Higg Materials Sustainability Index (MSI) Methodology

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SUSTAINABLE APPAREL COALITION OVERVIEW

The Sustainable Apparel Coalition (SAC) is the apparel, footwear and home textile industry's foremost alliance for sustainable production. It was born from a dynamic and unconventional meeting of the minds when, in 2009, Walmart, America's biggest retailer and Patagonia, one of the world's most progressive brands, came together with a radical mission: Collect peers and competitors from across the apparel, footwear and textile sector and together, develop a universal approach to measuring sustainability performance.

Today the Coalition has more than 250 members, including brands, retailers, manufacturers, academic institutions, and non-profit organizations across the global apparel, footwear, and home textile supply chain. Its focus remains the same: develop a standardized supply chain measurement tool for all industry participants to understand the environmental, social and labor impacts of making and selling their products and services. By measuring sustainability performance, the industry can address inefficiencies, resolve damaging practices, and achieve the transparency that consumers increasingly demand. By joining forces in a Coalition, members can address the urgent, systemic challenges that are impossible to change alone. For a comprehensive list of SAC Members visit http://www.apparelcoalition.org/members

HIGG OVERVIEW

Higg is a technology company formed to deliver and support implementation of unified sustainability measurement tools for consumer goods industries, beginning with the Higg Index. The Higg Index is a holistic suite of tools, originally developed by the Sustainable Apparel Coalition (SAC), that enables brands, retailers and facilities of all sizes — at every stage in their sustainability journey — to accurately measure and score a company or product's sustainability performance. The Higg Index delivers a comprehensive overview, enabling businesses to make meaningful improvements that protect the environment, well-being of factory workers and communities. For more information about Higg and the Higg Index tools and services visit www.higg.com

THE HIGG INDEX

The centerpiece of the SAC's work is the Higg Index, a suite of assessment tools that empower brands, retailers, and manufacturers to measure their environmental, social and labor impacts at every stage of the product life cycle. For those just starting to implement sustainable practices, the Higg Index guides their important first steps, helping to distinguish strengths and opportunities for improvement. For those already deeply engaged, it has more advanced potential, such as benchmarking sustainability performance of their supply chain partners and against industry peers, identifying risks and performing targeted research and analytics.

With the Higg Index, SAC aims to accomplish the following goals:

- Understand and quantify the sustainability impacts of apparel, footwear, and home textile products
- Reduce redundancy in measuring sustainability in apparel, footwear, and home textile industries
- Drive business value through reducing risk and uncovering improvement opportunities
- Create a common means and language to communicate sustainability to stakeholders

The Higg Index suite of tools is identified below. More information on each of these tools is available at http://apparelcoalition.org/the-higg-index/

Figure 1. Higg Index Suite of Tools

Higg Brand & Retail Tools	Higg Facility Tools	Higg Product Tools
Higg Higg Brand & Retail Module (BRM)	*Higg Facility Environmental Module (Higg FEM)* *Higg Facility Social/Labor Module (Higg FSLM)*	*Higg Material Sustainability Index (Higg MSI)* *Higg Product Module (Higg PM)* *MSI Contributor*

HIGG INDEX PRODUCT TOOLS

The Higg Index Product Tools include those specifically tied to assessing environmental impacts of products:

- **Higg Materials Sustainability Index (Higg MSI)**: a cradle-to-gate assessment tool for material, trim, and packaging manufacturing that uses life cycle impact assessment (LCIA) data and methodology to measure material impacts and engage product design teams and the global value chain in environmental sustainability.
- **Higg Product Module (Higg PM)**: a cradle-to-grave product assessment tool that uses the life cycle impact assessment (LCIA) data and methodology to measure product manufacturing footprints and the impacts-per-use of those same products. In addition to measuring impacts, the Higg PM provides credible and consistent results for external communication to influence purchasing decisions and scale industry adoption of leading practices.
- **MSI Contributor**: a tool where anyone may submit primary material production data and/or lifecycle analysis results to be reviewed and used to create new materials or processes in the Higg MSI and Higg PM.

The focus of this document is the Higg MSI. Learn more about how Higg MSI methodology is used in other Higg Index Product Tools below under *The Higg MSI Use in Other Higg Index Tools*.

HIGG MATERIALS SUSTAINABILITY INDEX

The Higg MSI is the quantitative underpinning of materials, trims, and packaging assessment in the Higg Index Product Tools. It is a cradle-to-gate material assessment tool that is meant to engage product design teams and the global supply chain in environmental sustainability. The Higg MSI was originally developed by Nike, and in 2012, it was adopted by the SAC and incorporated into the Higg Index. Since then, SAC has been working to expand this index into a tool that can provide value for the entire industry. See *Appendix A: Involved Parties*, for a list of people who have been involved in the evolution of the Higg MSI.

The Higg MSI addresses impacts from the extraction or production of raw materials, through manufacturing and finishing to the point where the material, trim/component, or packaging is ready to be assembled into a final product (referred to as "Material" herein). The declared unit of the Higg MSI is one kilogram. Examples of Higg MSI Materials include cotton, nickel, or EVA foam. The Higg MSI alone does not address the impacts of complete apparel, footwear, or home textile *products*. The Higg PM assesses the cradle-to-grave impacts of apparel, footwear, or home textile products, including finished goods manufacturing and assembly, logistics, consumer use, and end of use in addition to Material production. The Higg MSI is used to complete the Bill of Materials (BoM) of the Higg Product Module, in which users select appropriate Materials.

HIGG MSI COMPONENTS

The Higg MSI has three key components (see sections below for more information):

1) **Taxonomy**: a way to collect and organize material production data.
2) **Materials data**: cradle-to-gate Material production or life cycle impact assessment (LCIA) data. The Higg MSI database holds verified data for raw materials, various Material production processes, and other Material specifications.
3) **Scoring methodology**: a way to interpret the data. In addition to reporting impact midpoints, the Higg MSI includes a scoring framework to translate this data into an environmental score for each impact category.

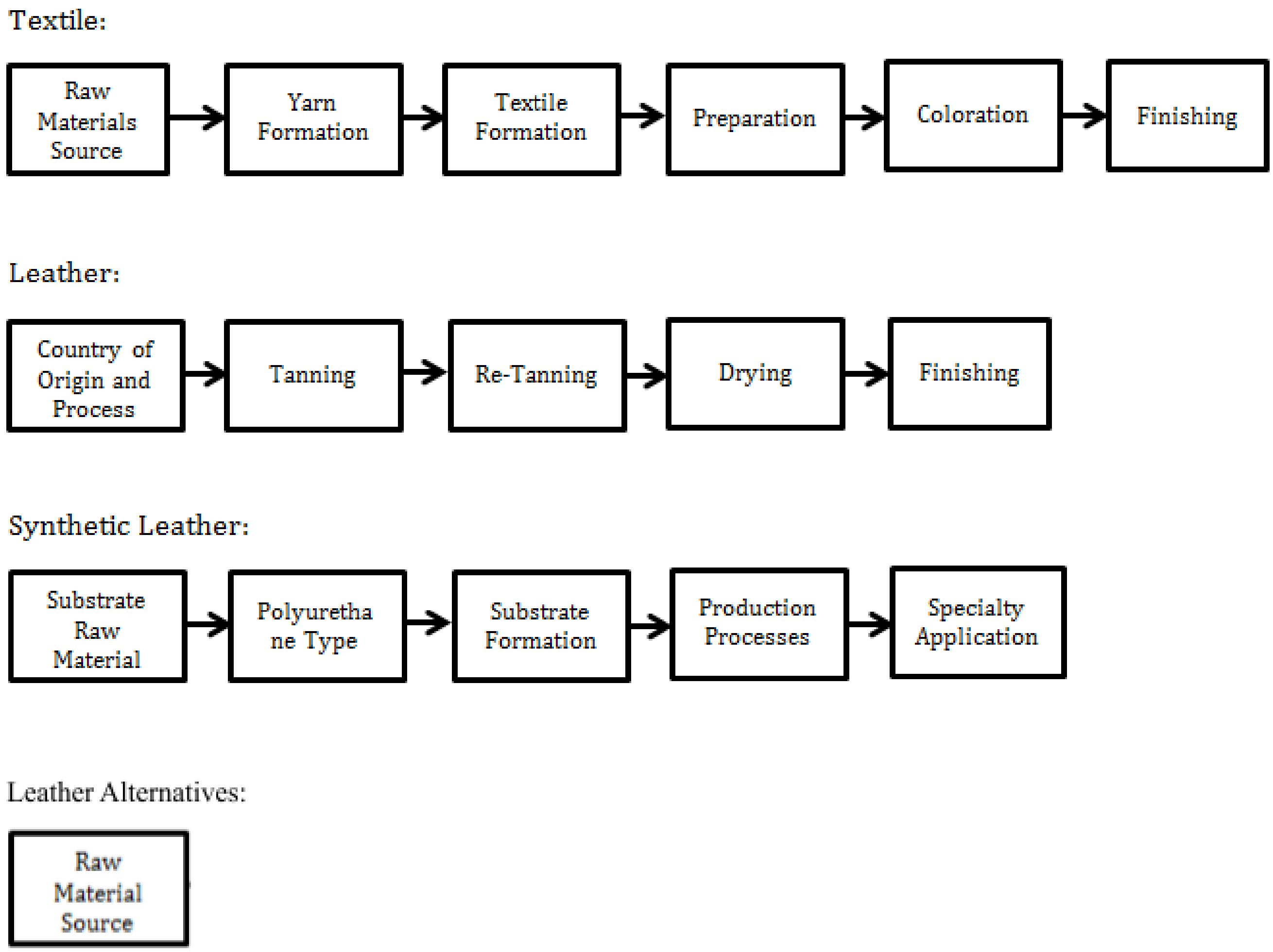
HIGG MSI DATABASE TAXONOMY

The Higg MSI database holds Material production data that is third party reviewed, modeled to determine impacts, and reported according to the Higg MSI assessment framework (see below). This database is organized according to a very specific taxonomy determined by SAC members. This taxonomy defines the following:

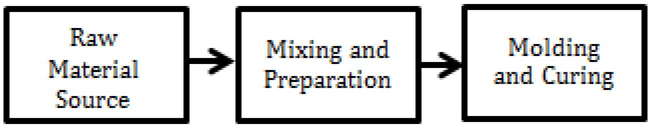
- **Material Categories**: categories of full Materials common in the apparel, footwear, and home textile industry. Current MSI Material Categories include Textiles, Leathers, Synthetic Leathers, Leather Alternatives, Plastics, Rubbers/Elastomers, Foams, Metals, Wood-Based Materials, Insulation Materials, and Coatings/Laminations. Material Categories share a common Production Phase hierarchy.
- **Production Phases**: Material production steps from which various processing options can be used. More than one Production Phase is used to assess a finished Material.
- **Example Materials**: common, generic Materials commonly used in the apparel, footwear, and home textile industries. Example Materials are made up of multiple processes using consistent assumptions as defined by SAC and involved parties (described in *Appendix A*). As part of the development process the task teams decided that all materials should be default modeled as knit fabrics with 200dtex yarn size. *Note: Example Materials are not themselves "average" materials.*
- **Processes**: actual production processes used to create Materials. Different processes could potentially be used within each Production Phase.

The Higg MSI Material Categories and their respective Production Phases are shown in Figure 2 on the following page. Example Materials and Processes can be found in the Higg MSI at https://portal.higg.org/.

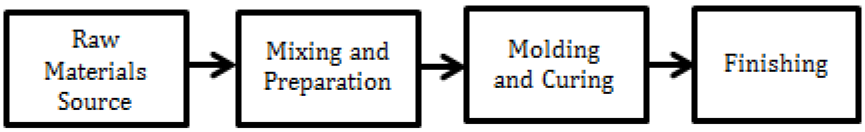
Figure 2. Higg MSI Material Categories and Production Phases



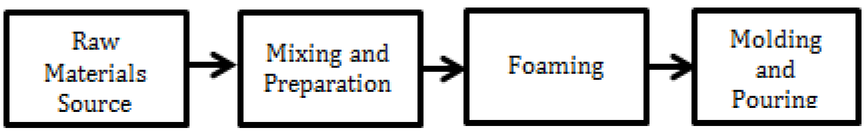
Plastics:



Rubber/Elastomer:

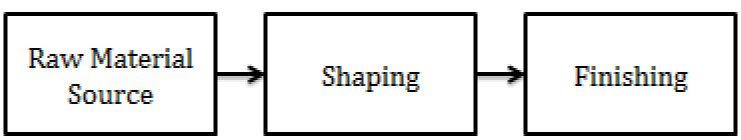


Foam:

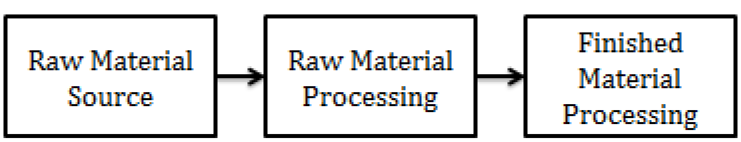


Metal:

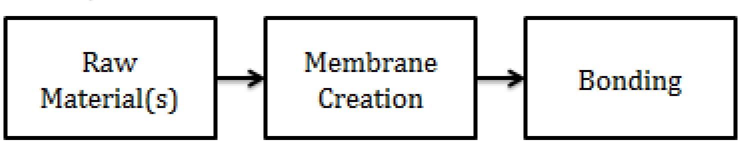
Wood-Based Materials (non-textiles):



Insulation Materials:



Coatings and Laminations:



MATERIALS DATA

Secondary data sources (publicly or commercially available datasets) used in the Higg MSI include GaBi, the World Apparel Lifecycle Database (WALDB), ecoinvent, literature, and SAC member input. The background database used for modeling uses the most current GaBi software version and Service Pack (Sphera).

Primary data (data collected from the site of production) is also collected from the industry for specific processes and raw materials. All data sources and metadata are made visible to Higg MSI users.

The modeling principles used for the construction of this database are based on leading international standards, including:

- GaBi Modeling Principles[1]
- Ecoinvent data quality guidelines (Weidema et al. 2013)[2]
- ISO 14040[3]/14044[4]
- PEF Guide[5]

Detailed information on each process in the database, including specific modeling approaches, allocation approaches, and other technical information can be found in the Higg MSI by clicking on individual processes.

The Higg MSI database holds data for individual production processes within each of the boxes above. The type of data associated with each process includes the following:

Inputs:

- Energy
- Water
- Materials and chemicals
- Agricultural Land

Outputs:

- Product (intermediate output) and amount
- Solid Waste
- Emissions
- Wastewater

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[1] Kupfer, Thilo, Baitz, Martin, et al (2020). GaBi Databases & Modeling Principles 2020.

[2] Weidema, B., C. Bauer, R. Hischier, C. Mutel, T. Nemecek, J. Reinhard, C. Vadenbo and G. Wernet (2013). Overview and methodology. Data quality guideline for the ecoinvent database version 3. St. Gallen, Swiss Centre for Life Cycle Inventories.

