Heavy Vehicle Safety Initiative Final Report

TRANSITION TO ZERO EMISSION BUSES – INDUSTRY ADVISORIES TO SUPPORT THE TRANSITION

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Contents

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We acknowledge the valuable input and feedback from the BIC Zero Emission Bus (ZEB) Committee who gave freely of their time and expertise. Their involvement has ensured that the content of the Advisories is accurate, up to date and covers the complexity involved in transitioning a heavy vehicle fleet to zero emissions and learning from the transition here and abroad. Committee members including Stephen Lucas (Chair of the BIC ZEB Committee), Dean Moule (BIC National Technical Manager) and subject matter experts including bus operators, manufacturers and suppliers, academics and the electrical and hydrogen infrastructure and supply sectors. We also recognise and acknowledge the valuable input from members of the BIC Technical, Safety and Environment Committee and state government agencies.

To the primary authors, we extend our thanks to Luke Hardy and Madonna Woodhouse who led the development of Advisory 1 – Electric Power Train Systems. Thank you also to Tiger Spider who led the development of Advisory 2 – vehicle operations and maintenance and Advisory 3 – fixed systems and infrastructure – and engaged openly with the bus industry, energy, and infrastructure experts across Australia to ensure first class products.

A final thank you goes to Dean Moule who took over project management once Advisory 1 was complete and lead the completion of both Advisory 2 & 3, ensuring they exceeded industry needs and expectations and will be a resource of importance for the bus industry and other heavy vehicle industry members.

Executive Summary

Overview of the project including scope and objectives

The bus and coach industry are early adopters of new technologies. Bus operators, particularly those contracted by governments to deliver public transport services, have been at the forefront of the transition to zero emission heavy vehicles with what was then Australia's largest electrified bus depot, becoming fully commissioned and operational, by the end of 2022. The speed of adoption of ZEB technology was and continues to be significantly faster than government's ability to develop an appropriate policy and regulatory framework to ensure the safe design, configuration, operation and maintenance of these heavy vehicles whose primary function is to *move people*.

At the time that the project was scoped and commenced it was deemed that a regulatory response would be too slow to provide the guidance needed to industry particularly as the ADR development program at the time did not have zero emission heavy vehicles on its radar.

The industry also identified that the policy and regulatory framework needed to be broader than vehicle design rules and cover a broad range of issues including training and skills development, infrastructure (charging and other), safety and emergency management for example.

The solution was for the industry to develop a series of advisories to assist manufacturers and suppliers, operators, and infrastructure providers, first responders and all levels of government transition safely and sustainability to ZEB and operations. Content in the advisories (except components related to passenger safety) would also be applicable to other heavy vehicle sector operators and suppliers.

Consequently, the projects scope was to develop a set of industry advisories that will assist with the safe and sustainable transition to ZEB (and other heavy vehicles) in the absence of regulations. These advisories were to be developed with the assistance of expert technical committees (the ZEB Committee and the BIC Technical, Environment and Safety Committee), input from state and territory and the Australian Governments, the Truck Industry Council, expertise within the BIC membership and drawing upon international best practice and regulation.

The objectives of the project were to

- Ensure operators of zero emissions buses adjust their operations to respond to different safety requirements associated with the new technology.
- Ensure that the manufacture of zero emission heavy vehicles complies with the highest safety standards.
- Increase industry and key stakeholders' knowledge about the safe design, configuration, operation, maintenance of zero emission heavy vehicles.

The aims of the project were to provide the following outcomes:

- Three industry advisories covering

  1) ZEB standards and specifications,

  2) ZEB General Safety –operations and maintenance,

  3) ZEB General Advisory – Fixed infrastructure

- Identification of international best practice and applicable regulation to adopt/adapt in Australia.
- Industry wide and government feedback and input to the draft advisory to ensure the complex topics are appropriately covered, gaps are filled and to allow for widespread industry ownership.

- Advisories designed so they can be called up in state/territory government bus (operator and supplier) contracts helping to overcome the current gap in regulation.
- Increased industry and key stakeholders' knowledge about the safe design, configuration, operation, maintenance of zero emission heavy vehicles through access to advisories and a variety of information exchange channels.

Project need identification.

