

ASX Limited

Independent Expert Assessment of ASX's Actions to address the IBM Review Recommendations

11 August 2023

LIMITATION

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1. Executive Summary

Reporting summary for quarter

This is the seventh and final planned Independent Expert quarterly report assessing the ASX Delivery Excellence Program's ("the Program's") implementation of the fifty-nine (59) IBM Review Recommendations ("IBMRs" or "Recommendations").

This quarter, ASX submitted the remaining three (3) Recommendations for our assessment, and all three (3) Recommendations were deemed "fully addressed". As a result, the ASX Delivery Excellence Program has successfully closed all fifty-nine (59) IBM Review Recommendations at the end of the quarterly review periods.

EY has no further recommendations for ASX.

Historic findings and recommendations

Below is a summary of the outcomes from each of our seven (7) quarterly reports to date under the Licence Condition:

Period	Submissions		Fully Addressed				Partially Addressed	
	IBMR	Actions	IBMR	%	Actions	%	IBMR	Actions
Q1	22	49	18	82%	44	90%	4	5
Q2	9	23	6	67%	20	87%	3	3
Q3	12	37	5	42%	26	70%	7	11
Q4	6	27	4	67%	24	89%	2	3
Q5	5	20	5	100%	20	100%	0	0
Q6	2	7	2	100%	7	100%	0	0
Q7	3	18	3	100%	18	100%	0	0
Total	59	181	43*		159*			

Please note, '%' refers to '% fully completed'.

*Excludes partially addressed IBMRs and ASX Actions from previous quarters that were re-submitted by ASX in subsequent quarterly review periods for re-evaluation.

This summary shows ASX's progress throughout the course of the Delivery Excellence Program and the changes in the percentage of fully addressed IBM Recommendations and ASX Actions per quarter. All partially addressed Recommendations from Q1, Q2, Q3 and Q4 were resubmitted by ASX and assessed by EY as fully addressed. For details and commentary, please refer to Appendix F 'Summary of Closed Partially Addressed Recommendations and ASX Actions from previous quarterly review periods'.

For detailed progress of the fifty-nine (59) Recommendations please refer to Appendix E 'Status summary of all 59 Recommendations'.

Furthermore, all four (4) IE Recommendations from the April 2022 Design Adequacy Report have been assessed as fully addressed as part of the Q3 and Q5 evaluations. For full details and commentary, please refer to Appendix G 'Summary of Closed Design Adequacy Report IE Recommendations' of this report.

Background

In November 2020 an outage occurred following a major upgrade to ASX Operations Pty Ltd equity trading platform (ASX Trade), called the ASX Trade Refresh project. Consequently, the Australian Securities and Investments Commission (ASIC) and the Reserve Bank of Australia (RBA) required an Independent Expert review of the ASX Trade Refresh project to be completed. ASX appointed IBM Australia Limited (IBM) to undertake this review. IBM made fifty-nine (59) recommendations ("Recommendations" or "IBM Review Recommendations") in total across the following seven key domains in the review: risk, governance, delivery, requirements, vendor management, testing and incident management.

ASX subsequently developed a management response plan ("Response Plan" or "Plan") which consists of 181 deliverables ("ASX Action") to address the fifty-nine (59) IBM Recommendations.

In November 2021, the Minister imposed certain Licence Conditions on ASX. The Australian Market Licence (ASX Limited) Additional Conditions Notice 2021 (No. 1) dated 24 November 2021 requires ASX to:

- Address each of the IBM Review Recommendations to the satisfaction of ASIC, and
- Appoint an Independent Expert ("IE") to conduct an assessment of its implementation of the ASX Actions to address the IBM Review Recommendations.

Scope

In accordance with the relevant Licence Conditions, ASX, with ASIC's and RBA's consent, engaged Ernst & Young ("EY") to review each of the Quarterly Reports produced by ASX and assess whether the actions undertaken in the period covered by the report demonstrate appropriate implementation of, and progress towards addressing the IBM Review Recommendations. Refer to section 2.2 for detailed scope related to this report.

Approach

Our approach is to assess the quarterly reports produced by ASX. This includes an assessment of the closure packs and supporting evidence for the ASX Actions reported as closed during the period. As part of our assessment, we will consider:

- Whether the ASX Actions comprehensively address the relevant IBM Review Recommendations
- Whether the ASX Action is implemented in a sustainable manner
- The skills and experience of the people engaged by ASX to implement the ASX actions
- The closure of ASX actions is supported by demonstrable evidence, and has been subject to appropriate internal due diligence and governance processes
- The consistency of the attestations reported in ASX's quarterly report with our understanding of the status of the ASX actions.

Refer to section 2.3 for detailed approach related to this report.

2. Introduction

2.1 Background

Recommendations Review

To address the fifty-nine (59) IBM Recommendations, ASX subsequently developed a management response plan which consists of 181 deliverables. The Plan is structured around the following seven elements (which are different to the seven domains from the IBM review) that seek to improve ASX's project execution capability and to reduce the likelihood of similar project execution incidents in the future:

- Ensuring diverse thinking, avoidance of group think and challenge
- Increasing resources
- Upgrading policies, standards, and frameworks
- Educating staff so that they clearly understand the standards and practices expected of them
- Monitoring individual projects and the portfolio for compliance with ASX's policies, standards and frameworks
- Improving ASX's testing capability and capacity
- Improving ASX's project reporting and quality.

In November 2021, the Minister imposed certain Licence Conditions on ASX. The Australian Market Licence (ASX Limited) Additional Conditions Notice 2021 (No. 1) dated 24 November 2021 requires ASX to:

- Address each of the recommendations to the satisfaction of ASIC, and
- Appoint an Independent Expert (IE) to conduct an assessment of its implementation of the ASX actions to address the IBM review recommendations.

ASX has obtained the consent of ASIC to appoint Ernst & Young (EY) as the IE to conduct this assessment.

2.2 Scope

EY has been engaged to deliver the following scope of work:

In accordance with Licence Condition 4, ASX must by 31 January 2022 and thereafter within 14 days of each quarter end date occurring during the period from 31 March 2022 to 30 June 2023, give a report to ASIC and the IE containing an update on:

- The progress of the implementation of the ASX actions to address the review recommendations, and
- If there are any issues in implementing any remediation actions, the reasons for those issues and what action ASX will take to address them.

The quarterly report must be accompanied by an attestation from the relevant oversight body from ASX.

The scope of our engagement as the IE in accordance with the relevant licence condition is to:

- Review and assess each of the quarterly reports produced by ASX (as required under Licence Condition 3) and
- Within 30 days of receipt of each quarterly report, provide ASX and ASIC with a written report setting out whether the ASX Actions undertaken in the period covered by the report demonstrate appropriate implementation of, and progress towards addressing, the IBM review recommendations.

2.3 Approach










When conducting our assessment for the delivery of this report, the following activities were performed:

1. **Documentation review:** A detailed review and analysis of ASX's actions and provided artefacts, including closure packs, written responses, and additional supporting evidence. All documentation was provided to EY

by ASX based on a documentation request. A list of documentation reviewed can be found in Appendix D.

2. **Question submission to ASX:** Following review of the documentation, the EY team submitted a set of questions (if any) related to the recommendations and subsequent ASX actions approx. 48 hours prior to the meeting where ASX prepared responses for the joint recommendation review workshops. A list of questionnaires submitted to ASX can be found in Appendix C.
3. **Recommendation review workshops:** Workshops were held to review and discuss the recommendations between key ASX stakeholders and EY SMRs (Subject Matter Resources) to go through the pre-submitted questions related to ASX's remedial actions approach. A list of all workshops conducted with ASX can be found in Appendix A and a list of interviewed ASX stakeholders can be found in Appendix B.

Following our review of the documentation, supporting evidence and knowledge gathered from recommendation review workshops with the relevant ASX stakeholders, the EY team have determined whether the ASX Actions are appropriate to close the IBM Recommendations by adopting the following approach for each of the ASX Actions:

1. **Has the recommendation been fully addressed by the ASX Action(s)?**
Yes  / No  / Partially done 
2. **Were ASX Action(s) in response to the IBM Recommendation reasonable and appropriate?**
Yes  / No  / Partially done 
3. **Is the ASX Action(s) sustainable? Has the ASX response to the recommendation considered measures to enforce / ensure that the ASX Actions remain closed in the future?**
Yes  / No  / Partially done 

The assessment criteria described above determines if the recommendation was fully, partially, or not appropriately addressed.

For detailed and comprehensive commentary around our decision, please refer to each recommendation's 'Findings' section.

2.4 Limitations

We draw your attention to the limitations inherent in this report:

- Our work was not performed in accordance with generally accepted auditing, review, or other assurance standards in Australia and accordingly does not express any form of assurance. This report does not constitute legal opinion or advice. We have not conducted a review to detect fraud or illegal acts.
- Our work does not assume any responsibility for any third-party products, programs or services, their performance or compliance with your specifications or otherwise.
- Our work did not intend to identify, address, or correct any errors or defects in your computer systems, other devices, or components thereof ("Systems"), whether or not due to imprecise or ambiguous entry, storage, interpretation, or processing or reporting of data. We are not to be responsible for any defect or problem arising out of or related to data processing in any Systems.
- Our Recommendations review was limited to the information available and provided by ASX at this stage, where for future reviews included in the plan only high-level planning has been conducted and a detailed analysis of scope and effort is pending.
- Our review was limited to documents provided by ASX as deemed relevant in line with the agreed scope and EY requests, with the expectation that ASX had those artefacts documented to satisfy its own reporting needs.
- Any projection of the outcome related to the recommendation's response and its sustainability for future periods, is subject to the risk that the actions may become inadequate due to changes in

conditions, or that the degree of compliance around remedial actions taken may deteriorate over time.

- Our scope under the licence conditions requires us to oversee the ASX Actions taken related to ASX's Plan and our Independent Expert review which are relevant to the recommendations and its remedial actions. For the purpose of our engagement, we define oversee as to observe and inspect ASX has acted accordingly. ASX is accountable and responsible for the implementation activities and EY will not act as management or direct the implementation.

2.5 Use and disclosure of our reports

We are providing specific advice only for this engagement and for no other purpose and we disclaim any responsibility for the use of our advice for a different purpose or in a different context. If you plan to use this advice on another transaction or in another context, please let us know and provide us with all material information that we can provide advice tailored to the appropriate circumstances.

Our Reports may be relied upon by ASX and ASX's regulators, ASIC and the RBA, for the purpose outlined in this SOW only. We understand that ASIC and the RBA may issue a media release and/or a public report referring to or publishing the content of our Reports and may publish our Reports and/or the EY Summary Reports or make or issue its own summary from the content of our Reports.

For the avoidance of doubt, no other party other than ASX, ASIC and the RBA may rely on the Reports. We disclaim all responsibility to any such other party for any loss or liability that the other party may suffer or incur arising from or relating to or in any way connected with the contents of our Reports, the provision of our Reports to the other party or the reliance upon our report by the other party.

3. Monitoring of Partially Addressed Recommendations and ASX Actions

The objective of this section is to monitor the status of IBM Recommendations that were submitted in previous quarterly review periods and deemed “partially addressed” or “not addressed” and determine if it is fully executed and/or appropriate and/or sustainable following a re-submission by ASX and re-evaluation by the IE.

All partially addressed Recommendations from Q1, Q2, Q3 and Q4 have now been resubmitted by ASX and assessed by EY as fully addressed. There were no partially addressed Recommendations found for Q5 and Q6 as ASX achieved a 100% pass rate for those quarters.

For full details and commentary, please refer to Appendix F ‘Summary of Closed Partially Addressed Recommendations and ASX Actions from previous quarterly review periods’. Further, all actions recommended in the Design Adequacy check have been addressed in prior quarters.

4. Our Findings

Detailed below are our Independent Expert findings following our assessment of the actions taken by ASX as part of their Response Plan to address the IBM Recommendations, on whether ASX have taken the adequate steps to close the recommendations.

The following pages provide detailed findings for each of the three (3) recommendations submitted by ASX to ASIC, RBA and the Independent Expert (IE) on 14 July 2023 as part of the seventh and final quarterly review period.

The 'Executed, Appropriate and Sustainable' summary table contains the final outcome of our review of the ASX Actions including the supporting materials, and whether they have been completed appropriately by ASX to close the IBM Recommendation. The 'Findings' section offers the rationale for an Action's successful completion or, in the event of an Action's failure to be successfully passed, the 'Comment' section of the summary table provides clarification of the shortcomings that should be addressed.

Summary of Review Recommendations Assessment

All three (3) Recommendations and the related eighteen (18) ASX Actions were fully addressed.

Below is a summarised view of the outcome of each Recommendation and its related ASX Action(s) submitted this quarter (June 2023). For detailed commentary around findings please refer to the following pages.