[3] ISO (2006a). Environmental management - Life cycle assessment - Principles and framework. Geneva, Switzerland, International Organization for Standardization. ISO 14040:2006.

[4] ISO (2006b). Environmental management - Life cycle assessment – Requirements and guidelines. Geneva, Switzerland, International Organization for Standardization (ISO). ISO 14044:2006.

[5] EC (2013). Product Environmental Footprint (PEF) Guide, Annex II to the Recommendations of the Commission of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organizations, COM (2013) 179. Luxembourg, Official Journal of the European Union, Legislation (L 124), Volume 56, Publications Office of the European Union

Instead of aforementioned detailed data, industry stakeholders may submit independently reviewed LCIA results, or midpoints, that have previously been calculated according to specific requirements defined herein. See *Higg MSI Scoring Framework* below for information on what midpoints are included.

The SAC plans to collect more, higher quality data over time through the following means:

- Data Pull: SAC prioritizes and solicits data from the industry
- Data Push: industry stakeholders submit data to include specific raw materials, processes, or other Material specifications in the Higg MSI

The Higg MSI database is managed in an LCA software platform by a qualified Data Manager. As data is added or updated in the database, updates will be published biannually in the Higg MSI. Maintaining a separate LCA database allows for proprietary information to be protected, for consistent modeling and selection of background data, and for flexibility as measurement, data, and impact methods evolve. All of the datasets for the Higg MSI are assigned a data quality rating as defined in *Appendix B: Higg MSI Data Submission Requirements and Guidelines.*

The datasets used for the Higg MSI are based on best available data, and each dataset was modeled to be as representative of the process as possible. The electricity grid mix used for modeling of textile manufacturing steps (spinning through finished fabric) is based on a weighted average of major textile producing countries.[6]

Consistency with the European Commission (EC) Product Environmental Footprint (PEF)[7] is an important factor for this database. The EC has proposed the PEF as a common way of measuring environmental performance of products. This initiative is currently in a pilot phase and is aimed to calculate products' environmental impact from inception to end of life and then share those findings with consumers via labeling. Therefore, when possible, assumptions and approaches for modeling individual product categories in the Higg MSI were done to be consistent with the corresponding Category Rules from the PEF. All modeling details for individual processes are described in the metadata.

For more information on Higg MSI Data Submission, please review *Appendix B: Higg MSI Data Submission Requirements and Guidelines*.

PRODUCTION STAGE ASSUMPTIONS

As mentioned previously, a Material assessment is made of multiple process selections across different Production Stages. Each Production Stage is linked to the next with additional assumptions that are visible in the tool. These include Process Loss Rates, Transportation Distance/Mode, and Process Chemistry Management.

- **Process Loss Rates**: the amount of the intermediate input from the previous Production Stage that is lost or consumed as part of the process (mass/mass basis). A loss rate of 20% indicates that for every 1kg of input, there is only 0.8kg of output. Alternately, this means that an output of 1kg from that process requires 1.25kg of input. Process Loss Rates are fixed for a process (non-customizable by the user) and were determined using values from secondary data sources,

[6] https://www.wto.org/english/res_e/statis_e/its2014_e/its14_highlights2_e.pdf

[7] http://ec.europa.eu/environment/eussd/smgp/index.htm

expert guidance, and industry methodology such as Textile Exchange's Fiber Conversion Methodology.[8]

- **Transportation Distance/Mode:** the transportation distance and mode (ex. truck, ocean, rail, air) for the inbound transportation from the previous Production Stage. A standard assumption of 200km by large truck is applied, though this can be updated should a user have this information. Transportation impacts are applied using kg-km (i.e. the mass of the incoming material is considered).
- **Process Chemistry Management:** chemistry management certifications and qualifications that are used as part of the Chemistry Impact Method described in *Appendix D: Chemistry Impact Framework.* The default assumption is that no chemistry management certification applies.

HIGG MSI ASSESSMENT FRAMEWORK

The data described above is translated into material impacts and scores through the Higg MSI assessment framework.

LCIA Methodology

In the Higg MSI assessment framework, the data is modeled using widely accepted LCIA methodology to calculate midpoints for the impacts listed below. Midpoints are calculated for a declared unit of one kilogram of Material.

Impact Category	LCIA Method	Unit	Reference
Climate Change	IPCC 2013 GWP 100a	kg CO_2 eq	Intergovernmental Panel on Climate Change. 2013. IPCC Fifth Assessment Report. The Physical Science Basis. http://www.ipcc.ch/report/AR5/wg1
Eutrophication	CML-IA baseline 2013	kg PO_4- eq	Center of Environmental Science of Leiden University (CML). 2013. CML-IA Baseline. http://www.cml.leiden/edu/software/data-cmlia.html
Abiotic resource depletion, fossil fuels	CML-IA baseline 2013	MJ	Center of Environmental Science of Leiden University (CML). 2013. CML-IA Baseline. http://www.cml.leiden/edu/software/data-cmlia.html
Water resources depletion/scarcity	AWARE*	m3	http://www.wulca-waterlca.org
Chemistry	Semi-quantitative impacts (Usetox) + qualitative modifiers	Chemistry Units	Usetox (https://usetox.org/) & SAC Chemistry Task Team. 2018. See Appendix D.

*In the GaBi software there are multiple AWARE methods that represent different characterizations of the unknown geographies. For this project, the EF 3.0 Water scarcity method found under EF 3.0 (Environmental Footprint 3.0) is used.

These LCIA methods were chosen by SAC members and LCA experts/consultants (see *Appendix A: Involved Parties*) based on the following criteria:

- Environmental Relevance/Importance
- Scientific robustness

[8] https://textileexchange.org/wp-content/uploads/2019/09/CFMB_2019_Fiber-Conversion-Methodology.pdf

- Completeness of scope
- Transparency of data sources
- Degree of acceptance in the LCA community
- Data Availability

USEtox methodology was considered to assess Ecotoxicity and Human Toxicity impacts. There are significant methodological and scientific barriers to the application of general toxicity criteria within an LCIA. Currently, all methods evaluated in the ILCD handbook for the assessment of the fate and effects of metal and chemical compounds, including USEtox, suffer from a lack of precision (i.e. a large uncertainty of 2 to 3 orders of magnitude). Therefore, the USEtox characterization factors for metal and many chemical compounds are rated as interim in the USEtox website and should only be used with caution and not for product comparison. A related concern is that relevant chemical substances from a toxicity perspective are not included in a consistent manner in inventory data. It was decided to use a semi-quantitative weighting combined with qualitative modifiers based on chemical management actions to assess chemistry until USEtox proves more relevant and consistent for the apparel, footwear, and home textile industries. This methodology will continue to be considered as it matures. In the meantime, SAC will continue to gather chemicals inventory data for materials. Please see *Appendix D: Chemistry Impact Framework*, for more information on the Higg MSI's chemistry framework for Material production.

Agricultural Land Occupation was originally considered to assess Land Use impacts. However, after further examination it was determined that this metric should not be included in MSI scores because it does not assess the actual impact of that land occupation, such as a loss of biodiversity. Other LCIA methods were considered (such as Soil Organic Matter and Land Use Change), but it was confirmed that no method currently available meets all MSI requirements. SAC will continue to investigate Land Use LCIA methodologies as they are developed and will continue to collect relevant Land Occupation data.

Abiotic Resource Depletion, Minerals was also considered for inclusion in the Higg MSI. Abiotic Resource Depletion, Minerals is an approach that estimates the availability of mineral reserves, based on current technologies for extraction and the economic feasibility of extracting those reserves. There is a high level of uncertainty associated with this method, and interpretation of results is difficult. Additionally, because the MSI normalization focuses heavily on footwear and apparel textiles, the inclusion of Abiotic Depletion, Minerals leads to extremely high impacts for the precious metals that are included in the database (for example, the gold score when including this impact category is over 5,000,000). Given the uncertainty in the assessment and the score results, the results of this impact are considered misleading, which could reduce credibility of the tool. Therefore, it was removed and the Higg MSI only includes Abiotic Resource Depletion, Fossil Fuels.

Abiotic Resource Depletion, Fossil Fuels has a much more straightforward assessment methodology and considers fossil resources necessary to extract materials from the earth. Precious metals still have a large impact, but the environmental relevance, scientific robustness, completeness of scope, transparency of sources, degree of acceptance, and data availability for Fossil Fuels is much higher than those for Minerals.

The WSI Pfister et al. LCIA method was replaced in 2020 with the AWARE model to reflect water scarcity and to align with the Product Environmental Footprint methodology.

See *Appendix C: LCIA Method Criteria*, for more information on why these methods were chosen. The LCIA methods used in the Higg MSI may be updated over time as new and improved methodologies are developed and approved by SAC members.

Normalization

Once midpoints have been calculated for each process using the methodologies mentioned above, the results must be normalized to create MSI scores for each impact category. The purpose of normalization is to contextualize these scores, with ten points per impact category representing the impact of the "average material" (with respect to that impact category). The reference of "average material" for normalization is based on the weighted volume of the Materials most used in the industry (See Table 1). This identifies the largest impacts from the apparel, footwear, and home textile industries, and then sets that as the reference.

SAC members used industry information and shared company information to determine the amounts of main materials used. Sources used to calculate the normalization factors are the following:

- Textile/Apparel volume information (assumed 50% of industry materials):
    - Food and Agricultural Organization, 2013[9]
- Footwear volume information collected from SAC members in 2016 (equally weighted to total 50% of industry materials). Each organization listed the percentage of top materials used by volume (by mass) within their company:
    - Nike to represent athletic footwear
    - VF to represent work and casual footwear
    - Aldo to represent fashion footwear

[9] Food and Agriculture Organization of the United Nations and International Cotton Advisory Committee. World Apparel Fiber Consumption Survey. July 2013. https://www.icac.org/cotton_info/publications/statistics/worldapparel-survey/FAO-ICAC-Survey-2013-Update-and-2011-Text.pdf

Table 1: Aggregated Material Volume

Material	Weighting
Polyethylene (PE) plastic	1%
Rubber, BR	14%
EVA foam	5%
Resin/Adhesive (silicone rubber)	3%
PU foam	1%
Polyurethane	3%
TPU plastic	3%
Polypropylene fabric	4%
Synthetic Leather	2%
Polyester fabric	32%
Acrylic Fabric	1%
Nylon 6.6 fabric	1%
Nylon 6 fabric	1%
Cellulosic fabric	3%
Cardboard	3%
Cotton fabric	15%
Sheep wool fabric	1%
Leather, Cow	6%
Brass	1%

Midpoints calculated for the full Example Materials (raw material through finishing phase) listed in Table 1 were multiplied by these weightings and added together to determine the weighted average material impacts. The normalization factors are then divided by this weighted average impact, per impact category.

Midpoint results for each process and respective impact category were then multiplied by their corresponding normalization factors to produce the number of points for each impact area. SAC will remain active in the LCA community to learn if any normalization and weighting methodologies are developed that could be useful to the apparel, footwear, and home textile industries.

HIGG MSI USE IN OTHER HIGG INDEX TOOLS

The Higg MSI is meant to be used to differentiate Materials for design and sourcing, based on environmental impacts from cradle-to-gate production. The Higg MSI is accessible online at https://portal.higg.org to provide transparency to data, scores, and scoring methodology. This is where users may learn about Material impacts, what is causing those impacts, and different production processes that can be used to reduce impacts. The Higg MSI allows users to customize materials by creating blends and swapping in/out different processes to see how Material scores change.

The Higg MSI has the following functionality:

- Ability to save and compare custom Materials in a Custom Materials library
- Packaging library, comparisons, and customization (assembled from MSI materials)
- Trims and components library, comparisons, and customization (assembled from MSI materials)
- Ability to download Excel export
- Access to LCIA (midpoint) results for each raw material and Process
- Access the biogenic carbon content of each Process
- Access water consumption inventory data for each Process (Water consumption for the full material is available on the Excel export)
- Access Process metadata, including data quality ratings
- Ability to customize transportation between processing steps (distance and mode)
- Ability to share custom materials between accounts

MSI Contributor

Anyone may submit data to the Higg MSI, but the targeted audience for submission is material manufacturers, material trade organizations and academics willing to submit high quality data to SAC. Data is submitted via the MSI Contributor, reviewed, modeled, and scored for the Higg MSI. Using this process, anyone can share material sustainability information and encourage the value chain to use that information in decision-making around Materials. Please review *Appendix B: Higg MSI Data Submission Requirements and Guidelines*, for more information on data submission.

Higg Product Module

The Higg MSI is used in the Higg Product Module to complete the Bill of Materials (BoM) section. The Higg Product Module is used to calculate the environmental impact of a finished product.

HIGG MSI TECHNICAL REVIEW

Prior to the initial launch of the Higg MSI 2.0 in 2016, a Technical Review was conducted by Dr. Gregory Norris, Co-Director of the SHINE Initiative for Net Positive Enterprise within the Harvard T.H. Chan School of Public Health. The review focused on the LCIA data aspects of the Higg MSI, including choices of background, secondary, and proxy data; on the normalization and weighting approaches; and on the technical aspects of the LCIA data modeling. The report concluded sound approaches and decisions were used in each of these areas. Please see *Appendix E: Higg MSI Technical Review Report* for the full report.

While the MSI 3.0 launch in 2020 did not have a dedicated technical review, updates to the MSI methodology were covered as part of the Higg Product Module review. Three independent reviewers were selected and provided feedback through individual reports that was incorporated into the final methodology decisions prior to launch. These reports can be found in *Appendix A: Higg PM External Review Reports and Responses* of the Higg Product Module Methodology document.

APPENDIX A: INVOLVED PARTIES

The Higg MSI 3.0, released in 2020, was an update to the Higg MSI 2.0 that was released in 2016. The core participants in this work include:

SAC Product Advisory Council: The core advisory group of SAC members with textile and LCA expertise that did the bulk of the "heavy lifting" in refining the Higg MSI and methodological decisions.

- Adam Brundage, Nike
- Ben Bowers, WL Gore & Associates
- Claire Boland, PVH *(From Dec 2019)*
- Dhanujie Jayapala, MAS Holdings
- Joël Mertens, MEC *(Until Oct 2019)*
- Logan Duran, PVH *(Until Dec 2019)*
- Michele Wallace, Cotton Incorporated
- Minako Hayashi, Toray
- Seiko Inoue, Asics
- Todd Krieger, Dupont
- Ugamoorthi Ramakrishnan, Eastman Exports

Chemistry Task Team: SAC members from across the value chain with knowledge of chemicals and chemicals management in the apparel and footwear industry. Tasked with evolving the qualitative chemistry methodology from Higg MSI 2.0 using feedback from SAC members and with the goal to continue to move towards a quantitative assessment methodology that provides accurate, directional information. The Chemistry Task Team was active in 2018.