The need for the project was initially identified at the BIC National Industry Summit where a range of speakers detailed their experiences transitioning parts of the fleet and depots to battery electric. Wide ranging discussions at this Summit highlighted key challenges, opportunities, and risks. The lack of an appropriate policy and regulatory framework nationally was determined to be a significant risk as was the lack of skilled and qualified staff and training pathways.

Advocacy to key political and bureaucratic stakeholders at state and federal levels revealed that the development of a policy and regulatory framework to support the safe transition to zero emissions heavy vehicles was not seen as a matter of urgency despite these vehicles already operating on public roads in Australia.

BIC determined that it was important to fill the void to assist manufacturers and suppliers, operators, infrastructure providers, first responders and all levels of government transition safely and sustainability to ZEB and operations. This approach and need were confirmed via discussions with the newly established ZEB Committee, with members at the National Conference and discussions with colleagues in the heavy freight vehicle sector.

Activities and outcomes.

The core activities that were undertaken was researching, drafting, refining, and finalising the three ZEB advisories. This was undertaken primarily by BIC staff in association with the subcontractors engaged on the project. This process also included site visits to relevant locations, and extensive engagement with the BIC ZEB Committee, Technical, Safety and Environment Committee, subject matter experts (here and abroad) and relevant state, territory, and federal government representatives. This engagement was online, in person and via email. The outcome of this was the development and release of the three industry advisories, namely:

- ZEB standards and specifications,
- ZEB General Safety –operations and maintenance,
- ZEB General Advisory – Fixed infrastructure.

The core activity was accompanied by education and awareness raising activities. These included dedicated webinars to walk participants through the main components of each advisory and allow for clarification and Q&A. ZEB Advisory 1 was also showcased at a National Industry Summit along with the proposed contents of Advisory 2 and 3 to help identify any gaps in the proposed contents. ZEB Advisory 2 and 3 were showcased at national technical webinars that have attendees from across the industry.

The outcome of the project is a valuable and concise resource guide consisting of three industry advisories that address key information needs of the bus and other industries as we transition the fleet to low and zero emission vehicles, whether that be hybrid, battery electric or hydrogen fuel cells. This includes safer vehicles, safer depots, safer on road operations and safer emergency response.

Project Success

Effectiveness

Project outcomes/ impacts?

The project has had a range of outcomes and impacts, proving invaluable for raising awareness and providing education across the industry (operators, manufacturers, suppliers, and governments. Even the experts in their respective fields have gained and broadened their knowledge in other areas.

These resources are now the go-to reference for industry members who are using them as a starting point for their transition or to help refine the pathway if the transition has already commenced. The advisories detail a range of considerations that may not have been thought of reflecting the fact that the transition is not business as usual. This is particularly the case with hydrogen fuel cell vehicles which have been in extremely limited operation in Australia.

They have also assisted operators (and governments) in their decision making on the transition to zero, addressing not only issues associated with the rolling stock but also depot conversion, design, and operation. This will have ongoing safety dividends as most operators will be using a mixed fuel fleet for many years to come.

Were there any unexpected outcomes?

There were a number of unexpected beneficial outcomes in the development of the second and third advisories. The development of these advisories took longer than expected, however the additional time resulted in a more informed industry, and a comprehensive resource for available information.

Second Advisory

Training: There was considerable TAFE course training being finalised or just released along with various micro-skills course at the time of the development of the second advisory. What became clear was a huge missing piece in linking all the training together to provide concise training information pathways for industry.

What the advisory was able to do was to link all this together in a single resource guide and assist everyone (including TAFEs and government) be more aware of what was out there and training pathways for current and future employees in the industry. This will also help our counterparts in other parts of the heavy vehicle industry.

Rescue Information: There was a general lack of knowledge about the ANCAP rescue App and its benefits for industry and first responders. Some government and private operators didn't realise such an App existed or assumed it was only for cars. Raising awareness and encouraging usage of the App for buses, and information within it, provided a better outcome for the industry especially in emergency response plans.

