

**FINAL**

# **NUCOR SOLAR FOUNDATION**

## Independent Assessment

**BV PROJECT NO. 404824**

**PREPARED FOR**

**NUCOR®**

**Nucor Corporation**

**21 December 2021**



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## 1.0 Executive Summary

Black & Veatch Management Consulting, LLC (Black & Veatch) was retained by Nucor Corporation (Nucor) to perform an independent assessment of the Ultrahigh Strength Weathering Steel and other high strength steel material products. Nucor also has developed a proprietary cold rolled “C” (NSP 6X) shaped pile to be used with both Ultrahigh Strength Weathering Steel and other high strength steel grades. Throughout the report, the term “Product” refers to the NSP C6X pile made with high strength steel. This pile can be made with varying thickness and a profile can be found in Appendix A.

During the independent assessment process, Black & Veatch evaluated information provided by Nucor and its manufacturing subcontractors. On October 21, 2021 Black & Veatch met with key Nucor personnel at the Modineer, a third party manufacturer, manufacturing site visit to review information provided by Nucor and Modineer and visually inspect Modineer’s manufacturing facility. All information provided was assumed to be current and correct.

This technical due diligence report (Report) provides a summary of Black & Veatch’s observations and findings regarding the Product.

### 1.1 SCOPE OF WORK

To conduct this independent assessment, Black & Veatch provided the following services:

- Reviewed Nucor’s company background to provide context for this independent assessment.
- Reviewed the results of the Product’s test program and testing results.
- Visited manufacturing facilities involved with the Product.
- Reviewed other available information on the Product.

Black & Veatch is uniquely qualified to conduct this study due to its extensive background and experience in solar tracker independent assessments.

### 1.2 APPROACH AND METHODOLOGY

The Black & Veatch team, comprised of professionals in solar tracker manufacturing, supporting engineers, reviewed data provided by Nucor to assess the status and performance of the technology and conducted a visit to manufacturing, assembly, and testing facilities involved in the fabrication of the Product. Data requests for additional or updated documentation were submitted as necessary.

### 1.3 ASSUMPTIONS

During the assessment of this technology, Black & Veatch used and relied upon certain information provided by representatives of Nucor.

Black & Veatch believes that the information provided is true, correct, and reasonable for the purposes of this Report. Black & Veatch has not been asked to make an independent analysis to verify the information provided to us, or to render an independent judgment of the validity of the information provided by others. As such, Black & Veatch cannot, and does not, guarantee the accuracy thereof to the extent that such information, data, or opinions were based on information provided by others. In preparing the Report and the opinions presented herein, Black & Veatch has made certain assumptions with respect to conditions that may exist, or events that may occur in the future. Black & Veatch believes that the use of this information and assumptions is reasonable for the purposes of this Report.

However, some events may occur or circumstances change in ways that cannot be foreseen or controlled by Black & Veatch and that may render these assumptions incorrect. To the extent that the actual future conditions differ from those assumed herein, or provided to Black & Veatch by others, the actual results will differ from those that have been forecast in this Report. This Report summarizes Black & Veatch's assessment of the technology. Throughout this Report, Black & Veatch has stated assumptions and reported information provided by others, all of which were relied upon in the development and conclusions of this Report.

## **1.4 KEY FINDINGS**

Black & Veatch notes the following major conclusions regarding Nucor and the Product:

### **1.4.1 Company**

- Black & Veatch believes the Nucor key staff has experience that is relevant to supporting Nucor's sales objectives.
- Black & Veatch is of the opinion that ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process is applicable to the Product.
- Nucor has been profitable in each year of operation since 2018. Nucor's reported liquidity metrics indicate that Nucor should have adequate liquidity to cover its debts.

### **1.4.2 Reliability and Durability**

- Based on the GRL report, Black & Veatch is of the opinion that the above test procedures appear to be appropriate for the purpose. Black & Veatch is also of the opinion that with appropriate geotechnical investigation, section selection, and pre-project in-situ testing, a shape made from the Product could be selected as a pile material to meet typical solar PV project load requirements.

### 1.4.3 Manufacturing and Quality Assurance

- Nucor maintains ISO 9001 certification, and requires all third party manufacturing suppliers to be certified per ISO 9001, which is one of the most universally recognized quality management standards.
- Black & Veatch finds the quality program Nucor has developed for its own operations and its third party suppliers to be similar to that of other solar racking manufacturers, and consistent with industry accepted practice.
- Black & Veatch believes that Nucor provides clear documentation of quality expectations and requirements in its vendor onboarding, ongoing vendor qualification, and in specific purchase orders. If followed, Black & Veatch believes that this guidance should be adequate to ensure consistent quality across several key component vendors.