- Allan Williams, CRDC
- Bob Buck, Chemours
- Joël Mertens, MEC
- Michele Wallace, Cotton Incorporated
- Kilian Hochrein, WL Gore & Associates
- Xiaofei Li, Eileen Fisher

Consultants: provided input into MSI methodology changes indirectly through Higg Product Module review and conversations

- Thomas Gloria, Industrial Ecology Consultants
- Gregory Norris, NewEarth B
- Subramanian Senthilkannan Muthu
- Sandra Roos, RISE IVF

SAC and Higg Staff: ensure that the Higg MSI decisions are credible and robust and that the tool and database conform with the developed methodology

- Cashion East, Director of Analytics (Higg)
- Joël Mertens, Senior Manager, Higg Product Tools *(SAC, From Oct 2019)*
- Julie M.H. Brown, Director, Higg Index (SAC)
- Paula Bernstein, Data Manager (Higg)

The core participants in developing the Higg MSI 2.0, released in 2016, are listed below for historical reference:

Duke University Review Team: in 2011, a team of external parties critically reviewed the MSI. Their findings helped shape the direction of how it evolved for its re-release in 2016. The organizations listed are those that each individual represented at the time of the review.

- Jay Golden, Duke University
- Joost Vogtlander, Delft University of Technology
- Keith Weitz, RTI International
- Krishna Manda, Utrecht University
- Martin Patel, Utrecht University
- Neethi Rajagopalan, Duke University
- Richard Vendetti, North Carolina State University
- Roland Geyer, University of California, Santa Barbara

Consultants: consultants were hired to help evolve Higg MSI methodology for the 2016 launch.

- Cashion East, PRe Consultants
- Gregory Norris, Harvard T.H. Chan School of Public Health
- John Jewell, thinkstep
- Krishna Manda, Utrecht University
- Rita Schenck, IERE
- Thomas Gloria, Industrial Ecology Consultants

Materials Core Team: The "heavy lifters". This is a team of SAC members who conduct life cycle assessment or product measurement within their organizations and were actively engaged in developing Higg MSI.

- Adam Brundage, Nike
- Allan Williams, CRDC
- Barruch Ben-Zekry, VF Corporation
- Ben Bowers, Timberland
- Beverley Henry, IWTO
- Francis Mason, INVISTA
- Joël Mertens, MEC
- Kevin McMullan, Toray
- Krishna Manda, Lenzing
- Michele Wallace, Cotton Incorporated
- Stewart Sheppard, WL Gore
- Jeremy Lardeau, Nike

Higg MSI Extended Team: These SAC Members provided valuable feedback on Higg MSI.

- Abi Rushton, Aid by Trade Foundation
- Anna Karlsson Ellison, Cotton Connect

- Bob Buck, Chemours
- Catherine Newman, Nike
- Christian Schuster, Lenzing
- Daniela Koelsch, Bayer Material Science
- Darlene Sharkey, WL Gore
- Elissa Loughman, Patagonia
- Greg Scott, MEC
- Jana Stadler, Adidas
- Jeff Wilson, Textile Exchange
- Les Jacques, INVISTA
- Louisa Holbrook, Burberry
- Rohan Batra, Birla Cellulose
- Shannon Avison, Better Cotton Initiative

Chemicals Assessment Team: These SAC members developed and/or continue to develop the methodology for assessing chemical impacts of materials and material production in Higg Product Tools.

- Anne-Laure Demarcy, TAL Apparel
- Bernhard Kiehl, WL Gore
- Beth Jensen, OIA
- Beverley Henry, IWTO
- Bob Buck, Chemours
- Crispin Wong, Nike
- Greg Scott, MEC
- James Carnahan, Archroma
- Jamie Baindridge, Bolt Threads
- Jeff Wilson, Textile Exchange
- Joël Mertens, MEC
- John Easton, Dystar
- Kevin Myette, Bluesign
- Libby Sommer, Nike
- Mike Cheek, Huntsman
- Peter Gregory, Huntsman
- Susan Sanchez, Disney
- Todd Copeland, Patagonia

SAC Staff: SAC Staff is responsible for ensuring all data supporting Higg methodology is underpinned by best available technical expertise. This includes materials assessment (e.g. chemistry), database development, quality assurance, and data collection, modeling and analysis.

- Betsy Blaisdell, VP, Higg Index
- Julie M.H. Brown, Director, Higg Index

APPENDIX B. HIGG MSI DATA SUBMISSION REQUIREMENTS AND GUIDELINES

Introduction

These *Higg MSI Data Submission Requirements and Guidelines* define the approach, methods and workflow to be used for the submission and review of data meant to change or create Higg MSI scores. Data submissions must adhere to the requirements detailed herein. Reviews will determine if new and/or updated data may be incorporated into the Higg MSI.

Process Summary

Data is to be submitted via the MSI Contributor, part of the Higg Index Product Tool portfolio. Once data is submitted via the MSI Contributor, an MSI Gatekeeper will be responsible for conducting a review of submitted Material production data. Review of Material data will enhance quality and credibility of Higg Index Product Tools by helping to avoid errors and ensuring all method requirements have been appropriately taken into account. If a large number of data sets are submitted, the Gatekeeper will prioritize review by the completeness of the data and if the data will have a large impact on the industry. Order of receipt will then be considered. Based on this review, the Gatekeeper will decide if data meets MSI methodology and quality requirements, and hence may be entered into the Higg MSI. Upon approval by the Gatekeeper, a final review is conducted by the Data Manager to ensure full compatibility with the Higg MSI scoring framework. The Data Manager will also calculate and communicate MSI scores to the submitting entity (referred to as "Data Submitter" herein) to confirm that the Data Submitter is comfortable publishing those scores in the Higg Index Product Tools. Upon confirmation, the MSI results and metadata will be published in the Higg MSI.

Note that new production processes that are unique to the MSI (use technology or equipment not already captured) will be prioritized for review, scoring, and addition to the tool.

The Higg MSI Gatekeeper

The MSI Gatekeeper is responsible for critically reviewing data to ensure that methods used to carry out the data submission are consistent with these Higg MSI Data Submission Requirements and Guidelines, and that the data is scientifically and technically valid.

The Gatekeeper will be responsible for the following:

- Ensuring data submitted follows accepted methodology
- Ensuring data assumptions and limitations are consistent with data submission guidelines
- Determining if calculations are accurate and correctly reflect specified sources
- Confirming data accurately down the supply chain to a practical and possible extent
- Ensuring data reflects the accurate scope, temporal coverage, geographical coverage, and technological coverage as specified in the data submission guidelines
- Confirming the data quality meets specified requirements
- Completing reviews in a reasonable amount of time
- Deciding what is and is not approved for entry into the MSI
- Communicating findings to SAC personnel

- Ensuring data is correctly entered and presented in the MSI Contributor

The Gatekeeper must obtain the following qualifications:

- Knowledge of life cycle assessment (LCA) methodology, LCA for product design and practical experience
- Knowledge of and experience with peer review, verification and audit practice
- Knowledge of and experience with relevant standards (e.g. ISO 14040, 14044, 14025)
- Understanding of environmental impact category indicators
- Has apparel/footwear supply chain experience and an understanding of/appreciation for business decision-making realities
- Demonstrates understanding of/alignment with SAC and Materials Task Team vision, goals and existing structure/operating norms
- Be self-sufficient and able to commit to review, schedule and dedicate sufficient critical review time to each submitted data set.
- Will accept reasonable compensation clearly in-line with deliverables
- Strong communication skills, able to explain complex concepts in easy to understand terms, and must regularly update the applicant and the SAC on progress
- The Gatekeeper should not have any conflicts of interest in their support of the vision and goals of the Materials Task Team

To avoid conflicts of interest, it is necessary that the MSI Gatekeeper does not consult with parties submitting data for inclusion in the MSI. Also during this time, the Gatekeeper may not recuse him/herself. Data generated by the Gatekeeper prior to his/her role as the Gatekeeper may be allowed in data sets if this data was published, peer reviewed, and is approved by the SAC. The Gatekeeper may not assist parties prepare previously collected data for submission via the MSI Contributor. However, the Gatekeeper may inform the Data Submitter how to fix incorrect data. This incorrect data must be corrected by the original party and resubmitted. The Gatekeeper may determine his/her review schedule to align with his/her schedule with the understanding that all reviews must be completed by a specific deadline. This deadline will be communicated between the Gatekeeper, the SAC, and the party submitting data. A list of Materials pending review will be published in the MSI.

Higg MSI Data Manager

The Higg MSI Data Manager is Paula Bernstein, Data Manager at Higg. After data is approved by the MSI Gatekeeper, the Data Manager will conduct a final review of the data and calculate MSI scores.

The Data Manager will be responsible for the following:

- Supporting Data Submitters during the data submission process
- Modeling the data according to the requirements detailed in this appendix (if the submitted data hasn't already been modeled)
- Conducting a final review of the data and communicate any mistakes or inconsistencies to the MSI Gatekeeper, SAC staff, and Data Submitter
- Calculating midpoints and MSI scores

- Once payment for the quality assurance process is processed, communicating MSI scores to the Data Submitter to confirm permission to publish scores in the Higg MSI.
- Transferring midpoints, MSI scores, and metadata to the Higg MSI to be published in a quarterly update
- Ensuring all new MSI data meets a “fair” or better data quality rating
- Ensuring data and MSI scores are aligned with current MSI methodology, even if the methodology changes

The Data Manager must obtain the following qualifications:
- Knowledge of LCA and MSI methodology and taxonomy
- Knowledge of and experience with relevant standards (e.g. ISO 14040, 14044, 14025)
- Understanding of environmental impact category indicators
- Experience conducting LCAs and peer reviews of LCAs
- Demonstrates understanding of/alignment with SAC and Materials Task Team vision, goals and existing structure/operating norms
- Strong communication skills, able to explain complex concepts in easy-to-understand terms, and must regularly update the applicant and the SAC on progress

Review Information

Data submitted may be for the addition of a new raw material, production process, or Material specification into the Higg MSI. It is important that the data be as complete as possible, and have consistent accounting for each input and output submitted. Although it is strongly preferred that data submitted to the Higg MSI be for basic input and output material, energy, and emission flows, submission of existing life cycle impact assessment (LCIA) characterized results, or midpoints, may be acceptable, provided that the Data Submitter can demonstrate that the data meets all of the requirements outlined below under *Higg MSI Requirements for Submission Types 1 and 2.*

Acceptance Criteria

The methods used to collect and report data must be consistent with the following data submission requirements:
- The data were correctly entered into the online platform
- Explanations of material production are clear and relevant production processes are accounted for
- The scope of the data is consistent with the defined boundary conditions
- Sources, vintage of the data (timeframe represented), source types, and methods for data collection are documented
- Methods used for data collection and decision making are scientifically and technically valid Assumptions and limitations are identified and plausible
- All calculations are correct
- All data are verifiable and reproducible
- The data submission is approved by the MSI Gatekeeper
- The processes are organized into the life cycle stages in the Higg MSI taxonomy
- The data quality is at a minimum “fair” or higher quality rated (see Table B3 Quality level and rating for the data quality criteria)

- If an LCIA Submission, data and midpoints must have been previously reviewed by an independent external expert. This expert must not be or have been employed in a full-time or part-time role by submitting organization or the practitioner of the study. This person also must not have been involved in defining the scope or conducting the LCIA. A review report must be submitted along with the results.

If there are any issues with the data submission, the Gatekeeper will communicate any outstanding issues with the Data Submitter, who may choose to update or revise the data.

The Higg MSI Data Submission Types

The MSI Contributor contains a flexible template that allows Data Submitters to provide data and calculate impacts according to the methodologies adopted by SAC. The basic structure of this data is to match the inputs to the product or process to the output(s). It is important that the data be as complete as possible, and have consistent accounting for each input and output submitted. Typically, inputs are based on a “per unit” (1 kg, m2, or other standard metric). This level of detail is required to calculate the scores for Processes and Materials. This level of data will not be made available to the public or any other users of the data.

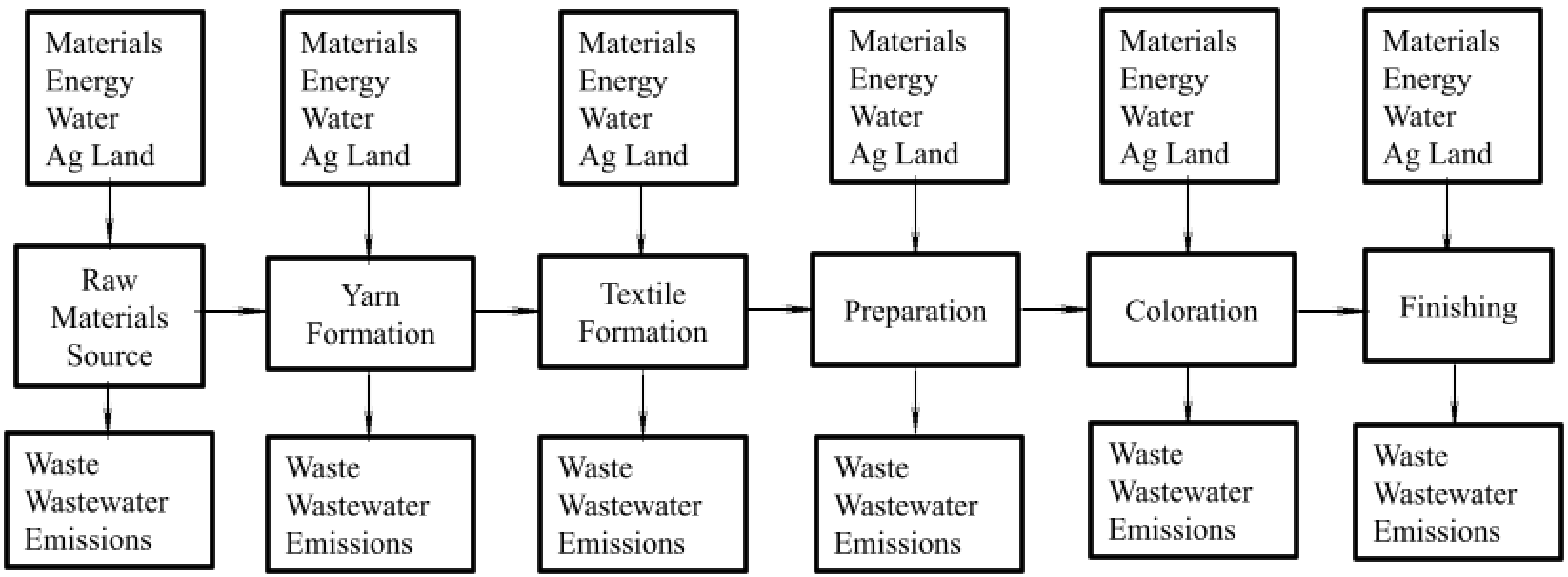
Every submission must appropriately fit into the MSI taxonomy, which separates Production Phases. See Figure 1 Higg MSI Material Categories and Production Phases for taxonomy for each material. Submissions may be applicable to more than one Base Material (e.g. a spinning process may be possible for various textiles), but they must fit within the boundaries of at least one.