Third advisory

Like the second advisory and training, the fixed systems and infrastructure advisory broadened people perspective and knowledge as it created a comprehensive resource of the information available on these rapidly evolving technologies and detailed how it can benefit the industry (operators, manufacturers, and governments). What became evident during the development of this advisory was that a similar resource had never been produced anywhere globally, so the document was at the leading edge of creating resource information on standards for infrastructure, especially Hydrogen.

How has the project improved safety in the heavy vehicle industry?

The benefits of the advisories from a safety perspective have been both tangible and intangible. Demonstrating this is best left to some of our industry experts, who provided their thoughts on the impact these advisories have had on their business. Each comment below represents a different sector of the bus Industry.

Volgren Australia – Bus Bodybuilder

The BIC team have created truly valuable documentation with these advisories. They provide clear insights and reference information to safely support the transition to zero emission vehicles into a more sustainable future. Covering everything from regulations, to training they are relevant for all aspects of the industry including operators, suppliers and manufacturers.

Brenton McCallum, Engineering Manager Volgren Australia

Scania Australia – Bus Chassis Supplier

Scania is a leading supplier of sustainable transport solutions across the globe, with a particular focus on the bus sector. We currently have over 100 hybrid electric buses operating in South Australia and Victoria, with a new generation of energy-efficient electric bus chassis set to be introduced over the next 12 months. The BIC advisories have been an invaluable reference guide for our company and customers, assisting in multiple key areas:

- Strategy and Safe Practices: The advisories provide comprehensive guidance on vehicle design and safe practices, reinforcing Scania's leadership in this area.
- Training Material: The second advisory offers clear guidance for our technicians on upskilling pathways and apprenticeships, ensuring that EV electives are included as part of their training.
- First Responders Information: The advisories highlight the importance of the ANCAP Rescue App, which is crucial for our customers.
- Customer Guidance: This has helped both Scania and our customers navigate the complexities of adopting new technologies, including workshop readiness, safety assurances, and transition planning.
- The advisories are designed to be flexible; sections can be read independently to address specific areas of interest. This makes them not only relevant now but also valuable for the foreseeable future. We anticipate that these benefits will extend to the truck sector as it embarks on a similar journey towards new technologies.

Julian Gurney, Sales Director Buses & Power Solutions

CDC Victoria – Bus Operator

The Zero Emission Bus Advisory documents are another fantastic initiative from the Bus Industry Confederation. Building on the first two advisories, it provides bus operators in Australia with valuable information on navigating all aspects relating to the infrastructure requirements for the safe and efficient deployment of ZEBs.

Steven Atchison, General Manager - Business Development

Denso Australia – Heating and Air Conditioning (HVAC) Supplier

The advisories gave us a single knowledge base from which to refer to in establishing the safety and integration aspects of supplying HVAC systems to the industry. We needed to ensure we followed the right regulations and knew how to upskill not just our technicians but staff in general to supply and maintain HVAC systems across the country This was both tools, training, and safety. The advisories provided that guidance.

Matt Rizio, Manager Electric and Thermal Solutions

Gosling Group – Engineering Consultants to the Industry

The ZEB advisories put together by the Bus Industry Confederation have proven to be an invaluable and effective source of information and direction for myself and several clients I represent including local bus body manufacturers as well as large scale multinational complete bus manufacturers. They have assisted local manufacturers align themselves with the accepted safe international standards which will form the basis of the ADR's moving forward effectively preparing them for transition to Zero Emission technology expected from the industry. It has also allowed the large multinational manufacturers the visibility of where Australian regulators are moving and to align themselves in preparation to import their vehicles in a safe and compliant manner. Australian bus regulations have become quite complex over the course of approximately 5-10 years with more stakeholders becoming involved with the industry each with their individual requirements. A tool such as the advisories brings together these stakeholders into one place and allows the industry full visibility of what is expected of them. In terms of Australian bus compliance, the work done by BIC on these documents has provided an invaluable tool for communication within the industry

Christopher Robertson, Senior Mechanical Engineer Gosling Group

Project Evaluation

Did you meet your expected outcomes/ objectives?

There were three project objectives as follows:

Objective 1 - Ensure operators of zero emissions buses adjust their operations to respond to different safety requirements associated with the new technology.

