

## Installation Planning Guide EZDP-2126 Rev G Shaft Ground Monitoring: Assurance – Series 2



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# 1. About Cutsforth

Cutsforth specializes in developing innovative new technologies and services to support the power generation industry. Cutsforth's patented EASYchange® brush holder design, online truing service, InsightCM™ condition monitoring software, and patented shaft grounding and monitoring systems have been installed across the globe in generators of all sizes and in nearly every industry application, including nuclear, natural gas, coal, wind, and hydroelectric.

Cutsforth's knowledge and commitment to excellence drives our innovative solutions for the changing needs of the power industry. Whether it is a quick response to a critical situation or a new way of solving an old problem, our commitment to quality ensures that our customers receive best-in-class products and services—Cutsforth is the Power of Innovation.

Cutsforth started back in 1991 as a small company focused primarily on making replacement brush holders for generators and exciters. Today, after 30+ years in business, Cutsforth's experience and innovative designs have brought its best-in-class excitation brush holder and shaft grounding replacements and collector ring services to some of the world's largest power companies.

## 1.1. Cutsforth Products

- [EASYchange® Removable Brush Holders](#)
- [EASYchange® Brush Condition Monitoring](#)
- [Cutsforth Shaft Grounding Systems](#)
- [Rotor Flux Monitoring](#)
- [Electro-Magnetic Interference Monitoring](#)
- [InsightCM™ Condition Monitoring Software](#)

## 1.2. Cutsforth Field Services

Cutsforth provides comprehensive product installations for all product offerings as well as on-site training after the installation. We work efficiently during your outage to ensure a smooth upgrade to our innovative solutions such as Product Installations, Online Collector Ring and Commutator Truing, Spiral Groove Restoration, and Consulting and Emergency Services.

## 1.3. Cutsforth Automation and Control Services

Cutsforth provides comprehensive Automation and Control services which include data historian integration, InsightCM™ integration, DCS logic, engineered drawings and much more. This further complements our turnkey monitoring system installations.

## 2. Legal Information

### 2.1. Limited Warranty

This document is provided 'as is' and is subject to being changed, without notice, in future editions. Cutsforth reviews this document carefully for technical accuracy; however, CUTSFORTH MAKES NO EXPRESS OR IMPLIED WARRANTY AS TO THE ACCURACY OF THE INFORMATION WITHIN THIS MANUAL AS IT RELATES TO SPECIFIC INSTALLATION. THE CUSTOMER IS RESPONSIBLE FOR VERIFYING INSTALLATION AND OPERATING CONDITIONS AT EACH INSTALLATION LOCATION AND FOR EACH GENERATOR TYPE. Cutsforth warrants that its hardware products will be free of defects in materials and workmanship that cause the product to fail to substantially conform to the applicable Cutsforth published specifications for one (1) year from the date of invoice.

For a period of ninety (90) days from the date of invoice, Cutsforth warrants that (i) its software products will perform substantially in accordance with the applicable documentation provided with the software, and (ii) the software media will be free from defects in materials and workmanship. If Cutsforth receives notice of a defect or non-conformance during the applicable warranty period, Cutsforth will, in its discretion: (i) repair or replace the affected product, or (ii) refund the fees paid for the affected product. Repaired or replaced hardware will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer. If Cutsforth elects to repair or replace the product, Cutsforth may use new or refurbished parts or products that are equivalent to new in performance and reliability and are at least functionally equivalent to the original part or product. You must obtain an RMA number from Cutsforth before returning any product to Cutsforth. Cutsforth reserves the right to charge a fee for examining and testing hardware not covered by the Limited Warranty.

This Limited Warranty does not apply if the defect of the product resulted from improper or inadequate maintenance, installation, repair, or calibration performed by a party other than Cutsforth; unauthorized modification; improper environment; use of an improper hardware or software key; improper use or operation outside of the specification for the product; improper voltages; accident, abuse, or neglect; or a hazard such as lightning, flood, or other act of nature.

THE REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND THE CUSTOMER'S SOLE REMEDIES, AND SHALL APPLY EVEN IF SUCH REMEDIES FAIL OF THEIR ESSENTIAL PURPOSE.