Production Phase. Any submission that covers more than one Production Phase should be split into separate submissions. See more information under Scope of Data.

Data may be submitted in the two following forms in order of preference:

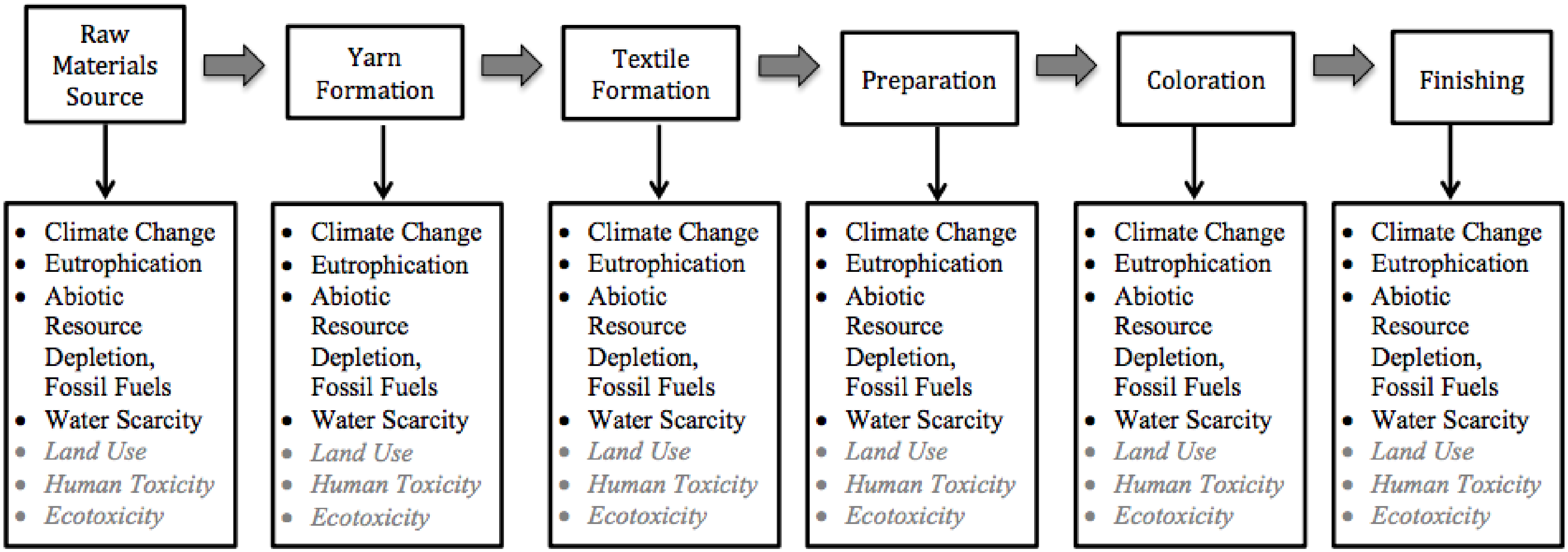
- Type 1: data inputs/outputs at the process level (Figure B1); (Material inputs may be in the form of unit process outputs, not just elementary flows)
- Type 2: characterized results life cycle impact assessment (LCIA) of the inputs at the process level (Figure B2); LCIA methodologies must match MSI LCIA methodologies exactly (see more information under Additional Requirements for Submission Type 2).

Figure B1: Data Submission Type 1 - data inputs/outputs at the unit process level



Note: This is an example for Textiles only.

Figure B2: Data Submission Type 2 - characterized results life cycle impact assessment (LCIA) of the inputs at the process level



Notes:
All production phases could produce midpoint results.
Inventory metrics for water consumption and biogenic carbon content also need to be provided
This is an example for Textiles only.
Land Use, Human Toxicity, and Ecotoxicity are not currently included directly as part of the MSI impact categories. Results are still modeled and the Ecotoxicity results are used as an input into the Chemistry assessment. Calculating these impacts now will also ease the process of adding them to the MSI in the future.

Higg MSI Requirements for Submission Types 1 and 2

Submissions must include information for each of the items listed below.

Metadata and descriptive information

General information about the submission, additional details about the raw material or production process, and any supporting documentation, must be provided. A description of the source and year of the data, and how the data was gathered, must also be included. Descriptive information is important to ensure a complete understanding of the data in the Higg MSI, and to ensure compatibility and comparability with other materials and processes in the database and other Higg Index Product Tools.

Production outputs

The primary product (or product being submitted) and any co- and by-products from the production process must be provided (See *Handling multi-functional processes* below for further details on allocation).

Material Inputs

Inputs from the Bill of Materials (BOM), recipe, or product design parameters must be provided. Inputs may be in the form of unit process outputs from upstream processes. Please include the total amount of inputs used, including any losses during the production process. Any material inputs that are greater than 1% of the total mass of the finished product must be included. This includes any packaging, chemical, or intermediary inputs into the product system.

Transportation of Materials

Transportation must include the inbound transportation required to move the materials to the manufacturing location.

Energy Inputs

Include all energy used for manufacturing or processing, plus any energy used as feedstock, as inputs to this process. All energy inputs over 1% of total energy inputs must be provided. Electricity use must be identified by wattage (high, medium, or low voltage) and must also be identified by geography. For electricity modeling, PEF modeling rules shall be used (including on-site generation, purchased, etc.).

Renewable Energy Credits

Based on PEFCR Guidance document[10] the following requirements must be met:

- The energy mix must be disclosed as part of the contractual agreement;
- The contractual agreement must ensure that any claimed energy as part of that contract is otherwise "retired" (it needs to be a unique claim);

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[10] European Commission, PEFCR Guidance document, - Guidance for the 14 development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 15 2017.

- The period of electricity consumption measured in the study and the contractual agreement should be the same (or as close as possible).

Water Inputs

Include total water inputs to the process. The total amount of water inputs must be included; water that is returned to the system or discharged will be accounted for in the water outputs section.

Direct Emissions

Direct Emissions to air, water, or soil from the process, except for emissions related to combustion of energy (these are counted in the energy inputs) must be provided.

Waste Products

All wastes or non-valuable by-products must be provided, by type of waste and by type of waste disposal method. This includes packaging and any materials sent to recycling.

Water Outputs

Include any water discharged from the process. This includes any water that is discharged directly to the environment, back to the municipality or is treated onsite. The net difference between inputs and outputs will be used to calculate total water consumption.

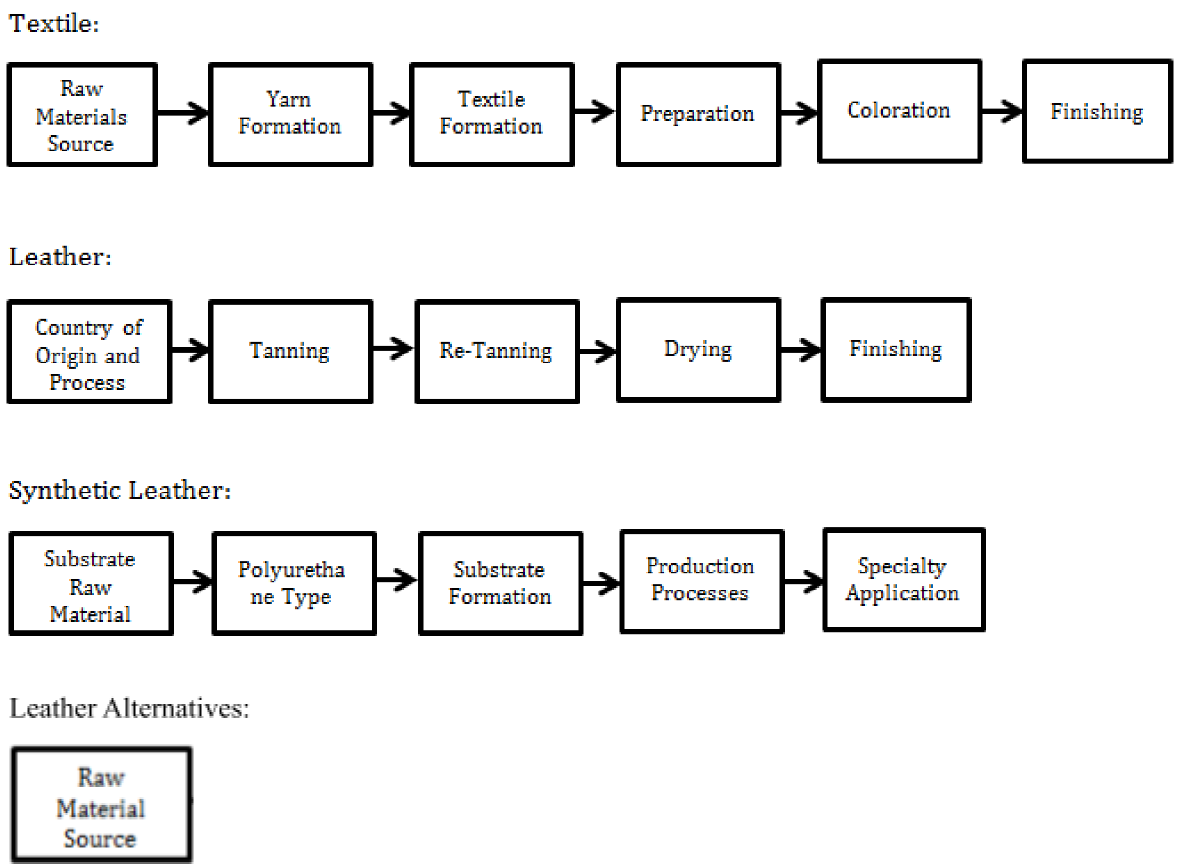
Biogenic Carbon content

Biogenic carbon refers to the carbon sequestered from the atmosphere due to biomass growth. It can be determined by radiocarbon analysis or stoichiometric analysis. It is reported in kilogram C per kilogram of material. *Note: This is different from the percentage of carbon in the material that is biogenic in origin as different materials can have different carbon content.*

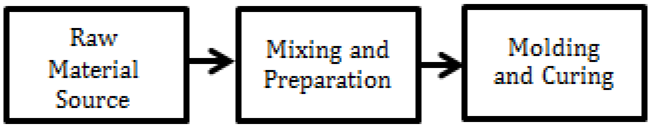
Scope of Data

This section details the scope of the data requirements for submission to the Higg MSI. The Higg MSI includes Processes in the following Production Phases for each Material Category. The figure B3 below shows the Production Phases for each Material Category.

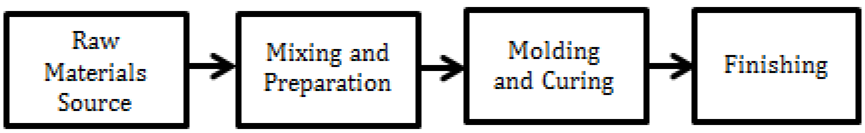
Figure B3. Higg MSI Material Categories and Production Phases



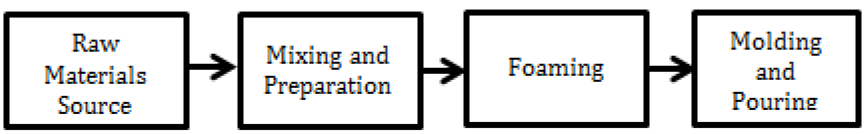
Plastics:



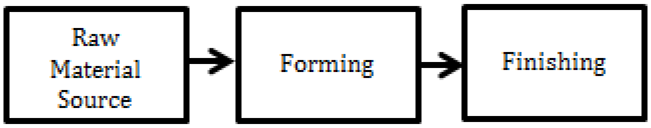
Rubber/Elastomer:



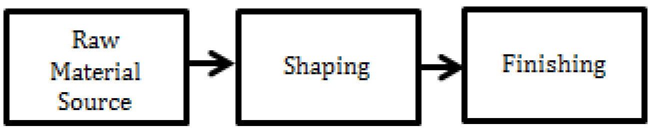
Foam:



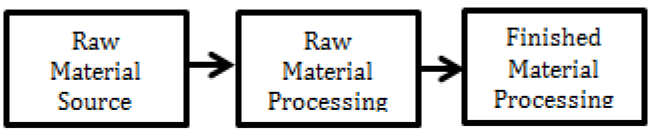
Metal:



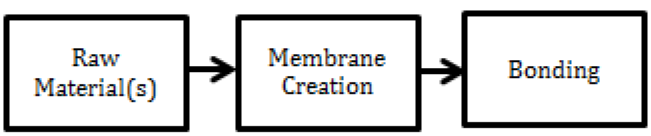
Wood-based materials (non-texties):



Insulation Materials:



Coatings and Laminations:



Data Collection Reporting Period

All processes must collect and report 1 year of data of commercial scale production. The 1 year period is averaged out to obtain a representative production cycle and level out any occasional differences.
For batch processes where the innovation does not represent the full production volume on that equipment and there is a justifiable rationale for segregating the data (e.g. traceable production claim) the reporting period must include data for consistent batches at a mature/established production state.

Pilot scale processes can be submitted for review in preparation for commercial scale, but the results will not be published on platform, thus not being official MSI results and not possible to communicate until the Data Submitter can provide 1 year of commercial scale operational data (or mature batch process data as above).

For agricultural systems, 3 years worth of crop data are required in accordance with PEFCR. If data for annual crops is not available for a 3 year period, at least 1 year of data must be provided and must be updated annually until a 3 year period is achieved (this is not applicable for perennial plants).

Inclusion of data

All known inputs for product production shall be included. Additionally, the following auxiliary operations shall be excluded:

- Labor, commuting and travels of employees and seasonal workers
- Administrative overhead
- Capital equipment and maintenance

Any exclusions must be noted and justified.

Multiple output processes

For processes that produce multiple valuable outputs, the total amount of each output, using the same units for each output stream, must be provided.

Allocation and multi-functional processes

Two main modeling approaches exist for the LCA methodology: attributional and consequential. The MSI follows the attributional LCA approach. The attributional life cycle model depicts the actual or anticipated specific or average supply chain, use and end-of-life scenarios. The consequential life cycle model depicts the anticipated generic supply chain as a consequence of a potentially relevant decision. The attributional and the consequential life cycle models differ with the manner in which multi-functional processes are considered. In the attributional approach, coproduction processes are allocated based on physical or economic relationships; in the consequential approach, system expansion including avoided processes is applied.

The following multi-functional decision hierarchy shall be applied for resolving all multi-functional problems[11]:

1. Subdivision or system boundary expansion;
2. Allocation based on a relevant underlying physical relationship (substitution may apply here);
3. Allocation based on some other relationship.

Allocation based on a physical relationship can be modeled using direct substitution if a product can be identified that is directly substituted. A direct substitution-effect must be robustly modeled by demonstrating that (1) there is a direct, empirically demonstrable substitution effect, AND (2) the substituted product can be modeled and the resource use and emissions profile data subtracted in a directly representative manner (i.e both processes must be represented in the Higg MSI).

