MEASUREMENT WORKING GROUP PROPOSAL

EXECUTIVE SUMMARY

The Measurement Working Group proposes that the annual percentage of asphalt roofing waste diverted from landfill be estimated by cumulating credible reports of waste quantities diverted from landfill and dividing the sum of those quantities by the total amount of roofing material waste generated in any given year. Total waste generated is based on the sum of estimates of tear-off waste generated during roof replacement projects, scrap generated during asphalt roofing installation, and manufacturing finished product waste generated within ARMA member company facilities. An estimated percentage not diverted from landfill is determined by difference. This approach incorporates aspects—such as cumulation of verifiable quantities diverted (which will never capture all diversion streams)—that generate a conservative estimate of diversion.

INTRODUCTION

The Measurement Working Group is to provide means and methods to estimate quantities diverted and not diverted from landfill. Based on the ARMA statement—which sets percentage targets by specific dates—results are to be communicated as a percentage. An estimate of total quantity is necessary for use in the percentage calculation in addition to estimates of quantities diverted and not diverted.

The Asphalt Roofing Recycling Ecosystem diagram, an important resource created by the Measurement Working Group to facilitate understanding and communication of waste generation and recycling within the asphalt roofing industry, is incorporated into this proposal by reference.

This proposal presumes an annual calculation of estimated percentages diverted and not diverted from landfill. The process can be altered to generate estimates at a different interval if desired.

PROPOSAL

The Measurement Working Group proposes to estimate percentages diverted and not diverted from landfill in accordance with the following formulas:

$$Diverted_\% = \frac{\sum Diverted_{Tons}}{Total_{Tons}}$$

$$Not\ Diverted_\% = \frac{(Total_{Tons} - \sum Diverted_{Tons})}{Total_{Tons}}$$

The sections that follow provide details that underlie the formulas above.

MEASUREMENT WORKING GROUP PROPOSAL

ESTIMATING TOTAL QUANTITY OF ASPHALT ROOFING

The ARMA shipment report provides the best available information about quantities of asphalt roofing materials introduced to the market each year. The formula shown below and described in the subsequent paragraphs determines the value used as a denominator in the subsequent calculations of percentages diverted and not diverted.

Waste generated during roof replacement projects.

$$Total_{Tons} = \left[\sum \left(SteepProduct_{Tons} \times Replacement_{SteepProduct} \right) \right.$$
$$\left. + \sum \left(LowProduct_{Tons} \times Replacement_{LowProduct} \right) \right]$$

Installation scrap generated during roof replacement, roof recover, roof repair, and new construction.

$$+ \left[\sum \left(SteepProduct_{Tons} \times Scrap_{SteepProduct} \right) \right.$$
$$\left. + \sum \left(LowProduct_{Tons} \times Scrap_{LowProduct} \right) \right]$$

Manufacturer finished product waste.

$$+ MFPW_{Tons}$$

Where, for any given year of analysis:

$SteepProduct_{Tons}$ = tons of a steep slope product type (from ARMA shipment report, converted from squares when necessary),

$Replacement_{SteepProduct}$ = the percentage of steep-slope roof installations which are replacements,

$LowProduct_{Tons}$ = tons of a low slope product type (from ARMA shipment report, converted from squares),

$Replacement_{LowProduct}$ = the percentage of low-slope roof installations which are replacements,

$Scrap_{SteepProduct}$ = the percentage scrap generated during installation of a steep-slope product type,

$Scrap_{LowProduct}$ = the percentage scrap generated during installation of a low-slope product type,

$MFPW_{Tons}$ = manufacturing finished product waste generated.

The estimate of total tons is determined by summing the results of the three expressions in the equation above. The first expression estimates the amount of asphalt roofing removed due to roof replacements during the calendar year. A one-to-one replacement of existing material is used to estimate the quantity of asphalt roofing either sent to or diverted from landfill that is generated by roof replacements.

The second expression estimates the amount of asphalt roofing scrap waste generated during installation of all asphalt roofs (i.e., replacements, recovers, and new construction) during the calendar year. All material shipped is included, based on the assumption that shipped materials will be utilized in

roof replacement, roof recover, or new construction projects at some future date. The percentage of scrap generated is assumed to be equivalent for replacement, recover, and new construction projects within each material category.

The third expression is the quantity of manufacturing finished product waste generated in asphalt roofing manufacturing facilities in the calendar year. The ARMA shipment report does not capture finished products that are created but not shipped. Therefore, an annual survey of ARMA manufacturing member companies is proposed to determine the quantity of manufacturing finished product waste generated by ARMA member companies. That quantity is added to the quantities determined by the other two expressions to generate an estimate of the total quantity of material for use as the denominator.