WARNING REGARDING USE OF CUTSFORTH SHAFT MONITORING EQUIPMENT: CUSTOMER IS ULTIMATELY RESPONSIBLE FOR VERIFYING AND VALIDATING THE SUITABILITY AND RELIABILITY OF THE PRODUCTS WHENEVER THE PRODUCTS ARE INCORPORATED IN THEIR SYSTEM OR APPLICATION, INCLUDING THE APPROPRIATE DESIGN, PROCESS, AND SAFETY LEVEL OF SUCH SYSTEM OR APPLICATION. PRODUCTS ARE NOT DESIGNED, MANUFACTURED, OR TESTED FOR USE IN LIFE OR SAFETY CRITICAL SYSTEMS, OR ANY OTHER APPLICATION IN WHICH THE FAILURE OF THE PRODUCT OR SERVICE COULD LEAD TO DEATH, PERSONAL INJURY, SEVERE PROPERTY DAMAGE OR ENVIRONMENTAL HARM (COLLECTIVELY, "HIGH-RISK USES"). FURTHER, PRUDENT STEPS MUST BE TAKEN TO PROTECT AGAINST FAILURES, INCLUDING PROVIDING BACK-UP AND SHUT-DOWN MECHANISMS. CUTSFORTH EXPRESSLY DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS OF THE PRODUCTS OR SERVICES FOR HIGH-RISK USES.

CUTSFORTH DOES NOT WARRANT, GUARANTEE, OR MAKE ANY REPRESENTATIONS REGARDING THE USE OF OR THE RESULTS OF THE USE OF THE PRODUCTS IN TERMS OF CORRECTNESS, ACCURACY, RELIABILITY, OR OTHERWISE. CUTSFORTH DOES NOT WARRANT THAT THE OPERATION OF THE PRODUCTS WILL BE UNINTERRUPTED OR ERROR FREE. INCIDENTAL AND CONSEQUENTIAL DAMAGES, INCLUDING LOSS OF USE, ARE SPECIFICALLY EXCLUDED FROM THIS WARRANTY; THE MAXIMUM VALUE OF A WARRANTY CLAIM CANNOT EXCEED THE ORIGINAL VALUE OF THE ASSEMBLY OR COMPONENT.

## **2.2. Copyright**

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## **2.3. Patents**

Please send patent information requests to [patents@cutsforth.com](mailto:patents@cutsforth.com).

## 3. Safety Information

### 3.1. Safety Information [English]

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

#### 3.1.1. Safety Conventions

|                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><b>NOTE:</b><br/>Additional information.</p>                                                                                               |  <p><b>ELECTRICAL DANGER</b><br/>Indicates an action or specific equipment area that can result in personal injury or death from an electrical hazard if proper precautions are not taken.</p> |
|  <p><b>CAUTION</b><br/>Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury or equipment damage.</p> |  <p><b>WARNING</b><br/>Indicates a hazardous situation that, if not avoided, could result in death or serious injury.</p>                                                                      |
|  <p><b>ROTATING PART CAUTION</b><br/>Indicates possible injury from rotating parts.</p>                                                      |  <p><b>DANGER</b><br/>Indicates a hazardous situation that, if not avoided, will result in death or serious injury.</p>                                                                      |

#### 3.1.2. General Safety Instructions

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><b>ELECTRICAL DANGER</b></p> <p>Only qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid injury should work with Cutsforth products. Among the many considerations are the following:</p> <ul style="list-style-type: none"> <li>▪ Avoid contact with energized circuits.</li> <li>▪ Avoid contact with rotating parts.</li> <li>▪ Never install any component that appears not to be functioning in a normal manner.</li> <li>▪ Always ensure proper installation of the holder assembly and shaft grounding rope.</li> </ul> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



### ELECTRICAL DANGER

Before working on the generator, de-energize, lock out, and tag out all power sources to the generator, shaft, and accessory devices. Electric shock and death may result due to failure to heed this warning.



### ROTATING PART CAUTION

High-voltage and rotating parts can cause serious or fatal injury. Installation, operation, and maintenance of this product must be performed only by qualified personnel, in accordance with all applicable safety regulations and guidelines.

## 3.2. Consignes de Sécurité [Français]

Les informations qui suivent sont essentielles afin d'assurer la sécurité de l'utilisateur lors de l'installation et de l'opération de l'équipement. Assurez-vous de bien lire et de comprendre tous les avertissements et mises en garde qui suivent.