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[11] European Commission, PEFCR Guidance document, - Guidance for the 14 development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 15 2017.

Note: Allocation methods in the Higg MSI are held consistent within the same hierarchy. These prescribed methods include allocation guidance in alignment with PEFCR[12]. For example, manure use in any dataset enters the system burden free as per the Cattle Model working group (WG).

If there is not a prescribed method for that process, the specific allocation method used should be documented and Data Submitters must justify their chosen allocation method. Key allocation decisions are included in the individual process modeling notes (i.e. metadata).

Biomass Balance Approach

If biomass is available, both a biomass (with bio-based feedstock amounts) and a non biomass version should be submitted, and there needs to be a mechanism to verify the biomass amount matches the claim to prevent any double counting of impact reductions.

Carbon Storage and Sequestration

The MSI is a tool to assess intermediate products (cradle to gate) and the lifetime of the material when used in a final product is not known. Therefore, no carbon credits are to be modeled for carbon entrained in the product at this point in the life cycle. Carbon that is embedded in the material or product may be reported separately as biogenic carbon.
Carbon emissions due to direct land use change are to be reported separately and modeled following the guidelines of PAS 2050:2011. Carbon removals (sequestered carbon) due to direct land use change are excluded. Emissions and removals from indirect land use change are excluded. Direct land use changes are the conversion of land used for growing crops to industrial use or conversion from forestland to cropland. Indirect land use change refers to conversions of land use as a consequence of changes in land use elsewhere.

Soil carbon related emissions, typically from aboveground residues, are to be reported under the GWP category. Soil carbon uptake (accumulation) is excluded in alignment with PEFCR Guidance version 6.3.

Other Nutrient Removals

No net removals from additional emissions to water, such as nitrogen (NH_3, N_2O, and NO_3) and phosphorus (PO_4 and P) will be included, in accordance with PEFCR[13] guidance on agricultural modeling. Any negative emissions will be removed and set to 0.

Recovered and Recycled Wastes

Wastes that are reused into the process should not be counted as an input. In such cases, include only the net additions to the process. For example, the total amount of a catalyst used in a production process should not be reported, only the portion that is depleted by that process. Another example would be excess product material that can be directly used as an input to the next process. For the two examples above, include only the additional amounts needed for the process, and not the total reused portion.

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[12] idem
[13] European Commission, PEFCR Guidance document, - Guidance for the 14 development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 15 2017.

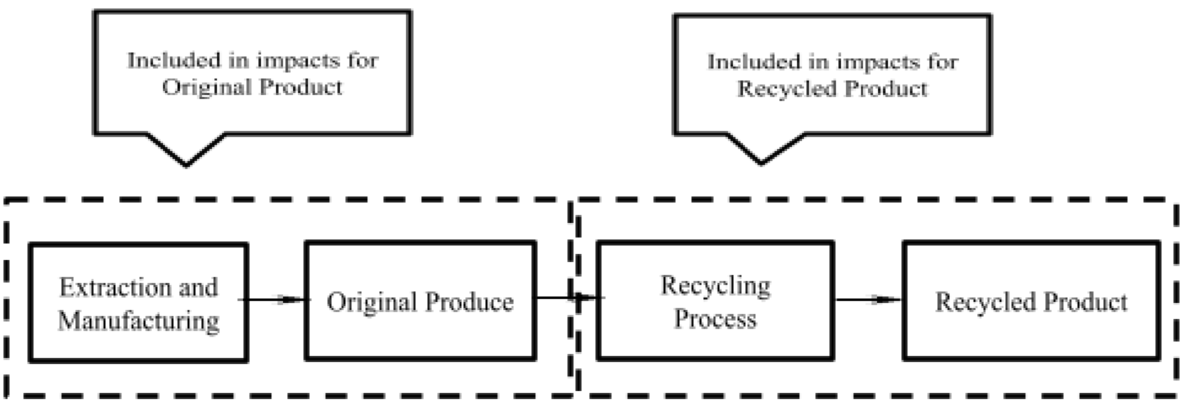
Proof of the recycled content such as a GRS or RCS certificate is required to claim recycled content inputs. This proof is applicable to all recycled inputs that enter the process and are purchased from external suppliers.

When the recycled input is the result of an internal recycling stream, the Data Submitter must provide two submissions: One with the inputs of the default process, and another with the inputs from the recycled stream.
Note: Having both processes ensures that efficiencies are captured and that 'waste' from inefficient processes is not being commercialized at a premium as recycled content.

Cutoff at Recycling

The Higg MSI utilizes the recycling cut-off approach. For recycled products, the transportation of the waste product to the recycling facility, and burdens of the recycling process, must be provided. No other upstream inputs are included. The chart below demonstrates this cut-off procedure.

Figure B4: Recycling Cut-off Rules



Definitions of Recycled Content, Pre-Consumer (Post-Industrial) and Post-Consumer materials[14]:

- **Recycled Content**: Proportion, by mass, of recycled material in a product or packaging. Only pre-consumer and post-consumer materials shall be considered as recycled content, consistent with the following usage of terms.
- **Pre-Consumer Material**: Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.
- **Post-Consumer Material**: Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

Agricultural Land Occupation

[14] ISO 14021 Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling), section 7.8.1.1

Agricultural or forest land occupation must be provided if the product being submitted includes agricultural materials (on field, farm, or forest). This impact is not included in the Higg MSI scoring or tool interface at this time, but it is available in the SAC database for future addition to the tool if appropriate.

List of Data Entries

Submissions are made using the MSI Contributor, accessible at msicontributor.higg.org. The platform includes entry fields for the following:

General Information:

- Submission Type (raw material or process)
- Submission Name
- Brand
- Material Category
- Base Material
- Production Phase
- Facility
- Reporting Period (start and end dates of data collection period)
- Supporting documents
- Image
- General Description
- Energy use allocation

Materials, Energy, and Transport:

- Name and amount of product/process
- Energy inputs, amounts, and measurement approaches
- Material inputs, amounts, and measurement approaches
- Agricultural land inputs, amounts, and measurement approaches
- Packaging inputs, amounts, and measurement approaches

Self-produced Energy:

- Output types and amounts
- Fuel sources and amounts
- Emissions specific to on-site energy production
- Amount exported to grid or sold

Water Use and Treatment:

- Total water use for reporting period per kg of product
- Total amount of water discharged per kg of product
- Total amount of water treated on-site per kg of product
- Total amount of water returned to municipal source per kg of product

Emissions:

- Air emissions type and amount per kg of product
- Water emissions type and amount per kg of product
- Soil emissions type and amount per kg of product

Solid Waste and Recycling:

- Materials sent to landfill and their amounts
- Materials sent to incineration and their amounts
- Recycled materials and their amounts
- Hazardous materials and their amounts

Data Quality (ranking from very poor to very good):

- Technological Representativeness
- Temporal Representativeness
- Geographical Representativeness
- Parameter Uncertainty

Data quality criteria and scores

The dataset quality shall be calculated based on the six quality criteria described below as consistent with the EU PEF data quality requirements. A semi-quantitative assessment of the overall data quality of the dataset shall be calculated summing up the achieved quality rating for each of the quality criteria, divided by the total number of criteria. The Data Quality Rating (DQR) result is used to identify the corresponding quality level. The semi-quantitative assessment of the overall data quality of the dataset requires the evaluation (and provision as metadata) of each single quality indicator. This evaluation shall be done according to Table B1 and formula [1]:

$$\text{DQR} = \frac{TiR + TeR + GR + C + P + EoL}{6} \qquad [1]$$

DQR:	DATA QUALITY RATING OF THE DATASET
TeR:	Technological Representativeness
GR:	Geographical Representativeness
TiR:	Time-related Representativeness
~~C~~:	~~Completeness;~~
P:	Parameter Uncertainty
~~EoL~~:	~~Implementation of the End-of-Life baseline formula (optional future measure)~~

Note that Completeness (C), and End of Life (EoL) will not be included in the data quality assessment of material production data at this time. The Higg MSI scoring methodology promotes the reporting of unit process life cycle inventory data as opposed to LCIA results, and contains only a cradle-to-gate boundary that does not consider impacts beyond the final Material factory gate. As such, the denominator of formula [1] is 4. As data becomes more out of date, the DQR will change. The DQR helps SAC prioritize data needs for future solicitation.
Only submitted data with a DQR of "Fair" (3) or better will be included in the Higg MSI.

The Criteria for the semi-quantitative assessment of overall data quality of the submitted datasets are the following:

- **Time Representativeness**: Degree to which the dataset reflects the specific conditions of the system being considered regarding the time / age of the data, and including background datasets, if any.
- **Technological Representativeness**: Degree to which the dataset reflects the true population of interest regarding technology, including for included background datasets, if any. Comment: i.e. of the technological characteristics including operating conditions.
- **Geographical Representativeness**: Degree to which the dataset reflects the true population of interest regarding geography, including background datasets, if any. Comment: i.e. of the given location / site, region, country, market, continent, etc.
- **Parameter Uncertainty**: Qualitative expert judgment or relative standard deviation as a % if a Monte Carlo simulation is used.

Data Submitter is responsible for updating their process submission if the above criteria are no longer fulfilled, for example: the data is considerably out of date and not representative of the current process, the production has been relocated to a different country or expanded to other countries not accounted on the original submission, inputs to the process have changed, etc.

Table B1: Quality level and rating for the data quality criteria

Quality level	Quality rating	C (Future Measure)	TiR	P	TeR	GR	EoL (Future Measure)
Very good[15]	1	15 PEF Impact Categories	Data[16] are not older than 4 years with respect to the release date or latest review date	≤ 10%	The technologies covered in the dataset are exactly the one(s)modeled	The processes included in the dataset are fully representative for the geography stated in the title and metadata	The EoL formula [2] is implemented in the entire dataset (foreground and all background processes)
Good	2	14 PEF Impact Categories (and all 10 categories classified I or II in ILCD are included[17])	Data are not older than 6 years with respect to the release date or latest review date	10% to 20%	The technologies modeled are included in the mix of technologies covered by the dataset	The processes included in the dataset are well representative for the geography stated in the title and metadata	The EoL formula [2] is implemented in foreground level-1 + level-2 disaggregated processes (see Figures E.2 and E.3)
Fair	3	12-13 PEF Impact Categories (and all 10 categories classified I or II in ILCD are included)	Data are not older than 8 years with respect to the release date or latest review date	20% to 30%	The technologies modeled are representative of the average technology used for similar processes	The processes included in the dataset are sufficiently representative for the geography stated in the title and metadata	The EoL formula [2] is implemented in foreground at level-1disaggregated processes (see Figure E.2)
Poor	4	10-11 PEF Impact Categories (and all those covered are classified I or II in ILCD)	Data are not older than 10 years with respect to the release date or latest review date	30% to 50%	Technology aspects are different from what described in the title and metadata	The processes included in the dataset are only partly representative for the geography stated in the title and metadata	The EoL formula [2] is not implemented, but all information and data needed to calculate all parameters in the EoL formula are available and transparently documented

[15]In some cases referred to as "excellent"

[16]The reference time is the one when data have been originally collected and not the publication/calculation date. In case there are multiple data, the oldest is the one against which the calculation should be made.

[17]The 10 impact categories classified in ILCD Handbook as category I or II are: Climate change, Ozone depletion, particulate matter, ionizing radiation human health, photochemical ozone formation, acidification, eutrophication terrestrial, eutrophication freshwater, eutrophication marine water, resource depletion mineral fossil and renewable.

Very poor	5	Less than 10 PEF Impact Categories (and all those covered are classified I or II in ILCD)	Data are older than 10 years with respect to the release date or latest review date	> 50%	Technology aspects are completely different from what described in the title and metadata	The processes included in the dataset are not representative for the geography stated in the title and metadata	The EoL formula [2] is not implemented

$$\left(1-\frac{R_1}{2}\right)\times E_V+\frac{R_1}{2}\times E_{recycled}+\frac{R_2}{2}\times\left(E_{recyclingEoL}-E^{*}{}_{V}\times\frac{Q_S}{Q_P}\right)+R_3\times\left(E_{ER}-LHV\times X_{ER,heat}\times E_{SE,heat}-LHV\times X_{ER,elec}\times E_{SE,elec}\right)+\left(1-\frac{R_2}{2}-R_3\right)E_D-\frac{R_1}{2}\times E_D^{*} \quad [2]$$

Details of the EOL formula can be found in Wolf, M.A., and K. Chomkhamsri (2014) The "Integrated formula" for modeling recycling, energy recovery and reuse in LCA, unpublished document. Maki Consulting and PPP International Trader LP. Berlin, Germany. Accessible on the web: http://maki-consulting.com/wp-content/uploads/2013/05/White-paper-Integrated-approach_Wolf&Chomkhamsri2014_Final.pdf

Additional Requirements for Submission Type 2

A Type 2 Submission allows for direct submission of LCIA (midpoint) results to the MSI Contributor. The midpoints submitted must use the listed LCIA methods and the prescribed version listed in Table B4. Since data is less transparent for review, Type 2 data submissions must be independently reviewed either by a sole reviewer or review panel prior to submission. The reviewer or review panel do not have to be a third party, only independent of the analysis. The submission must include the LCA project report and review results.

Midpoint Categories

Impacts for products and processes are first calculated from a "midpoint" methodology. These approaches come directly from LCIA. The individual impact categories listed in Table B2 are calculated based on methodologies currently available and widely used by the LCA community. These impact categories chosen were based on their scientific accuracy, their applicability to the apparel, footwear and home textile industries, and their compatibility with other global product sustainability programs.

Table B2: Higg MSI Midpoints

Impact Category	LCIA Method	Unit
Climate Change	Baseline model of 100 years of the IPCC (based on IPCC 2013)	kg CO_2 eq
Eutrophication	CML-IA baseline 2013	kg PO_4-eq
Abiotic Resource Depletion, Fossil fuel	CML-IA baseline 2013	MJ
Water Use	Available Water Remaining (AWARE) as recommended by UNEP, 2016 *and* Blue Water Consumption*	m3 world eq (for both)
Human Toxicity	USE-Tox (Recommended only)	CTUh
Ecotoxicity	USE-Tox (Recommended only)	CTUe

In an attempt to not require more frequent data updates from the Data Submitter, we recommend the following midpoints also be submitted. These are the additional categories required for Product Environmental Footprinting to date.

Table B3: Additional Optional Midpoints

Impact Category	Method	Unit
Biogenic carbon content	Inventory Metric	kg C/kg
Acidification terrestrial and freshwater	EF Method	Mole of H+ eq.
Cancer human health effects	EF Method	CTUh
Climate Change	EF Method	kg CO2 eq.
Climate Change (biogenic)	EF Method	kg CO2 eq.
Climate Change (fossil)	EF Method	kg CO2 eq.
Climate Change (land use change)	EF Method	kg CO2 eq.
Ecotoxicity freshwater	EF Method	CTUe
Eutrophication freshwater	EF Method	kg P eq.