#	Recommendation / ASX Actions	Executed	Appropriate	Sustainable	
6.2.1	Enhance in-house capabilities for combinatorial testing strategies, methods, tools and datasets to combine functional, negative-functional, non-functional and operational testing at volume with representative data (real or simulated) in an end-to-end environment to create "production-like" testing scenarios targeted at reducing the risk of latent defects causing catastrophic failures in production situations.	Recommendation has been addressed			
	Action 1	Recruit Test Lead (Methods, Processes, Procedures)	✓	✓	✓
	Action 2	Recruit Test Data Lead	✓	✓	✓
	Action 3	Recruit Non-Functional Test Lead and Non-functional Test Engineer	✓	✓	✓
	Action 4	Update ASX QE Policy and procedures to include combinatorial testing aligned to risk-based pathways	✓	✓	✓
	Action 5	Establish a combinatorial testing capability including tooling, training, methods, infrastructure, and environment enhancements	✓	✓	✓
	Action 6	Review of high risk in-flight projects to ensure combinatorial testing has been appropriately considered in test strategy and test design	✓	✓	N/A*
	Action 7	Define roles and responsibilities in relation to test data and test environment management	✓	✓	✓
	Action 8	Specify standardised test data and test environment requirements aligned to risk-based pathways	✓	✓	✓
	Action 9	Enhance test data processes, procedures and associated tooling including relation to production data, synthetic data, data governance and customer testing	✓	✓	✓
	Action 10	Integrate planning and estimation processes with ASX delivery framework	✓	✓	✓
Action 11	Maturity roadmap to ISO29119 L4 CMM	✓	✓	✓	
6.4.2	Engage the market to understand the benefits and demand for the re-introduction of a performance testing environment. Post market engagement, determine the required implementation, if any.	Recommendation has been addressed			

#	Recommendation / ASX Actions		Executed	Appropriate	Sustainable
	Action 1	Conduct survey with participants to get input on the different types of testing that customers want to be able to do with ASX Trade, and the benefits and relative priority of that testing for them.	✓	✓	N/A*
	Action 2	Using the survey as input, consider what testing environments would be appropriate and propose whether any changes are required.	✓	✓	N/A*
	Design, document and implement a test selection and prioritisation process supported by test design optimization methods and/or combinatorial test tools.		Recommendation has been addressed		
6.4.6	Action 1	Define test selection and prioritisation criteria framework, aligned to ISO29119	✓	✓	✓
	Action 2	Define knowledge management requirements for test optimisation and create and implement plan for knowledge base creation	✓	✓	✓
	Action 3	Define requirements for test optimisation tool and secure funding	✓	✓	✓
	Action 4	Implement test optimisation processes and tools	✓	✓	✓
	Action 5	Regular audit/review of test selection and prioritisation framework effectiveness	✓	✓	✓

*Sustainability not applicable for this ASX Action as it is a one-off activity required to be performed by ASX.

Recommendation 6.2.1: Enhance testing capability - combinatorial strategies, methods, tools and datasets, negative testing

	Executed	Appropriate	Sustainable
ASX Action 1	✓	✓	✓
ASX Action 2	✓	✓	✓
ASX Action 3	✓	✓	✓
ASX Action 4	✓	✓	✓
ASX Action 5	✓	✓	✓
ASX Action 6	✓	✓	N/A*
ASX Action 7	✓	✓	✓
ASX Action 8	✓	✓	✓
ASX Action 9	✓	✓	✓
ASX Action 10	✓	✓	✓
ASX Action 11	✓	✓	✓
Recommendation Addressed?	Yes		
Comment	<p>Recommendation has been addressed, as evidenced by the findings outlined below. ASX Actions are deemed appropriate and sustainable.</p> <p>EY's experience with Combinatorial Testing (CT) illustrates that organisations have different approaches to the implementation of CT each with varying results. ASX should include CT as part of their 'Continuous Test Process Improvement' program implemented as part of Recommendation 6.1.3 during Q6. This should include an objective assessment of the ongoing impact that CT is having to help define and track improvement initiatives.</p>		

	<p>ASX's methodology for determining whether CT Design Technique (CTDT) should be used for a project is through the Risk Based Testing (RBT) Assessment process, which consists of both objective criteria (i.e., change characteristics) and subjective discussions (i.e., RBT workshop with Test Managers and Subject Matter Experts). The Test Plans are ultimately reviewed and signed off by the Head of Quality Engineering and Testing to confirm that the RBT Assessment was appropriately conducted to support the inputs of the Test Plan.</p> <p>EY suggests including CT in scope for its upcoming IBMR Sustainability Spot Checks engagement to determine ASX's progress in using CT, as ASX has only been able to provide evidence that one project has used CTDT to generate test scenarios.</p>
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*Sustainability not applicable for this ASX Action as it is a one-off activity required to be performed by ASX.

Background/Tasks

Enhance in-house capabilities for combinatorial testing strategies, methods, tools and datasets to combine functional, negative-functional, non-functional and operational testing at volume with representative data (real or simulated) in an end-to-end environment to create "production-like" testing scenarios targeted at reducing the risk of latent defects causing catastrophic failures in production situations.

ASX Action(s)

1. Recruit Test Lead (Methods, Processes, Procedures)
2. Recruit Test Data Lead
3. Recruit Non-Functional Test Lead and Non-functional Test Engineer

4. Update ASX QE Policy and procedures to include combinatorial testing aligned to risk-based pathways
5. Establish a combinatorial testing capability including tooling, training, methods, infrastructure, and environment enhancements
6. Review of high-risk in-flight projects to ensure combinatorial testing has been appropriately considered in test strategy and test design
7. Define roles and responsibilities in relation to test data and test environment management
8. Specify standardised test data and test environment requirements aligned to risk-based pathways
9. Enhance test data processes, procedures and associated tooling including relation to production data, synthetic data, data governance and customer testing
10. Integrate planning and estimation processes with ASX delivery framework
11. Maturity roadmap to ISO29119 L4 CMM

Findings

ASX Action 1 - Recruit Test Lead (Methods, Processes, Procedures)

ASX recruited a new full-time Quality Engineering Lead (Test Methods, Processes and Procedures) who started on 20 February 2023 - this person was an external recruit. In the Summary Consolidation Page for Recommendation 6.2.1, ASX stated that the role is in ASX's headcount plan as a permanent member of staff.

During the recruitment process, ASX included as part of the position description that the position *"will be directly responsible for providing and embedding structured, mature and contemporary testing capabilities across ASX, including the Testing Policy and associated processes, tools, templates and performance metrics."*

In particular, the position description also included the below responsibilities related to combinatorial testing:

- Support establishing a capability for advanced contemporary testing methods (including exploratory testing, combinatorial testing, test optimisation among others)
- Enhance and implement a test selection and prioritisation process supported by test design optimisation methods and/or combinatorial testing tools

ASX has stated in the Summary Consolidation Page that the person is currently still in the role.

ASX Action 2 - Recruit Test Data Lead

ASX recruited a new full-time Test Data Management (TDM) Lead who started on 20 March 2023 - this person was an external recruit. In the Summary Consolidation Page for Recommendation 6.2.1, ASX stated that the role is in ASX's headcount plan as a permanent member of staff.

During the recruitment process, ASX included as part of the position description that the responsibilities of the role would include the following:

- Design and implementation of Static Data Masking SDM, Dynamic Data Masking DDM solutions, test data sub-setting and data mining
- Analyses of test data requirements in agile environment and develop iterative test data provisioning approach, with possibility of enabling self-serve test data wherever possible
- Developing Data Security strategy and roadmap, operating model, policies/standards, and tool design and process documentation
- Strong hands-on experience with one of the tools such as Broadcom CA Test Data Manager, FileAid or IBM Optim
- Possess the ability to think strategically, self-motivated with the ability to work in a team as well as take individual responsibility
- Sound knowledge of the reasoning for data masking - GDPR (General data protection regulation)

ASX has stated in the Summary Consolidation Page that the person is currently still in the role.

ASX Action 3 - Recruit Non-Functional Test Lead and Non-functional Test Engineer

ASX recruited a new full-time Quality Engineering Performance Test Lead who started on 17 October 2022 and a new full-time Quality Engineering Performance Test Engineer who started on 25 October 2022 - both were external recruits. In the Summary Consolidation Page for Recommendation 6.2.1, ASX stated that the roles were in ASX's headcount plan as permanent members of staff.

During the recruitment process, ASX included as part of the 'Quality Engineering Performance Test Lead' position description that the responsibilities of the role would include the following:

- Design, implement and maintain Performance test assets to ensure desired level of quality and test coverage
- Contribute to the estimates on the Performance test/ engineering efforts for various features and new initiatives as part of definition of done
- Collaborate closely within your scrum team to drive testability in solution design and promote best test engineering practices in the development process
- Establish traceability and coverage through effective mapping of test cases & scripts to acceptance criteria as defined in user story
- Advise and apply best test engineering practice, and supporting tools and technologies to specific features and projects

For the 'Quality Engineering Performance Test Engineer' position description, ASX included that the responsibilities would include the following:

- Design, implement and maintain Performance test assets to ensure desired level of quality and test coverage
- Collaborate closely within your scrum team to drive testability in solution design and promote best test engineering practices in the development process

- Establish traceability and coverage through effective mapping of test cases & scripts to acceptance criteria as defined in user story
- Advise and apply best test engineering practice, and supporting tools and technologies to specific features and projects

ASX has stated in the Summary Consolidation Page that the 2 people are currently still in their roles.

During the Q7 Recommendation Review Workshop held on 27 July 2023, ASX clarified that while ASX Action 3 had stated a 'NFT Lead' and 'NFT Engineer' would be recruited, ASX hired Performance Testing resources instead as that was the need for the QE&T Capability at that point in time to join the 'QE&T Shared Performance Testing Services' - the NFT Lead and NFT Engineer roles fell under this area of the QE&T Capability.

In the written response shared by ASX on 2 August 2023, ASX shared a copy of the QE&T Capability organisation structure to show that the 'Performance Test Lead' and 'Performance Test Engineer' roles were part of the 'Shared Performance Testing Services' area and that there were currently no open roles at present. ASX also stated that in the 'QE&T Roles and Responsibilities' Confluence page, all roles in the QE&T Capability Practice have a responsibility relating to "Non-Functional Testing Capability", which is "*establishing and leading a contemporary enterprise non-functional testing capability, delivering the medium to long term non-functional test strategy and responsible for developing and growing ASX's non-functional testing capability from a process, people, skills and tools perspective.*"

ASX Action 4 - Update ASX QE Policy and procedures to include combinatorial testing aligned to risk-based pathways

ASX has updated the 'Quality Engineering and Testing (QE&T) Policy', which is found under the QE&T repository on the Confluence site, to include 'Combinatorial' as part of the 'Term Definitions and Glossary' section.

Under the 'Test Design Techniques' subsection, ASX has described 'Combinatorial' as the below:

“Combinatorial test design techniques are used to systematically derive a meaningful and manageable subset of test cases that cover the test conditions and test coverage items that are derivable during testing. The combinations of interest are defined in terms of test item parameters and the values these parameters can take. Where numerous parameters (each with numerous discrete values) must interact, this technique enables a significant reduction in the number of test cases required without compromising functional coverage. The test item parameters represent particular aspects of the test item that are relevant to the testing and often correspond to the input parameters to the test item, but other aspects may also be used.”

Under the 'QE Strategy' page, ASX has created a subpage titled 'Combinatorial Test Design Technique' which provides detailed guidance and criteria to plan for appropriate risk-based test (RBT) coverage by using the 'Combinatorial Test (CT) design technique'. This includes processes for planning and executing combinatorial tests, and how to appropriately plan test coverage aligned to risk.

As part of the 'Risk Based Testing' subpage of the 'QE Strategy' page, ASX has included 'Combinatorial Test Design Technique' in the Test Treatment Library, which can be used in RBT assessments.

Furthermore, ASX updated the Test Plan template under the subsection 'Test Design Approach' (part of section 'Test Process') to include 'Combinatorial Test Design Technique' as one of the available Test Design Techniques to choose from based on the risk of change from the RBT assessment.

As part of the evidence submitted for this Recommendation 6.2.1, ASX shared an example of a project's test plan where the 'Combinatorial Test Design Technique' was listed as the 'RBT Nominated Test Design Technique' for System level testing.

ASX Action 5 - Establish a combinatorial testing capability including tooling, training, methods, infrastructure, and environment enhancements

As stated in the findings for ASX Action 4, ASX has updated their QE&T Policy and procedures (i.e., QE&T Strategy, RBT, Test Plan template) to

include 'Combinatorial Test Design Technique' as part of the QE&T Capability.

The ASX QE&T Capability has also established a centralised function called the 'QE&T Shared Test Tool Service', which helps with the evaluation and deployment of test tools that support test execution. This centralised function consists of a dedicated QE&T resource (Manager - Test Tools and Infrastructure) who has the responsibility to:

- work with dependent teams and/or vendors for the test tool implementation and operational readiness check
- administer the test tool in the production environment

The Quality Engineering Lead (Test Methods, Processes and Procedures) is responsible for:

- supporting the establishment of a capability for advanced contemporary testing methods (which includes combinatorial testing)
- enhancing and implementing a test selection and prioritisation process supported by test design optimisation methods and/or combinatorial testing tools

ASX states that the 'QE&T Shared Test Tool Service' provides support to the QE&T Community by:

- Providing streamlined service to evaluate and select suitable shared test tools for ASX use cases
- Maintaining the catalogue of shared test tools
- Procuring and managing licences for shared test tools, including forecasting and user access management
- Providing Shared Test Tool coaching (internal/external delivery)
- Providing access to training and knowledge management for shared test tools
- Collaborating with relevant stakeholders (including QE&T Community and delivery stakeholders) to:
 - Define and document use cases and selection criteria for tooling

- Validate tools and tooling proposals against use cases, selection criteria, and ASX Policies (e.g. alignment to QE & T Standards, architecture principles, etc.)
- Validate tooling implementation against use cases and selection criteria

The test tools currently listed in the QE&T Shared Test Tools Services

[REDACTED]

- [REDACTED]
- [REDACTED]

As part of the evidence submitted for this Recommendation, ASX shared how the QE&T Shared Test Tools Services Team conducted the 'Test Tool Evaluation' and 'Combinatorial Test Tool Assessment and Selection' processes in order to determine that the [REDACTED]

Tool' was the appropriate tool for ASX and subsequently made it available in the ASX Software Centre for users to download onto their laptops. The 'Combinatorial Test Tool Assessment and Selection' process included review of the mandatory, desirable and optional features (i.e., requirements) that needed to be considered for the new tool. ASX also shared the 'Combinatorial Test Tool Assessment Report' which showed [REDACTED] as the recommendation from the assessment.

The QE&T Shared Test Tools Service has a [REDACTED] [REDACTED] Documentation' which provides guidance on how to install the test tool – it is available for QE&T community to install and use from their laptops. The combinatorial test tool is available for the Head of QE&T and Line of Business Test Managers, however individuals and teams that do not have access may request access from the Shared Test Tools Services team. There is also a 'User Guide for [REDACTED]' available which provides an overview of the features and information about the interfaces (i.e., command line interface and GUI interface). If users have any technical issues with the test tool, they can contact the Technical Owner via the dedicated Shared Test Tools Service mailbox.