Operators who currently have ZEB in their fleets have been adjusting their operations (on road and in depot) in line with the recommendations in the advisories and based on lessons learnt from very early adopters nationally and international. Over the past three years BIC and state bus associations have had a focus on awareness raising and informing the industry about best practice and lessons learnt in the roll out of ZEB. Discussions with operators across the country has revealed that they are using the advisories as the starting point for their transition.

Objective 2 - Ensure that the manufacture of zero emission heavy vehicles complies with the highest safety standards

Suppliers and manufacturers have engaged extensively with the advisories, particularly as the introduction of ADR's 109/00 and 110/00 relating to zero emissions technology for heavy vehicles approached. As noted above the advisories provide clear insights and reference information to safely support the transition to zero emission vehicles for manufacturers.

Objective 3 - Increase industry and key stakeholders' knowledge about the safe design, configuration, operation, maintenance of zero emission heavy vehicles.

The advisories and associated webinars and presentations at Conference and the Summits has increased industry and stakeholder s knowledge. The testimonials above demonstrate the value to the industry.

Project Management Evaluation

Overall

How was the project managed?

The project was managed by a small steering committee that included the BIC Executive Director and the BIC National Technical Director and the Chair of the ZEB Committee. The current National Technical Manager commenced in the role towards the finalisation of the first advisory, subsequently taking over direct project management from the former Technical Manager. In addition, the National Technical Manager coordinated the input from the ZEB Committee and Technical, Safety and Environment Committee, managed the consultants engaged to draft advisory 2 and 3 and liaised with the NHVR and state and territory governments.

Risk Management

What risks were identified during the project? How were these managed?

The following table outlines risks identified during the project and how they were managed.

Risk	Management Action
No precedent, here or internationally, on some aspects of the advisories	In the development of the advisories, especially the 2nd and 3rd books, it became apparent that there was no established precedent in the areas dealing with hydrogen because it was such an emerging technology. Also, the areas regarding infrastructure standards for charging was also new and First Responder information was also developing. This was managed by extensive additional research and engagement with subject matter experts here and overseas.
Scope creep impacts budget and timelines	The project was constantly reviewed against scope and budget. A decision was made that where there was the likelihood of scope creep, if it was an area deemed critical for the advisories the work would continue.
Key staff members no longer available to work on project	The two staff members involved in advisory 1 left BIC at the completion of this stage of the project. Whilst they were replaced it was a while before the project recommenced. Consultants were appointed to assist with the delivery of the remainder of the project.
Project ran over budget	BIC self-funded additional work to complete the project given the complexities identified in the development of the second and third advisories as mentioned earlier in this report.

Stakeholder Management

Who was involved with the project? How were they engaged/ how did they contribute to the project?

There was a broad range of stakeholders engaged in the project. Some were engaged in only one or two aspects whilst others were actively engaged throughout the entire project. The following table summaries involvement.

Stakeholder	Involvement

The multidisciplinary BIC Zero Emission Bus Committee	The ZEB Committee was actively involved in the development and review of the three advisories from concept, draft and final copy. This included providing content, identifying gaps, requirements, subject expertise, future direction, and providing feedback where clarity was required. They were also involved in the design and development of the webinars.
	The 22 committee members represented a wide cross section of the bus and infrastructure industry
	• Bus Suppliers
	  ○ Complete vehicle manufacturers
	  ○ Bus Bodybuilders
	  ○ Chassis Manufacturers
	  ○ Component Suppliers
	• Infrastructure
	  ○ Electrical Energy providers
	  ○ Electrical component suppliers
	  ○ Hydrogen component suppliers
	  ○ Hydrogen energy providers
	• End Users
	  ○ Bus Operators (vehicles)
	  ○ Bus Operators (Infrastructure)
	• Academia (Universities)
	  ○ Electrical energy experts
	  ○ Hydrogen energy experts

The BIC Technical, Environment and Safety (TES) Committee	Covering a similar representative base as the ZEB Committee, the TES Committee provided additional technical input and review as required on areas regarding vehicle specifications, safety, micro skills training, and emergency response planning.
Australian, State and Territory government representatives	In the process of developing the advisories BIC liaised with governments from multiple states regarding regulatory requirements of the vehicle specifications, training and first responders. This provided an opportunity for them to provide feedback on our draft concepts and identify any gaps in the areas we were tackling.
National Heavy Vehicle Regulator	Provided feedback on the edited drafts prior to going to final print. In the case of the second advisory there were several consultations following an NHVR request to include additional hybrid vehicle content.
Truck Industry Council	Provided feedback on the relevance of information collated to their industry.

