Temperature, Ignition and Growth Modelling for application in Smart Qualification of Energetics

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What is Smart Qualification?

Smart Qualification is the term used internally to BAE Systems Land UK and can broadly be used interchangeably with Agile Qualification, Agile Assurance or Agile Product Development. In the longer term the internal nomenclature may change in an effort to standardise the language around the wider industry.

Breaking the term into its constituent parts:

- Smart or Agile refers to a faster paced, more efficient approach delivered through use of high technology toolsets partnered with an enabling cultural shift.
- Qualification, Assurance or Product Development refers to the end goal, a product or service delivered to the user with such a level of confidence in its Safety & Suitability for Service that the regulator can certify it for use.

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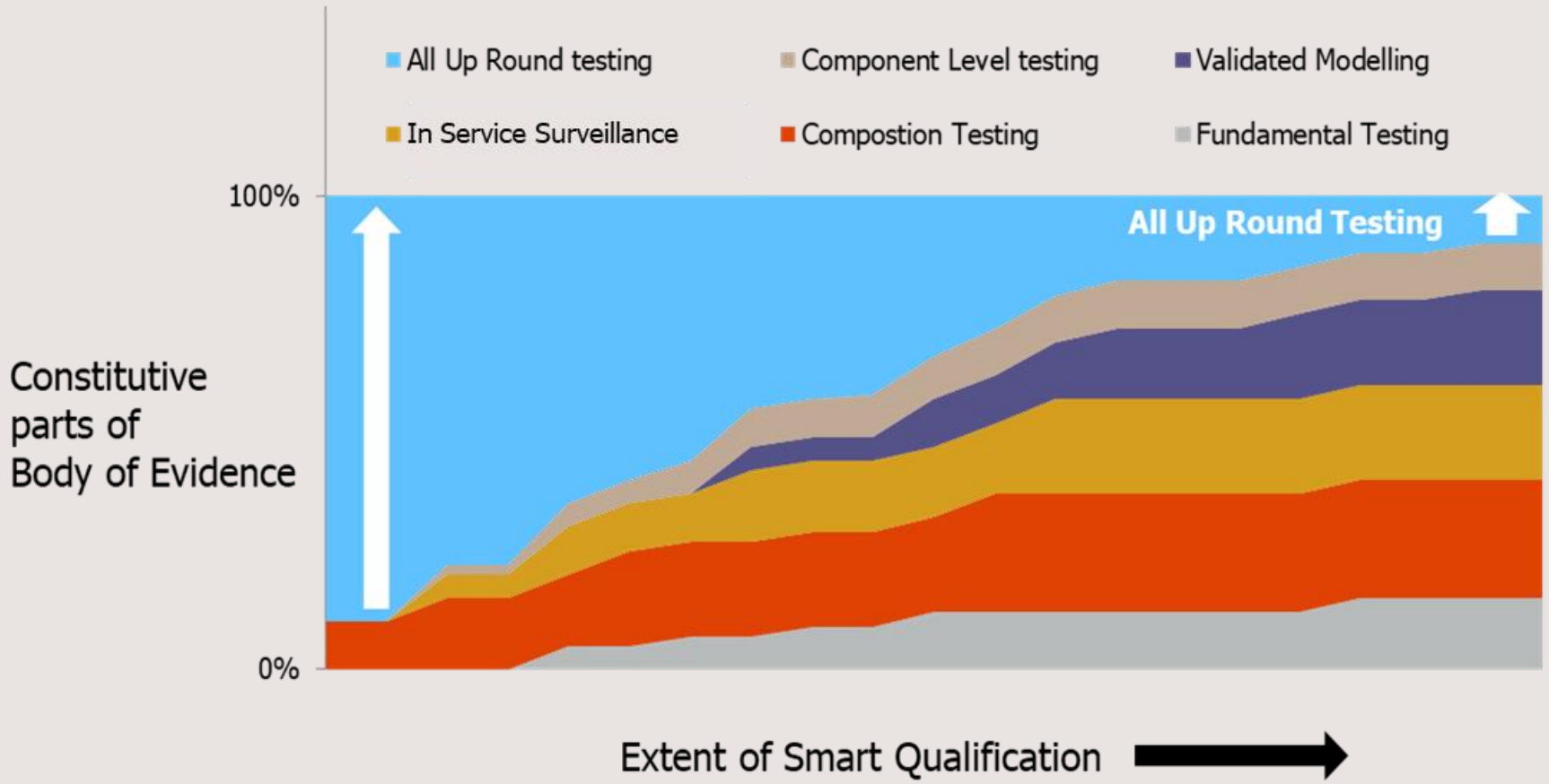
What is Smart Qualification?



