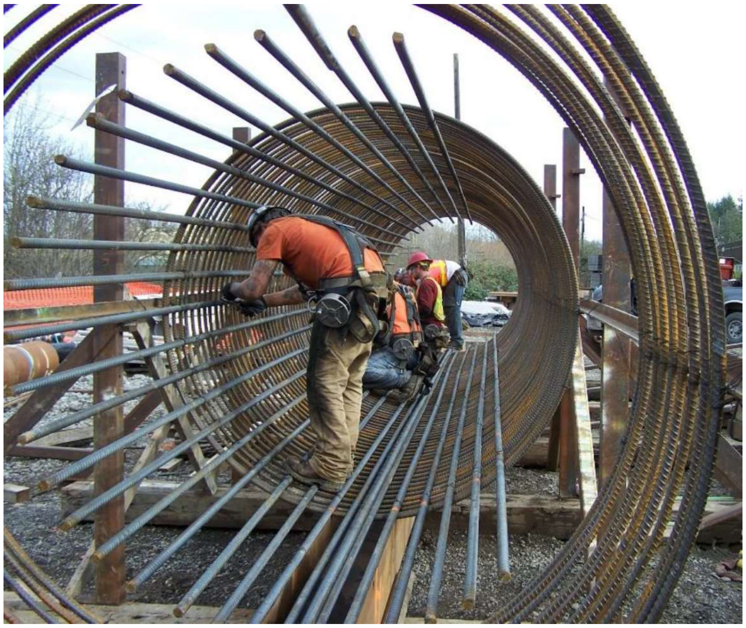
ENVIRONMENTAL PRODUCT DECLARATION

According to ISO 14025 and ISO 21930:2017

STEEL REINFORCEMENT BAR

CONCRETE REINFORCING STEEL INSTITUTE



About the Concrete Reinforcing Steel Institute
Founded in 1924, the Concrete Reinforcing Steel Institute (CRSI) is a technical institute and Standards Developing Organization (SDO) that stands as the authoritative resource for information related to steel reinforced concrete construction. CRSI offers many industry-trusted technical publications, standards documents, design aids, reference materials, and educational opportunities.

Membership Facts
Approximately 8 million tons of reinforcing steel (rebar) is manufactured per year using scrap steel in efficient manufacturing operations. It is estimated that the industry impacts over 75,000 people in steel transportation and placement.

CRSI members include manufacturers, fabricators, material suppliers, and placers of steel reinforcing bars and related products as well as professionals who are involved in the research, design, and construction of steel reinforced concrete. CRSI members employ approximately 15,000 people in steel production and rebar fabrication at over 450 locations in 47 states throughout North America.

CRSI Concrete Reinforcing Steel Institute

Issue Date: September 20, 2022

Valid Until: September 19, 2027

Declaration Number: EPD 362

DECLARATION INFORMATION

Declaration

Program Operator: ASTM International
Company: Concrete Reinforcing Steel Institute
933 North Plum Grove Road
Schaumburg, Illinois 60173-4758

www.astm.org

Product Information	Validity / Applicability
Product Name: Fabricated steel reinforcement	**Period of Validity:** This declaration is valid for a period of 5 years from the date of publication.
Product Definition: Reinforcing bar or "rebar" is used to strengthen concrete or other masonry structures	
Declaration Type: Business-to-business (B2B)	**Geographic Scope:** North America
PCR Reference: • ISO 21930 (ISO, 2017) • Part A: Product Category Rules for Building Related Products and Services (UL Environment, 2018) • Part B: Designated Steel Construction Product EPD Requirements (UL Environment, 2020)	**PCR Review was conducted by:** • Dr. Tom Gloria • Brandie Sebastian • James Littlefield

Product Application and/or Characteristics

This declaration covers fabricated steel reinforcing bar ("rebar") for use in concrete and masonry structures.

Technical Drawing or Product Visual	Content of the Declaration
	• Fabricated steel reinforcement ("rebar") based on US-milled steel • Steel made in the US from 98% recycled steel scrap via electric arc furnace (EAF) technology • Life Cycle Assessment results

Verification

Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006	☐ internal ☒external

This declaration and the rules on which this EPD is based have been examined by an independent verifier in accordance with ISO 14025.