## 2.0 Company

This section provides an overview of the corporate structure of Nucor's as it relates to the Ultrahigh Strength Weathering Grade Steel and Product. Black & Veatch focused its review on Nucor's organization, market, competition, manufacturing capacity, warranty, and intellectual property. The following sections summarize Black & Veatch's findings, which were derived from documentation and conversations with Nucor.

### 2.1 ORGANIZATION AND MANAGEMENT

#### 2.1.1 Company Background

Nucor was founded in 1940, and is a public company. They are a large steel producer located across the US with capabilities of producing approximately 27 million tons of steel. Nucor is also one of the largest recyclers of steel in North America with over 22.2 million tons of scrap metal recycled. They have approximately 26,000 employees at over 300 manufacturing facilities across North America. Nucor offers a number of products including carbon and alloy steel sheets, plates, beams, bars, and piles. These products are used in many applications including metal building systems, joists, joist girders, and decking. Other products include hollow structural tubing, electrical conduit, cold finished bars, fasteners, grating, wire, wire mesh, concrete reinforcing steel and raw material.

#### 2.1.2 Office and Manufacturing Locations

Nucor is headquartered in Charlotte, North Carolina and has manufacturing facilities located throughout North America with a majority of the facilities located in the United States.

#### 2.1.3 Key Staff

Nucor's leadership consists of individuals with a background in manufacturing, engineering, finance, and project planning. The following is a description of these key individuals and their experience:

- **Leon J. Topalian**, President & CEO, Mr. Topalian was named President and Chief Executive Officer effective January 1, 2020. He previously served as President and Chief Operating Officer of Nucor beginning in September 2019. Mr. Topalian began his career with Nucor as a project engineer at Nucor Steel-Berkeley in 1996 and was promoted to Cold Mill Production Supervisor in 1998. He has

held various leadership positions throughout his Nucor career in Australia, at Nucor Steel South Carolina, Nucor Steel Kankakee, and Nucor-Yamato Steel Company. He served as Executive Vice President of Beam and Plate Products from 2017 to 2019.

- **James D. Frias**, CFO, Treasurer & Executive Vice President, Mr. Frias has been Chief Financial Officer, Treasurer and Executive Vice President since January 2010. He previously served as Vice President of Nucor in 2006; Corporate Controller of Nucor from 2001 to 2009; Controller of Nucor Steel Indiana from 1994 to 2001; and Controller of Nucor Building Systems Indiana from 1991 to 1994.
- **David A. Sumoski**, COO, Mr. Sumoski was named Chief Operating Officer in January 2021. He served as an Executive Vice President from September 2014 to December 2020. He previously served as Vice President and General Manager of Nucor Steel Memphis from 2012 to 2014; Vice President of Nucor in 2010; General Manager of Nucor Steel Marion in 2008; Maintenance Manager of Nucor Steel Berkeley County, South Carolina in 1999; and Electrical Supervisor there in 1995.
- **Al Behr**, Executive Vice President, Plate and Structural Projects, Mr. Behr was named Executive Vice President in May 2020. He previously served as General Manager of Nucor Steel Texas from 2017-2020; President of the Vulcraft/Verco Group in 2014; Vice President of Nucor 2012; General Manager of Vulcraft South Carolina in 2011; General Manager of Nucor Building Systems South Carolina in 2008; Engineering Manager there in 2001; Nucor Building Systems Texas in 1999; Design Engineer at Nucor Building Systems Indiana in 1996.
- **Douglas J. Jellison**, Executive Vice President, Raw Materials, Mr. Jellison was named Executive Vice President in January 2021. He began his Nucor career in 1990 as Materials Manager at Nucor Bearing Products and has worked in various positions and businesses in his 30 years with Nucor, including several controller and business development roles. Mr. Jellison served as General Manager of Nucor Bearing Products, Vice President and General Manager of Nucor Steel Seattle, Inc. and Vice President and General Manager of Nucor-Yamato Steel Company. He then subsequently worked as President of Nucor Tubular Products before most recently serving as President of Nucor's steel piling subsidiary, Skyline Steel LLC.
- **Gregory J. Murphy**, Executive Vice President of Business Services and General Counsel, Mr. Murphy was named Executive Vice President in January 2021. He began his Nucor career in 2015 as Vice President and General Counsel and later assumed responsibility for environmental and public affairs in 2020. Prior to joining Nucor, Mr. Murphy was a Partner with the law firm of Moore & Van Allen PLLC in Charlotte, where he was the team leader of the Litigation Practice Group and served for a decade on the firm's Executive Committee.
- **Daniel R. Needham**, Executive Vice President, Bar and Rebar Fabrication Products, Mr. Needham was named Executive Vice President in February 2021. Mr. Needham began his career with Nucor in 2000 as Controller at Nucor Steel Hertford County. He subsequently served as Controller of Nucor Steel Decatur, LLC and Nucor Steel Utah. In 2011, Mr. Needham became General Manager of Nucor Steel Connecticut, Inc. He later served as General Manager of Nucor Steel Utah and was elected Vice President in 2016. He most recently served as Vice President and General Manager of Nucor Steel Indiana from 2019-2021.
- **K. Rex Query**, Executive Vice President, Sheet and Tubular Products, Mr. Query was named Executive Vice President in January 2021. He joined Nucor in 1990 as a financial analyst in the Corporate Office and subsequently served as Controller at Vulcraft South Carolina, Nucor Steel Berkeley and Nucor Steel Hertford. After serving as General Manager and Corporate Controller, Mr. Query's positions included Vice President and General Manager at Nucor Steel Auburn, Inc., Nucor Steel Decatur, LLC,