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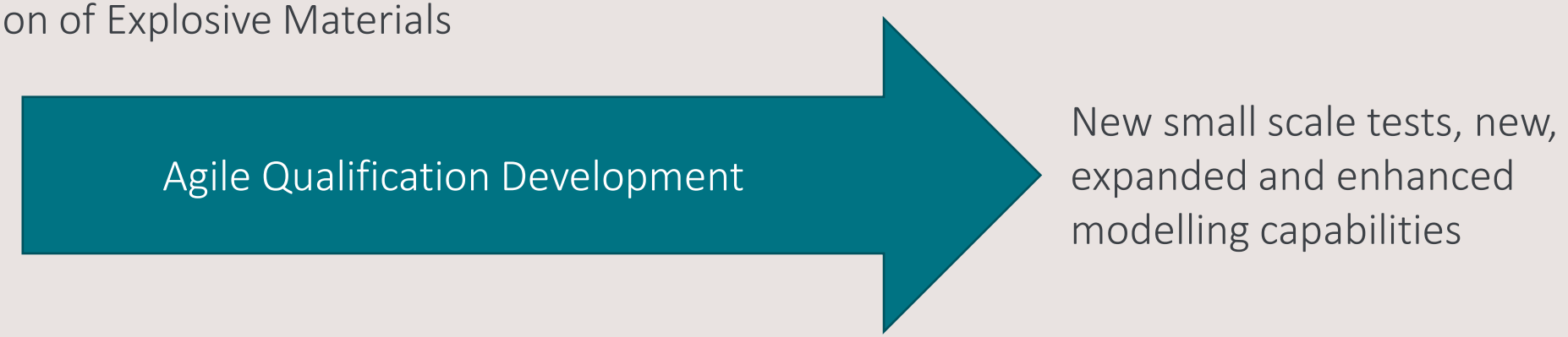
Energetic Materials and Smart Qualification

Current qualification carried out as per StanAg 4170 - Principles and Methodology for the Qualification of Explosive Materials for Military use



New small scale tests, new, expanded and enhanced modelling capabilities

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Current model capabilities

- High velocity impact
- Critical diameter prediction
- Detonation Velocities prediction
- Fragment Attack

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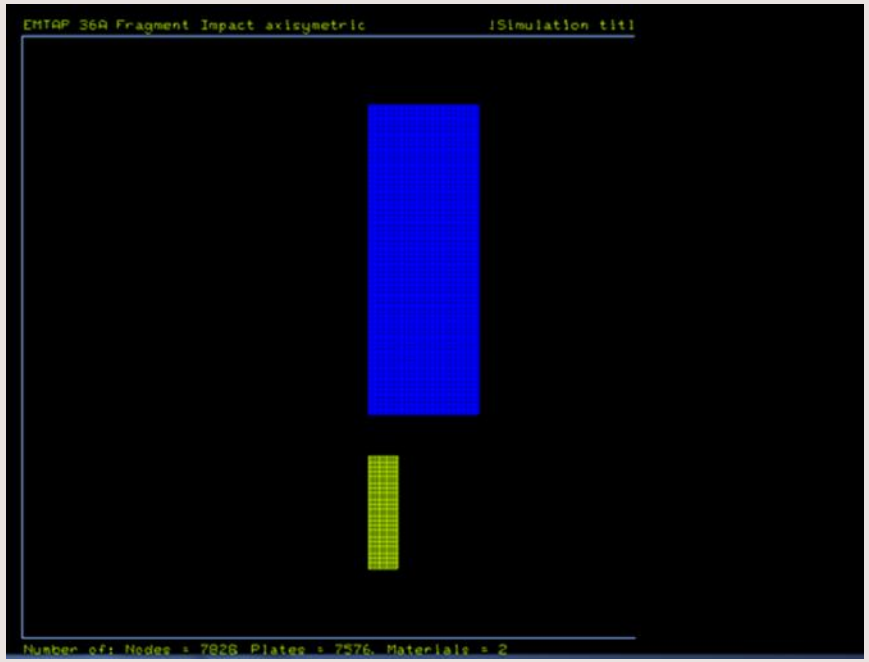
Energetic Materials and FEA modelling

- The work carried out in 2022 was predominately a familiarisation exercise for BAE Systems staff with alternative methods for geometry and mesh generation and use of LS-DYNA.
- Aim was to generate a fragment impact model.
- A simple geometry was generated and an example of the fragment impact model geometry and mesh is shown opposite.



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Energetic Materials and FEA modelling

- Model inputs
  - Typical model inputs include: Initial internal energy, mass density, specific heat capacity, tensile strength, Poisson's ratio, Young's modulus, bulk modulus, yield stress, coefficient of thermal expansion, shear modulus, material dimensions, mesh details and initial velocity of the fragment in this case.
- Model interpretation
  - The out puts from the model require to be interpreted usually through a post-processor. This enables data like the pressure change over time to be extracted. In this case a video was created of the fragment impact and the resulting pressure wave travelling through the material.
- Validation
  - Current validation methods are to compare the results to specific small scale tests empirical data and to recreate experiments from scientific papers.