During the Q7 Recommendation Review Workshop, ASX stated that the QE&T Shared Test Tools Services centralised team have existing knowledge and expertise in Combinatorial Testing and are provided

ongoing training. The wider QE&T Community have been made aware through communications that the Shared Test Tools Services team has been launched and is available for them to engage for Combinatorial Testing whenever needed.

ASX also stated during the workshop that the current testing environment is suitable for executing the test scenarios generated by the 'Combinatorial Test Design Technique'. Where an environment enhancement is required, this can be set up accordingly (by the Test Environment Capability Team) based on the data required.

ASX Action 6 - Review of high risk in-flight projects to ensure combinatorial testing has been appropriately considered in test strategy and test design

ASX reviewed all the high risk in-flight projects there were in the 'Refine & Implement' phase from their 'In-Flight Project Portfolio' database to determine whether combinatorial testing had been appropriately considered in test strategy and test design.

Below is summary of their review for the identified high risk projects, as stated in the 'Summary Consolidation Page' for Recommendation 6.2.1.1:

- [REDACTED] Project - RBT assessment completed. Combinatorial Testing Design Technique was not required as there was a [REDACTED] and comprehensive test coverage was achieved by operational testing at [REDACTED] environment
 - As part of the evidence submitted for this Recommendation, ASX shared the project's Test Strategy document for EY to validate this
- [REDACTED] Project - RBT assessment completed. Relevant Combinatorial Test Design Techniques were included in the RBT Assessment. Combinatorial Test Design Technique will be applied to release 4 of the project
 - As part of the evidence submitted for this Recommendation, ASX shared the project's RBT assessment document for EY to validate this

- ██████████ **Project** - 2 RBT assessments completed for 2 changes (██████████). Relevant Combinatorial Test Design Techniques were included in the RBT Assessment for ██████████
 - As part of the evidence submitted for this Recommendation, ASX shared the 2 RBT assessment documents for EY to validate this
- ██████████ **Project** - RBT assessment completed. ASX Trade updated the project's Test Strategy in June 2023 to ensure appropriate consideration of Combinatorial Test Design Technique would be included
 - As part of the evidence submitted for this Recommendation, ASX shared the project's Test Strategy document for EY to validate that ASX had documented in the test strategy that Combinatorial Test Design Technique would be considered as a Test Design technique
 - In the written response provided by ASX on 3 August 2023, ASX stated that the RBT assessments for the project did not identify Combinatorial Test Design Technique as required considering the change types identified
- ██████████ - RBT process and Combinatorial Test Design Technique were not applicable as this project does not involve a technology change involving test management
- ██████████ - The project had not yet reached the point of the project lifecycle requiring it to complete a RBT assessment. The project has an action to review their consideration for Combinatorial Testing in the test strategy and test design which will be completed after the RBT assessment
 - As part of the evidence submitted for this Recommendation, ASX shared the Jira ID and page

which captured the action for the project to complete the Test Strategy once the RBT assessment was completed

In the written responses provided by ASX on 2 August 2023 and 3 August 2023, ASX stated that the review was performed by the Lead and Senior Manager roles that make up the QE Authority. The 'Combinatorial Test Design Technique' review occurred between 15 June 2023 to 11 July 2023, with an initial assessment performance, Q&A and detailed discussion occurring between the QE Authority and the Test Managers in weekly QE&T team meetings. The Head of QE&T endorsed the assessments as part of his role and responsibility.

ASX provided evidence demonstrating the Head of QE&T's endorsement of the inflight Combinatorial Test Design project review outcomes in the '6.2.1 LOB Attestation Page' document, shared on the 14 July 2023 as part of the closure pack.

ASX Action 7 - Define roles and responsibilities in relation to test data and test environment management

The 'QE&T Roles and Responsibilities' page on the QE&T repository Confluence site describes roles and responsibilities for all test related positions.

In the written response provided by ASX on 2 August 2023, ASX identified the specific roles below which have responsibilities related to Test Data and Test Environment Management:

Test Data Management

- Senior Manager QE Services (QE&T Shared Services)
- Test Data Lead
- Program Test Manager

Test Environment Management (TEM)

- Program Test Manager
- Test Lead
- Senior Test Engineers (Senior Test Analyst)

- Senior Manager Test Environment Management (ASX Solution Engineering Team)
- Senior Engineer, Environments Automation (ASX Solution Engineering Team)
- Senior Engineer, Environments (ASX Solution Engineering Team)
- Test Environment Analyst (ASX Solution Engineering Team)

On 3 August 2023, ASX confirmed that for the roles under the ASX Solution Engineering Team, the responsibilities are documented under the 'TEM Delivery & Support Services Catalogue' page, which has been shared as additional evidence.

ASX Action 8 - Specify standardised test data and test environment requirements aligned to risk-based pathways

The QE&T Policy includes a section titled 'QE&T Standards' which covers the following in detail:

- Minimum Testing Standards
- Testing Assessments
- Risk Based Testing Standards
- Quality Maturity Standards

Under 'RBT Standards', ASX has identified the minimum acceptable standards and evidence for testing, including:

- Test Environment Set-Up
- Test Environment Access
- Test Data Set-Up

The 'QE Strategy - Risk Based Testing' page includes a Test Treatment Library to be used in RBT assessments - the Test Treatments also specify the 'Test Data' and 'Test Environment' that would be appropriate for the 'Test Level', 'Test Type' and 'Test Coverage'.

Furthermore, the QE&T Policy includes a 'Quality Engineering Guidelines' page which includes details for the following:

- **Test Environment Management**
 - Objective
 - Design Principles (including Non-Functional Testing)
 - Outcomes
- **Test Data Management**
 - Objective
 - Design Principles (including Non-Functional Testing)
 - Outcomes

ASX Action 9 - Enhance test data processes, procedures and associated tooling including relation to production data, synthetic data, data governance and customer testing

As stated in the findings for ASX Action 8, under 'RBT Standards' of the 'QE&T Standards' page, ASX has identified the minimum acceptable standards and evidence for testing, including:

- Test Environment Set-Up
- Test Environment Access
- Test Data Set-Up

These are then incorporated into the Test Strategy and Test Plan, and a Test Summary Report is produced after testing has been completed.

Findings for ASX Action 8 also states that the QE&T Policy includes a 'Quality Engineering Guidelines' page which includes details for Test Environment Management and Test Data Management.

In ASX's Test Plan template, there is a section titled 'Test Data and Test Environments', which requires the Test Manager to demonstrate compliance with RBT data and test environment minimum standards by confirming whether there are any variances to the 'Nominated Test Data Approach' and 'Nominated Test Environment' listed in the template - any variances from the minimum standards and the reasoning, need to be documented in the Test Plan.

To set up and plan the required Test Data, ASX specified in their 'Test Plan template' that projects should contact the team below via email:

- **Test Data Services** - provides support with planning and implementing compliant test data approaches
 - Test Data Engagement Request template will need to be completed

In relation to Test Data, if more detail is required, a 'Test Data Approach' template is available to be completed to provide information that would give test practitioners and stakeholders confidence in a planned approach to procuring and using test data - this is then included into the Test Plan. The 'Test Data Approach' template allows capture of detailed test data requirements for the Test Data Scope, including:

- Test data for test levels
- Test data for different test types
- Test data required based on applying various test techniques

As part of the Test Data Scope, the following need to be captured:

- **Test Data Requirement ID** - ID to uniquely identify this test data requirement for reference and traceability
- **Test Data Requirement Summary** - A summary of the test data requirement. The requirements may be defined as granular as needed; a good starting point is to create one Test Data Use Case per Test Treatment identified as part of the associated RBT Assessment
- **Application Name(s), Criticality and Application Owner(s)** - Name, criticality from [REDACTED], and owner(s) of the application(s) where the test data will be used, noting that test data use cases/requirements may span multiple applications and owners
- **Data Owner(s)** - The owner(s) of the related data, noting that data use cases/requirements may span multiple datasets and owners
- **Test Data Requirement Owner** - The person responsible for ensuring the test data requirement is met according to the

required delivery timelines. This may be someone outside the testing team

Under the 'Test Data Management Approach' section of the 'Test Data Approach' template, ASX requires test practitioners to provide details about the test data management approach that applies for the full test data scope, including production data and synthetic data.

A 'Roles and Responsibilities' section is also included, where responsibilities related to Test Data and the name of the person responsible need to be specified for the below:

- Application Owner
- Data Owner
- Test Lead
- Test Manager
- Solution Engineering
- Solution Architecture
- Design Authority
- Data Governance
- Subject Matter Experts (SMEs) and Business Analysts
- Testing Team
- Vendors
- Enabling Roles, including external vendors, developers, app support etc who may be responsible for portions of testing
- Any additional roles identified

Once a test plan has been produced, the General Manager of Engineering and Architecture, as well as the Head of Testing must review and sign off on the Test Plan.

One of the test tools currently listed in the 'Enterprise Test Tool Catalogue' (from the 'QE&T Shared Test Tool Services') is the [REDACTED]. As part of preparing the Test Plan and Test Data Approach, if a Test Manager determines there is a need for data masking or synthetic data, then they would contact the Test Data

Services team to assist using this tool. This shared test tool was assessed and selected by the QE&T Shared Tools Services Team through a confidential RFP process, and the Test Data Services Team uses this tool to complete the Production Test Data Process and the Test Data Generation Process.

ASX shared as part of the evidence submitted how the QE&T Shared Test Tools Services Team conducted the 'Test Data Service - Test Tool Assessment and Selection' process in order to determine that the [REDACTED] was the appropriate tool for ASX, for the purpose of data masking and synthetic data generation. The 'Test Data Service - Test Tool Assessment and Selection' process included review of the mandatory, desirable and optional features (i.e., requirements) that needed to be considered for the new tool. ASX also shared the [REDACTED] which showed this tool as the recommendation from the assessment.

As part of the evidence submitted for this Recommendation, ASX shared an example of a project that completed the Test Data Approach template. ASX also shared an example of another project that used the [REDACTED].

ASX also has an enterprise data management policy (Data Management Policy) which sets out how data is managed across ASX. The key principles of the policy are:

1. Data Governance is the main data advisory authority at ASX
2. Data Ownership is established
3. Data Lifecycle is in place
4. Data Classification is in place for all key Data Assets
5. Data Issue resolution

The policy states that the Data Governance Group is the main data authority at ASX. Data Governance Group (DGG) is an ASX senior management advisory body with authority and responsibility for ASX wide strategic guidance on the handling of data across ASX, chaired by the ASX Chief Operating Officer ('COO'). DGG provides executive leadership and oversight of the implementation of sound data management practices. These are expressed in the form of ASX Data

Management strategy, ASX data related procedures. The operations of DGG are covered by approved DGG Charter.

ASX Action 10 - Integrate planning and estimation processes with ASX delivery framework

As part of Recommendation 6.4.5 submitted by ASX during the December 2022 quarterly review period (Q5), ASX outlined the planning and estimation process taken prior to a Business Case being completed. In preparation for completing the relevant Business Case form, project teams need to firstly determine the costs and efforts of the project, by completing an 'Estimation Template' to gather work estimates in a consistent and standardised manner. A 'Testing Estimation Checklist' is available to guide project teams on what needs to be considered. Please refer to the Q5 quarterly report 'ASX Independent Assessment of IBM Review Recommendations_February 2023 Final Report_10022023' and for full details and findings for Recommendation 6.4.5 and the planning estimation process.

For the submission of this Recommendation (6.2.1), ASX updated the categories in the 'Testing Estimation Checklist' with following points for consideration as part of the estimation process:

- **Test Planning** - changes made:
 - Effort for documenting Test Prioritisation Criteria
 - Effort to select appropriate risk-based test design techniques and to identify, document, and confirm availability of required prerequisites
- **Test Environments** - changes made:
 - Added "Efforts required to change/update configuration of the test environments for different test cases"
 - Added "how much effort to refresh test data" to "Effort to run test environments (e.g. how much allocation required from TEM team; effort and time to refresh test environments; how much effort to refresh test data)"
- **Test Data** - changes made:
 - Effort to complete Data Impact Assessment

- Activities required as a result of data impact assessment outcome and requirements
- **Test Execution (functional and non-functional)** - in particular:
 - Effort to deploy test data (including refresh of test data)
 - Effort to create tests with nominated test design techniques, including analysis to identify and document appropriate scenarios, permutations, and combinations
 - Effort to apply test prioritisation criteria to planned test cases
- **Governance & Quality Assurance (no changes)**
 - Ongoing tracking and reporting of quality metrics
 - Periodic quality review of test artefacts (test cases, defects etc - correct labelling, correct priorities etc)
 - Review, insights etc. for vendor test deliverables (vendor test plans, test execution etc.)
- **Skills/Resourcing** - changes made:
 - Will QE&T Shared Services be required (Test Data Services, Shared Performance Testing Services and Shared Test Tools Services)

As part of the evidence submitted by ASX for this Recommendation, ASX shared an example of the 'Test Estimation' being completed for a project.

ASX Action 11 - Maturity roadmap to ISO29119 L4 CMM

On 31 March 2023, the QE&T Capability Practice provided an update on its target state and roadmap, specially including as part of the 'QE&T Maturity - Path to Maturity for Outcomes and Opportunity Improvements' section that the QE&T Target State is TMMi Level 4. ASX stated that the following maturity steps would be used to assess where the outcomes and improvement opportunities are on a path to maturity:

1. Opportunity Identified - opportunities exist in the form of methods and processes that are unpredictable, reactive, or non-existent (TMMi level 1)

2. Strategy/Policy Developed - delivering an endorsed strategy for the opportunity including awareness, training fundamentals, and socialisation (TMMi level 2)
3. Adoption - adopters are implementing the strategy for their needs and context (TMMi level 3)
4. Measuring Process/Product Quality - using empirical evidence, data and metrics are implemented to determine how successful the strategy has been in achieving its outcomes and purpose (TMMi level 4)
5. Scaling and Optimising - strategy has provided success stories and is widely adopted and implemented across the organisation, continuous improvement of strategies to enable agility, adaptability, and responsiveness to change and opportunity (TMMi level 5)

As part of the evidence submitted for this Recommendation, ASX shared the meeting pack used for the QE&T roadmap update. A view of the 2021/2022 Roadmap (Roadmap of Outcomes and Improvement Opportunities) with what was 'Done' and what has 'Continuous Improvement Underway' was included, as well as the 2023 Roadmap (also indicating what was 'Done', 'Continuous Improvement Underway' and 'Roadmap Future Target').