### 3.2.1. Conventions de Sécurité



#### NOTE:

Informations supplémentaires.



#### RISQUES DE CHOC ÉLECTRIQUE

Indique que l'action ou la partie de l'équipement concernée peut mener à des blessures par électrisation ou à la mort par électrocution si les précautions adéquates ne sont pas prises.



#### MISE EN GARDE

Indique la présence d'une situation dangereuse qui, si elle n'est pas évitée, pourrait mener à des blessures mineures à modérées ou à des dommages matériels.



#### AVERTISSEMENT

Indique la présence d'une situation dangereuse qui, si elle n'est pas évitée, pourrait mener à des blessures sévères ou à la mort.



#### MISE EN GARDE : PIÈCE ROTATIVE

Indique la présence de pièces d'équipement rotatives pouvant causer des blessures.



#### DANGER

Indique la présence d'une situation dangereuse qui, si elle n'est pas évitée, pourrait mener à des blessures sévères ou à la mort.

### 3.2.2. Consignes de Sécurité Générales



#### RISQUES DE CHOC ÉLECTRIQUE

L'utilisation des produits Cutsforth n'est recommandée qu'aux professionnels qualifiés qui savent comment reconnaître la présence de risques de choc électrique ainsi que les consignes de sécurité à suivre pour éviter les blessures liées à ces risques. Lesdites consignes de sécurité incluent, sans s'y limiter :

- Éviter tout contact avec des circuits alimentés;
- Éviter tout contact avec des pièces d'équipement rotatives;
- Ne jamais installer de composante ne paraissant pas fonctionner normalement;
- Toujours s'assurer que la structure de soutien et le câble de terre de l'arbre de la génératrice sont correctement installés.



#### RISQUES DE CHOC ÉLECTRIQUE

Avant de travailler sur la génératrice, désalimentez, cadenassez et étiquetez toutes les sources d'énergies liées à la génératrice, à l'arbre et aux appareils accessoires. L'opérateur s'expose à des risques de chocs électriques pouvant causer la mort s'il ne tient pas compte de cet avertissement.



#### MISE EN GARDE : PIÈCE ROTATIVE

Les pièces d'équipement rotatives et sous haute tension peuvent causer des blessures sévères ou fatales. L'installation, l'opération et la manutention de ce produit ne doivent être faites que par des professionnels qualifiés et en respectant toutes les règles et consignes de sécurité applicables.

## 4. Installation Planning for the Cutsforth Assurance Monitoring System—Series 2

This manual is a guide for planning the installation of the Cutsforth Assurance Monitoring System – Series 2. Review the documentation for the original or OEM shaft grounding system for planning the removal of that system.



This manual does not cover all details or variations in equipment, nor does it consider every possible contingency for installation, operation, or maintenance. If you have questions or concerns that are not addressed in this manual, contact Cutsforth Engineering Support.

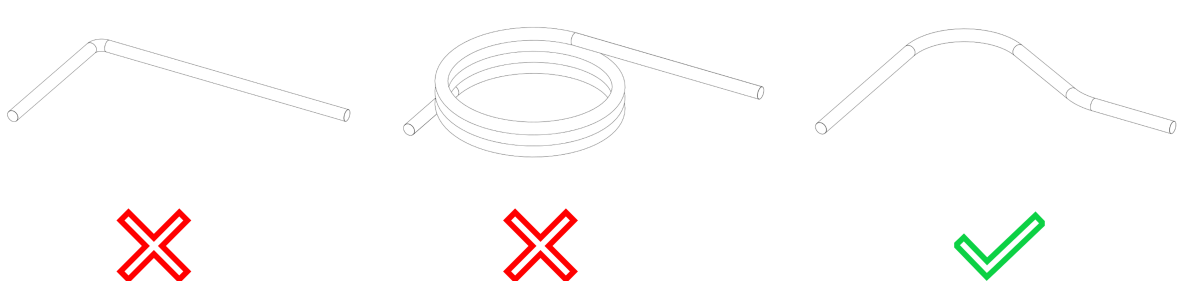
## 5. Installation Strategies

Determine the best component locations for your installation by applying the following strategies.

### 5.1. Cabling Requirements

Please review the list of best practices for installation below to help ensure maximum effectiveness of your Cutsforth Assurance Monitoring System:

- Avoid sharp bends and coils in the grounding wire whenever possible. Bending or coiling the conductor can create induction back on itself and reduce grounding effectiveness.