Nucor Steel South Carolina and Nucor Cold Finish as well as President of Nucor Europe. He most recently served as President of Nucor's Vulcraft/Verco Group.

- **Mary Emily Slate**, Executive Vice President, Commercial, Ms. Slate was named Executive Vice President in May 2019. Ms. Slate began her career with Nucor in 2000 as District Sales Manager at Nucor Steel Arkansas. She later served as Sales Manager at Nucor Steel Decatur, LLC and then as Cold Mill Manager. In 2010, Ms. Slate was promoted to General Manager of Nucor Steel Auburn, Inc. and was elected Vice President in 2012. She most recently served as Vice President of Nucor Steel Arkansas from 2015 to 2019.
- **D. Chad Utermark**, Executive Vice President, Bar Products and Fabricated Construction Products, Mr. Utermark has been an Executive Vice President since May 2014. He previously served as the Vice President and General Manager of Nucor-Yamato Steel Company from 2011 until 2014; Vice President of Nucor in 2009; General Manager of Nucor Steel Texas in 2008; Roll Mill Manager of Nucor Steel Texas in 2003; Hot Mill Manager of Nucor Steel Arkansas in 1999; Shift Supervisor there in 1995; and Utility Operator there in 1992.

Black & Veatch is of the opinion that the members of the Nucor management team have significant experience that is relevant to their responsibilities at Nucor.

### 2.1.4 Market and Competition

The Product is designed specifically for solar mounting applications and is meant to have improved performance compared to other hot dipped galvanized products. The shape is also proprietary to Nucor and includes multiple stiffeners and bends throughout the "C" shape. It is also available in multiple bolt and hole patterns to allow connection to a wide variety of racking products. Nucor indicated the following competitive advantages:

- **No Coating** – For appropriate soil types, weathering steel does not need to be coated which eliminates the need of galvanizing but with a similar product lifetime. Also reduces cost and the need to repair the galvanization.
- **Lighter Weight with High Strength** – The Product's weight may be up to half the weight of a traditional hot rolled beam or 70 percent of the weight of a traditional galvanized product. The higher strength steel was shown to deform less during installation than standard steel used in wide flange products. This may result in less deformation and pile refusals during installation. Nucor also noted that the higher strength is also a result of the proprietary "C" shape.
- **Interlocking Packaging** – Nucor states that they can provide up to two times more piles per truck than conventional piles.
- **Faster Response/Delivery Time** – The Product with either no coating or galvanizing applied at the mill, results in reduced production and delivery times. The steel mill galvanizing process, reduces the time it takes to have current products hot dip galvanized. Hot dipped galvanizing is generally a separate post fabrication process.

### 2.1.5 Projects

Nucor has built a fixed tilt array using the Ultrahigh Strength Weathering Steel and a single axis tracking system using the high strength galvanized NSP 6X pile at the Nucor Solar Lab in Utah.