Eutrophication marine	EF Method	kg N eq.
Eutrophication terrestrial	EF Method	Mole of N eq.
Ionizing radiation - human health	EF Method	kBq U235 eq.
Land Use	EF Method	Pt
Non-cancer human health effects	EF Method	CTUh
Ozone depletion	EF Method	kg CFC-11 eq.
Photochemical ozone formation - human health	EF Method	kg NMVOC eq.
Resource use, energy carriers	EF Method	MJ
Resource use, mineral and metals	EF Method	kg Sb eq.
Respiratory inorganics	EF Method	Disease incidences
Water scarcity	EF Method	m^3 world equiv.

Required Impact Categories and LCIA Methods will be reassessed every two years by SAC membership to ensure that the most important impacts to the apparel, footwear, or home textile industries are captured credibly.

Review Protocol

Once data is submitted through the MSI Contributor, data must go through a quality assurance process before it is incorporated to the Higg MSI. The review is completed by the MSI Gatekeeper to ensure that the data meets all acceptance criteria. The following review protocol describes the basic steps and actors involved in submitting and approving a dataset for use in the Higg MSI.

STEP 1: Data Submission

In this step, the Data Submitter completes the data entry using the MSI Contributor to meet the submission requirements to the extent possible. See above under List of Data Entries to see what information is required. An initial submission notification is sent to the SAC and MSI Gatekeeper by completing the "General Information" section of the data submission form. This informs SAC if a submission has been started and allows the MSI Gatekeeper to plan for a review.

STEP 2: Gatekeeper Review

Once the submission has been completed, the MSI Gatekeeper reviews the data including the material and energy flows, outputs and metadata. A review checklist is used for both Type 1 and Type 2 data submissions cataloging all requirements to achieve conformance. The review cycle will loop until the data set is determined to conform or the Gatekeeper rejects the submission in total.

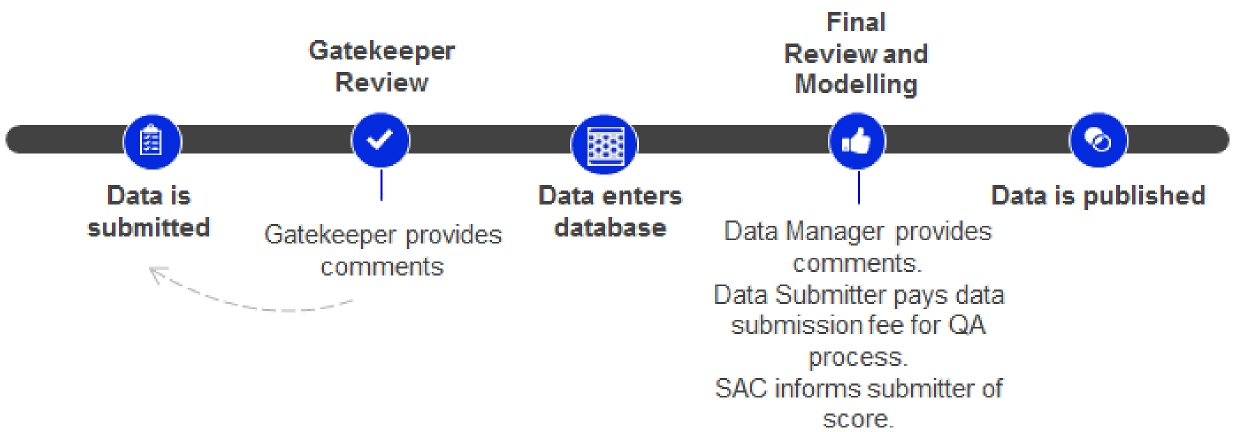
STEP 3: Final Review and Modeling

The data submission undergoes a final review to ensure complete integration into the Higg MSI. If there are any issues found during this final review, revisions are to be made by the Data Submitter and re-approved by the Gatekeeper. During this step, the Higg MSI scoring framework will be applied to calculate MSI scores. After payment by the Data Submitter for this quality assurance process, this MSI score will be communicated to the Data Submitter for final permission to publish the information in Higg Index Product Tools.

STEP 4: Publishing

Once the data passes the final review process it is then published and available for access by users of Higg Index Product Tools.

Figure B5: Data Submission and Review Process



Data Uses

Material scores and metadata will be available to the public through the Higg MSI. In addition, the Higg MSI will make midpoint data available to SAC members. Data can be leveraged for the Higg Product Module, which will calculate the environmental impacts of finished products.

Metadata to be included in the Higg MSI includes the following:

- Modeling notes
- Primary source
- Timeframe (data age)
- Source description
- Geography
- Applicable materials (base materials that the submitted process/raw material is applicable to)
- Data quality
- Uncertainty Score (to be determined during review)

APPENDIX C: LCIA METHOD CRITERIA

Impact Category	LCIA Method	Criteria						Decision for Inclusion in MSI
		Environmental Relevance/Imp.	Scientific Robustness	Completeness of Scope	Transparency of sources	Degree of Acceptance	Data availability	
Abiotic Resource Depletion, Fossil Fuels	**CLM, 2013 v4.2**	**High:** Global. Energy use is a major driver of environmental impacts, and depletion of global resources is a widely recognized concern.	**High:** very measurable.	**High:** assess the extraction and use of fossil fuel resources based on availability and access.	**High:** underlying data model clearly documented	**High:** often used.	**High**	**Included**
Abiotic Resource Depletion, Fossils and Minerals	**CML, 2013 v4.2**	**Moderate-High:** Global. Energy use is a major driver of environmental impacts, and depletion of global resources is a widely recognized concern.	**Moderate-low:** these metrics are based on the depletion of known reserves and must be constantly update and revised based on depletion, exploration, and identification of reserves. Estimation of resource availability is highly uncertain.	**Moderate-High:** characterization factors must be continually updated. Limited by temporal relevance.	**Moderate-High : sources are transparent but difficult to interpret.	**High-Low:** general agreement that resource depletion is an important impact to measure. High by LCA practitioners, Low for extraction industry.	**High-Low:** measurements based on known reserves and depletions and must be continually updated based on extraction and new technology.	**Not included** due to uncertainty in the mineral assessment, which was magnified with MSI normalization methodology. See Abiotic Resource Depletion, Fossil Fuels.
Blue Water Consumption	**Not an LCIA method** (looking at amount of	**Moderate-Low:** water use is a globally recognized impact but it	**Moderate-Low:** while conceptually simple, data for water use/	**Low:** Global, but does not take water scarcity into consideration.	**Moderate:** sources are transparent as they are estimates that	**Moderate:** Water consumption is generally accepted as	**Moderate:** removed complexity of regional water availability, but	**Included** but not part of MSI scores.

	water displaced from watershed)	does not account for water availability.	consumption is notoriously difficult to gather. Method is at the country level.		may be based on water rights, but also on site well systems that may not be tracked. Water return in most cases is estimated (not measured).	the units are simple and readily understood. It is an improvement over water withdrawal as it measures net water use.	consumption values still necessary and difficult to gather.	
Climate Change	**IPCC GWP over a 100-year time horizon v1.02**	**High**: Global. Widely recognized global impact.	**High**: 100-year time horizon widely accepted as appropriate metric	**High**: Global. GWP of individual emissions are based on consensus of scientific community	**High**: based on IPCC published values	**High**	**High**: one of the most widely tracked environmental metrics globally.	**Included**
Cumulative Energy Demand	**CED**	**High:** Global. Energy use is a major driver of environmental impacts, and depletion of global resources is a widely recognized concern.	**High:** very measurable	**High:** can be subdivided into different types of energy demand (renewable/non-renewable)	**High:** very transparent	**High:** often used	**High:** one of the highest	**Not included:** Used Abiotic Resource Depletion, Fossil Fuels instead.
Ecotoxicity	**USEtox model**	**Moderate-High:** Europe and N. America	**Moderate-Low:** each species and individual will react differently to different levels of exposure to hazardous chemicals, making a general predictive model	**Moderate-Low**: very few of the known global chemicals have been assessed for toxicity, and LCIA models are based on extrapolations of limited studies.	**Moderate-High**: sources are transparent but difficult to interpret.	**Moderate-Low**: hazard vs risk approaches are often at odds and there is significant disagreement on the appropriate approach.	**Moderate-Low**: substances are often assessed using equivalent/proxy chemicals, and eco-responses vary widely.	**Not included.** SAC is collecting chemicals data to use in the semi quantitative Chemistry assessment, see more details in Appendix D: Chemistry Impact Framework

			of limited use. High uncertainty.					
Eutrophication	**CML-IA baseline 2013 v3.03**	**High**: direct impact on water quality with visible impacts on bodies of water. Western Europe.	**Moderate-High:** Eutrophication is the result of nutrient loading, and is measured in Nitrogen and Phosphorous equivalents. Each waterway will respond differently to different nutrient loads.	**Moderate**: measurements are based on P and N limited streams, and there is limited data for each waterway. Limited in geography.	**Moderate-High**	**Moderate-High**: "dead" zones are evident in many areas across the world, however the causes of these zones are often disputed. Often used as a proxy for Water Quality . High in Europe.	**High-Low**: data for specific releases to specific waterways is difficult to gather, and averaging does not accurately assess acute impacts. High for Europe.	**Included**
Human Toxicity	**USEtox model**	**Moderate-High**: Europe and N. America. Human toxicity is a highly tracked metric and many brands are particularly concerned with their impacts on the population	**Moderate-Low:** dose response curves are very difficult to model and broad metrics may not identify specific threats in specific situations. High uncertainty.	**Moderate-Low:** very few of the known global chemicals have been assessed for toxicity, and LCIA models are based on extrapolations of limited studies.	**Moderate-High**: sources are transparent but difficult to interpret.	**High-Low**: hazard vs risk approaches are often at odds and there is significant disagreement on the appropriate approach.	**Moderate-Low**: substances are often assessed using equivalent/proxy chemicals, and human responses vary widely.	**Not included.** SAC is collecting chemicals data to use in the semi quantitative Chemistry assessment, see more details in Appendix D: Chemistry Impact Framework
Land Use	**Land Occupation**	**Moderate-High**: Global. Land occupation is most relevant in agricultural and forestry based products	**Moderate-Low**: this is an aggregated inventory metrics that sums up occupation, but does not assess impacts of that occupation.	**High**: Global. Metric only tracks occupation, and data is not difficult to gather	**High**	**Moderate**: only assess occupation, and not impacts.	**Moderate-High**: data is generally available and can be estimated. Data availability is lower for agricultural practices.	**Not included.** SAC is collection land occupation data and will investigate alternative methodologies. Assessment results may be required by SAC members.

Land Use	**Land Use Change**	**Moderate-Low**: measuring what happened, but not the effects of those practices	**Moderate-High**: measures inventory of what's being transformed	**Moderate**: Lack of land types, good coverage of change and footprint.	**High**: methodology is transparency	**Low**: no authoritative bodies that have accepted it	**Moderate-Low** : available in databases to an extent	**Not included.** SAC is collecting land occupation data and will investigate alternative methodologies.
Land Use	**SOM**	**Moderate**: only considers one indicator (organic matter)> Is very localized.	**Moderate**: measure of soil health for agriculture and forestry systems by looking at land occupation/transformation.	**Moderate**: must have good data (difficult in practice). Uses occupation and transformation to calculate carbon.	**Moderate**: well documented but characterization factors need to be developed by the user.	**High**: accepted by ILCD	**Low**: need case-specific characterization factors	**Not included.** SAC is collecting land occupation data and will investigate alternative methodologies.
Water Footprint	**Hoekstra, 2012**	**Moderate**: Global. Water use and availability is a globally recognized impact. Takes a product system approach.	**Moderate-Low**: does not consider water stress, but does include green water and water quality impact	**Low**: Global, but does not take water scarcity into consideration.	**Moderate-High** : method and sources are transparent and published in peer reviewed literature.	**Moderate-low** : generally accepted and implemented by non-LCA practitioners. Green and grey water methods typically not included in LCA.	**Low**: removed complexity of regional water availability, but consumption values (blue and green) and water discharge (grey) still necessary and difficult to gather.	**Not included.** Using AWARE instead to calculate water impacts.
Water Resource Depletion/ Scarcity	**Pfister et al. 2009**	**High**: Global. Water use and availability is a globally recognized impact.	**Moderate-Low:** while conceptually simple, data for water use/consumption is notoriously difficult to gather. Method is at the country level.	**High-Low**: Global. Water scarcity is a regionally specific impact, and data is limited on the scale needed for meaningful assessments	**Moderate-High** : sources are transparent but often built on extrapolations of older models.	**Moderate-High**: general agreement that water depletion is an important impact to measure.	**Moderate-Low** : data for globally sensitive regions is very difficult to gather and often unreliable. Need to have geographical	**Not included.** Using AWARE instead to calculate water impacts.

							water extraction info.	
Water Use	**Available WAter REmaining (AWARE)**	**Moderate-High:** Global applicability with regional differentiation.	**Moderate-High:** more complex model, data for water use/ consumption is relevant at watershed spatially specific level, country level. Water availability varies over time and needs to be periodically updated in order to be accurate.	**Moderate-High:** Global. Water availability is assessed at regionally specific levels.	**Moderate-High:** method and sources are transparent and published in peer reviewed literature.	**Moderate-High:** Developed in a consensus method. Chosen to be the PEF method.	**Moderate-Low:** primary data for globally sensitive regions is very difficult to gather and often unreliable. Need to have geographical water extraction information and input data with spatial resolution.	**Included.**
Water withdrawal	**Not an LCIA method** (just a measure of water volume use)	**Moderate-Low:** water use does not directly correlate to impacts.	**Low:** water use does not directly correlate to impacts.	**Low:** does not take water scarcity into consideration	**Low:** data is often proprietary	**Low:** Not an LCIA method	**High:** Easiest to measure	**Not included.** Using AWARE instead to calculate water impacts.

APPENDIX D: CHEMISTRY IMPACT FRAMEWORK

Introduction

While the eventual goal is to fully integrate and utilize quantitative chemistry impacts based on the USEtox model, the Chemistry Task Team recognized that there are significant methodological and scientific barriers to the application of general toxicity criteria within an LCIA. Currently, all methods evaluated in the ILCD handbook for the assessment of the fate and effects of metal and chemical compounds, including USEtox, suffer from a lack of precision (i.e. a large uncertainty of 2 to 3 orders of magnitude). A related concern is that relevant chemical substances from a toxicity perspective are not included in a consistent manner in inventory data. It was decided to use a semi-quantitative weighting combined with qualitative modifiers based on chemical management actions to assess chemistry until USEtox proves more relevant and consistent for the apparel, footwear, and home textile industries. This methodology will continue to be considered as it matures.