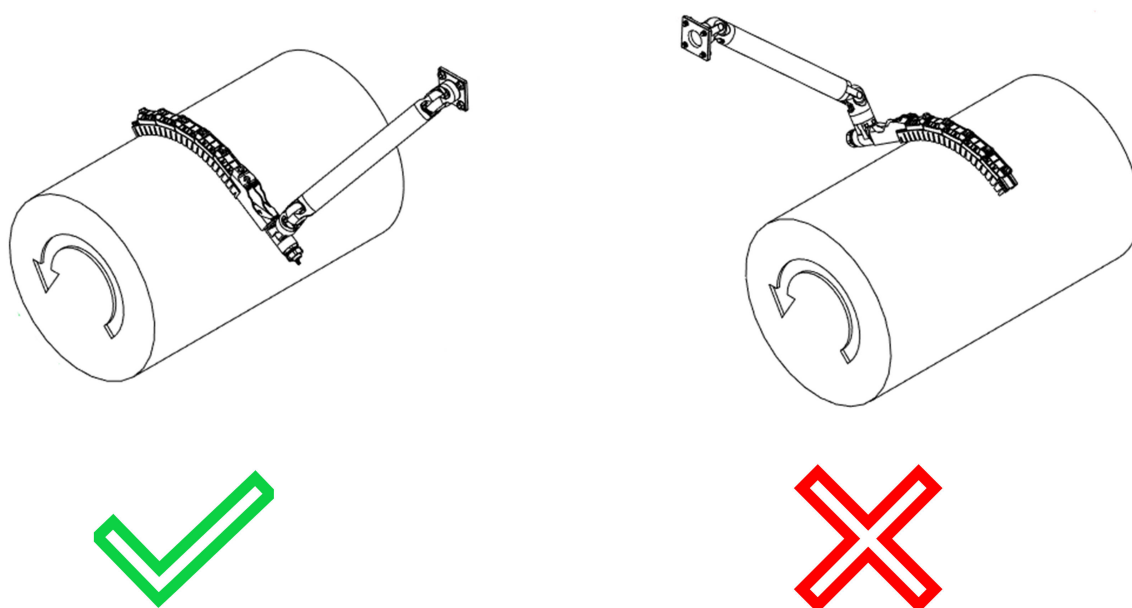
- The grounding conductor and signal cable shall be routed according to the shortest possible paths.
  - For Series 3 Shaft Grounding Assemblies (SGA):
    - The total ground conductor length from the SGA to the unit case's ground termination point shall not exceed 5 ft (1.5 m).
    - The total signal cable length from the SGA to the Cutsforth Monitoring System shall not exceed 30 ft (9 m). Deviations require sign-off by Cutsforth Engineering.

## 5.2. Positioning the Cutsforth Shaft Grounding Assembly

The Cutsforth Shaft Grounding Assembly has a maximum operating temperature of 150°C (302°F).

The Cutsforth Shaft Grounding Assembly is installed on the same portion of exposed shaft as the previous grounding equipment.

The Shaft Grounding Assembly must be installed on the “uphill” side of the shaft rotation. Installing on this side of the shaft ensures that the rope does not bunch up or bind up inside the rope guide. The configuration on the left in the following illustration shows the correct orientation.



## 5.3. Determining a Ground Conductor Termination Location

The goal for selecting a grounding location is to electrically bond the shaft to the unit case. The unit case is defined by the lower half of the turbine case, generator case, or coupler case near the SGA to which the shaft can be grounded. Cutsforth suggests drilling and tapping into the lower half of the unit case to create a grounding location close to the Shaft Grounding Assembly. The location at which the ground wire will terminate should have all paint removed and should be free of all contaminants to create a smooth, conductive surface. Structural steel and station ground are examples of unacceptable grounding locations. It is important to note that it is not necessary for the ground conductor to be grounded to an existing generator grounding pad.

## 5.4. Identifying an Accessible and Safe Monitoring System Mounting Location

The Assurance Monitoring System has a minimum/maximum operating temperature range of –20°C (–4°F) to 65°C (149°F). Avoid mounting the enclosure in areas where the temperature falls outside this range on a regular basis. If possible, avoid mounting the monitoring system in a location that experiences direct sunlight for extended periods of time throughout the day.