Although annual shipment quantities vary in response to many market forces, it is expected that amounts diverted will be correlated to amounts shipped, albeit with a lag. This lag, combined with the choice to report for equal, successive time periods—which are expected to be unrelated to market events (e.g., storms, pandemics)—may contribute to year-to-year variation in the reported percentages diverted and not diverted. However, significant event-caused variation is expected to self-correct within one to two subsequent report periods.

Although the quantity in the ARMA shipment report for saturated felt is in tons, the quantities for shingles, modified bitumen, and built-up roofing are provided in squares. Conversion factors are employed to transform squares to tons for each product category, using the following formula:

$$Product_{Tons} = \frac{Product_{Squares} \times Conversion_{Product}}{2000}$$

where, for any given year of analysis:

$Product_{Squares}$ = squares of product shipped (from ARMA shipment report),

$Conversion_{Product}$ = factor to convert squares to tons for the product.

ESTIMATING QUANTITY AND PERCENTAGE DIVERTED FROM LANDFILL

There is no definitive report of quantities of asphalt roofing materials diverted from U.S. and Canadian landfills. There are estimates of quantities of various construction and demolition materials sent to and diverted from landfill. However, these existing estimates are all deficient in some manner for ARMA's purpose. As an example, none includes modified bitumen and built-up roofing materials. As a further example, U.S. government generated estimates do not consider Canadian roofing materials.

In the absence of usable existing estimates, the Measurement Working Group proposes that ARMA capture and cumulate credible reported quantities of existing diversion streams, as is symbolized in the following formula, and determine a percentage diverted by dividing the cumulated diverted quantity by the previously determined total quantity sent to or diverted from landfill:

$$Diverted_\% = \frac{\sum Diverted_{Tons}}{Total_{Tons}}$$

It is understood that a cumulation of credible quantities diverted will always underestimate actual diversion, but this is seen as beneficial because it positions reports associated with the ARMA statement as purposefully conservative.

An example of existing data that will initially be included as credibly diverted asphalt roofing is that reported by the National Asphalt Pavement Association (NAPA) in their annual survey. Other potential sources of data that could be added with further development include:

1. ARMA member company quantities reported as diverted via their individual efforts. A survey could be created to collect such data.
2. Non-ARMA member companies that independently obtain and process asphalt roofing materials may publicly offer (or be persuaded to offer) estimates of their diversion quantities.
    a. Processing to obtain components.
    b. Processing for waste-to-energy purposes.
3. Recyclers may provide a source of data for end-markets which don't fall into the prior categories (e.g., dust suppression, soil stabilization).
4. Other sources that have not yet been identified.

Future responsibilities of the Measurement Working Group or another working group should be to identify, develop, and incorporate credible diversion data and to ensure that duplications of reported diversion quantities from different sources are understood and eliminated.

ESTIMATING PERCENTAGE NOT DIVERTED FROM LANDFILL

As with quantity diverted, no suitable third-party estimates of quantities of asphalt roofing materials placed in U.S. and Canadian landfills have been identified. Estimates that exist are focused solely on asphalt shingles. Therefore, the Measurement Working Group proposes that the percentage not diverted be calculated by difference, as in the formula which follows. This approach is expected to conservatively estimate the percentage sent to landfill.

$$Not\ Diverted_\% = \frac{(Total_{Tons} - \sum Diverted_{Tons})}{Total_{Tons}}$$

OR

$$Not\ Diverted_\% = 100 - Diverted_\%$$

SENSITIVITY OF PERCENTAGE ESTIMATES TO ASSUMPTIONS

This measurement methodology includes three sets of assumptions: (1) roof replacement rates, (2) conversion factors to transform shipments from squares to tons, and (3) proportion of scrap generated during roofing installation. A sensitivity analysis was conducted to confirm which assumptions most strongly impact the percentages diverted and not diverted. The analysis indicates that the most critical assumptions, in order of importance, are (1) asphalt shingle replacement rate, (2) asphalt shingle conversion factor, and asphalt shingle scrap rate. Large variances in the other assumptions have minimal effect on the estimated percentages diverted and not diverted from landfill.

CONCLUSION

The measurement process described herein provides a framework upon which ARMA can continually build. Each year, ARMA teams can seek data for additional diversion streams to add to the quantity diverted estimate. ARMA may use information from this process to communicate an appropriate narrative about member company recycling efforts. The process provided is logically defensible and purposely conservative, supports continuous improvement, and is believed to be sufficiently robust to serve beyond the 2050 final target of the ARMA statement.