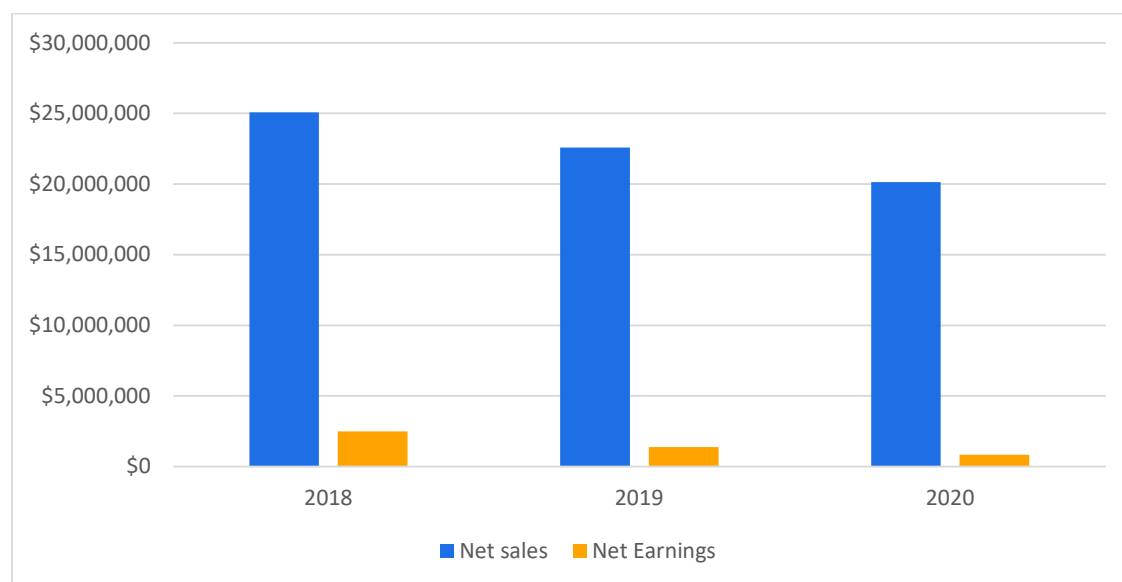


## 2.2 FINANCIAL OVERVIEW

Black & Veatch reviewed Nucor's key high level financial metrics as they pertain to profitability and liquidity, as discussed in the following subsections.

### 2.2.1 Profitability

Nucor provided net sales, gross profitability, and pre-tax income records for 2018 through 2020, as shown in Figure 2-1.



**Figure 2-1: Nucor Financial Performance, 2018 – 2020 (\$000s)**

Based on the information provided by Nucor, Black & Veatch notes that net sales and earnings have declined since 2018. Nucor reports that a contributing factor to the lower net sales and earnings is due to decreased demand and lower prices during that time. However, Nucor provided financial data for 2021 through July 3, 2021 which showed net sales of approximately \$15.7B compared to last year's net sales of approximately 10.0B through July 4, 2020. Similarly, net earnings increased from approximately \$188M to \$2.6B during the same July 2020 and 2021 periods.

### 2.2.2 Liquidity

In addition to profitability, Black & Veatch examined Nucor's reported assets and liabilities as they pertain to Nucor's key liquidity metrics, as summarized below in Table 2-1.

**Table 2-1: Nucor Assets and Liabilities, 2018 – 2020 (\$000s)**

LIQUIDITY METRIC	2018	2019	2020
Total Current Assets	\$8,636,265	\$8,226,370	\$9,488,662
Total Assets	\$17,920,588	\$18,344,666	\$20,125,394
Total Current Liabilities	\$2,806,300	\$2,463,774	\$2,627,860
Total Liabilities	\$7,718,620	\$7,553,490	\$8,893,533
<b>Current Ratio</b>	<b>3.08</b>	<b>3.34</b>	<b>3.61</b>
<b>Debt Ratio</b>	<b>0.43</b>	<b>0.41</b>	<b>0.44</b>

The current ratio is defined as the current assets divided by the current liabilities and is considered an indicator of a company's liquidity. A current ratio above one indicates that a company would be capable of paying all short-term liabilities if they became due at once. A high current ratio is typically correlated with a lower risk for bankruptcy. Nucor's current ratio was above three in 2018, 2019 and 2020.

The debt ratio is the level of total liabilities compared to a company's total assets. A debt ratio below one indicates that a company has asset values exceeding total long term debt and is typically correlated with a lower risk of bankruptcy. Nucor's debt ratio was below one from 2018-2020 with the lowest value coming in 2019.