During the workshop Q7 Recommendation Review Workshop held on 26 July 2023, ASX stated that 'Combinatorial Testing & Tooling (6.2.1)' and 'Test Selection & Prioritisation (6.4.6)' were added to the roadmap for 'Q2 2023' and ASX intends to uplift these services across Q3 and Q4 2023, as per their roadmap. ASX plans to demonstrate measurement through the QETF process every quarter in order to assess whether they are on track to achieving ISO29119 CMMi L4.

ASX Action(s) update Communication Log:

Channel	Description	Date
Meeting	Introductory Lighthouse Session for QE&T Test Leadership Community - Test Optimisation	24/02/2023
QETF Meeting	February 2023 QETF Meeting	28/02/2023
Meeting	Lighthouse Session for QE&T Test Leadership Community - Combinatorial Design Technique	3/03/2023
Meeting (Demo Session)	Test Data Tool Demonstration for Data Governance Infrastructure Architecture Application Test Practitioners - Test Data Management Data Masking	21/03/2023
Meeting	Introductory Lighthouse Session for QE&T Test Leadership Community - Test Optimisation	6/04/2023
Outlook Email	Delivery Excellence - April Awareness Comms. Update on a new QE & T Shared Services team being established which will provide shared test tools services, test data services and shared performance testing services. Includes: 'Awareness_Comms_Final.ppt.pptx'	18/04/2023
Meeting	Lighthouse Session for QE&T Test Leadership Community - TPCF (Test Prioritisation Criteria Framework)	21/04/2023
QETF Meeting Addendum	April 2023 QETF Meeting Addendum	2/05/2023
Meeting	11/05/2023 Business Readiness Session for Business Analysis Community of Practice 17/05/2023 Business Readiness Session for Project Management Community of Practice 25/05/2023 Business Readiness Session for ASX Delivery Framework Working Group	11/05/2023 - 25/05/2023
Meeting	Lighthouse Session for QE&T Test Leadership Community - Test Optimisation	17/05/2023
Outlook Email	Delivery Excellence Phase 1 - Pre-Go-Live Update. Update on changes in the QE&T Space. Includes: 'Pre-Go-live Comms v1.0.pptx'	18/05/2023
	Detailed Review of Test Optimisation changes Includes: TestOptimisation_Lighthouse_Detailed_V1.0.pptx	18/05/2023

	Meeting recording of Lighthouse session held on 17/05/2023	
Outlook Email	Communication that Test Optimisation is now Live	26/05/2023
Outlook Email	Delivery Excellence Phase 1: Test Optimisation. Update for General Managers, highlighting key aspects of Test Optimisation Includes: Test Optimisation GM pack.pptx	14/06/2023
Blog Post	Blog update on Test Optimisation Changes	23/06/2023

Recommendation 6.4.2: Engage customers on re-introduction of performance testing environment

	Executed	Appropriate	Sustainable
ASX Action 1	✓	✓	N/A*
ASX Action 2	✓	✓	N/A*
Recommendation Addressed?	Yes		
Comment	Recommendation has been addressed, as evidenced by the findings outlined below. ASX Actions are deemed appropriate and sustainable.		

*Sustainability not applicable for this ASX Action as it is a one-off activity required to be performed by ASX.

Background/Tasks

Engage the market to understand the benefits and demand for the re-introduction of a performance testing environment. Post market engagement, determine the required implementation, if any.

ASX Action(s)

- 1) Conduct survey with participants to get input on the different types of testing that customers want to be able to do with ASX Trade, and the benefits and relative priority of that testing for them
- 2) Using the survey as input, consider what testing environments would be appropriate and propose whether any changes are required.

Findings

ASX Action 1 - Conduct survey with participants to get input on the different types of testing that customers want to be able to do with

ASX Trade, and the benefits and relative priority of that testing for them

On 28 February 2023, ASX released 'Market Management Consultation 3: ASX Testing Uplift, Environments and Business Continuity Planning (BCP)' (Market Consultation 3) which was the third in a sequence of three formal market consultations (surveys) that ASX undertook following ASIC's expectations of market operators set out in ASIC's Report 708.

In this third market consultation, ASX provided information and sought stakeholder feedback across the following topics:

- Enhancements to ASX Platform Test Strategy
- Simulation Testing with Market Participants
- Market Operators' Interconnectedness
- Improvements to BCP Strategy
- Customer Test Environments

For the 'Customer Test Environments' topic, ASX noted under section '1.6 Summary of Consultation 3' of the market consultation paper that this was related to the IBM Recommendation 6.4.2 and provided the following information which would require feedback through the questions listed in section '6. Customer Test Environments':

- **Content**
 - Explanation and description of the Customer Development Environments and test opportunities offered by ASX
 - Investigate and determine any gaps or potential improvements to the current offering
 - Assess if there is value or drivers for building a dedicated performance test environment
- **Potential Benefits**
 - To maximise functions and availability of testing environments for better quality testing by Market Stakeholders, balancing industry-wide costs and benefits

- **Potential Limitations**

- Designated weekends available for production testing environments

Under section '6.5 Performance and Load Testing Requirements' (a subsection of section '6. Customer Test Environments', ASX included the following questions for stakeholders to respond to in order to understand the demand for a separate performance testing environment:

- **Question 6.1:** Provide any feedback you have on the current ASX CDE environments. What could we add to improve your experience?
- **Question 6.2:** Where is your test environment located in relation to the ASX test environment and how do you connect, i.e., ASX Net, VPN, Colocation? How does this compare to your production application(s)?
- **Question 6.3:** What aspects are important to your performance testing, e.g., latency, rate of message, number of messages, recovery of processes, likeness of Participant settings, products, network topography?
- **Question 6.4:** What aspects of testing cannot be covered unless ASX makes available a production replica performance environment? How often would you be likely to use such a service for performance testing?

As part of the background information under section '6.1 Background', ASX clarified that *"ASX has never offered a separate and dedicated 'performance test environment". During the ASX Trade Upgrade project, ASX decided to remove the term Participant Test Environments (PTE)10 and replace the collective term with Customer Development Environment (CDE/CDE+). The removal of the PTE naming convention is where ASX believe there has been confusion.*

ASX continues to make available two externally facing functional test environments (CDE/CDE+). ASX also makes the production or the 'pre-production' environments available on weekends prior to any major release deployment and during BCP testing days. This section is intended

to describe the externally available environments and to consult on and identify any gaps in requirements or drivers for change."

The Market Consultation 3 was open for a period of approx. 6 weeks and closed on 14 April 2023. ASX invited 26 stakeholders to respond and received 14 written responses from a broad range of stakeholders including:

- 9 x Participants
- 2 x Industry Bodies
- 2 x Vendors
- 1 x Market Operator

Stakeholders provided their feedback by sending responses to questions in the Market Consultation 3 to consultations@asx.com.au, and ASX also provided stakeholders with the option of providing "additional feedback on topics which they feel to be of relevant and which have not already been referenced in this series of consultation papers." If requested by the response provider, ASX organised consultation meetings with stakeholders to better understand the feedback.

During the Q7 Recommendation Review Workshop held on the 27 July 2023, ASX stated that some participants who did not provide a written response to ASX directly would have had their feedback captured by the industry bodies. The industry bodies would have consolidated the confidential feedback they received and provided this to ASX as one response. As a result, the exact response rate is unknown to ASX.

The responses were analysed by the ASX Trade team and summarised feedback and key themes from the market consultation were presented for discussion at the following forums:

- Regulatory Committee on 27 April 2023
- ASX and ASIC Monthly Rep 708 Meeting on 18 May 2023
- ASX Executive Committee on 23 May 2023

On 23 May 2023, ASX subsequently published their 'Response to ASX Market Management Consultation 3: ASX Testing Uplift, Environments and BCP' paper on their website.

ASX Action 2 - Using the survey as input, consider what testing environments would be appropriate and propose whether any changes are required

Following the feedback and analysis of the Market Consultation 3 responses, ASX published in their 'Response to ASX Market Management Consultation 3: ASX Testing Uplift, Environments and BCP' paper (response paper) on their website, which stated that ASX would plan to undertake the following high-level actions as a result of the feedback received:

- Increase the number of BCP events to two per year
- Incorporate new scenarios into BCP testing including an ALC Customer Network failure and CANCEL_ONLY session state functionality
- Develop an improved capability to simulate 'production-like' transaction profiles during BCP and Industry Wide Testing events
- Communicate more prescriptive test plans for BCP and IWT events including expectations on customers
- Continue to collaborate with AMOs on industry testing including scenarios and alignment of dates to minimise risks and impacts on costs and resourcing
- Investigate simulating large trading days in the Customer Development Environments (CDE)
- Extend hours of availability for Exchange Traded Options in the CDE
- Investigate provisioning of a Signal B feed in the CDE (currently available in CDE+ only)

In the response paper, ASX included the background information behind the topic area that required consultation, a summary of the general feedback that had been received, and then ASX responses in relation to the feedback. In particular for the 'Customer Test Environment' topic, ASX stated as part of their response that:

"ASX will develop a capability to simulate a 'production-like' transaction profile to generate public market data for customers to interact with for their individual validation and testing use cases for a subset of symbols.

ASX will investigate simulating a "large trade day" to support customer performance and capacity testing.

ASX CDE environments cater to what is important to customer testing in regard to capacity.

ASX will not build a full production replica environment for customer latency testing. However, the current CDE environments are scaled for production capacity.

ASX notes only one customer conducted any level of "latency testing" during the ASX Trade refresh program IWTs leading up to go-live.

ASX to further extend trading hours in the CDE environments for Options and Tailor Made Combinations.

ASX to investigate offering customers dedicated tradable instruments for testing purposes in the CDE environments.

ASX will investigate Signal B feed in the CDE Environment. Note: this is currently available in the CDE+ Environment.

ASX will update CDE documentation to reflect any enhancements."

As part of the evidence submitted for this Recommendation 6.4.2, ASX shared a redacted version of the raw survey responses to enable EY to determine whether ASX had adequately analysed the feedback and summarised the key themes appropriately as part of their response paper. Based on the raw survey responses received by ASX, some participants indicated that a separate performance testing environment would be beneficial, and some indicated that the existing testing environments were sufficient but suggested some enhancements.

ASX stated that the ASX Trade team conducted several internal sessions to understand the themes behind the feedback collated and to discuss what actions and responses would be appropriate to address the feedback. These internal sessions were not recorded, nor were minutes taken. To evidence that the feedback was taken as input into ASX's decision making EY was provided a copy of the 'Consultation Feedback - Action Plan' Confluence page. This document captured feedback themes

from the Market Consultation 3, ASX's proposed actions to address the feedback, and whether there was internal agreement on the action. This document was consistent with the ASX public report 'Response to ASX Market Management Consultation 3: ASX Testing Uplift, Environments and BCP' dated 23 May 2023, which sets out the stakeholder feedback received to Consultation 3 and ASX's response. As part of the actions outlined for 'Section 6.5 - Performance and Load Testing', ASX stated that 'No additional or new Prod performance environment required' and an 'Agreed' decision was noted next to this item.

ASX Action(s) update Communication Log:

Channel	Description	Date
Website	ASX released 'Market Management Consultation 3: ASX Testing Uplift, Environments and BCP' paper (Market Consultation 3) on the ASX website	28/02/2023
Meeting (In Person and Virtual)	Feedback and key themes from Market Consultation 3 paper shared with Regulatory Committee	27/04/2023
Meeting (Virtual)	Feedback and key themes from Market Consultation 3 paper shared with ASIC at the ASX and ASIC Monthly Rep 708 Meeting	18/05/2023
Meeting (In Person)	Feedback and key themes from Market Consultation 3 paper shared with ASX Executive Committee	23/05/2023
Website	ASX published the 'Response to ASX Market Management Consultation 3: ASX Testing Uplift, Environments and BCP' paper on the ASX website	23/05/2023

Recommendation 6.4.6: Implement test selection and prioritization process

	Executed	Appropriate	Sustainable
ASX Action 1	✓	✓	✓
ASX Action 2	✓	✓	✓
ASX Action 3	✓	✓	✓
ASX Action 4	✓	✓	✓
ASX Action 5	✓	✓	✓
Recommendation Addressed?	Yes		
Comment	<p>Recommendation has been addressed, as evidenced by the findings outlined below. ASX Actions are deemed appropriate and sustainable.</p> <p>EY's experience with Combinatorial Testing (CT) illustrates that organisations have different approaches to the implementation of CT each with varying results. ASX should include CT as part of their 'Continuous Test Process Improvement' program implemented as part of Recommendation 6.1.3 during Q6. This should include an objective assessment of the ongoing impact that CT is having to help define and track improvement initiatives.</p> <p>ASX's methodology for determining whether CT Design Technique (CTDT) should be used for a project is through the Risk Based Testing (RBT) Assessment process, which consists of both objective criteria (i.e., change characteristics) and subjective discussions (i.e., RBT workshop with Test Managers and Subject Matter Experts). The Test Plans are ultimately reviewed and signed off by the Head of Quality Engineering and Testing to confirm that the RBT Assessment</p>		

	<p>was appropriately conducted to support the inputs of the Test Plan.</p> <p>EY suggests including CT in scope for its upcoming IBMR Sustainability Spot Checks engagement to determine ASX's progress in using CT, as ASX has only been able to provide evidence that one project has used CTDT to generate test scenarios.</p>
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Background/Tasks

Design, document and implement a test selection and prioritisation process supported by test design optimization methods and/or combinatorial test tools.