Name: Timothy S Brooke, ASTM International	Date: September 20, 2022	Name: Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	Date: September 20, 2022

Limitations

The environmental impact results of steel products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the steel product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted. See Section 3.10 For additional EPD comparability guidelines. Environmental declarations from different programs (ISO 14025) may not be comparable.

EPD SUMMARY

This document is a Type III environmental product declaration by Concrete Reinforced Stell Institute (CRSI) that is certified by ASTM International (ASTM) as conforming to the requirements of ISO 14025. ASTM has assessed that the Life Cycle Assessment (LCA) information fulfills the requirements of ISO 14040 and ISO 14044 in accordance with the instructions listed in the referenced product category rules. The intent of this document is to further the development of environmentally compatible and sustainable construction methods by providing comprehensive environmental information related to potential impacts in accordance with international standards.

No comparisons or benchmarking is included in this EPD. Environmental declarations from different programs based upon differing PCRs may not be comparable. Comparison of the environmental performance of construction works and construction products using EPD information shall be based on the product's use and impacts at the construction works level. In general, EPDs may not be used for comparability purposes when not considered in a construction works context. Given this PCR ensures products meet the same functional requirements, comparability is permissible provided the information given for such comparison is transparent and the limitations of comparability explained. When comparing EPDs created using this PCR, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared.

Table 1. A1-A3 GWP results for 1 metric ton of fabricated steel reinforcement (rebar)

Indicator	Unit	A1	A2	A3	A1-A3
Global Warming Potential	kg CO_2 eq.	7.78E+02	4.90E+01	2.70E+01	8.54E+02

Table 2. A1-A3 LCIA results for 1 metric ton of fabricated steel reinforcement bar (rebar)

Indicator	Unit	A1	A2	A3	A1-A3
Ozone Depletion Potential	kg CFC 11 eq.	8.30E-10	8.38E-15	2.57E-10	1.09E-09
Acidification Potential	kg SO2 eq.	1.58E+00	5.27E-01	6.10E-02	2.17E+00
Eutrophication Potential	kg N eq.	7.87E-02	3.21E-02	6.11E-03	1.17E-01
Smog Formation Potential	kg O3 eq.	3.47E+01	1.30E+01	1.48E+00	4.91E+01
Abiotic Depletion Potential (Fossil)	MJ, surplus	7.61E+02	9.18E+01	1.63E+02	1.02E+03

SCOPE AND BOUNDARIES OF THE LIFE CYCLE ASSESSMENT

The Life Cycle Assessment (LCA) was performed according to ISO 14040 (ISO, 2020a) and ISO 14044 (ISO, 2020b) following the requirements of the ASTM EPD Program Instructions and the referenced PCR.

System Boundary: Cradle-to-gate

Allocation Method: Mass allocation (multi-output allocation approach)

Declared Unit: 1 metric ton (1,000 kg) of fabricated steel reinforcement (rebar)

GENERAL INFORMATION

DESCRIPTION OF COMPANY/ORGANIZATION

Concrete Reinforcing Steel Institute
933 North Plum Grove Road
Schaumburg, Illinois 60173-4758

List of Participating Companies

Mills		**Fabricators**	
Evraz	Pueblo, CO	Western States Rebar	Pleasant View, UT
CMC	Mesa, AZ	Rebarfab Inc.	New Brighton, MN
CMC	Jacksonville, FL	Katy Steel	Katy, TX
CMC	Sayreville, NJ	CMC	Dallas, TX
CMC	Durant, OK	CMC	Kissimmee, FL
CMC	Cayce, SC	CMC	Tracy, CA
CMC	Knoxville, TN	CMC	Auburn, WA
CMC	Seguin, TX	Nucor	Zellwood, FL
Cascade	McMinnville, OR	Nucor	New Braunfels, TX
Steel Dynamics	Roanoke, VA	Nucor	Kansas City, MO
Nucor	Auburn, NY	Dimension Fabricators	Scotia, NY
Nucor	Wallingford, CT	Farwest Steel	Vancouver, WA
Nucor	Flowood, MS	Farwest Steel	Eugene, OR
Nucor	Bourbonnais, IL	Re-Steel Supply Co	Eddystone, PA
Nucor	Kingman, AZ	Victory Steel Company (Re-Steel)	Baltimore, MD
Nucor	Marion, OH	Conco	Benicia, CA
Nucor	Jewett, TX	Conco	Rochester, WA
Nucor	Brigham City, UT		
Nucor	Birmingham, AL		