The monitoring system should be installed in a location that does not complicate generator disassembly during outages.

The monitoring system should be accessible to personnel for data collection using the local display or monitoring system test points, as well as for servicing and troubleshooting, as needed.

The monitoring system should be mounted in a location that does not experience excessive vibration. Mounting directly to rotating equipment, such as a generator or other vibrating structures, is not recommended. All cabling should be strain-relieved near input connectors. Take care to not directionally bias cable connectors when applying strain relief.

## 5.5. Mounting the Assurance Monitoring System

The Assurance Monitoring System enclosure is commonly installed using strut channel provided by the electrical contractor. Cutsforth recommends the use of a floor-mounted strut channel structure, as it is typically less susceptible to excessive vibration. If a wall-mounted structure is necessary, Cutsforth recommends using vibration-isolation mounting. The example image below shows a suitable location.



## 5.6. Power Requirements:

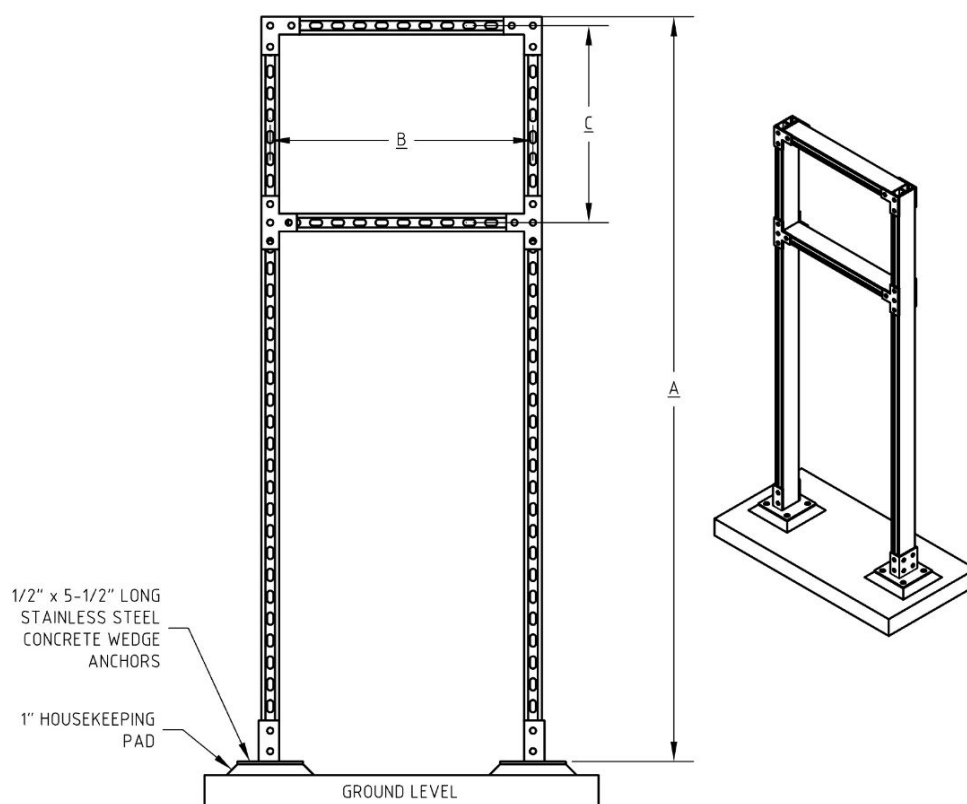
| Power Requirement                    | Value              |
|--------------------------------------|--------------------|
| Voltage                              | 85–264 VAC         |
| Recommended breaker size             | 20 A               |
| Recommended power cabling wire gauge | 12 AWG             |
| Actual operational current draw      | ~ 0.5 A at 120 VAC |

## 5.7. Conduit and Strut Channel Recommendations

| Component                        | Standard Recommendation              | Recommendation for High-Corrosion Environments |
|----------------------------------|--------------------------------------|------------------------------------------------|
| Conduit type                     | Galvanized rigid metal conduit (RMC) | Rigid Aluminum Conduit (RAC)                   |
| Conduit fittings type            | Malleable                            | Aluminum                                       |
| Strut channel type               | Hot dipped galvanized, back-to-back  | 316 Stainless steel                            |
| Mounting hardware                | 316 Stainless steel                  | 316 Stainless steel                            |
| Liquid flexible metallic conduit | Type HCX                             | Type HCX                                       |

Cutsforth recommends that a duct seal be used to seal the inside of any conduit entering the Cutsforth monitoring system enclosure(s). The duct seal should be non-permanent in nature to accommodate future equipment or cable maintenance.