ASX Action(s)

1. Define test selection and prioritisation criteria framework, aligned to ISO29119
2. Define knowledge management requirements for test optimisation and create and implement plan for knowledge base creation
3. Define requirements for test optimisation tool and secure funding
4. Implement test optimisation processes and tools
5. Regular audit/review of test selection and prioritisation framework effectiveness

Findings

ASX Action 1 - Define test selection and prioritisation criteria framework, aligned to ISO29119

As part of Recommendation 6.2.1 also submitted by ASX during this quarterly review period (Q7), ASX introduced as part of its QE Strategy the 'Combinatorial Test Design Technique', which provides detailed guidance and criteria to plan for appropriate risk-based test (RBT)

coverage. This includes processes for planning and executing combinatorial tests, and how to appropriately plan test coverage aligned to risk. The 'Test Treatment Library' section in the 'Risk Based Testing Strategy' contains several 'Test Design Techniques' that may be used for the RBT assessment - ASX has now included 'Combinatorial Test Design Technique' in the Test Treatment Library.

Furthermore, ASX updated the Test Plan template under the subsection 'Test Design Approach' (part of section 'Test Process') to include 'Combinatorial Test Design Technique' as one of the available Test Design Techniques to choose from based on the risk of change from the RBT assessment.

Please refer to Findings for 6.2.1 for details on 'Combinatorial Test Design Technique'.

In addition to the above, ASX has created the 'Test Prioritisation Criteria Framework (TPCF)' as part of its QE Strategy, aligned to ISO/IEC/IEEE 29119-3 - Test selection and prioritisation. ASX states that the TPCF outlines a method for prioritising testing relative to their inherent risk of defect leakage into production. The purpose of TPCF is to be a preventative approach that helps mitigate the risk of testing coverage gaps and defect leakage into production and customer testing environments to within ASX risk appetite. It is not intended to completely eliminate the risk but increase the likelihood of identifying high risks early, so some residual risk may remain.

TPCF is primarily performed by Test Managers (TMs) with other change delivery SMEs such as business analysts, program/project managers, business, domain, and customer representatives all contribute as supporting roles.

Benefits of TPCF include:

- Improved product and process quality through detecting high-risk or critical defects early in the development cycle
- Optimised testing effort/value ratio through tuning of testing scope aligned to risk appetite
- Improve testing effectiveness by optimising testing scope given the delivery constraints e.g. schedule etc.

- Continuous improvement through feedback loops from TPCF implementations

It is mandatory for the TPCF to be applied to:

- All technology changes involving test management (including changes derived from programs, projects, minor works, BAU or other sources)
- All development methodologies (waterfall, agile, hybrid)
- All delivery or development sources (e.g. internal teams, vendor delivery, vendor supplied updates etc)

Test prioritisation is performed at different levels and across the various test phases. For example:

- In the initial test planning stage where RBT process aides testing selection & high-level test prioritisation to be considered for the first time on a change
- During test plan finalisation, agreed test prioritisation criteria drives the order of test creation and execution
- During test design and execution if change scope, testing dependencies e.g. test environment, delivered functionality, or risk profile change due to internal or external circumstances
- If it becomes unfeasible at any point to implement a planned testing scope in the agreed order

Under the TPCF, ASX has provided an overview of the generic Test Prioritisation Process across different test phases (i.e., Test Planning Phase, Test Development Phase and Test Execution & Closure Phase) and outlined the key activities, inputs, outputs, and considerations involved.

In particular, the key outputs for each test phase are:

- **Test Planning Phase**
Key outputs:

- Test Manager will document the test prioritisation criteria and define test priorities to be assigned to tests scenarios/cases in the Test Plan document, and review and approve as per the test planning guidelines
- Raise any residual risks pertaining to test prioritisation through the governing risk management process used on the change (for acceptance into the RAID register or equivalent)
- **Test Development Phase**
Key outputs:
 - The priority of each test case will be recorded in the test management tool based on the prioritisation outcome
 - Test Cases will be traceable to prioritisation criteria as identified in the test planning phase
- **Test Execution & Closure Phase**
 - Test Summary report includes test results by priority and record any variances test prioritisation criteria approach agreed in the test plan
 - Test prioritisation criteria and test priorities can be retained/Re-used to test changes in the future

The below areas are also covered as part of the TPCF:

- Roles and Responsibilities
- Continuous Improvement
- Metrics and Reporting
- Implementation
- Principles & Requirements
- ASX Tooling, Technology and Data

As part of the evidence submitted for this Recommendation 6.2.1, ASX shared an example of a project's Test Plan where the TPCF was applied to testing activities. ASX also shared an example of a project's Test Summary Report showing how tests were executed relative to their priority.

ASX Action 2 - Define knowledge management requirements for test optimisation and create and implement plan for knowledge base creation

As part of Recommendation 6.2.2 submitted by ASX during the March 2022 quarterly review period (Q2), ASX created a centralised 'Quality Engineering Repository' for all testing related policies, procedures, methods and tools, to provide a uniformly accessible and integrated source for reference - this can be accessed via the 'Quality Engineering & Testing (QE&T) Home' page on the Confluence site. The QE Lead for Methods, Processes and Procedures is responsible for establishing and maintaining the central repository. Please refer to our second IE quarterly report 'ASX Independent Assessment of IBM Review Recommendations_May 2022 Final Report_13052022' and for full details and findings for Recommendation 6.2.2.

During the Q7 Recommendation Review Workshop held on 26 July 2023, ASX stated that following the implementation of the centralised QE&T repository (as part of Recommendation 6.2.2 in Q2), ASX has been adding documentation to this knowledge base incrementally, and the guidance and instruction for QE&T practitioners is to visit the central repository if they require anything related to testing.

ASX Action 3 - Define requirements for test optimisation tool and secure funding

This Action has been addressed as part of Recommendation 6.2.1, also submitted during this quarterly review period.

As part of Recommendation 6.2.1, ASX's centralised QE&T Shared Test Tool Services Team assessed, selected and implemented two enterprise test tools to be part of ASX's 'Enterprise Test Tool Catalogue'. These were the:

- [REDACTED]
- [REDACTED]
- [REDACTED]

- [REDACTED]
- [REDACTED]

The 'Test Tool Assessment and Selection' process included review of the mandatory, desirable and optional features (i.e., requirements) that needed to be considered for the new tool. Both these tools were funded by the Head of QE&T as part of the IBMR Program for both Capital Expenses and ongoing Operational Expenses.

Please refer to Findings for 6.2.1 more details, in particular the Findings for Action 4 and Action 9.

ASX Action 4 - Implement test optimisation processes and tools

This Action has been addressed as part of Recommendation 6.2.1, also submitted during this quarterly review period, and through ASX Action 1 for this Recommendation (6.4.6), where ASX has defined the test selection framework (i.e., RBT Strategy) and Test Prioritisation and Criteria Framework (TPCF).

As part of Recommendation 6.2.1, ASX implemented two new test tools ([REDACTED]), specified standardised test data and test environment requirements aligned to risk-based pathways, and enhanced test data processes, procedures and associated tooling including relation to production data, synthetic data, data governance and customer testing. Please refer to Findings for 6.2.1 more details, in particular the Findings for Action 4, Action 5, Action 8 and Action 9.

Additionally, ASX has also established a 'QE&T Shared Performance Testing Services', which exists to support and assist the Lines of Business to provide performance testing services in line with ASX's test policy and strategy. The Shared Performance Testing Services team consists of two full time resources - ASX states these are operationally funded.

Based on the application's requirements, performance testing requirements and risk-based testing assessment, the Test Manager will determine that they need support to conduct performance testing and

engage the Shared Performance Testing Services during the 'Define & Plan' stage of the project.

According to the 'QE&T Shared Performance Testing Services' page on Confluence, the Performance Testing Service Team will:

- Provide an independent expert assessment of performance testing coverage and approach
- Provide guidance, templates, and performance test tools to efficiently plan, implement, execute and report on performance testing
- Provide consistent, centralised performance testing services that uplift the performance test capability across the organisation
- Consolidated knowledge management enabling continuous improvement across the organisation

To engage the Shared Performance Testing Services team, the Test Manager will need to complete the Risk Based Test process and follow the below process:

1. Complete all the required prerequisites using the 'Performance Test Engagement Request' template and email this to the Shared Performance Testing Services Team
2. Shared Performance Testing Services Team will then work with the Test Manager to provide test estimates, contribute or enhance the Test Strategy and/or Test Plan
3. After the Test Strategy and Test Plan is approved, the Shared Performance Testing Service team will work with the project if it team to setup tests, validate access to servers, execute test, gather monitoring data and to analyse the outcome of the performance tests
4. The Shared Performance Testing Service team will ensure the test artefacts are retained by the appropriate delivery teams for future engagements

As part of the evidence submitted by ASX for this Recommendation, ASX shared an example of a project engaging the Shared Performance Testing Services team once the RBT assessment for the project had been

completed (i.e., The RBT assessment indicated performance testing was required). The Shared Performance Testing Services team provided the project with performance testing estimates. The project's Test Strategy and Test Plan included performance testing.

ASX Action 5 - Regular audit/review of test selection and prioritisation framework effectiveness

As stated previously, ASX uses the Risk Based Testing Strategy as its framework for testing selection and the Test Prioritisation Criteria Framework (TPCF) for testing prioritisation.

Both these frameworks are reviewed as part of the QE&T's overall Continuous Improvement Program, which is through the QE Authority - the Quality Engineering & Testing Forum (QETF). The QE Lead for Metrics and Reporting is responsible for gathering the data to be reported at the QETF. As part of Recommendation 6.1.3 submitted by ASX during the sixth quarterly review period in March 2023 (Q6), ASX designed, documented and implemented a Continuous Improvement process for testing. Please refer to our sixth IE quarterly report 'ASX Independent Assessment of IBM Review Recommendations_May 2023 Final Report_12052023' and for full details and findings for Recommendation 6.1.3.

The key metrics reported to the monthly QETF are:

- Risk Based Testing
- Test Coverage
- Defect Management
- eQSI
- Independent Testing Assessment
- Test Quality Index

The metrics for RBT and Defect Management are collected by the QE Lead (Metrics and Reporting) through the raw data, calculated values, and metrics from various RBT and Defect Management measurement plans.

ASX has stated that the aim of test optimisation is to mitigate risk of test coverage gaps and defect leakage into production aligned with ASX Risk

Appetite. The metrics from the RBT and Defect Management measurement plans provide the QETF insight into the effectiveness of the RBT Strategy and TPCF depending on the reported defect leakage metrics. ASX states the goal of the defect leakage metric is to reflect the effectiveness of the end-to-end test process from unit testing to production, with a better score being reflected when defects are either not found or found in earlier phases (i.e., ASX has selected the appropriate tests and prioritised them appropriately, leading to a lower defect leakage percentage).

As part of the evidence submitted by ASX for this Recommendation, ASX has shared the QETF meeting pack for May 2023. This pack included reporting on Quality Measurement Insights, Overview of Quality Measurement Outcomes, RBT Metrics Data, RBT Insights and Recommendations, Defect Management Metrics Data and Defect Management Insights and Recommendations.

ASX Action(s) update Communication Log:

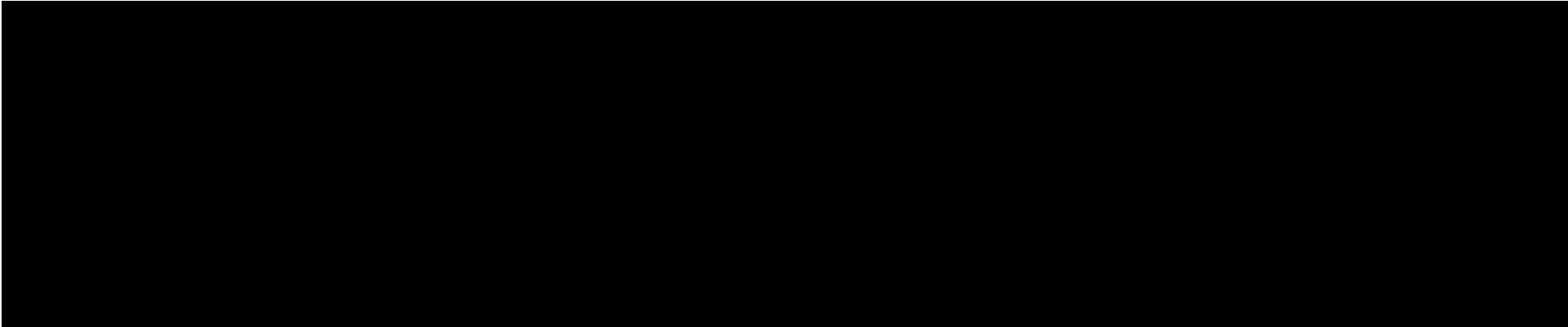
Channel	Description	Date
Meeting	Introductory Lighthouse Session for QE&T Test Leadership Community - Test Optimisation	24/02/2023
QETF Meeting	February 2023 QETF Meeting	28/02/2023
Meeting	Lighthouse Session for QE&T Test Leadership Community - Combinatorial Design Technique	3/03/2023
Meeting (Demo Session)	Test Data Tool Demonstration for Data Governance Infrastructure Architecture Application Test Practitioners - Test Data Management Data Masking	21/03/2023
Meeting	Introductory Lighthouse Session for QE&T Test Leadership Community - Test Optimisation	6/04/2023
Outlook Email	Delivery Excellence - April Awareness Comms. Update on a new QE & T Shared Services team being established which will provide shared test tools services, test data services and shared performance testing services. Includes: 'Awareness_Comms_Final.ppt.pptx'	18/04/2023

