TC-B Barriers Workshop – Geosynthetic Barrier Quality Assurance, Quality Control, and Installation

September 2023

Workshop report by Jonathan Shamrock, compiled from summaries and inputs from the workshop participants.

In September 2023, as part of the 12th International Conference on Geosynthetics held in Roma, Italy, the International Geosynthetic Society, Technical Committee on Barriers (TC-B), held a workshop session on Wednesday 20 September from 14:00 to 16:00 as part of the conference programme.

A panel of invited speakers delivered their experience and insights on the topic of Geosynthetic Barrier Quality Assurance, Quality Control, and Installation. Each presentation is summarized below, with some additional comments from the Q&A sessions at the end of the presentations also captured.

First session chair: Jonathan Shamrock

TC-B Introduction

Jonathan from Tonkin & Taylor Ltd, gave a brief presentation on the activities of the TC-B committee since the last ICG in Seoul in 2018. The activities included:

- Ongoing webinars focusing on specific technical issues of barrier manufacturing, installation and performance. To date 17 webinars have been delivered, with an average registration of over 300 per event, demonstrating the demand for the content. This was also reflected in the over 50 countries typically registering for the webinars.
- Revised barriers in landfill leaflet compiled and published.
- Chapter support, e.g. ACigs forums and webinar delivered to the Philippine chapter in May 2022 on geosynthetics in landfill.
- TC-B session at GeoAfrica conference in February 2023.
- Liaison with IGS Recognition task force for the inaugural Kerry Rowe lecture to be delivered at the 12th ICG in Rome in September which will become a regular feature of future ICGs.
- Preparing TC-B committee list of barrier courses and content for the IGS credentialling programme.
- ACigs webinar panel discussion on Geosynthetics for Sustainable Development delivered on 4 April 2023.
- Joint webinar with TC-H on Service Life of Geomembranes in Hydraulic Applications, 1 June 2023.

Future planned events of the TC-B include:

- Webinar series, focusing on specific technical issues of barrier manufacturing, installation and performance. Please let us know if you have any topics you would like to see discussed.
- Geosynthetic barrier leaflets, similar to the one completed for landfills, focusing on barrier applications, looking for volunteers for this.
- Convert the Philippine webinar into a Geosynthetics in landfill video for the University Lecture series.
- Preparation of a Journal Paper on a Worldwide Database of Guidelines/Regulations using Geosynthetic Barriers.

- Preparing TC-B barrier courses and reviewing the barrier sections of the IGS handbook for the IGS credentialling programme.
- Arranging the next workshop on topical barrier issues, following Munich and Barcelona, venue/timing to be determined, likely 2024.
- Chapter support.
- TC-B sessions at regional conferences.

Boyd Ramsey - To do and not to do during geomembrane installation.
Boyd, an independent consultant from Boyd Ramsey Consulting, highlighted that the topic of geomembrane CQA has been extensively covered in conferences, workshops and publications, including books on the subject. However, there is still evidence in practice that the focus is on the wrong areas, like over specifying the materials, and that under specifying the installation can have disastrous outcomes in terms of liner leak rates. The suggested basic steps to be followed for a successful barrier installation include:

- Decide how much leakage is acceptable – this will guide all other decisions
- Make the site geometry as simple as possible
- Make the penetrations and connections as simple as possible
- Hire and design engineer and geosynthetic installer who are experienced at the level of performance you are seeking
- Use a reputable material supplier
- Hire a CQA firm to watch over all of them

The not to do section of the presentation was summarized with a quote and a with a series of photos showing very poor installation practice, all under the title of "don't do stupid stuff', and as per the saying, pictures are worth a thousand words. The quote used to illustrate the "you get what you pay for" principle is by John Ruskin and is worth considering "*It's unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money - that's all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do. The common law of business balance prohibits paying a little and getting a lot - it can't be done. If you deal with the lowest bidder, it is well to add something for the risk you run, and if you do that you will have enough to pay for something better.*"


Boyd addressing the audience during his presentation

Todd Harman - IAGI update
Todd, from Hallaton Environmental Linings, and the current president of the International Association of Geosynthetic Installers (IAGI), introduced IAGI and described its mission as "IAGI provides a forum for geosynthetics installers to advance installation and construction techniques, and to strengthen the knowledge, image and communication within the industry." IAGI currently has 102 members in 23 countries and runs programs for Certified Welding Technicians (CWT) and Approved Installation Contractor (AIC) which are gaining worldwide recognition. CWT tests are now available online and can be taken online with a Proctor present with the Candidate. Dr. Tim Stark and the FGI have made it possible for the IAGI to administer the CWT test through the University of Illinois. This will save time and expense in taking the written part of the exam. IAGI has also published Installation Guidelines, which are available free of charge on their website www.iagi.org. IAGI is also in the process of drafting a best practice manual for installation of geosynthetics in MSW applications. Having industry generated guidelines and best practice manuals assists with those specifying installation, and these generic documents can be referred to, removing any issues of commercial bias from engineering design documents, and ensuring all installers are competing on a level playing field.