PRODUCT DESCRIPTION

Steel reinforcement is used as reinforcement in concrete or masonry structures. Fabricated reinforcement is reinforcing steel that has been cut, bent, or modified according to job specifications set by the design professional.

Fabricated steel rebar is defined by the following standards.

- CSA G30.18-09 (R2014) Standard Specifications for Carbon Steel Bars for Concrete Reinforcement
- ASTM A615/A615M Standard Specification for Derformed and Plain Carbon-Steel Bars for Concrete Reinfrocement
- ASTM A706/A706M Standard Specification for Deformed and Plain Low-Ally Steel Bars for Concrete Reinforcment

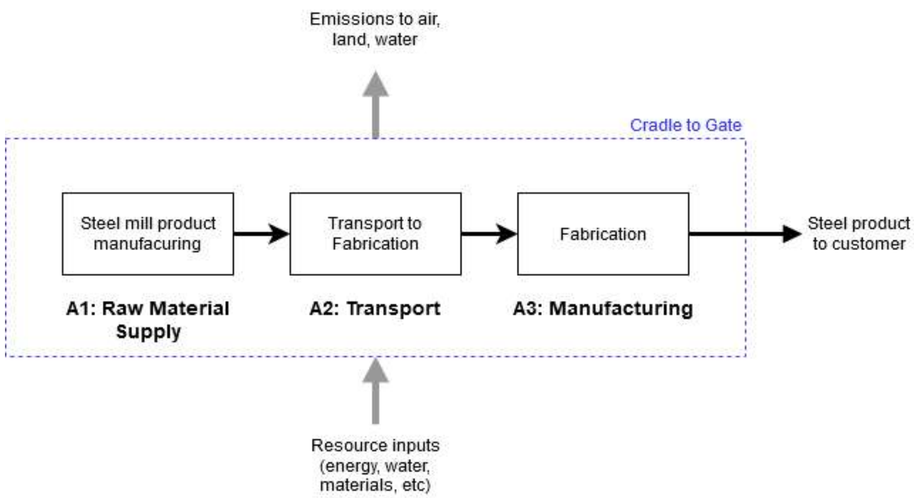


Figure 1. Product flow diagram

PRODUCT AVERAGE

This EPD represents an industry average of North American fabricated rebar production for a reference year of 2020 as produced by the Concrete Reinforced Steel Institute (CRSI).

APPLICATION

Steel reinforcement is delivered fabricated or in straight lengths and shapes as per project specifications. It is used as reinforcement in concrete or masonry, including concrete roads, bridges, foundations, columns and pillars.

TECHNICAL REQUIREMENTS

Table 3 - Technical data for fabricated steel reinforcement (rebar)

Properties	Value	Unit
Density	7,850	kg / m^3
Melting point	1425-1450	°C
Electrical conductivity at 20°C	NA	% of IAC
Thermal conductivity	NA	W/(m-K)
Coefficient of thermal expansion	NA	m/m-°C
Modulus of elasticity	NA	N/mm^2
Shear modulus	NA	N/mm^2
Yield strength	250-550	N/mm^2
Ultimate tensile strength	410-790	N/mm^2
Breaking elongation	6-20	%

Additional information can be found on Concrete Reinforced Steel Institute (CRSI)'s website at crsi.org

MATERIAL COMPOSITION

The vast majority of fabricated steel reinforcement (ASTM A615 and A706) has recycled material content typically greater than 97% along with 1 to 3% of alloying elements and additives as per the typical material composition described below.