## **2.3 MANUFACTURING CAPACITY**

Nucor's annual manufacturing capacity as of 2021 is approximately 6,750,000 total feet, or approximately 28.5 million pounds, per line. This is based on the assumption of 45 feet per minute and 4.23 lbs per foot for a single shift for 50 weeks per year. Nucor stated that a single line has the capability to produce up to 60 feet per minute however typical running rate is 40 to 50 feet per minute. Nucor also stated that if production needs increase beyond current capacity then they plan on adding an additional shift.

Nucor stated that they estimate approximately 15 tons of piles per megawatt of solar installation. Also, Nucor stated that they plan to manufacture and sell approximately 100 tons in 2022 with an average growth of 20 percent per year for the next five years. Black & Veatch notes that Nucor has demonstrated that they have enough capacity to facilitate their near term sales goals.

## **2.4 WARRANTY**

### **2.4.1 Standards and Guarantee**

Nucor does not offer a standard solar warranty for the Product however Nucor stated that the Product is manufactured to ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process. The Ultrahigh Strength Weathering Steel with twin roll casting Nucor steel is manufactured to ASTM A1039/A1039M-20, Standard Specification for Steel, Sheet, Hot-Rolled, Carbon, Commercial, Structural, and High-Strength Low-Alloy, and Ultra-High Strength, Produced by Twin-Roll Casting Process. The steel is also tested to the requirements of the ASTM standard. Black & Veatch notes that the ASTM standard defines and covers chemical composition, mechanical properties, and coating properties.

Black & Veatch is of the opinion the associated ASTM standard is applicable to the Product.

### **2.4.2 Warranty Claims**

Nucor indicated to Black & Veatch that no warranty claims have been filed at the time of this Report.

## **2.5 INTELLECTUAL PROPERTY**

Black & Veatch was provided with two United States Patent Applications, publication numbers US2020/0256029 A1 and US 2021/0087649 published on August 13, 2020 and March 25, 2021, respectively. Both patent applications are for ultra-high strength weathering steel piles and structural foundations.

Nucor stated that they believe that they are not infringing on any patents in the United States or elsewhere.

## 2.6 COMPANY CONCLUSIONS

Based on the above findings, Black & Veatch has formed the following conclusions:

- Black & Veatch believes the Nucor key staff has experience that is relevant to supporting Nucor's sales objectives.
- Black & Veatch is of the opinion that ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process is applicable to the Product.
- Nucor has been profitable in each year of operation since 2018. Nucor's reported liquidity metrics indicate that Nucor should have adequate liquidity to cover its debts.

## 3.0 Reliability and Durability Review

This section addresses the reliability and durability analyses performed by Nucor on the Product. Black & Veatch focused its review on Nucor's reliability program and qualification testing results. The following sections summarize Black & Veatch's findings, which were derived from documentation review and conversations with Nucor personnel.

### 3.1 QUALIFICATION TESTING

Table 4-2 provides a summary of reliability documentation that Black & Veatch would expect to review for a single axis tracking system, and the status of each item as it pertains to the Product.

#### 3.1.1 Cantilever Testing

Black & Veatch reviewed the test report titled Cantilever Testing of Solar Panel Piles 2021 which was performed by the University of Nebraska-Lincoln. The test report is dated November 19, 2021. The test report states that the twelve samples, six 6' pile specimens and six 8' pile specimens, of the Product, NSP 6X at 4.23 lb/ft) were tested to observe various failure modes.

The test procedure stated that cantilever configuration consisted of two cantilever piles bolted to and protruding from a large concrete wall with loading applied at the ends. A load was then applied at the ends of the piles and failure modes were observed. The test configuration is shown in Figure 3-1.



**Figure 3-1: Cantilever Testing Configuration**

Most piles assemblies had a single pile fail most often due to flange buckling which is shown in Figure 3-2. The test report states that the failure is localized due to the support apparatus and the deflection that occurred during these test configurations may be more than in ground testing



**Figure 3-2: Cantilever Testing Failure**

The test report shows record of the maximum load and deflection at the maximum moment. The 6' piles recorded an average maximum load of 2,114 lbs with an average deflection of 5.3 inches while the 8' piles recorded an average maximum load of 1,489 lbs with an average deflection of 7.0 inches.

### **3.1.2 Pile Testing**

Nucor contracted with KiloNewton to perform strength testing of the NXW-1000 and NSP 6X Castrip® shapes (Static Pile Test Report). The laboratory work was performed by the Department of Civil, Construction and Environmental Engineering at the University of New Mexico. As per the Static Pile Test Report the six foot beam test samples were loaded, supported on each end, with an applied load in the middle of the span. Two versions of the NXW-1000 piles were tested for two different connections of the folded over flanges, one with a single row of spot welds down the center of the pile at six-inch spacing and the other with a pair of spot welds running down the center of the pile at five-inch spacing. It is Black & Veatch's understanding that, since the time these tests were performed, Nucor has decided not to offer the NXW-1000 configuration for solar PV applications. This decision was made because the NXW-1000 pile were not as cost efficient as the NSP C6X.