### 5.7.1. Recommended Strut Rack Design

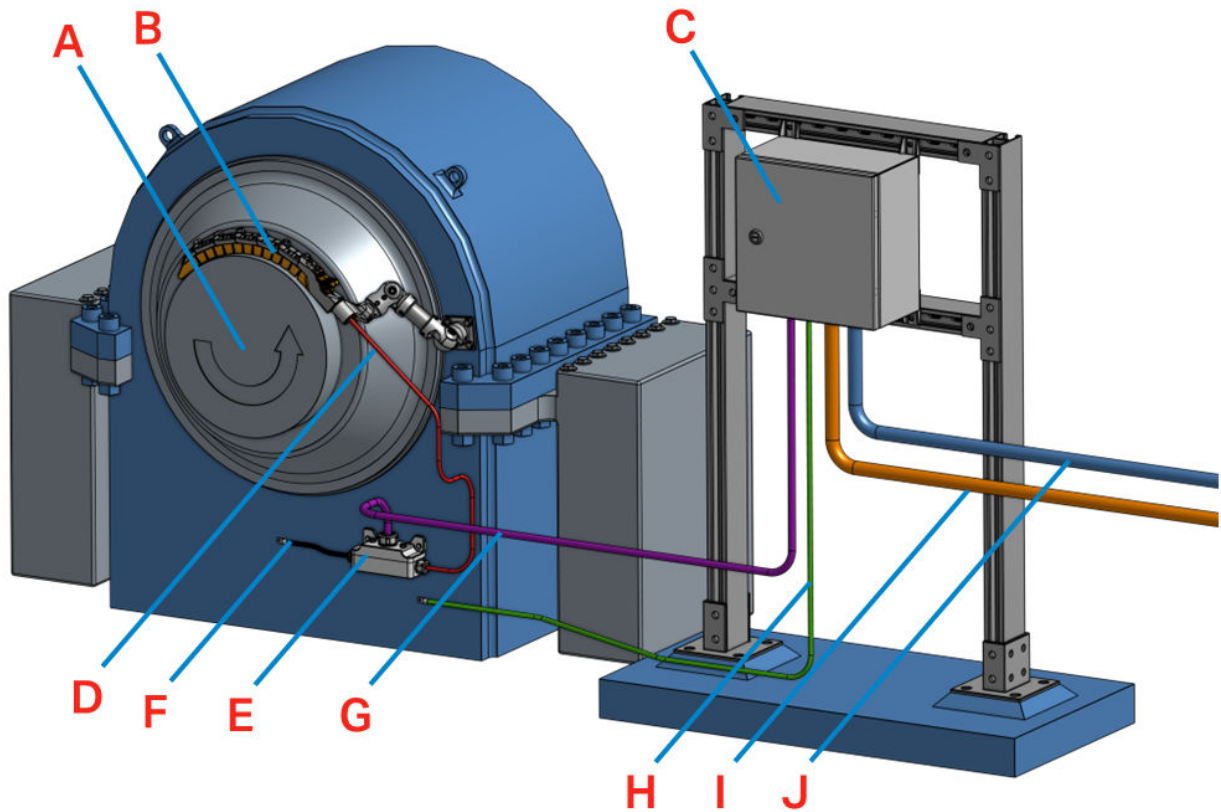


| A (in (cm)) | B (in (cm)) | C (in (cm))                                 |
|-------------|-------------|---------------------------------------------|
| 68 (173)    | 24 (61)     | Refer to enclosure mounting feet dimensions |