Table 4: Typical material composition of ASTM A615/A706

	Steel	Manganese	Carbon	Chromium	Silicon	Others (Ni, S, V, Mo, P…etc)
ASTM A615/A706	98.3%	<2%	<1%	<1%	<1%	<1.5%

MANUFACTURING

Steelmaking involves two major processes: the melt shop and rolling mill. The melt shop operations typically utilize EAF technology and take steel scrap as an input to the steel billet production process. The rolling mills then hot roll the steel billet from the melt shops into steel products. The unfabricated steel rebars are then shipped to fabrication. The main input to the fabrication process is the steel rebar product, followed by small amounts of processing materials, such as lubricants for the machines. The fabrication of rebar includes bending, cutting, and manufacturing of rebar shapes. Metal scrap generated during fabrication is recycled externally.

TRANSPORTATION

Inbound truck and rail transportation distances for rebar to the fabricators were calculated using a production-weighted average of the distances between CRSI's locations and their rebar suppliers throughout the United States.

PRODUCT INSTALLATION

Installation is outside the scope of this EPD.

USE

Product use is outside the scope of this EPD.

REUSE, RECYCLING, AND ENERGY RECOVERY

Product reuse, recycling, and incineration for energy recovery is outside the scope of this EPD.

DISPOSAL

Product disposal is outside the scope of this EPD.

METHODOLOGICAL FRAMEWORK

DECLARED UNIT

The declared unit for this EPD is one metric ton of fabricated steel reinforcing bar. Note that comparison of EPD result on mass basis, alone, is insufficient and should consider the technical peformance of the product.

Table 5. Declared unit

Name	Required Unit
Declared Unit	1 metric ton
Density	7,850 kg / m^3

SYSTEM BOUNDARY

The “cradle-to-gate” life cycle stages representing the product stage (information modules A1-A3) include:

- A1: all extraction and processing of raw materials, any reuse of products or materials from a previous product system, processing of secondary materials, and any energy recovery or other recovery processes from secondary fuel;
- A2: all transportation to the factory gate and all internal transport;
- A3: generation of fabrication electricity from primary energy resources, including upstream processes; production of all ancillary materials, pre-products, and co-products, including any packaging.

PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

CUT-OFF RULES

All available energy and material flow data were included in the model for the processes identified within the system boundary of this study. Therefore, no cut-off criteria were applied. In cases where life cycle inventory data were not available to represent a flow, proxy data were applied based on conservative assumption regarding environmental impacts.

Data Sources

Primary data for rebar manufacturing and fabrication were provided by CRSI member companies. Data provided by the member companies were cross-checked for completeness and plausibility, as well as, when possible, benchmarked against existing numbers. Secondary data were obtained from the GaBi 2021 databases.

Data Quality

A variety of tests and checks were performed by the LCA practitioner throughout the project to ensure high quality of the completed LCA. Checks included an extensive review of project specific LCA models as well as the background data used.

Geographical Coverage

All primary and secondary data were collected specific to the United States. Regionally specific datasets, where available, were used to represent each manufacturing location's energy consumption. Proxy datasets were used as needed for raw material inputs to address lack of data for a specific material or for a specific geographical region. These proxy datasets were chosen for their technological representativeness of the actual materials. Geographical representativeness is considered to be high.

Period under Review

Primary data collected represent production during the 2019 and 2020 calendar years. This analysis is intended to represent production year in 2020.

Allocation

Co-products during steel mill operations are allocated using a method developed by the World Steel Association and EUROFER (worldsteel and EUROFER, 2014). The methodology takes into the account the way in which changes in inputs and outputs affect the production of co-products. It uses system expansion for the excess BF and BOF gases that leave the product system. The method also takes account of material flows that carry specific inherent properties. This approach is conformant with the PCR and ISO 21930. ISO 21930 takes precedence over EN15804, per the PCR Part A and Part B (UL Environment, 2020; UL Environment, 2018).

Table 6: Co-product allocation, mass basis

Flow	% to Steel	% to Slag
Steel inputs	100	0
Slag	0	100
Steel scrap outputs	86.4	13.6
Oxygen	100	0
Carbon dioxide	100	0
All other inputs/outputs	86.4	13.6

Mill outputs such as scale and baghouse dust are handled via the cut-off approach, in line with ISO 21930. Allocation of background data (energy and materials) taken from the GaBi 2021 databases is documented online at https://sphera.com/wp-content/uploads/2020/04/Modeling-Principles-GaBi-Databases-2021.pdf

ESTIMATES AND ASSUMPTIONS

This study uses a weighted average of rebar produced by CRSI members to represent rebar production for module A1. CRSI fabrication members do not buy their rebar exclusively from CRSI mills however, so transportation distances used to model module A2 represent production-weighted average distances provided by the fabricators for reported rebar purchases.