### **3.1.3 Static Load Testing**

In addition to the above pile strength test performed by KiloNewton, GRL also performed static pile strength testing of both W6 shapes and the new Product shape at Nucor's Brigham City Solar Lab site in Brigham City, Utah.

Following the testing, GRL provided the Detail Report and the Summary Report. The Detail Report references a previous geotechnical study at the site which characterized the soils as "natural soils consisting of silty lean clay and plastic clay (USCS Classifications CL, CH) with some fine sand, clay/fine sandy silt (ML), and occasional layers of fine sand with varying silt content (SP-SM, SM). The clay and silt soils were stiff, grading soft to very soft; moist grading to wet; and brown and gray. The sand soils were medium dense, wet, and gray. During drilling, groundwater was observed in each borehole at depths ranging from approximately three to four feet below the ground surface.

GRL indicated that static compression, tension, and lateral load tests were performed on all five pile sections (W6x9, W8x10, NSP 6X, NCW-1100, and NXW-1000), for a range of embedment lengths for

each test type and pile section. Tests were performed in general accordance with relevant ASTM standards. Under compression, at shallow embedment the Product shapes developed more strength than the W-shapes. However, at deeper depths the W-shapes had relatively more strength. Under tension, the results were more varied. Under lateral loading, the W-shapes had relatively more strength than the Product shapes, which was expected due to the greater mass of the W-shapes. In addition, all shapes benefited from increased embedment. Based on the GRL reports, Black & Veatch is of the opinion that the above test procedures appear to be appropriate for the purpose. Black & Veatch is also of the opinion that with appropriate geotechnical investigation, section selection, and pre-project in-situ testing, a shape made from the Product could be selected as a pile material to meet typical solar PV project load requirements.

### **3.2 RELIABILITY AND DURABILITY CONCLUSIONS**

Black & Veatch notes the following conclusions:

- Based on the GRL reports, Black & Veatch is of the opinion that the above test procedures appear to be appropriate for the purpose. Black & Veatch is also of the opinion that with appropriate geotechnical investigation, section selection, and pre-project in-situ testing, a shape made from the Product could be selected as a pile material to meet typical solar PV project load requirements.

## 4.0 Manufacturing Process and Quality Assurance

Black & Veatch reviewed documentation regarding the manufacturing processes and quality assurance programs utilized to manufacture the Product. Black & Veatch also reviewed supply chain and logistics documentation. The following sections summarize Black & Veatch's findings, which were derived from documentation from Modineer. Black & Veatch visited Modineer Plant No. 6 (Modineer), one of Nucor's manufacturing suppliers, in October 2021. The Modineer facility is located in Niles, Michigan.

The following sections summarize Black & Veatch's findings, which were derived from documentation and conversations with personnel from Nucor's manufacturing facility.

### 4.1 MANUFACTURING

#### 4.1.1 Overview

Nucor engages a US manufacturer, Modineer, to manufacture the Product. The Modineer facility visited by Black & Veatch is located in Niles, Michigan approximately 10 miles north of South Bend, Indiana.

Black & Veatch visited the Modineer facility on October 21, 2021. During the site visit, Black & Veatch observed a number of the manufacturing capabilities at the plant including stamping, bending, punching, and welding. However, Black & Veatch did not witness roll forming due to a manufacturing delay. Black & Veatch was later provided with videos, similar to those provided during a virtual site visit. The videos showed the steel rolls being formed and cut into final Product pile foundations.

Modineer is certified under International Organization for Standardization (ISO) standard 9001:2015 - Quality management systems – Requirements, which is a widely accepted standard for the requirements of a quality management system for organizations that need to demonstrate their ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements. Modineer is also ISO 14001:2015 - Environmental management systems - Requirements with guidance for use, and International Standard for Automotive Quality Management (IATF) 16949:2016 certified.

Black & Veatch reviewed the certificates and notes that the ISO 9001:2015 and IATF 16949:2016 certificates expired in October 2021. Black & Veatch recommends obtaining a more recent certification for the facility. Black & Veatch also notes that the ISO 14001:2015 certificate, which was issued on July 5, 2019, expires on July 4, 2022. Nucor indicated to Black & Veatch that they intend to update the certifications.

