIRP safe.
- A documented SMS capable of ensuring that controls are proportionate to each hazard and that include robust peer review, challenge, monitoring and supervision.
- A contractual process clearly identifying and balancing the risks owned by both the client and the contractor.
- An engineered demolition design that is technically underpinned, conservative, fault tolerant and safe to undertake. The design should be demonstrably robust and be supported by a transparent audit trail[9].
- A competent explosives contractor retained to:
  - identify appropriate blow-down methodologies
  - develop, produce, justify and implement a detailed engineered design
  - produce a detailed method statement to demonstrate how the works are to be implemented and undertaken safely.
- A robust system of site supervision to ensure works are undertaken as specified in the agreed Safety Case and CPP.
- A change management system that identifies and addresses all aspects of change decision and records all changes or modifications to the original design and method statement.
- Thorough, well planned and practiced command and control arrangements for the day of the blow-down which address contingencies, emergencies and mitigation if issues arise.
- Evidence that key elements of the engineered design and the supporting information have been subject to both appropriate internal challenge and third party peer review.

Demolition works are often outside of the clients core business activities but they should recognise they need to be an "Intelligent Customer" (IC) before the start of the planning and procurement phase. On a Licensed Nuclear site the Licensee is solely responsible for the site activities and this responsibility cannot be transferred to another commercial entity or organisation.

This approach helps them to learn from previous shortfalls and past incidents together with examples of good practice on safety culture

The explosive demolition of the Paraquat distillation column at Widnes.

Experience indicates that effective clients:

- Recognise their legal duties and have a core capability of competent staff able to manage and control the safety of their undertaking and works carried out by contractors.
- Have IC capability and show that they are a learning organisation, sourcing information and knowledge from appropriate engineering institutions, organisations and professional bodies in the UK or overseas as well as from other private, public organisations and industry which have undertaken similar projects. This approach helps them to learn from previous shortfalls and past incidents together with examples of good practice on safety culture.
- Ensure that members of the Project Team attend an explosives awareness course. Details of providers can be obtained from the Institute of Explosives Engineers (IExpE) or Mineral Products Qualifications Council (MPQC).
- Provide appropriate levels of resource and information to safely deliver a particular project.

Effective project teams generally include a Temporary Works Designer (TWD) and Coordinator (TWC) with experience of similar explosive demolition projects. Their early involvement can provide valuable assistance in preparing adequate tender documents, assisting design development, peer review of contractors design and constructability.

On a nuclear licensed site, the Licensee should also ensure that an Independent Nuclear Safety Assessment (INSA) is undertaken to provide the Licensee with assurance that the project is being undertaken safely. The role of INSA is to challenge the assumptions, philosophy and details of the developing project. All parties should be clear in their roles and responsibilities as defined in CDM 2015. For large scale or complex demolitions or demolitions taking place on a major civil hazard site or environment, a client may choose to appoint a similar form of third party organisation to fulfil a similar function mirroring the INSA methodology.

Planning

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Detailed planning is important for any demolition work, particularly where the overall characteristics of the structure and its hazards are not fully quantified. This is particularly significant in explosive demolition where the blow-down is a single operation. The degree and rigour of planning should reflect the complexity, hazards, unknowns and risks from the structure to be demolished. Greater information provides better understanding and certainty whilst information gaps lead to higher uncertainty so requiring extra caution, conservatism and contingency planning.
The planning process should aim to deliver:

- A comprehensive CDM2015 PCI document, together with a procurement and tender strategy and arrangements for how the design and works are to be developed and reviewed. Similarly there should be clear expectations on how the method statement and any Safety Case are to be produced, peer reviewed and approved, then supervised and implemented on site.
- A project risk register which is regularly reviewed and updated to identify changes in existing conditions and address any new arising risks.
- Optioneering and feasibility studies to seek and assess all available information relating to the structure and different blow-down techniques and methodologies. Planning requires identifying the conditions, hazards, methods and opportunities that provide certainty and reduce risks SFAIRP. Competent planning includes consideration of options and their feasibility which generally reduces design risks and improves the safety of the works and certainty of programme delivery and costs.
- Early Contractor Involvement (ECI) from the explosives demolition contractor. Their experience of hazard identification and working methods can inform decision making during concept design stage. The timing of engagement depends on the selected contractual process, together with the scale and complexity of the project.
- Appropriate contingency plans and command and control procedures. This should cover not only site issues but also interfaces and communications with external stakeholders and the public.