The study did not collect data from all CRSI fabricators for module A3, but rather a representative selection. However, fabrication is such a small share of the impacts compared to upstream rebar manufacturing so the impacts would be negligible.

LIFE CYCLE ASSESSMENT RESULTS

Life cycle assessment results are presented per metric ton of fabricated steel reinforcement, the required reporting unit. The product stage (module A1-A3) has been aggregated into a single number for each metric.

Table 7: LCIA results, per 1 metric ton of fabricated steel reinforcement

Indicator	Unit	Total (A1-A3)	A1	A2	A3
Global Warming Potential (GWP 100)	kg CO2 eq.	8.54E+02	7.78E+02	4.90E+01	2.70E+01
Ozone Depletion Potential (ODP)	kg CFC 11 eq.	1.09E-09	8.30E-10	8.38E-15	2.57E-10
Acidification Potential (AP)	kg SO2 eq.	2.17E+00	1.58E+00	5.27E-01	6.10E-02
Eutrophication Potential (EP)	kg N eq.	1.17E-01	7.87E-02	3.21E-02	6.11E-03
Smog Formation Potential (SFP)	kg O3 eq.	4.91E+01	3.47E+01	1.30E+01	1.48E+00
Abiotic Depletion Potential (ADP_{fossil})	MJ, surplus	1.02E+03	7.61E+02	9.18E+01	1.63E+02

Table 8: Resource use results, per 1 metric ton of fabricated steel reinforcement

Parameter	Unit	Total (A1-A3)	A1	A2	A3
Renewable Primary Resources Used as Energy Carrier (RPRe)	MJ	1.17E+03	1.13E+03	2.42E+01	2.42E+01
Renewable Primary Resources with Energy Content Used as Material (RPRm)	MJ	-	-	-	-
Non-Renewable Primary Resources Used as Energy Carrier (NRPRe)	MJ	1.09E+04	9.06E+03	6.91E+02	1.16E+03
Non-Renewable Primary Resources with Energy Content Used as Material (NRPRm)	MJ	3.04E+02	3.04E+02	0.00E+00	0.00E+00
Use of Secondary Material (SM)	kg	1.68E+03	1.64E+03	0.00E+00	3.54E+01
Use of Renewable Secondary Fuels (RSF)	MJ	-	-	-	-
Use of Non-Renewable Secondary Fuels (NRSF)	MJ	-	-	-	-
Recovered Energy (RE)	MJ	-	-	-	-
Net Use of Fresh Water (FW)	m^3	8.42E+00	8.25E+00	1.03E-01	6.72E-02

Table 9: Output flows and waste categories results, per 1 metric ton of fabricated steel reinforcement

Parameter	Unit	Total (A1-A3)	A1	A2	A3
Hazardous Waste Disposed (HWD)	kg	1.31E+00	6.16E-01	0.00E+00	6.94E-01
Non-Hazardous Waste Disposed (NHWD)	kg	5.57E+00	4.60E+00	0.00E+00	9.71E-01
High Level Radioactive Waste (HLRW)	kg	5.23E-04	5.13E-04	1.99E-06	8.00E-06
Intermediate and Low-Level Radioactive Waste (ILLRW)	kg	1.44E-02	1.41E-02	5.47E-05	2.20E-04
Component for Re Use (CRU)	kg	-	-	-	-
Material for Recycling (MFR)	kg	3.51E+01	3.51E+01	-	-
Material for Energy Recovery (MER)	kg	-	-	-	-
Exported Energy (EE)	MJ	-	-	-	-