Meeting	Lighthouse Session for QE&T Test Leadership Community - TPCF (Test Prioritisation Criteria Framework)	21/04/2023
QETF Meeting Addendum	April 2023 QETF Meeting Addendum	2/05/2023
Meeting	11/05/2023 Business Readiness Session for Business Analysis Community of Practice 17/05/2023 Business Readiness Session for Project Management Community of Practice 25/05/2023 Business Readiness Session for ASX Delivery Framework Working Group	11/05/2023 - 25/05/2023
Meeting	Lighthouse Session for QE&T Test Leadership Community - Test Optimisation	17/05/2023
Outlook Email	Delivery Excellence Phase 1 - Pre Go-Live Update. Update on changes in the QE&T Space. Includes: 'Pre Go-live Comms v1.0.pptx'	18/05/2023
Outlook Email	Detailed Review of Test Optimisation changes Includes: TestOptimisation_Lighthouse_Detailed_V1.0.pptx Meeting recording of Lighthouse session held on 17/05/2023	18/05/2023
Outlook Email	Communication that Test Optimisation is now Live	26/05/2023
Outlook Email	Delivery Excellence Phase 1: Test Optimisation. Update for General Managers, highlighting key aspects of Test Optimisation Includes: Test Optimisation_GM pack.pptx	14/06/2023
Blog Post	Blog update on Test Optimisation Changes	23/06/2023

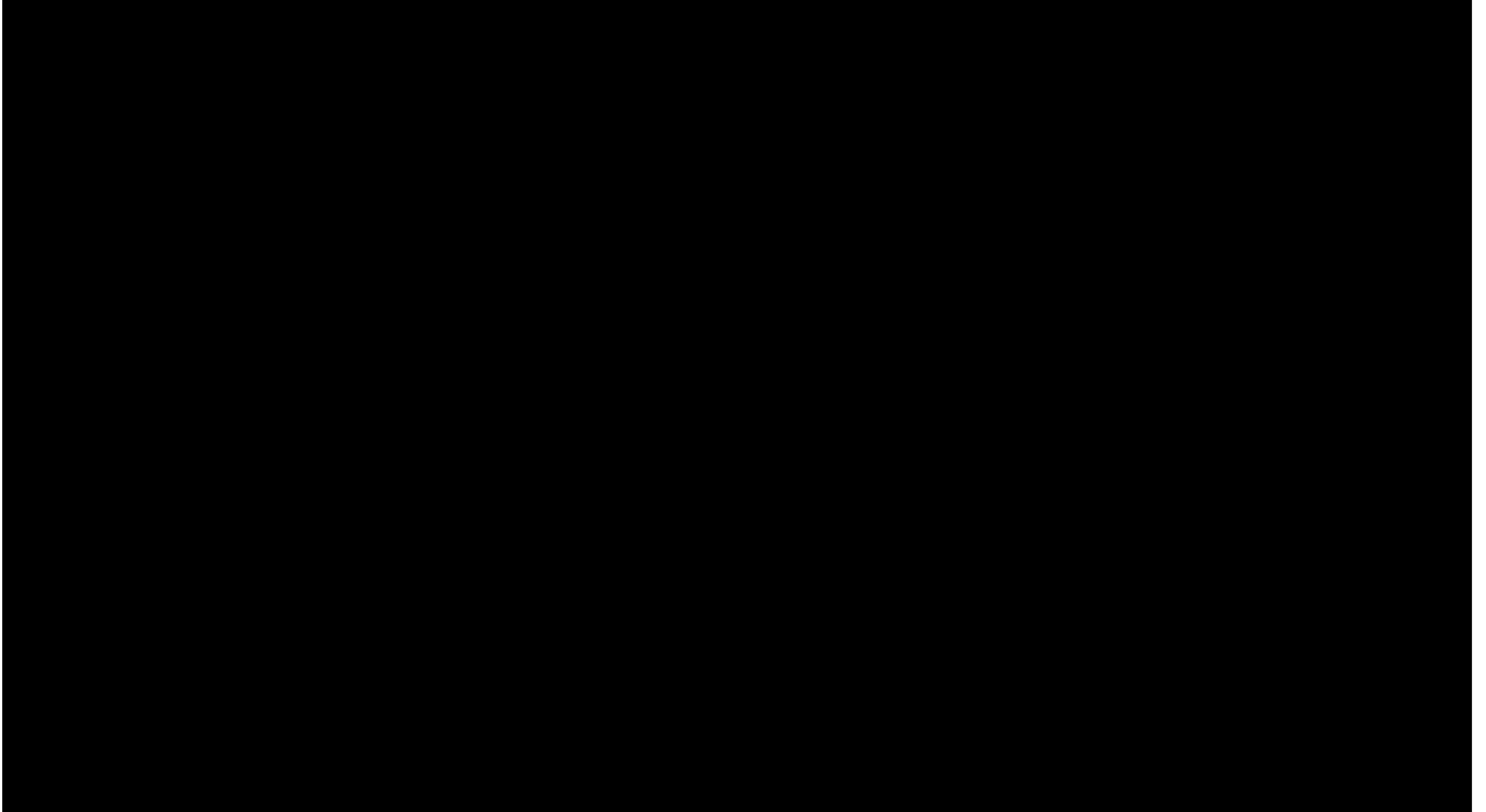
Appendix A Recommendation review workshops list

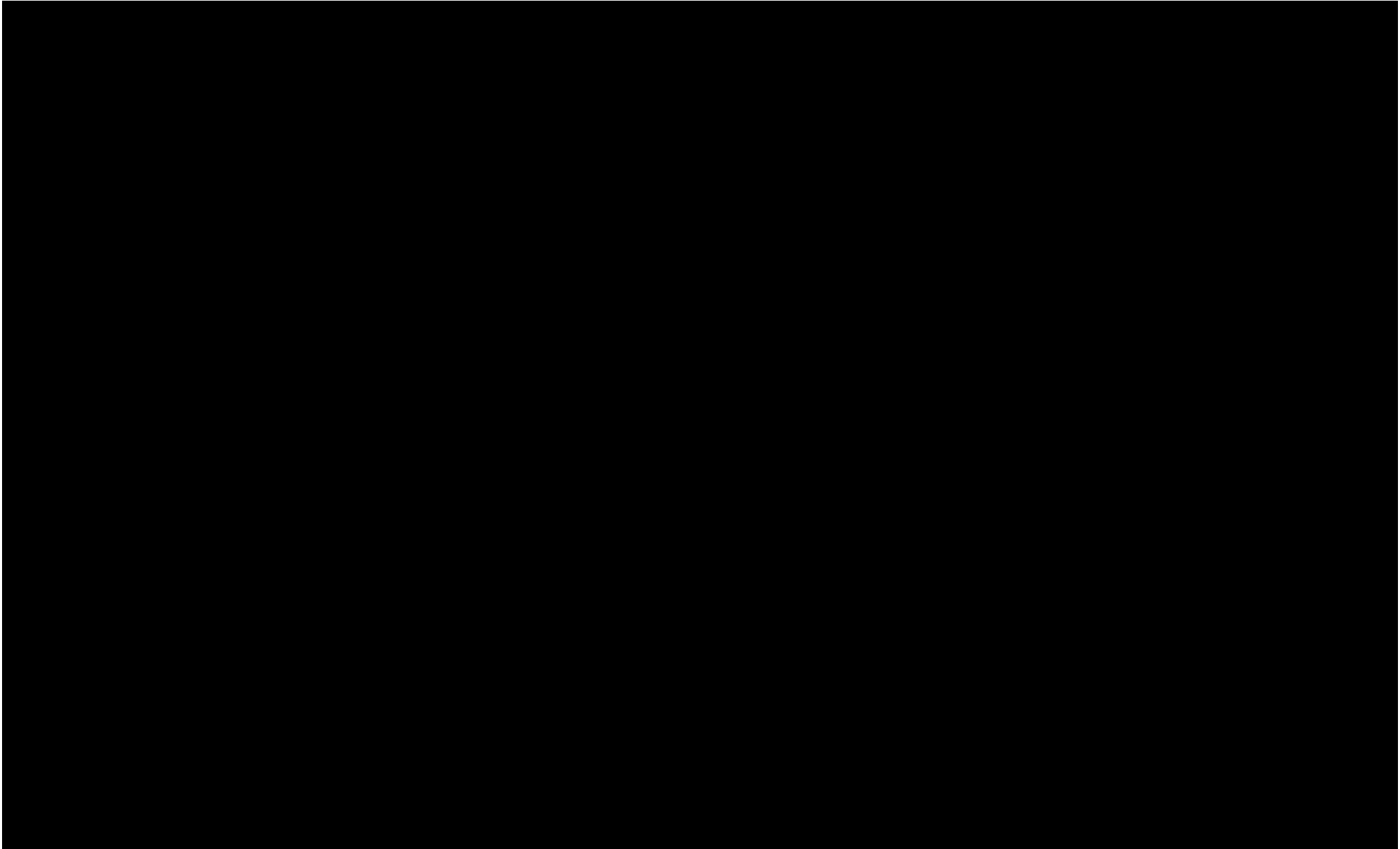
#	Date	Meeting Title
1	26/07/2023	Q7 ASX Remedial Actions - Q&A Review for Recommendations 6.2.1 and 6.4.6
2	27/07/2023	Q7 ASX Remedial Actions - Q&A Review for Recommendation 6.4.2
3	9/08/2023	Q7 ASX IBM Recommendations: EY IE Draft Report Factual Accuracy Check Review