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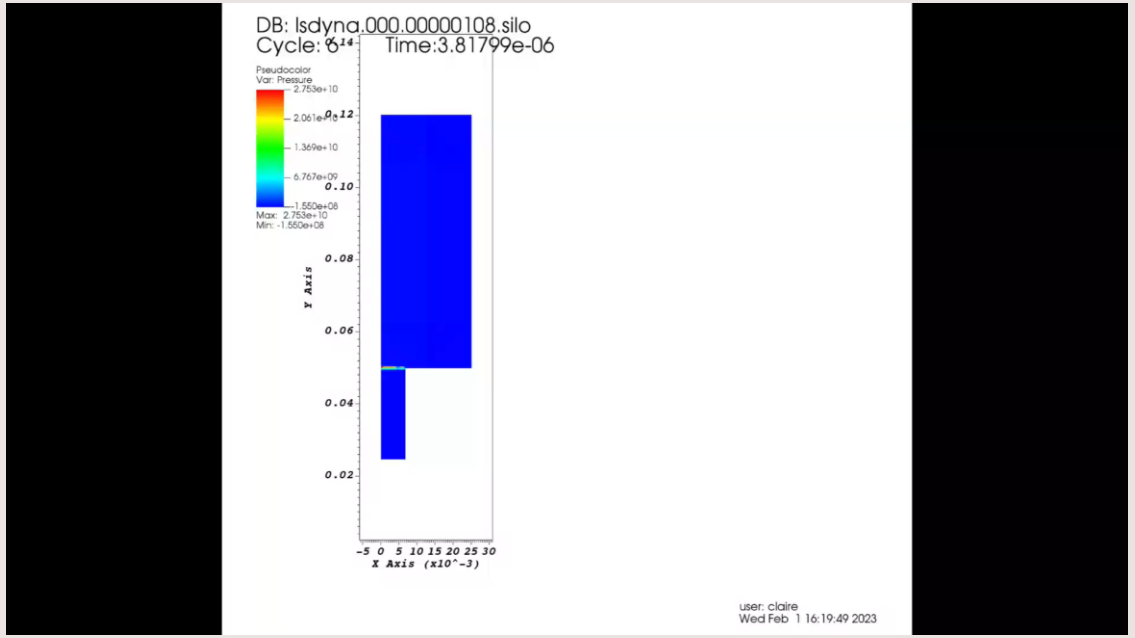
Energetic Materials and FEA modelling

- The simulation shows a detonation wave propagating though the energetic material with a detonation wave pressure of 32 Gpa - which for the model was as expected.
- The model currently supports Lagrangian mesh. There are plans to introduce an Eulerian capability as well subject to funding.



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Proposed model development

- The model has been designed to be modular and further development is planned.
- It currently can model shock to detonation.
- The plan is to develop the model to encompass ignition and burning under low velocity impact including the transition from deflagration to detonation.

- Key areas identified for development are:
  - A Material model
  - Low velocity impact model
  - Burning Function
  - Chemical Equilibrium function

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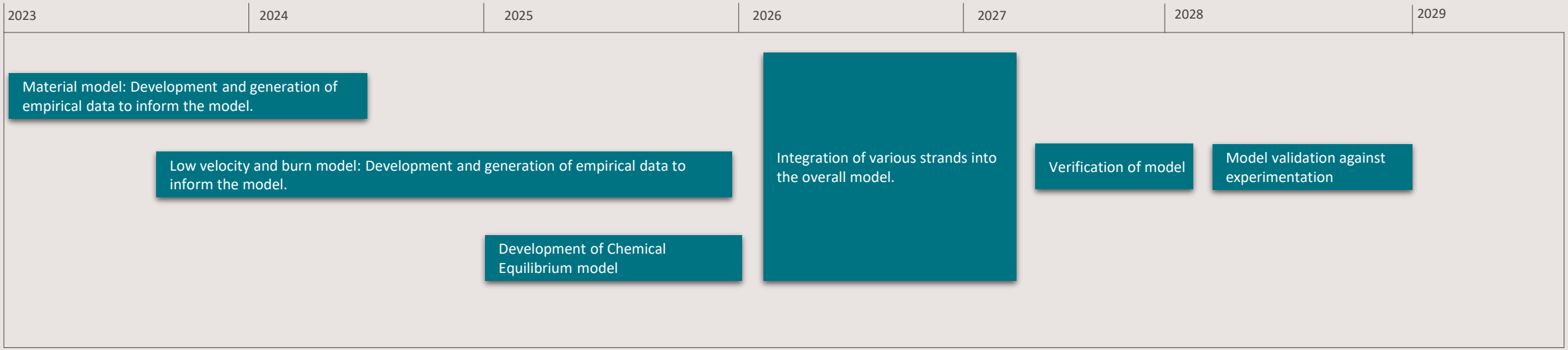
Proposed model development

In order to develop the model capability as per the last slide the following activities could be carried out in the following time frame



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Potential model capability

- Effect of Compression
- Effect of Friction
- Impact tests
- Effect of ESD
- Temperature of Ignition
- Heating test simulations
- Shaped Charge Attack simulation
- Thermal Sensitivity tests

- Simulation of EMTAP tests with the following features:
  - Impact
  - Friction
  - ESD
  - Ease of ignition
  - Heating tests
  - Temperature of Ignition

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Why?

How will increased modelling improve the qualification of energetics?

- Efficiency
- Optimisation
- Safety
- Reduction in cost

How can this support the Smart Qualification of Munitions in general?

- Support in design and develop phase
- Support prediction of the effect of MTDS on energetic materials
- Optimisation
- Reduction in cost

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Thank you, any questions?

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