#### 4.1.2 Manufacturing Process

The Product is manufactured by roll forming. After the material has been inspected, the process begins by loading a coil of steel into the un-coiler. The steel is then fed into the machine, leveled, and welded, if needed. The steel coil is then punched with the customer requested hole configuration. After the steel coil is punched it is fed into the roll-formers and shaped to the desired profile. The steel profile is then sheared at the desired length and inspected. After inspection it is packaged for shipment to the customer. A manufacturing flow chart is shown below.

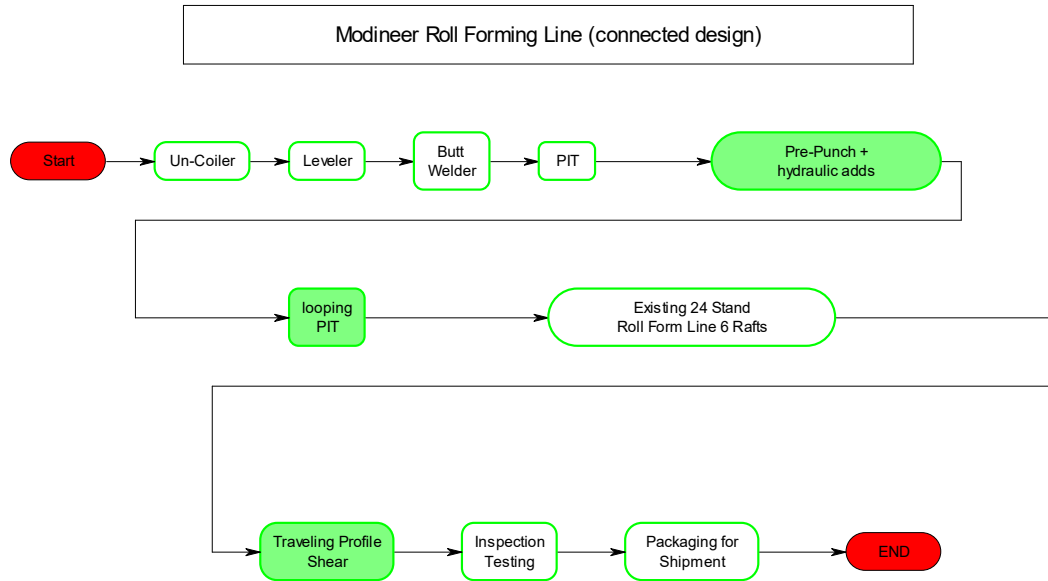


Figure 4-1: Modineer Roll-Form Manufacturing Flow Diagram

#### 4.1.3 Equipment, Maintenance

During the site visit, Black & Veatch observed the machine maintenance records. Modineer noted that they keep a roll form log that is maintained by the operators when any changes to the machinery or adjustments are made. Maintenance logs for all machines, parts used, oil changes, lubricant filter changes, and repairs are also kept on-site to monitor the equipment. There is also a coolant log that checks the percentage of roll form coolant that is in the machine and is recorded.

Black & Veatch reviewed monthly and semi-annual maintenance logs dated October 15, 2021 and October 21, 2021, respectively. The maintenance records show that all maintenance had been performed, passed condition inspection and had been returned to service. The maintenance logs also included the specific maintenance activities and total time spent.

#### 4.1.4 Equipment Yield and Scrap Rate

Black & Veatch was provided with manufacturing yield data for June, July, August, and October 2021. Modineer noted that scrap rate is defined as the percentage of unusable or non-conforming product during a manufacturing period. Scrap rate for the provided months ranged from 2.11 in October 2021 to 6.37 percent in August 2021. Nucor stated that typical scrap rate for other mature roll form products is one to four percent. Nucor also stated that the target for this process is five percent.

### 4.2 QUALITY ASSURANCE

Modineer utilizes a quality assurance system that has been developed in accordance with internal quality standards and applies to all its activities. Modineer has developed specifications and procedures to ensure compliance with these standards both for its suppliers, as well as for its own internal quality program.

Black & Veatch reviewed the process flow chart dated and control plan both dated January 13, 2021, which details all manufacturing steps from incoming inspection to outgoing shipment as well as the



inspection activities throughout the manufacturing process. Black & Veatch notes that, since the Product has not entered into commercial production, actual quality inspection logs for the Product were not available. Black & Veatch instead reviewed quality inspection logs for similar roll-formed products that undergo the same quality inspection methods.