Appendix B Interviewed ASX stakeholders list

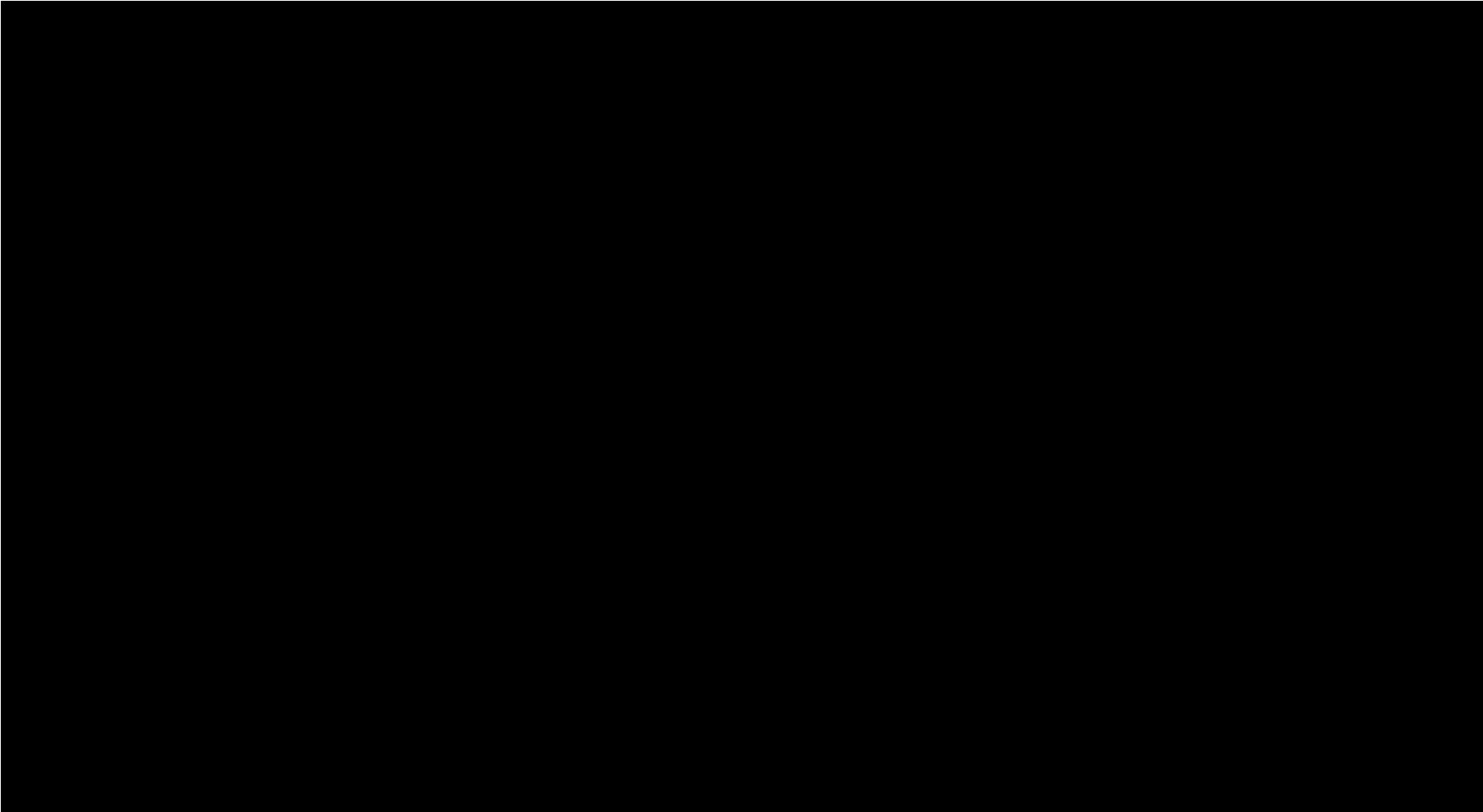


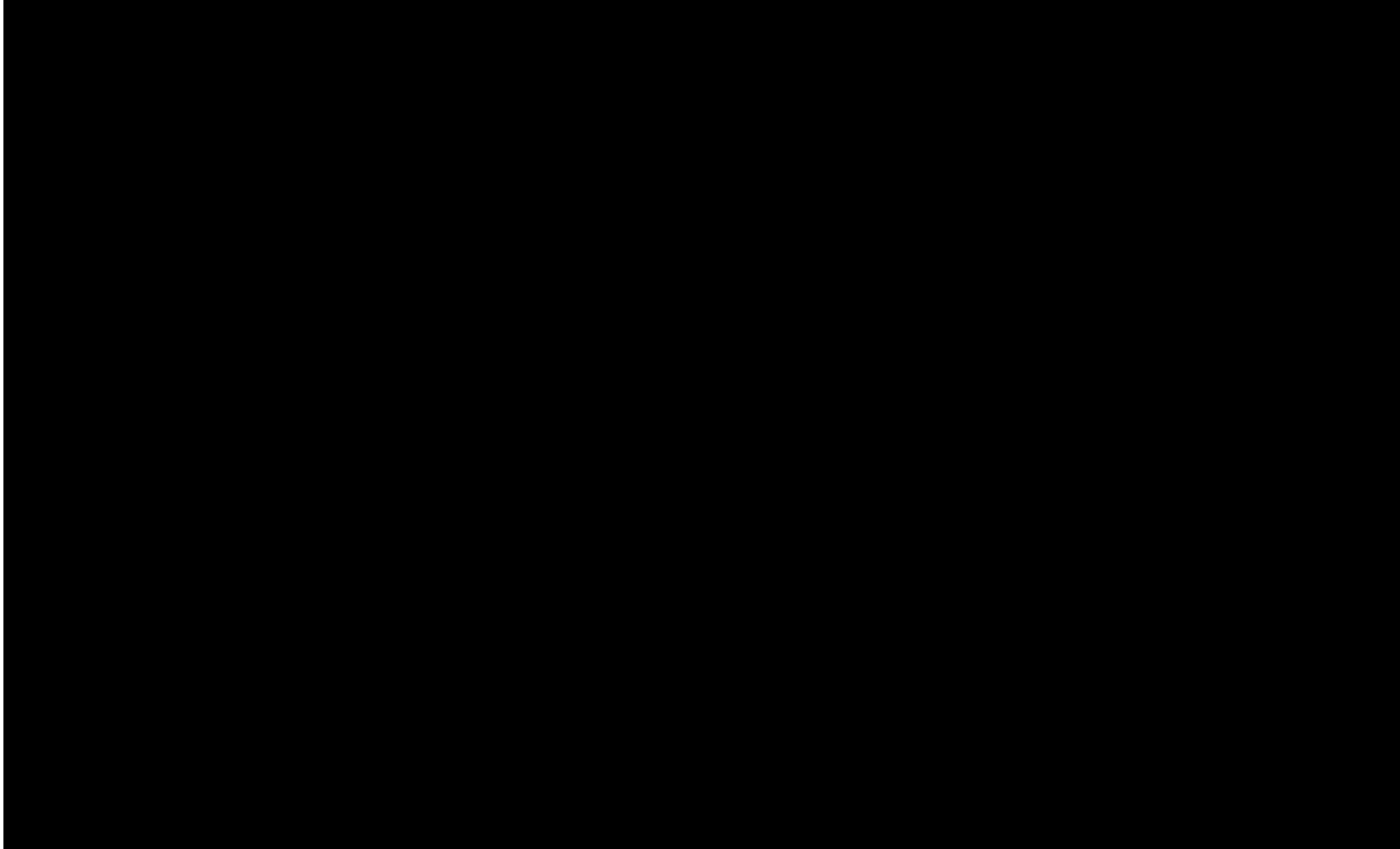
Appendix C Recommendations Questions submitted to ASX post SMR documentation review