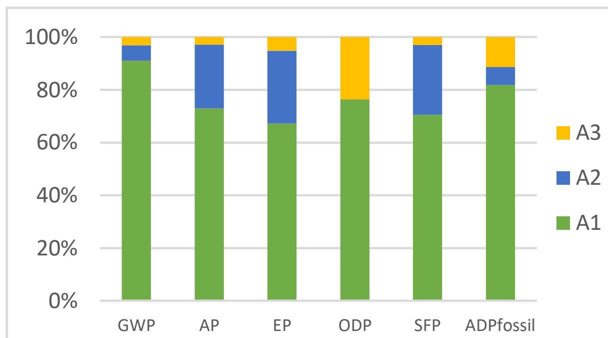
Table 10: Statistical metrics of LCIA results, per 1 metric ton of fabricated steel reinforcement across all facilities

Indicator	Unit	Min (A1-A3)	Max (A1-A3)	Max/Min Ratio (A1-A3)	Mean (A1-A3)	Median (A1-A3)
Global Warming Potential (GWP)	kg CO2 eq.	8.09E+02	1.00E+03	1.24E+00	8.46E+02	8.39E+02
Ozone Depletion Potential (ODP)	kg CFC 11 eq.	8.24E-10	2.71E-09	3.29E+00	1.14E-09	1.01E-09
Acidification Potential (AP)	kg SO2 eq.	2.06E+00	2.33E+00	1.13E+00	2.14E+00	2.13E+00
Eutrophication Potential (EP)	kg N eq.	1.08E-01	1.27E-01	1.17E+00	1.14E-01	1.13E-01
Smog Formation Potential (SFP)	kg O3 eq.	4.64E+01	5.41E+01	1.16E+00	4.84E+01	4.81E+01
Abiotic Depletion Potential, Fossil (ADP$_{fossil}$)	MJ, surplus	8.41E+02	2.67E+03	3.18E+00	1.01E+03	8.73E+02

LCA INTERPRETATION

Across the steel products produced by CRSI member companies, rebar production (steelmaking, categorized under module A1) is the main contributor to environmental impacts. This dominance of impact categories is primarily due to the alloying materials, electricity generation, and emissions from fuel combustion of the rebar manufacturing processes. Silico-manganese and vanadium, the two largest inputs (by mass) among the alloying materials, dominate the impacts for the alloying materials.

Inbound transportation (A2), the module in which steel rebar is transported to the fabrication facilities, is the second largest impact driver. Transport in A2 represents up to a quarter of cradle-to-gate impact for fabricated rebar (AP and EP and SFP from tailpipe emissions). Fabrication doesn't represent more than 3% of cradle-to-gate impacts except for ODP and ADP$_{fossil}$.



ADDITIONAL ENVIRONMENTAL INFORMATION

ENVIRONMENT AND HEALTH DURING MANUFACTURING

CRSI member companies are committed to providing safe and healthy working conditions for the prevention of work-related injuries and illness; protecting the environment by preventing pollution and conserving natural resources; and contributing positively to the communities in which we operate by acting with integrity and fulfilling our compliance obligations. We strive to incorporate sound environmental, health & safety practices into our daily decisions.

In support of our environmental, health & safety policy and mission statement, we are committed to continually improve our environmental, health & safety management and performance by:

- Integrating our core values, strategic focus, and environmental, health & safety management objectives and initiatives.
- Fulfilling our environmental, health & safety compliance obligations by meeting all applicable local, state and federal regulations, customer requirements, and corporate governance.
- Demonstrating proper safety and environmental behavior through personal example.

- Maintaining open, two-way consultation and participation when addressing environmental, health & safety issues and goals.
- Driving continuous improvement initiatives to eliminate safety hazards and to reduce environmental, health & safety risks.
- Promptly reporting all safety and environmental concerns.
- Identifying opportunities for environmental sustainability by emphasizing responsible use of energy including the adoption of innovative practices to encourage energy conservation and improve energy efficiency.
- Communicating and fostering the use of environmental, health & safety best practices.
- Actively participating in the environmental, health & safety community and taking prominent roles within our industry to set the standard for environmental stewardship and safe working conditions.

Environmental Activities and Certifications

CRSI member companies are IATF 16949, ISO 9001, ISO 17025, ISO 14001, and ISO 45001 accredited.

References

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