#### **4.2.1 Incoming Inspection**

Black & Veatch reviewed the process flow chart provided by Modineer which shows the incoming inspections of the steel coils performed by the facility. The material composition is verified by the coil asset tag. Black & Veatch reviewed the asset tag and it shows the customer, supplier information, serial number, weight, and production date. The material width and thickness is also verified and measured.

Black & Veatch also reviewed the control plan which details the methods and frequency of the incoming inspections performed. The control plan was produced specifically for the Product. It showed that material composition is verified by visual inspection for every lot and shipment that is received. The material thickness is verified by caliper measurement and includes the allowable tolerance. Material width is performed by tape measurer. Every lot and shipment is measured and verified.

Modineer indicated that the tape measures and calipers used for incoming inspection were required to be calibrated annually by local third party calibration institutions. Black & Veatch observed that the measurement tools had calibration stickers on the equipment documenting the date which is a good industry practice.

#### **4.2.2 In-Process Quality Control**

Black & Veatch reviewed the process flow chart for in process inspections performed on the Product. It included material thickness, width, hole size and location, slot size and location, Product height, Product width and visual inspections. The process flow chart also included tolerances for all of the associated measurements and inspections.

The control plan includes the frequency at which the measurements and inspections are performed. The steel material thickness and width measurements are performed at the beginning of every manufacturing set-up and every coil change. Hole and slot size and location measurements are performed on the first and last piece of every manufacturing run as well as on one part every hour of manufacturing time. These measurements are performed with calipers, gauge pins and tape measurers. An additional visual check is performed on each part as it comes off the manufacturing line. Every completed part is visually checked for cracks or splints.

In the event that a measurement or inspection check is not met the control plan indicates the reaction plan to be taken by Modineer. If any part does not meet inspection then production is stopped and the roll-former set up is checked and any issues are corrected.

#### **4.2.3 Outgoing Inspection**

Black & Veatch reviewed the process flow chart for outgoing packaging, labeling, and shipment to the customer. It included visual inspections of the packaging and labeling. It showed that every shipment is inspected for proper packaging per Modineer's and Nucor's specifications and that every shipment is properly labeled. If the inspection conditions are not met then the shipment is placed on hold and the issue is corrected. Finished product storage is shown in Figure 4-2.



Figure 4-2: Finished Product Storage and Packaging

## 4.3 SUPPLY CHAIN

### 4.3.1 Vendor Qualification Process and Quality Monitoring

Black & Veatch reviewed Nucor’s vendor qualification process. Each supplier is evaluated based on a questionnaire designed to assess the supplier’s ability to produce parts using manufacturing methods, materials, and dimensional tolerances approved by Nucor. Nucor’s supplier requirements include:

- Adopt ISO-TS 16949 quality system requirements
- Maintain a document quality system
- Comply AIAG Production Approval Process which includes developing a control plan and process flow diagram
- Zero defect acceptance criteria
- Submit a certification of compliance warranting the compliance of Nucor’s requirements
- Use statistical methods to control and evaluate process variation
- Maintain 100 percent on-time delivery
- Submit to a supplier performance evaluation
- Respond to Nucor’s corrective action reports in the event of a non-conformity
- Have methods in place for continuous product improvement
- Complete TS 16949 survey

If the supplier fails to meet Nucor’s expectations in some of the assessment criteria, the supplier must submit an improvement plan to Nucor that contains specific corrective actions and timelines.

If Nucor chooses to approve the supplier, they will issue a purchase order for parts.

Black & Veatch reviewed Nucor's supplier audit form. After this initial supplier qualification, Nucor reports that supplier are continually qualified and re- assessed on an annual basis considering subsequent manufacturing facility visits by Nucor as well as a supplier's performance in consistently meeting Nucor's quality standards.

#### **4.4 MANUFACTURING AND QUALITY CONCLUSIONS AND RECOMMENDATIONS**

Black & Veatch notes the following conclusions:

- Nucor maintains ISO 9001 certification, and requires all third party manufacturing suppliers to be certified per ISO 9001, which is one of the most universally recognized quality management standards.
- Black & Veatch finds the quality program Nucor has developed for its own operations and its third party suppliers to be similar to that of other solar racking manufacturers, and consistent with industry accepted practice.
- Black & Veatch believes that Nucor provides clear documentation of quality expectations and requirements in its vendor onboarding, ongoing vendor qualification, and in specific purchase orders. If followed, Black & Veatch believes that this guidance should be adequate to ensure consistent quality across several key component vendors.