Project Communications

Detail the marketing and advertising activities that occurred.

The release of each advisory was accompanied by a webinar which was widely advertised across BIC communication channels including e-newsletters and social media. The state bus associations also advertised these webinars to ensure maximum coverage of the industry. An article on the content of each advisory was also included in the relevant months e-newsletter.

Social media posts, including links to the dedicated webpage for the advisory, were used to publicise the release and availability of the advisories.

Issues and barriers to completing the project milestones.

Were there any delays? Did you require any project variations or timeframe extensions?

Transition to different authors

Between the first and second advisories the author of the first advisory ceased working for the Bus Industry Confederation. This resulted in a new search to find a suitable consultant to engage with as an author for the remaining advisories. This search and subsequent time period of onboarding them into the project scope did result in a delay to the engagement of and start of the second and third advisories, resulting in extended timeframe.

Complexity of third advisory

The infrastructure section was a very complex document to write due to the shear amount and complexity and development of regulatory framework around Hydrogen systems. This resulted in an extended timeframe to both gather the information, draft and review the draft, mainly as it had never been attempted before as a single body of work. The outcome was better than anticipated as mentioned earlier in this report, but to cover it properly so it could serve its intended purpose of supporting bus and other automotive industries it took extra time. This also resulted in timeframe extensions, but for a better outcome.

Deliverables

There have been three main deliverables as part of this project. These are as follows:

- **Advisory 1** – Electric Power Train Systems which was released in August 2023 which was ultimately deigned to support incoming ADR's 109/00 and 110/00 relating to zero emissions technology for heavy vehicles (noting that work on this advisory commenced before the Australian Governments decision to develop these ADRS). Content (chapters) of this advisory is as follows:
    1. Componentry of battery and hydrogen zero emissions vehicles
    2. Heavy vehicle regulations in Australia and ADR's.
    3. Recommendations for the adoption of United Nations regulations and website links to the latest regulations:
        A. UN R100 Rev. 3 – Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train.
        B. UN R10 Rev. 6 – Electromagnetic compatibility
        C. UN R134 – Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (HFCV)

D. EC 79/2009 – Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (Note: as a base as R134 does not require all components subject to high pressure hydrogen to be tested and certified)
E. UNR138 Rev. 1 – Uniform provisions concerning the approval of Quiet Road Transport Vehicles with regard to their reduced audibility (QRTV).

4. Review of other related or equivalent international standards and specifications.
5. Future global technical specification – Global Technical Regulation 20 on electric vehicle safety.

- **Advisory 2 –** Vehicle operations and maintenance was released in June 2024. This Advisory is intended to provide guidance on the operation and maintenance of zero emissions vehicles specifically in relation to the new vehicle technology systems such as: battery packs, electrical power control and distribution systems, high-pressure hydrogen storage and distribution componentry, fire protection and emergency response. Content (chapters) is as follows:

1. Requirements of AS 5732:2022 in relation to:
   A. Processes for maintenance and repairs not related to the rechargeable electric energy storage system (REESS)
   B. Processes for maintenance and repairs which involve working with the REESS and associated hazardous voltage systems
   C. Handling and storage where a REESS is removed
   D. Safe Work Practices
   E. Damaged high voltage batteries
   F. Fire safety
2. High pressure hydrogen storage tank safety, maintenance, and inspection requirements
3. High pressure piping and components safety, maintenance, and inspection requirements
4. System Decanting
5. Dangerous goods and transport of lithium-ion batteries
6. Generic maintenance check sheets
7. Electromagnetic emissions testing and safe levels for humans
8. Training and licencing requirements by State
9. Emergency response
10. Summary of related international standards and codes
11. Break down procedures (including towing)
12. Signage and markings for first responders App in accordance with ANCAP requirements ISO 17840-2
13. Inspection and maintenance of on-bus safety signage

- **Advisory 3** – Fixed systems and infrastructure was released end October 2024. This Advisory is intended to focus on the fixed systems and infrastructure needed to support zero emissions vehicles, including:

14. Recharging stations and systems
15. Periodic maintenance of refuelling/recharging infrastructure
16. Hydrogen refuelling/recharging stations
17. Traffic/impact protection.
18. Security
19. Infrared fire protection.
20. Venting
21. Location in depot
22. Depot and operating safety
23. Tunnels and on-road infrastructure
24. Operations in enclosed spaces (for example – tunnels)

The advisories are freely available on a dedicated page on the BIC website https://bic.asn.au/zero-emissions-advisories

The launch of each advisory was accompanied by a webinar open to BIC members and invited guests. The webinars provided an overview of the main components of the advisory, key issues for consideration and allowed time for a Q&A session. These webinars are not publicly available.

Project Transition and implementation

Will the project continue after the completion of the funding?

As the major outputs of this project are written resources for the industry, they will be available after the completion of the project on the BIC website. It is intended, subject to resource availability, that they will be updated as technology and learnings evolve.

The educational component of this project, and the written resources also means that we have an industry which has been upskilled in certain aspects of manufacturing, operating, and maintaining zero emission heavy vehicles, and associated infrastructure. This will have a long-term dividend.

The BIC National Technical Manager is also available to provide advice and assistance to the industry based on their previous experience and learnings whilst undertaking this project.

What strategies are in place to ensure sustainability of the initiative?

As noted above the intent is that these resources will not be static documents but will be updated as technology changes and knowledge evolves. However, this will be dependent on resources.

The transition to zero emissions will be a lengthy process. It is intended that the ZEB Committee will continue well into the future. The committee's role is knowledge development and dissemination across the industry. Further ZEBs will continue to be a significant item at conferences and other industry events well into the future. This will help to ensure the objectives of the project will continue to be delivered beyond the project's lifespan.

Lessons Learned and Best Practices

What worked well?

The collective collaboration of the Committees developing the advisories was highly successful. Their engagement in the process—given that this was a volunteer role on top of their regular responsibilities—was instrumental in shaping the advisories into what they are today. This commitment also ensured that the document reflects a broad range of perspectives rather than just one individual's viewpoint.

Improvement areas:

Reflecting is important and in the washup on the completed series, the improvement we could have made was to have a backup consultant given what happened in the transition between advisories one and two. This would have allowed more time to develop the hydrogen area although this was difficult to foresee, even with the benefit of hindsight.

In future, as part of the planning phase, identifying risks associated with potential change in consultants will be considered in future applications. Recognising this possibility allows us to proactively address any disruptions it may cause in our projects and implement strategies to mitigate these risks, such as establishing a robust onboarding process for new consultants and maintaining a network of potential candidates. This approach will help ensure continuity and support the overall success of our initiatives.

Post Project Recommendations

Identify any gaps or areas that require further work.

The series of documents are in their very nature dynamic and with the fast-evolving pace of new technologies it is worthy that they should be updated to reflect changes so their currency as a valued reference guide is always present. Based on consultation with the ZEB Committee, it is BICs recommendation that these advisories undergo a periodic update every 3-4 years. This is not meant to re-write existing content but incorporate changes that occur over time. As more zero emissions vehicles enter service, there may also be the need to develop additional advisories as new technologies emerge and lessons from operations are learned.

What are the next steps, post funding?

BIC recommend future funding be considered for an update in 3.5 years from now. Funding allocation would initially be estimated at $40k to engage a consultant to review and update relevant content of the advisories. A detailed scope of what content is required to be updated would be developed closer to the date (3 years from now in late 2027 once changes that occur between now and late 2027 are known).

How will future projects be funded?

Funding of all projects at the BIC is determined by the governing body, with priority and necessity being key factors in the Councils consideration. Projects undertaken by BIC are typically funded in one of the following ways:

- from general revenue or reserves.
- sponsored by an industry member,
- funded via a special levy of members or
- via grants or funding provided by Governments.

Appendix 1: References and Related Documents

Three industry advisories are available online at https://bic.asn.au/zero-emissions-advisories/

1) ZEB standards and specifications,
2) ZEB General Safety –operations and maintenance,
3) ZEB General Advisory – Fixed infrastructure