There are two parts to the chemistry impact framework:

1. **Process Level Chemistry Impacts**: a semi-quantitative model that uses USEtox Ecotoxicity results as an input to assign a high/medium/low chemistry impact
2. **Chemical Qualifiers (Certifications/Standards/Programs)**: a qualitative framework based on demonstrated chemical management practices that is used to modify (reduce) the process level chemistry impacts. This framework builds upon the work of the 2016 Chemical Assessment Team and the previous Higg MSI chemistry scoring.

Process Level Chemistry Impacts:

Each process in the Higg MSI is assigned a low, medium, or high chemistry impact. This is calculated, using process level USEtox Ecotoxicity results (CTUe, recommended characterization factors) as the input. As the USEtox Ecotoxicity results span several orders of magnitude, the results are first re-scaled using a log10 transformation. This data compression helps account for the uncertainty and variability in the USEtox results. Consideration was also given to using USEtox Human Toxicity results as an input in addition to the USEtox Ecotoxicity impacts. The decision was made to only use the Ecotoxicity results since the Ecotoxicity impacts (in comparative toxic units, CTU) were orders of magnitude higher than the Human Toxicity impacts for all existing Higg MSI processes. The relative ranking of processes when looking at either Ecotoxicity or Human Toxicity were also consistent, with only a few process outliers. Therefore, basing the chemistry impacts in the Higg MSI on process level USEtox Ecotoxicity results is considered representative.

The second step involves grouping the re-scaled results into low, medium, or high chemistry impacts. The decision was made to add this additional step to further reduce process variability and the potential for misleading impressions on the precision of the results. To determine the ranges for the groupings, an analysis was performed using the process data from the 2016 Higg MSI and the following cutoffs were used:

- Low: Re-scaled (log10) results are below -2.5.

- Medium: Re-scaled (log10) results are from -2.5 to -1.0.
- High: Re-scaled (log10) results are -1.0 or higher.

In the initial analysis, this resulted in a relatively even split of processes into low, medium, and high chemistry impacts.

The last consideration for the process level chemistry impacts was to re-assess the calculated process-level impacts at the Production Stage level. This step was used to check for consistency between similar processes used in the same Production Stage. For most Production Stages, the results showed high consistency and it was decided to use the median chemistry impact for all comparable processes. The Raw Material Source Production Stage showed the most variability and it was decided to continue to analyze all processes separately. Textile Additional Coloration and Finishing also showed a bimodal split, with wet processing and mechanical processing as the two primary groupings. For this Production Stage, processes impacts were assigned based on whether it was wet processing or mechanical processing. Lastly, process outliers (such as solution dyeing) were also kept separate from the Production Stage impacts.

Material Category	Production Stage					
Textiles	Raw Material Source	Yarn Formation Method	Textile Formation	Preparation	Coloration	Additional Coloration & Finishing
Leather	Country of Origin and Process	Tanning	Re-Tanning	Drying	Leather Finishing	
Foam	Raw Material Source	Raw Material Form	Mixing/Preparation	Foaming	Molding/Pouring	
Synthetic Leather	Substrate Raw Material	PU Type	Substrate Formation	Production Process	Specialty Application	
Rubber	Raw Material Source	Mixing/preparation	Molding/curing	Finishing		
Barriers	Raw Material Source	Membrane Creation	Bonding			
Insulation Materials	Raw Material Source/ Animal Husbandry and Region	Raw Material Processing				
Metals	Raw Material Source	Forming	Finishing			
Plastics	Raw Material Source	Mixing/preparation	Molding/curing			
Wood Materials	Raw Material Source	Shaping	Finishing			

White = Process Level Assessment
Grey = Assigned Low Chemistry
Blue = Assigned Medium Chemistry
Pink = Assigned High Chemistry

Each of the levels of chemistry impacts (high, medium, low) are assigned a number of chemistry "units" at the process level to create consistency with the rest of the Higg MSI (quantitative numbers). The units for each level are:

- Low: 2 Chemistry Units
- Medium: 4 Chemistry Units
- High: 6 Chemistry Units

Chemistry Qualifiers

To provide a level of objectivity, Qualifiers (certifications, programs, and other tools) are assessed against six areas of chemical impact: Input Chemistry Assessment, Chemical Inventory Management, Worker Occupational Health & Safety, Chemical Use Efficiency, Chemical Emissions Reduction, and Product Safety Assurance. This framework allows for consideration of many different elements of chemical management practices, all of which can have an effect of chemical impacts. Actions in each of these impact areas are assessed and supporting documentation must be provided to demonstrate that the specific criteria are actively managed.

Qualifier:
A Qualifier is any certification, program, or tool that can be assessed against the individual criteria of the desired outcomes in an objective manner.

A "Qualifier" must be specific to a material, facility, or process, with a claim or certification that can be supported through documentation. Note: Internal chemical management programs are scored as part of the Higg Brand and Retailer Module.

Each Qualifier must meet the following requirements:
- Relevant to User
  - End user has access to necessary information to make selection
  - End user can influence change
- Must be attributable directly to a material, facility, or process
- Demonstrated chemical management improvements (actively assessed and managed)
- Value Add (drives action and education; non-zero score)

Chemical Impact Areas: Each qualifier must meet required actions in at least one of six specific Chemical Impact Areas. Each Chemical Impact Area has a principle it is intended to achieve, as well as required actions that the Qualifier must provide documentation that shows their active management and measurement. The Chemical Impact Areas and their defining principles are as follows:
- **Input Chemistry Assessment:** Chemical inputs have been screened as part of quality assurance practices. Screening focuses on both product stewardship knowledge (managing consistent quality and understanding of impurities) as well as site stewardship practices. These criteria refer to chemical manufacturing sites.
- **Chemical Inventory Management:** Production Sites have a demonstrated ability to understand the chemicals entering and being used as part of their production. This includes selecting chemical products that have been assessed to proactively improve worker safety, manufacturing restrictions, and product restrictions.
- **Worker Occupational Health & Safety:** Workers are protected from acute and chronic hazards associated with exposure to chemical substances through appropriate knowledge and tools
- **Chemical Use Efficiency:** Production sites follow current Best Environmental Practice (BEP) and demonstrate continuous improvement to reduce the impacts of chemical use.
- **Chemical Emissions Reduction:** All production site emissions and discharges from the production site are managed to Best Environmental Practice using Best Available Technology where control systems are applicable.
- **Product Safety Assurance:** Products have demonstrated low risk from chemical exposure associated with product use, handling, and end of life.

Assessment Types: Different required actions and/or applicable chemical impact areas were developed for different types of Qualifier program. This includes:
- **Raw Material – Agricultural:** For Qualifiers that are focused on agricultural raw materials, Chemical Emissions Reduction is not applicable since they are open systems. Instead, Chemical Use Efficiency has double impact weighting. Likewise, Product Safety Assurance is not included as it is intended to cover consumer product assurance.
- **Raw Material – Manufactured:** For Qualifiers that are focused on manufactured raw materials. Product Safety Assurance is not included in the assessment as it is intended to cover consumer product assurance.

- **Facility Certification:** For Qualifiers that are focused on assessing a facility, regardless of the production processes covered. Product Safety Assurance is not included in the assessment as it is intended to cover consumer product assurance which is outside the scope of a facility assessment that doesn't also consider the materials/products being created.
- **Finished Material/Product Certification:** For Qualifiers that are focused on assessing materials, components, and products. These Qualifiers may also include facility assessment in conjunction with material certification within their scope and all Chemical Impact Areas are included.

Required Actions: The required actions for each Chemical Impact Area are divided into different topics and levels of achievement. The level of achievement for a Chemical Impact Area is the lowest level achieved in any topic. Required Actions are also mapped over to the Higg FEM questions, where applicable. This allows for more detailed guidance on what constitutes meeting the requirements for different required actions. Below is an example of the required actions for Finished Material/Product Certification. As mentioned previously, some sections are not applicable to all assessment types and some wording of the required actions is modified to reflect the different assessment scopes.

Input Chemistry Assessment

Principle
Chemical inputs have been screened as part of quality assurance practices. Screening focuses on both product stewardship knowledge (managing consistent quality and understanding of impurities) as well as site stewardship practices. These criteria refer to chemical manufacturing sites.

Required Actions

Level	Formulation Review	Product Stewardship	Site EH+S Practices
1	Independent review and/or analytical test of the formulation to MRSL limits that support the phase out of an identified list of hazardous chemicals. SDS is reviewed to ensure GHS compliant format or equivalent		
2		Product Stewardship capabilities of the chemical manufacturer is verified, ensuring quality is managed consistently (including understanding and management all impurities) through formal input and quality management systems. The safety and technical data sheets are reviewed to ensure content is complete and accurate.	Processes for managing site air emissions, wastewater treatment, and solids waste disposal are verified, including mass balance analysis of relevant inputs and outputs. There are documented occupational health and safety programs and training.
3	Proactive management of formulation requirements drive best available technology through an evaluation process that includes an understanding of underlying substance hazards, worker and environmental exposure scenarios, and achievable functional requirements (both outputs and processing limitations).	Practice of validating incoming material SDS for accurate and complete hazard classification and, if needed, complementing by accessing authorative sources of hazard and/or equivalency data.	A site visit is performed to confirm the documented processes for managing site air emissions, wastewater treatment, and solids waste disposal are effective and adequately cover the production site. General housekeeping and occupational health and safety practices are observed and confirmed.

Chemical Inventory Management

Principle

Manufacturing Sites have a demonstrated ability to understand the chemicals entering and being used as part of their production. This includes selecting chemical products that have been assessed to proactively improve worker safety, manufacturing restrictions, and product restrictions.

Required Actions

Level	Storage	Inventory Management	Preferred Chemistry
1	Defined chemical storage areas are well marked and there is controlled access. Appropriate controls for hazards (secondary containment, explosion proof lighting, etc) is in place. Incompatible substances are segregated from each other. *FEM CM 1.9 - Partial Yes*	A chemical inventory is kept for the production site that covers, at minimum, chemicals that are used in manufacturing processes. The chemical name and supplier are listed and SDS are available. *FEM CM 1.1 - Partial Yes, Only Manufacturing Chemicals*	Access to a list of screened chemical formulations is provided that meets at least Level 1 criteria for Input Chemistry Assessment
2	In addition to chemical storage areas there are temporary storage locations at the point of work where chemicals are applied in production processes. *FEM CM 1.9 - Yes*	A chemical inventory is kept for the production site that covers all chemicals used at the site (including those for tooling/operations). The chemical name and supplier are listed and SDS are available. Function, Hazard classification, where used, and quantities are included. *FEM CM 1.1 - Partial Yes, All Chemicals*	All chemicals used in manufacturing a certified output are required to be screened and approved and there is a means to verify ongoing compliance
3		A chemical inventory is kept and actively managed as part of chemical procurement processes. The inventory is updated whenever a new chemical is purchased and new chemicals are not moved into bulk storage until it is fully assessed and approved. *FEM CM 1.1 - Yes*	

Worker Occupational Health and Safety

Principle

Workers are protected from acute and chronic hazards associated with exposure to chemical substances through appropriate knowledge and tools

Required Actions

Level	Worker Knowledge and Training	Protective Equipment and Use	Signage and OHS Management
1	All employees who use chemicals are trained on chemical hazards, risk, proper handling, and what to do in case of emergency or spill *FEM CM 1.3 - Partial Yes*	Appropriate and operable protective and safety equipment, as recommended by the safety data sheets, is readily available in all areas where chemicals are used and stored. *FEM CM 1.5 - Yes*	SDS Information related to operation worker safety and storage requirements (such as first aid, hazard, and flammability information) is available and accessible by worker in a language and format that is readily understood. Chemical hazard signage is clearly posted in all areas where chemicals are stored or used. Handling equipment is available at relevant locations and correspond with the safety requirement and hazard communication/signage for each particular chemical. *FEM CM 1.2 - Partial Yes + FEM CM 1.6 - Yes*
2	Employee training is carried out regularly and is documented. There are documented chemical spill and emergency response plans. *FEM CM 1.3 - Yes + FEM CM 1.4 - Partial Yes*		
3	The manufacturing site keep records of all employee and environmental incidents related to chemical spills and emergency response to drive continuous improvement through process reviewand updating *FEM CM 1.4 - Yes*		The manufacturing site has a documented environmental and occupational health and safety program specific that includes chemicals management. *FEM CM 1.8 - Yes*

Chemical Use Efficiency

Principle

Production sites follow current Best Environmental Practice (BEP) and demonstrate continuous improvement to reduce the impacts of chemical use.

Required Actions

Level	Chemical Use Tracking	Chemical Choice and Efficiency	Hazardous Chemical Substitution
1	Chemical use at the manufacturing site is required to be tracked and reported	A process or system to ensure the appropriate choice of chemicals and use efficiency is implemented	
2	Chemical use at the manufacturing site is verified through a review of the Chemical Inventory records.		
3	Chemical use at the manufacturing site is verified through a review of the Chemical Inventory records and audit of purchase records.		The manufacturing site has an implementation plan to reduce the use of hazardous chemicals beyond those specified by regulations and brand RSL/MRSL requirements. *FEM CM 2.15 - Yes*

Chemical Emissions Reduction

Principle

All production site emissions and discharges from the production site are managed to Best Environmental Practice using Best Available Technology where control systems are applicable.

Required Actions

Level	Wastewater	Air Emissions	Waste
1	Industrial wastewater volume is tracked. The final discharge points for both industrial and domestic wastewater are known. *FEM WW 1.1 - Yes*	Air emission point sources are tracked, including the pollutants known or likely to be present, the quantity emitted, frequency of monitoring. *FEM AE 1.1 + 1.2 Full Points*	Hazardous Waste streams are identified, tracked, and disposed in accordance with regulatory requirements. *FEM W 1.2 + FEM WW 1.7*
2	Industrial wastewater is treated and conventional effluent quality parameters are tracked. At minimum, ongoing compliance with permits is demonstrated. *FEM WW 1.4 (Permits)*	Control devices and abatement systems are present for major emission sources. An improvement plan is required to be implemented for air emissions where they fall below best practice. *FEM AE 1.4 -Yes*	Storage areas for hazardous waste are designated and well-marked. Hazardous waste is segregated from non-hazardous waste.*FEM W 1.3 + FEM W 1.4*
3	Chemical substances that can remain in the effluent are considered and checked on a periodic basis. *FEM WW 1.4 - including wastewater standard with chemical substance requirements*	Major air emission sources are further tracked through a mass balance approach against reported use as part of verification criteria.	Accuracy of waste tracking is verified through a periodic waste mass balance with supporting documentation.

Product Safety Assurance

Principle	
Products have demonstrated low risk from chemical exposure associated with product use, handling, and end of life.	
Required Actions	
Level	**Product Safety Assurance**
1	Independent review and/or analytical test of the final product to RSL limits that provide assurance that, at minimum, the product should meet global regulatory requirements.
2	There is a Quality Assurance process that validates input components to the product can meet RSL requirements, reducing risks of unexpected product failures.
3	All additional processing of the product has been validated to meet RSL requirements through demonstrated site and process management.