Bruno Herlin - Using the appropriate GCL based on the working conditions/application
Bruno, from Terrafix Geosynthetics, focused on some standard GCL specifications, like GRI GCL3, and how some key elements, that will determine GCL performance, are often not included in these standard specifications. Examples of incorrectly specified GCL's include:

- Double nonwoven GCLs not required to be scrim-reinforced, these type of GCL's should always be scrim reinforced.
- GCLs with a peel strength of only 175 N/m used in pond applications and in mining applications, high shear stress will delaminate the carrier and cover geotextiles if peel strength is too low.
- How nonwoven/wovens GCLs still make up the majority of all specified GCLs on projects, given the impact installation geometry and covering can have on this material.
- How specifications don't list the textile weight on a GCL.

Bruno also focused on how correct specification, specifically double nonwoven scrim-reinforced GCLs, can assist with onsite installation issues like steep slopes, uncovered applications, premature hydration, hydraulic head resistance to avoid internal erosion, rock subgrade and deployment in subzero temperature conditions.

Second session chair: Boyd Ramsey

Sam Allen - Importance and suggestions for QC and QA of Geomembranes and GCLs
Sam, from TRI Environmental and president of the IGS, covered some general concepts on what good geosynthetic Quality Control (QC) and Quality Assurance (QA) should look like. These include:

- Trust but Verify – ALWAYS - at least the POSSIBILITY of third party verification
- NEVER send samples without paperwork / transmittal.
- Special sensitivities with regard to sample representation
- Pre-plan what to do with apparent material failures.
- Be aware of, and plan for, time-dependent testing
- Make sure test results go to those who need them.
- Communicate with manufacturers / laboratories

Sam covered the ongoing work into revised durability assessments for geomembranes, that will take tests, that currently run for weeks or months, and provide an answer in days, like strain hardening to replace the Stress Crack Resistance test. Sam also covered the issues with sampling and testing bentonite from GCL's, and how these tests are applied to powdered vs granulated products, and also

how some tests on whole GCL samples need to make allowance for very slow test rates to get reproducible results.

George Koerner – Interpretation of geosynthetic barriers test results during QA
George, from the Geosynthetic Institute, presented on the differences between Material Quality Control (MQC) and Construction Quality Assurance (CQA). The first thing which was emphasized is that Manufacturing Quality Control is very different from Construction Quality control.

- Quality control in manufacturing (MQC); which is, oftentimes, organized around the ISO 9000 or ISO 14000 protocols and CE Marking
- Quality control in construction (CQC); which should follow the quality manual developed by the installation contractor. Individuals and companies can be certified by the International Association of Geosynthetic Installers (IAGI); see www.iagi.org for details.

The presentation focused only on HDPE geomembranes due to the time constraints. The audience was reminded to consider not only the geomembrane itself but the Incoming Raw Materials, Welding Rod, Geomembrane Finished Product and the Outgoing Inventory & Logistics. The task of the CQC is involved throughout the course of the project. It is involved and requires much coordination and communication. It is aided today by an expert system which keeps the following on track and organized. Inputs to such systems include but are not limited to, Paperwork, Observation, Thickness verification, field tensile tests, seam tests and nondestructive testing results. One of the biggest tasks of the CQA is protection of the geomembrane barrier when backfilling. Puncture from stones must be avoided from above and below. The continuity and appropriateness of the geotextile cushion should be assessed. In no cases should the geomembrane be trafficked by construction vehicles/equipment. At a minimum, soil thickness > 300 mm should be placed over the geomembrane before light ground pressure equipment is allowed to roll over it. In addition to puncture, wrinkles and waves in the geomembrane need to be addressed. Entombed waves (of any size) do not disappear after backfilling. Unfortunately, they are “fixed” in position by friction. Therefore, a height to width ratio needs to be discussed on any wave that is covered. H/W = ¼ are generally the limit due to concerns over lack of intimate contact, residual stresses, and mini-dams. For geomembranes, MQC is almost universally specified by GRM GM13. CQA is the processes followed once the material leaves the factory, and is summarized by the steps shown below:

- Paperwork – MQA data, Bill of lading, inventory list
- Observation – shipping and storage, site observations during deployment, and the difference between a blemish and a defect, condition of subgrade and its impact on liner durability
- Thickness – measurement of thickness, both in the laboratory and the field, and implications of smooth edge thickness being lower than textured area thickness for textured materials
- Tensile – liner deployment method, panel orientations relative to slopes, rub sheets for textured materials to prevent them dragging, sandbags to prevent wind uplift,
- Seams – Peggs 2001 “80% of leaks prior to installation of overlying materials due to poor seaming”, details and penetrations are difficult, and therefore areas of great risk, importance of trial seams prior to production welding, to ensure equipment is dialed into site conditions, test as per GRI GM19. George also noted the work Kerry Rowe is doing in terms of weld thickness reduction and its impact on the long-term durability of the geomembrane in the heat affected zone.
- Non-Destructive Testing (NDT) - the increasing use of automatic hot wedge welders that monitor Temperature, Speed and Pressure of the weld in real time, this makes post seam analysis possible and provides a solid reference for real time weld CQA. This increasing use of digitalization in the welding process gives us the opportunity to incorporate new technologies and improve seaming quality even further. This, with Electrical Leak Location Surveys (ELL)

provide additional tools to limit any impacts defects in the geomembrane manufacture or installation will have on the ultimate system performance.

George finished off with a slide highlighting that good barrier performance requires a Quality System Approach for containment facilities, with the main steps summarized below:

- Good design by Professional Engineer
- Quality materials
- Accredited testing
- Best Available Installation
- Quality Assurance
- Leak Integrity Survey (LIS) prior to commissioning facility
- Careful operations and maintenance
- The use of welding machines with data recording capabilities

Orchestrating this can lead to facilities with very low leakage rates. George commented that they regularly see action leakage rates of 10 gpad (100 lphd) for landfill and 100gpad (1,000 lphd) for surface impoundments in the USA.

Panel discussions facilitated by Amir Shahkolahi (Global Synthetics) – panel consisted of Eddie Weiser (Leister), Bruno Herlin (Terrafix), Boyd Ramsey (Boyd Ramsey Consulting), Todd Harman (Hallaton Environmental Linings) and Jonathan Shamrock (T+T) and facilitated by Amir Shahkolahi (Global Synthetics) - panel consisted of Sam Allen (TRI), George Koerner (GSI), Jonathan Shamrock (T+T), Kent von Maubeuge (Naue)

The discussions focused on current HDPE geomembrane dual track fusion weld welding standards (GRI GM19) only focusing on the completed weld strength for trial and destructive weld testing. The welding process, if not done correctly (high temperature and pressure) can impact the material adjacent to the weld, in the Heat Affected Zone (HAZ) and therefore impact the long-term durability of the geomembrane in this area. This aspect is being investigated by Professor Kerry Rowe and his team at Queens University in Canada, specifically the impact of welded area thickness on Standard Oxidative Induction time of the geomembrane in the HAZ. Based on his recommendations, the German standard DVS 2225-3. "Welding of lining membranes made of polyethene (PE) for the protection of groundwater", should be considered as an additional parameter when evaluating dual track fusion welds. This standard aims at limiting weld thickness reduction, to achieve the specified strength but at the same time prevent the welding process from damaging the geomembrane material. The panel pointed out however that the DVS 2225-3 standard exists in an ecosystem, that also covers the type of material used (BAM) and the actual welding parameters, and that some caution needs to be exercised when picking out specific elements of the standard.

Jonathan Shamrock - Session closure thank you

The 12th ICG was the first real post covid opportunity for the international geosynthetics community to come together. It was a privilege to meet up with friends and colleagues, who haven't seen each other in person since 2020. The workshop session was again a very productive forum to discuss emerging trends/data and have an open discussion with members of the audience contributing to the knowledge sharing in the room. Each panelist was presented with an All Blacks rugby cap, as a small token of thanks.

Photo of the TC-B CQA panelists at the end of the session.

The TC-B then held a separate moment of appreciation for two special people, Kent von Maubeuge and Boyd Ramsay.

Photos of Kent and Boyd shown at the workshop.

Both Kent and Boyd had indicated that they wanted to step back from their roles as past chair and past vice chair, of the TC-B. They have been supporting the committee since 2020, with valuable insights and experience, and we have greatly benefited from their participation in the committee. To acknowledge their contributions, they received a Māori Patu, engraved with the following inscription "In recognition of your outstanding contribution to the Technical Committee Barriers and distinguished service to the Society."

The Patu, or Mere, is symbolic of mana in Māori culture and is often presented to tribal leaders or kaumatua. Mana is a person's prestige, authority, influence and status. Mana is a representation of a person's standing in a community and is something that takes a lifetime to build and acquire. We as the TC-B, and the larger geosynthetic community, have had the benefit of Kent and Boyd's knowledge, wisdom and experience over the years, and we will miss their presence on our committee.

TC-B Chair (Jonathan Shamrock) and TC-B Secretary (Amir Shahkolahi) presenting the Patu to Kent and Boyd in recognition of their service to the TC-B.