Capturing existing information

The project team should collect all reasonably available, relevant information held by the client. An assessment should be undertaken to identify the degree of confidence that can be put in its accuracy. Any gaps or identified shortfalls should be resolved by undertaking further investigations. If there has been a change in site ownership, then information should still be available as part of the legal "due diligence" procedure. Since 1994, the clients should have a Health and Safety File under the extant CDM 1994 / 2007 regulations. However it is recognised that the content of this file is often incomplete, unreliable or entirely missing. On a nuclear Licensed Site it would be expected that this information would be available through existing safety cases.

A valuable source of information is that held by current or previous employees who can provide "unrecorded" details of the design, construction, contamination sources and other hazards, modifications or changes, maintenance or operation of the plant or structure. This information should be captured for inclusion in the PCI.

This information is essential for adequate tender submissions, demolition design and safe systems of work

The client and the project team should follow the guidance in BS6187:2011, BS5607:2017, BS5975:2019 and CDM 2015 which, for example, covers such areas as:

- The identity and location of services on the site, including gas, electricity and steam, telephone and other cabling, chemical gases, demineralised water and all wastewater drains.
- The original structural design and construction details with any refurbishments or changes of the structure to be demolished.
- Similarly any structural or geotechnical information required for the temporary work design and construction.
- The identity and location of any adjacent structure sensitive to vibration, blast loading, dust, or impact. Any limits, conditions, protection requirements or other safety requirements should be included in the Pre-Construction Information.

The author in front of the demolished Paraquat Tower.

- The type, extent and implications of the hazard from any contamination arising from the demolition, together with the implications for the safe containment and treatment of that waste, which may introduce its own hazards and risks.

The aim should be to accumulate as much information as reasonably practical to be included in the PCI. This information is essential for adequate tender submissions, demolition design and safe systems of work.

Information on expected standards of construction forms can be sourced from withdrawn BSI Codes of Practice and technical guidance for structures in different materials. Other sources are technical papers submitted to professional institutions, conferences, industries and other organisations such as the Building Research Establishment (BRE). However confirmatory studies should be undertaken to provide assurance that historical standards were followed. Publicly available HSE accident and research reports, together with information on the internet are another useful source.

SMS – summary of key requirements

The client and design team should have arrangements that demonstrate the appropriate levels of controls including robust, auditable and transparent reviews and internal challenge within the SMS. Milestones or gateways should define where and how rigorous the reviews and challenges should be. Examples of gateways include contractor pre-selection and tender award together with design reviews and third party checks of the contractor's method statement.

The system should identify who is responsible, what they are responsible for, and how they exercise the appropriate level of control. It should also identify the process for undertaking monitoring, reviews, and audit as well as recording decisions and retaining documents.

On a nuclear licensed site these requirements would be included in the Licensee's safety case as the Licensee remains responsible for safety. On other sites, the responsibility for safety may change as the project progresses in accordance with CDM 2015. Such changes should be clearly identified, suitably authorised and effectively managed to ensure that the SMS continues to operate effectively and as designed.

References

1 https://www.heraldscotland.com/news/12719259.woman-dies-in-demolition-blast/
2 https://www.canberratimes.com.au/story/6030620/katie-benders-family-commemorate-20-years-since-royal-canberra-hospital-implosion/
3 Enr.com news article August 19 2013 Pacific Gas and Electric Co incident 3 August 2013
4 https://www.independent.co.uk/news/uk/home-news/didcot-power-station-reports-of-explosion-at-building-in-oxfordshire-a6891596.html
5 ONR and HSE do not discriminate between the levels of safety expected by the terms 'so far as is reasonably practicable', 'as low as is reasonably practicable' and 'all measures necessary'.
6 https://www.hse.gov.uk/risk/theory/alarp2.htm
7 ONR Technical Assessment Guide NS-TAST-GD-049 Revision 6 http://www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-049.pdf
8 This will generally involve the project team undertaking a comprehensive and effective survey of the existing structure (including where appropriate use of intrusive techniques) to identify and confirm the structural information from the clients existing records. This survey should also identify any missing structural or contamination information not previously identified. This will enable the tenderer to develop and produce the preliminary engineered design. The tenderer should be provided with sufficient resource by the client to undertake any additional structural investigation. The tenderer can then clarify or confirm any doubts in the adequacy of the Pre Construction Information required in Appendix 2 of CDM 2015.
9 The design should be developed within a 3D Building Information Modelling (BIM) model where appropriate. This facilitates the demonstration and accurate simulation of the demolition philosophy in order to design out risks. It has advantages for the decision-making processes whilst providing improved visibility and communication both within the project and to external stakeholders. For small-scale works, the use of BIM may not be appropriate but as uptake and familiarity of digital technology increases its use should not be precluded

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