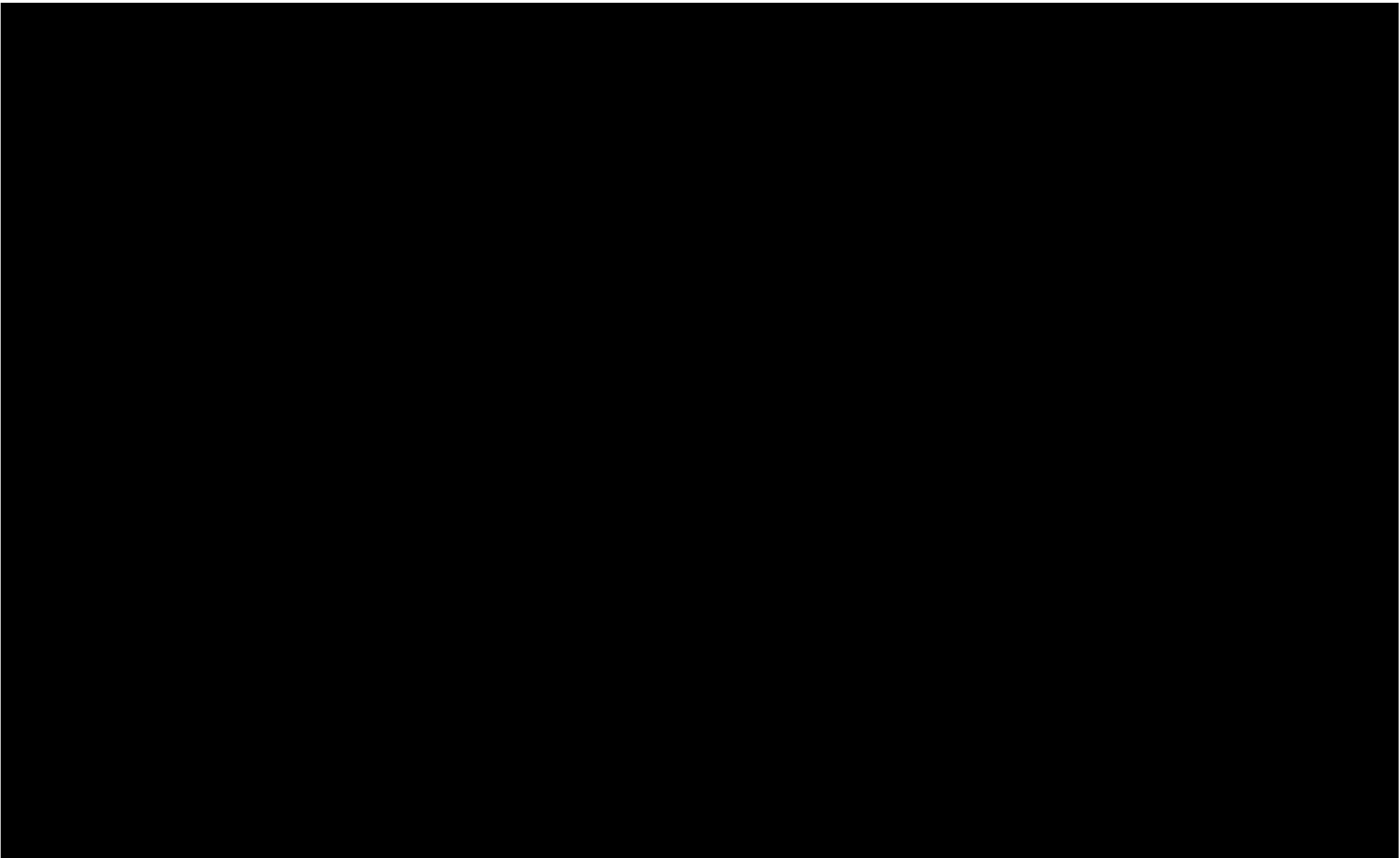


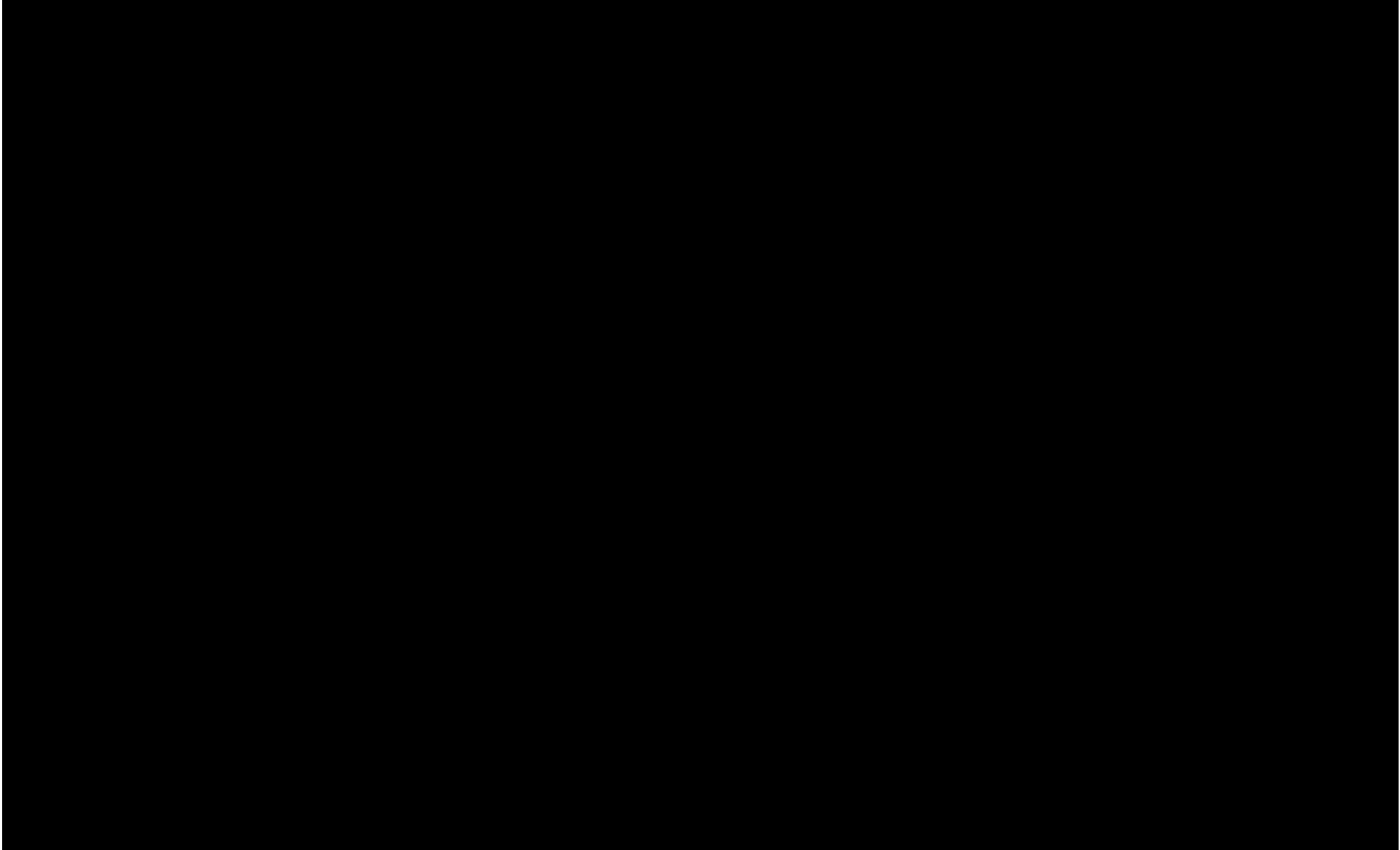


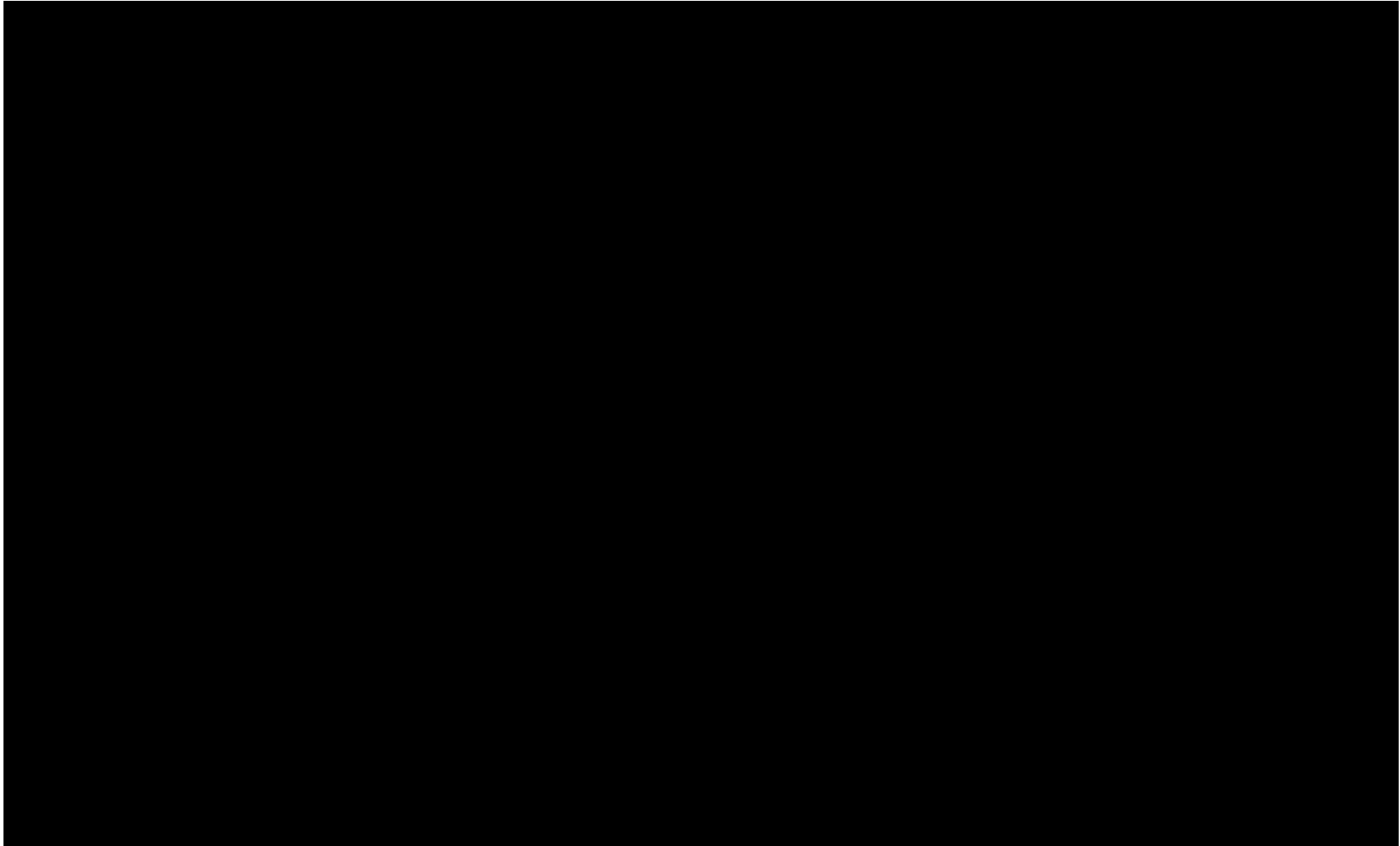
Appendix D Documents reviewed

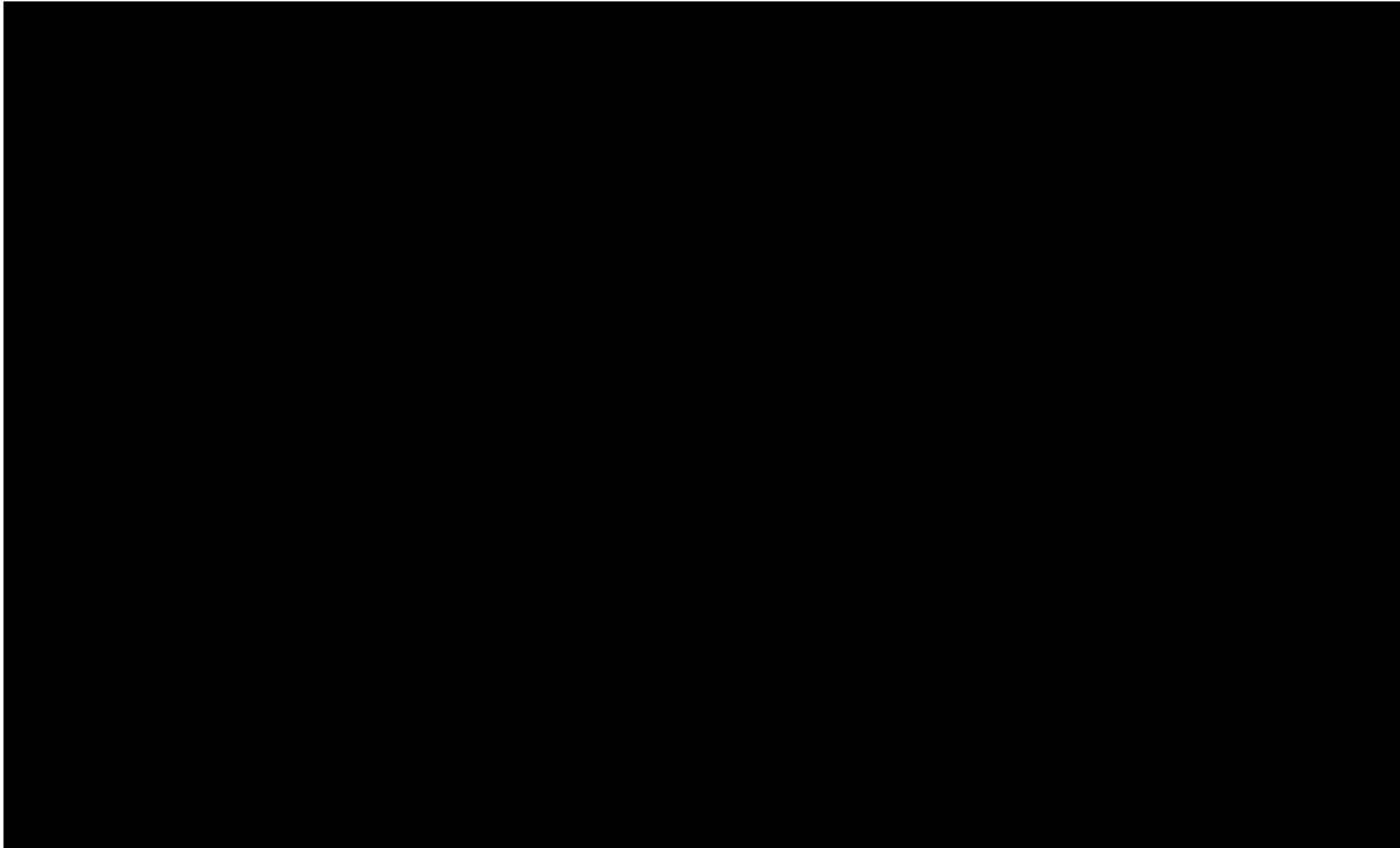












Appendix E Status summary of all 59 Recommendations

ASX has submitted all fifty-nine (59) Recommendations for closure to date and all fifty-nine (59) Recommendations have been deemed as 'fully addressed'.

The Design Adequacy ("DA") Report submitted on 27 April 2022 identified that 13 Recommendations out of the remaining 37 Recommendations which had yet to be submitted at that point in time, were partially addressed and did not have ASX Actions fit for purpose to address the IBM Recommendations. In order for ASX to fully address the Recommendations during the relevant quarterly submission period, ASX should take into consideration the Independent Expert Recommendations for those partially addressed Recommendations in the DA Report.

Below is an overview of each of the 59 Recommendations and their closure / submission status at the end of the seventh and final quarterly review period (11 August 2023):

Status	Description	Total (59)
✔ Closed	Recommendation reviewed by the IE and deemed fully addressed	59
✔ Partially Addressed	Recommendation submitted by ASX, reviewed by the IE but currently deemed partially addressed	0
Not Submitted	Recommendations not yet submitted by ASX (expected due date indicated)	0
✘ Original Submission Date	Indicates the original date Recommendation was submitted by ASX but deemed partially addressed by IE after review. <i>*Applicable for Recommendations deemed fully addressed in subsequent quarterly review periods.</i>	

#	IBMR	Design Adequacy - Fit for Purpose?	Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7 (Current)
1. Risk Related Recommendations										
1	1.1.1	Partial	Closed			✔				
2	1.2.1	N/A	Closed	✘		✔				
3	1.2.2	Yes	Closed			✔				
4	1.2.3	Yes	Closed			✔				
5	1.2.4	N/A	Closed	✔						
6	1.2.5	Partial	Closed			✔				
7	1.2.6	Yes	Closed		✘	✔				
8	1.3.1	N/A	Closed	✔						

#	IBMR	Design Adequacy - Fit for Purpose?	Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7 (Current)
9	1.3.2	N/A	Closed	✓						
10	1.3.3	N/A	Closed	✓						
11	1.3.4	Yes	Closed				✓		✓	
12	1.3.5	N/A	Closed	✓						
13	1.3.6	Partial	Closed		✗	✓				
14	1.3.7	Partial	Closed			✓				
15	1.3.9	N/A	Closed	✓						
16	1.3.10	N/A	Closed	✓						
17	1.4.1	Yes	Closed			✓		✓		
2. Governance Related Recommendations										
18	2.1.1	N/A	Closed	✓						
19	2.1.2	N/A	Closed	✓						
20	2.1.3	N/A	Closed	✓						
21	2.1.4	N/A	Closed	✓						
3. Delivery Related Recommendations										
22	3.1.1	Yes	Closed			✓		✓		
23	3.1.2	N/A	Closed	✓						
24	3.1.3	N/A	Closed	✓						
25	3.1.4	N/A	Closed	✓						
26	3.2.1	Yes	Closed				✓		✓	
27	3.2.2	Partial	Closed			✓		✓		
28	3.2.3	Yes	Closed			✓		✓		
29	3.2.4	N/A	Closed	✓						
30	3.2.5	Yes	Closed			✓		✓		
31	3.2.6	N/A	Closed	✓						
32	3.2.7	N/A	Closed	✓						
4. Requirements Related Recommendations										

#	IBMR	Design Adequacy - Fit for Purpose?	Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7 (Current)
33	4.1.1	N/A	Closed	✓						
5. Vendor Management Related Recommendations										
34	5.1.1	N/A	Closed	✗		✓				
35	5.1.2	N/A	Closed	✗		✓				
36	5.1.3	Yes	Closed		✓					
6. Testing Related Recommendations										
37	6.1.1	Yes	Closed				✓			
38	6.1.2	Yes	Closed					✓		
39	6.1.3	Yes	Closed						✓	
40	6.2.1	Yes	Closed							✓
41	6.2.2	Yes	Closed		✓					
42	6.3.1	Partial	Closed					✓		
43	6.3.2	Yes	Closed			✓	✓			
44	6.3.3	Yes	Closed					✓		
45	6.4.1	Partial	Closed		✓					
46	6.4.2	Yes	Closed							✓
47	6.4.3	Partial	Closed				✓			
48	6.4.4	Yes	Closed		✓					
49	6.4.5	Partial	Closed					✓		
50	6.4.6	Yes	Closed							✓
51	6.4.7	Yes	Closed					✓		
52	6.4.8	Yes	Closed		✓		✓			
53	6.5.1	Partial	Closed			✓		✓		
54	6.5.2	Yes	Closed				✓			
55	6.5.3	Partial	Closed						✓	
56	6.5.4	Yes	Closed				✓			
57	6.6.1	N/A	Closed	✗		✓				

#	IBMR	Design Adequacy - Fit for Purpose?	Status	Q1	Q2	Q3	Q4	Q5	Q6	Q7 (Current)
58	6.7.1	Partial	Closed		✓					
7. Incident Management Related Recommendations										
59	7.1.1	Partial	Closed		✓					

Appendix F Summary of Closed Partially Addressed Recommendations and ASX Actions from previous quarterly review periods

Below is a summary of when partially addressed or not addressed Recommendations and ASX actions from previous quarterly review periods were closed following re-submission by ASX and re-evaluation by the IE.

Q1 January 2022

In the first quarterly report submitted by ASX on 28 January 2022, we identified four (4) out of the twenty-two (22) submitted Recommendations as needing further evidence in future quarters for re-evaluation: 1.2.1, 5.1.1, 5.1.2 and 6.6.1.

ASX submitted all four (4) Partially Addressed Recommendations for re-evaluation in Q3 and these Recommendations have now all been assessed by EY as fully addressed.

Please refer to our third IE quarterly report dated 12 August 2022 for outcome details and commentary.

Q2 March 2022

In the second quarterly report submitted by ASX on 13 April 2022, we identified three (3) out of the nine (9) submitted Recommendations as needing further evidence in future quarters for re-evaluation: 1.2.6, 1.3.6 and 6.4.8.

ASX submitted two (2) of the three (3) Partially Addressed Recommendations (1.2.6 and 1.3.6) in Q3 and one (1) Recommendation (6.4.8) in Q4 for re-evaluation, and these Recommendations have now all been assessed by EY as fully addressed.

Please refer to our third IE quarterly report dated 12 August 2022 and fourth IE quarterly report dated 11 November 2022 for outcome details and commentary.

Q3 June 2022

In the third quarterly report submitted by ASX on 14 July 2022, we identified seven (7) out of the twelve (12) submitted Recommendations as needing further evidence in future quarters for re-evaluation: 1.4.1, 3.1.1, 3.2.2, 3.2.3, 3.2.5, 6.3.2 and 6.5.1.

ASX submitted one (1) of the seven (7) Partially Addressed Recommendations (6.3.2) in Q4 and six (6) Recommendations (1.4.1, 3.1.1, 3.2.2, 3.2.3, 3.2.5 and 6.5.1) in Q5 for re-evaluation, and these Recommendations have now all been assessed by EY as fully addressed.

Please refer to our fourth IE quarterly report dated 11 November 2022 and fifth IE quarterly report dated 10 February 2023 for outcome details and commentary.

Q4 September 2022

In the fourth quarterly report submitted by ASX on 13 October 2022, we identified two (2) out of the six (6) submitted Recommendations as needing further evidence in future quarters for re-evaluation: 1.3.4 and 3.2.1.

ASX has submitted both Partially Addressed Recommendations in Q6 for re-evaluation, and these Recommendations have now all been assessed by EY as fully addressed.

Please refer to our sixth IE quarterly report dated 12 May 2023 for outcome details and commentary.

Appendix G Summary of Closed Design Adequacy Report IE Recommendations

In April 2022, EY produced a report (“Design Adequacy Report”) assessing the design adequacy of the ASX Response Plan to address the IBM Recommendations.

In our Design Adequacy Report, we provided four (4) recommendations (“IE Recommendations”), with two (2) relating to the overall ‘Program governance and management’ by ASX of its Delivery Excellence Program, one (1) relating to the ‘Timing of ASX Actions’ and one (1) relating to ‘Adequacy of ASX Actions’.

ASX submitted responses for all four (4) IE Recommendations in June 2022 (Q3) for assessment and three (3) IE Recommendations were assessed as fully addressed. Please refer to the third IE quarterly review report dated 12 August 2022 for outcome details and commentary.

The remaining IE Recommendation relating to ‘Program governance and management - Change Management Strategy’ was deemed partially addressed in Q3. ASX re-submitted the final IE Recommendation for evaluation in Q5 and it was assessed as fully addressed. Please refer to the fifth IE quarterly review report dated 10 February 2023 for outcome details and commentary.

Please refer to the Design Adequacy Report dated 27 April 2022 to read our detailed findings and commentary.

Appendix H Release Notice

Ernst & Young ("EY") was engaged on the instructions of ASX Operations Pty Ltd ("ASX", "Client" or "you") to conduct an Independent Assessment of ASX's Actions to address the IBM Recommendations ("Project"), in accordance with the engagement agreement dated 22 December 2021 including the General Terms and Conditions ("the Engagement Agreement").

The results of EY's work, including the assumptions and qualifications made in preparing the report, are set out in EY's report dated 11 August 2023 ("Report"). ASX and ASX's regulators ASIC and the RBA, should read the Report in its entirety including any disclaimers and attachments. A reference to the Report includes any part of the Report. No further work has been undertaken by EY since the date of the Report to update it.

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2. EY disclaims all liability in relation to any other party who seeks to rely upon the Report or any of its contents.
3. EY has acted in accordance with the instructions of ASX, in conducting its work and preparing the Report, and, in doing so, has prepared the Report for the benefit of the ASX and ASX's regulators ASIC and the RBA, and has considered only the interests of ASX and ASX's regulators ASIC and the RBA. EY has not been engaged to act, and has not acted, as advisor to any other party. Accordingly, EY

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- (b) must release and forever discharge the EY Parties from any such claim, demand, action or proceedings.

11. In the event that a recipient discloses the Report to a third party in breach of this notice, it will be liable for all claims, demands, actions, proceedings, costs, expenses, loss, damage and liability made or brought against or incurred by the EY Parties, arising from or connected with such disclosure.

12. In the event that a recipient wishes to rely upon the Report that party must inform EY and, if EY agrees, sign and return to EY a standard form of EY's reliance letter. A copy of the reliance letter can be obtained from EY. The recipient's reliance upon the Report will be governed by the terms of that reliance letter.

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