Qualifier Assessment Scoring

To determine the final Qualifier Assessment Scoring, the chemical impact areas, level achievements and assessment types are all considered.

- **Chemical Impact Areas and Assessment Type:** Recognizing that Input Chemistry Assessment encompasses a full level of the supply chain (chemicals manufacturing), the weighting for this Chemical Impact Area is double the weighting of other categories (30%). Product Safety Assurance has a slightly lower weighting as it has the least requirements and least impact on overall chemical impacts (10%). The other impact categories are weighted at 15%. For Assessment types that do not have the Product Safety Assurance Impact Area, the points from this section are redistributed amongst the other Chemical Impact Areas (2% higher weighting in each Chemical Impact Area). For Raw Material – Agriculture assessments, Chemical Emissions Reduction is reduced to 0% weighting (not applicable) and Chemical Use Intensity weighting is doubled. This is to account for the fact that in an open system, use of chemistry is equivalent to the emissions to the environment.

Assessment Type	Input Chemistry	Chemical Inventory Management	Worker Occupational Health & Safety	Chemical Use Efficiency	Emissions Reductions	Product Safety Assurance
Raw Material - Agriculture	32%	17%	17%	34%	0%	0%
Raw Material - Manufactured	32%	17%	17%	17%	17%	0%
Facility	32%	17%	17%	17%	17%	0%
Finished Material/Product	30%	15%	15%	15%	15%	10%

- **Level Achievement:** The level achievement in each Chemical Impact Area is weighted, with higher levels assigned a higher percentage achievement. The distribution of the percentage achievement factors in that higher levels are both harder to achieve and have better demonstrated chemicals management and impact reduction potential. Therefore, the achievement from going from Level 2 to Level 3 is larger than from Level 1 to Level 2, which in turn is larger than going from Level 0 to Level 1. The percentages assigned for each level are as follows:

- Level 0: 0%
- Level 1: 15%
- Level 2: 45%
- Level 3: 100%

The overall score for a Qualifier is composed of these two elements weighted together. For instance, a Finished Material Qualifier that achieves Level 3 in Product Assurance but no points in other Chemical Impact Areas would be assigned 10% (100% of 10%). A Facility Qualifier that achieves Level 1 in Impact Chemistry Assessment and Chemical Inventory Management would be assigned 7.3% (15% of 32%, plus 15% of 17%).

Qualifier Applicability:
The Qualifiers self-report which processes and Production Stages that they cover. Within the Higg MSI, the Qualifier will only be shown as an option for the processes that match the reported applicability.

Higg MSI Chemistry Scoring

The default chemistry impacts shown in the Higg MSI are the Process Level Chemistry Impacts. As with other LCIA categories, the MSI scores are normalized from the LCIA category results. For chemistry, this is equivalent to the Chemistry Units.

Applying Qualifiers to a material or process modifies the chemistry impacts for the applicable processes. The maximum reduction in the chemistry impacts for any process is two-thirds of the total chemistry impacts, occurring only when the Qualifiers achieve a maximum score of 100%. The general formula of how a Qualifier modifies the chemistry score is:

*[Chemistry Impact] = [Default Process Chemistry Impact] * (1- (2/3 * [Qualifier Percentage]))*

It is possible to select multiple Qualifiers, but only one Qualifier is applied to a process at a time. If multiple Qualifiers are selected, the Qualifier with the largest impact reduction is applied. Note that since Qualifiers can apply to different processes, there are situations where selecting multiple Qualifiers for a material is relevant.

APPENDIX E: HIGG 2.0 MSI TECHNICAL REVIEW REPORT (2016)

Peer Review of

The Higg Materials Sustainability Index (MSI) Methodology

August 2016

Gregory A. Norris

INTRODUCTION

This report summarizes findings of a critical/peer review of the July 20, 2016 version of "The Higg Materials Sustainability Index Methodology" report; an Excel workbook titled "Process Review July 2016t.xls"; and other details of the method and approach as communicated via web meetings with Cash East, of Pre Sustainability. The findings reported here represent the independent judgment of the reviewer.

While the topics under consideration in this review tend to focus on life cycle assessment (LCA) data sources and modeling choices, this is a review of an LCA-based assessment methodology and tool, rather than a single LCA study. As such, this report does not constitute a conventional "critical review" of an LCA study for conformance with the ISO 14044 standard for LCAs. Consideration will be given to several topics also addressed by the ISO 14044 standard, but this review is both broader and less particular than a conventional 14044-style review.

OVERVIEW

The following topics are addressed in this review of the Higg Material Sustainability Index (Higg MSI):

- Major data selection decisions
- Normalization
- Selected modeling decisions

Data Selection Decisions

The first major choice necessary in rendering the Higg MSI operational is how to source the extensive "background data" needed to complete the numerous material and processing supply chain models. The methodology employed by the Higg MSI is LCA, so life cycle inventory (LCI) data are needed to complete the supply chain and life cycle models.

As specified on page 7 of the report, the choice has been made to use the following secondary sources for the Higg MSI launch: Ecoinvent versions 3, PlasticsEurope, GaBi, JRC European Commission, and literature. In general these choices are strongly supported by this review.

Delving into the Process Review spreadsheet, we note that among these sources, the Ecoinvent version 3 database plays a major role. This choice is sound and supported by the following considerations:

- This database provides unit process transparency, meaning that the thousands of unit processes which comprise supply chain models are individually specified and visible for scrutiny by any interested party, and what's more, their importance and individual contributions to the final results can be quantitatively assessed using all standard LCA software packages. Such scrutiny supports continuous improvement and refinement of the data, including support of prioritization of such refinement.

- Version 3 of the Ecoinvent database includes regionalization and global markets. Research in LCA increasingly shows the importance of regionalization in assessing impacts, and clearly apparel supply chains span the globe and involve significant contributions from countries outside of zones where the bulk of LCI data have historically been developed (Europe and North America). Explicit modeling of markets and the locations of supply chain processes adds to the ability of future enhancements of the Higg MSI data.

Next, we note that extensive use has also been made of a recently published benchmarking study of textiles, to provide a consistent and transparent basis for estimating energy use for a wide set of textile production steps. This choice too appears sound and supported by the following considerations:

- The source is transparent and was peer-reviewed prior to being published in the International Journal of LCA
- The source provides a single consistent basis for these estimates.

Finally, in relation to secondary data selection in general, we note that in the development of supply chain models for what turn out to be hundreds of material/process combinations, there are numerous cases where data that provides an imperfect match in terms of the specific material, technology, and country(s) of origin for which data were sought. This obviates the use of "proxy" or "best available substitute" data. Such a fallback is common practice when the data scope is as large as is the case in this project. It is supported by the considerations that:

- The choices are all transparently documented in the spreadsheet noted, which has supported internal scrutiny and cross-checking by a group of experts this far in the process, and can be further subject to scrutiny and to refinement wherever better data can be immediately obtained;
- By keeping the choices transparent at a unit process level, uncertainties introduced by the use of proxy data can be assessed and compared in the future to prioritize which data choices warrant refinement because of the possible sensitivity of final results and conclusions to these uncertainties.

Normalization

As noted on pages 9 and 10 of the report, if a final score is to be obtained (as is the case in the Higg MSI) then the step of "normalization" is needed prior to weighting (or summing of un-weighted results) by impact category. An interesting approach has been taken in the development of the Higg MSI in the selection of what is called the "reference system" for normalization – the system whose impacts are used as the denominator in calculating normalized results for a given material, process, or product.

It is common practice in LCA to use as a reference system the sum total of all processes and activities within all sectors of the economy for a given country or continental region. The results of normalization then indicate the relative share of contribution to total impacts from this reference system (region) that are due to the product being studied. This approach has the advantage that it can be applied widely across applications in all sectors.

The Higg MSI is a methodology that is designed to support decision making by users within a specific sector: apparel. In such an instance, use is sometimes made of sector-specific reference systems for normalization. For example, decision makers may wish to know, and take into account: how influential is a given product design or material selection decision, compared with or in the context of, the total impacts of our sector (the apparel industry including its supply chains).

This is the approach that has been taken in developing the Higg MSI. The normalization basis used is the weighted average of impacts for a representative set of the most-often-used materials for footwear and for apparel. These materials were weighted in terms of percentage of usage by volume, based on data provided by member companies and trade associations.

The approach is defensible and sound, and will provide a stable basis for normalization results (and thus final Higg MSI scores). In future versions of the method and tool, it might be considered to test the influence of adopting an all-sector reference system perspective for a large region or for the globe. Doing so would, for example, give higher relative importance (than found in the current version of the Higg MSI) to those impact categories on which the apparel sector makes a higher-than-average contribution compared with the rest of the economy, and likewise would give lower relative importance (than found in the current version) to those impact categories on which the apparel sector makes a lower-than-average contribution. That said, it must be also recognized that publicly available normalization datasets suffer from their own incompleteness, which has the impact of biasing results in giving higher importance to impact categories for which global or national emissions inventories are more incomplete. The normalization reference system selected in the development of the Higg MSI circumvents this problem, based as it is on the life cycle inventories calculated directly from the datasets used.

Selected Modeling Decisions: Foreground Transportation

In order to create a set of results that is usable at a high level without needing to use life cycle assessment software, one simplification which has been made is to not include explicit modeling of transportation within "foreground" systems. Transportation impacts are included within the "background" systems farther upstream. It is considered relatively likely that this exclusion of foreground system transport modeling will not strongly affect the conclusions or results. Inclusion of foreground modeling of transportation would have significantly increased the complexity of the user experience and back-end database modeling.

For a future version of the Higg MSI system, sensitivity calculations might be advisable, to test whether – and for which specific materials or decision types) foreground transportation can make a significant impact in the final results and swing a decision or choice. If it is found that foreground transport does not in fact tip the decision scales in general, knowing this would add user confidence in the final results.

APPENDIX F: GLOSSARY

Allocation: partitioning the input and/or output flows of a process to the product system under study (ISO). This is necessary when more than one product is produced (joint production), and environmental impacts need to be divided between the product systems.

Characterization: substances that contribute to an impact category are multiplied by a characterization factor that expresses the relative contribution of the substance.

Climate Change: a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Cradle-to-gate: The cradle-to-gate life cycle spans the origin of raw materials to a finished textile or component part, ready to be shipped to a product manufacturing facility.

Ecotoxicity: the potential for biological, chemical or physical stressors to affect ecosystems.

Eutrophication: excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen.

Higg Index Product Tools: Higg Index Product Tools include the Higg MSI, the MSI Contributor, and the Higg Product Module.

Higg Product Module: a Higg Tool to provide credible external communication to influence purchasing decisions and scale industry adoption of leading practices. It will be used by sustainability and communication experts to assess the full impacts of a finished product. Methodology will be aligned with life cycle assessment (LCA) methodology, particularly that of the Product Environmental Footprint (PEF).

Higg Materials Sustainability Index (MSI): cradle-to-gate material scoring tool informed by life cycle assessment (LCA) data and methodology to engage product design teams and our global value chain in environmental sustainability. Through this tool, users can view material scores, processes, and metadata. Users can also swap in and our different production processes to see score changes and create blends. SAC members can also access LCA midpoints for each process.

Human Toxicity: The Human Toxicity Potential (HTP) is a quantitative toxic equivalency potential (TEP) that has been introduced previously to express the potential harm of a unit of chemical released into the environment. HTP includes both inherent toxicity and generic source-to-dose relationships for pollutant emissions.

Land Occupation: the amount of land necessary to be used specifically for production of the material.

Life Cycle Assessment (LCA): Life-cycle assessment is a technique to assess environmental impacts associated with all the stages of a product's life from cradle to grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

Life Cycle Impact Assessment (LCIA): Phase of Life Cycle Assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product.

Material: a finished material, ready to be shipped to a product manufacturing facility and assembled into a product. It is made up of a chain of individual processes that illustrate full cradle-to-gate material production. It will have an associated score reflected in the Higg PM and Higg MSI.

Material Category: a generic material type (ex: textile, foam, metal).

Materials Sustainability Index (MSI): cradle-to-gate index informed by life cycle assessment (LCA) data to engage product design teams and our global value chain in environmental sustainability. Through this tool, users can view material scores, processes, and metadata. Users can also swap in and our different production processes to see score changes and create blends. SAC members can also access LCA midpoints for each process.

Materials Task Team: a team of SAC members (brands, retailers, manufacturers, and service providers in the apparel, footwear, and home textile industries) with the goal of creating content and scoring methodology for the Higg MSI.

Midpoint: an impact category that translates impacts into environmental themes such as climate change, eutrophication, ecotoxicity, etc.

Process (also called Unit Process): an individual production process used in the cradle-to-gate life cycle of a material. A process in the Higg MSI is associated with specific inputs and outputs from/to the environment. A chain of processes makes up a Material.

Production Phase: a material production step for which various processes could be used. More than on Production Phases are used to create a finished material.

Product Environmental Footprint (PEF): harmonized methodology for the calculation of the environmental footprint of products (including carbon). It has been spearheaded by the European Commission and DG Environment.

Resource Depletion, Fossils and Minerals: Resource depletion is the consumption of a resource faster than it can be replenished. This impact area model is based on available fossil fuel reserves and the technology available to access those reserves.

Sustainable Apparel Coalition: The Sustainable Apparel Coalition is the apparel, footwear and home textile industry's foremost alliance for sustainable production. The Coalition's main focus is on building the Higg Index, a standardized supply chain measurement tool for all industry participants to understand the environmental and social and labor impacts of making and selling their products and services. By measuring sustainability performance, the industry can address inefficiencies, resolve damaging practices, and achieve the environmental and social transparency that consumers are starting to demand.

USEtox: a scientific consensus model endorsed by the UNEP/SETAC Life Cycle Initiative for characterizing human and ecotoxicological impacts of chemicals. Main output is a database of recommended and interim characterization factors including fate, exposure, and effect parameters.

Water resources depletion/scarcity: a means to measure potential environmental damages of water use for three areas: human health, ecosystem quality, and resources.

APPENDIX G: INITIALISMS

BOM: Bill of Materials

BRM: Brand & Retailer Module

CED: Cumulative Energy Demand

CML: Centre of Environmental Science – Leiden University

DQR: Data Quality Rating

EC: European Commission

FEM: Facility Environmental Module

FSLM: Facility Social/Labor Module

GWP: Global Warming Potential

ILCD: International Reference Life Cycle Data System

IPCC: International Panel on Climate Change

LCA: Life Cycle Assessment

LCI: Life Cycle Inventory

LCIA: Life Cycle Inventory Analysis

MSI: Materials Sustainability Index

PEF: Product Environmental Footprint

PEFCR: Product Environmental Footprint Category Rules

PM: Product Module

SAC: Sustainable Apparel Coalition

SOM: Soil Organic Matter

WSI: Water Stress Indicator