## 6. Diagrams

### 6.1. Conduit Layout

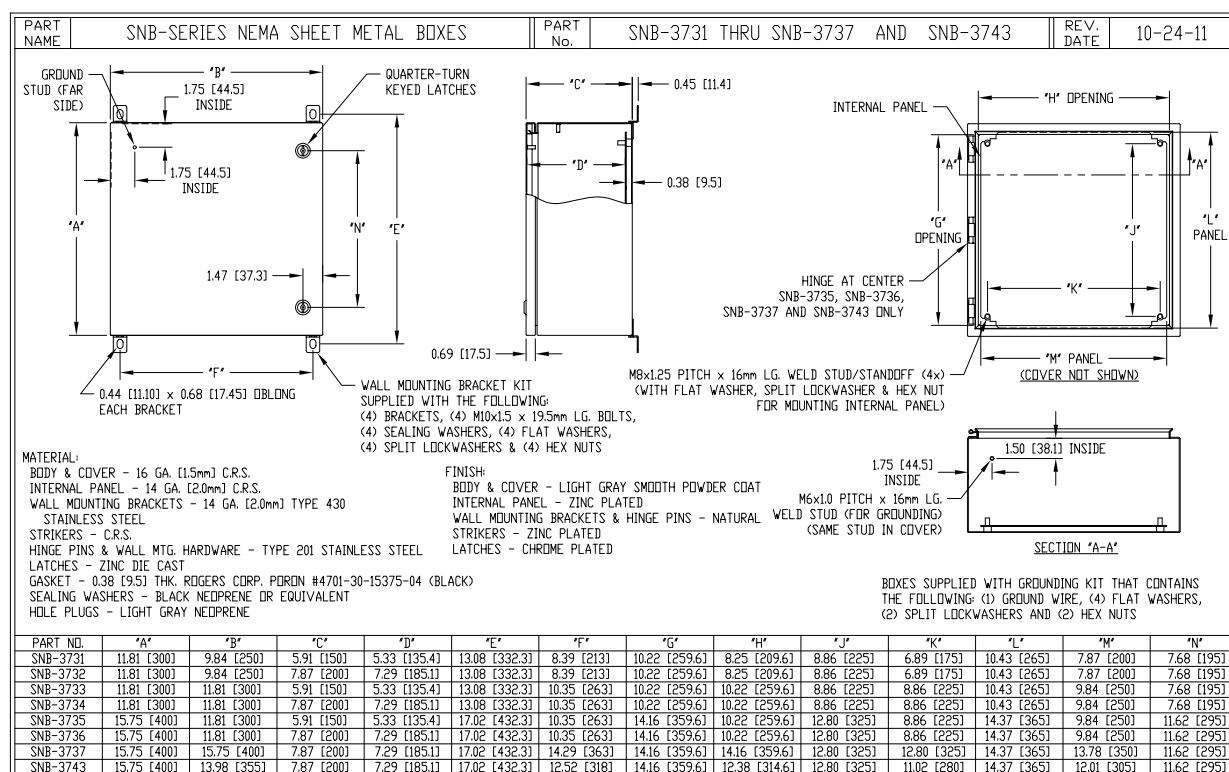
| Color on Diagram (next page) | Conduit Run Description                      | Conduit Trade Size | Max Run Length | Wire Description                                                             | Purpose                                                | Wire Supplied by            | Conduit Supplied by         |
|------------------------------|----------------------------------------------|--------------------|----------------|------------------------------------------------------------------------------|--------------------------------------------------------|-----------------------------|-----------------------------|
| Red                          | Shaft grounding assembly to junction box     | 3/8 in (1 cm)      | 4 ft (1.2 m)   | Twisted pair, individually shielded, high temp, 18 AWG<br><br>+ 8 AWG ground | Signals and ground from SGA to junction box            | Cutsforth                   | Cutsforth                   |
| Black                        | Junction box to unit case ground             | N/A                | 1 ft (0.3 m)   | Single conductor, 8 AWG, high temp                                           | Ground from junction box to unit case ground           | Cutsforth                   | N/A                         |
| Purple                       | Junction box to monitoring system            | 3/4 in (2 cm)      | 27 ft (8.2 m)  | Two high-voltage, CAT6a ethernet cables                                      | Signals from junction box to monitoring system         | Cutsforth                   | Plant electrical contractor |
| Green                        | Monitoring system to unit case ground        | N/A                | 20 ft (6.1 m)  | Single conductor, 12 AWG                                                     | Case ground connection for monitoring system enclosure | Cutsforth                   | N/A                         |
| Blue                         | Dedicated 120V AC power to monitoring system | 3/4 in (2 cm)      | N/A            | AC 85–264 V AC, 47–440 Hz, 10 W<br><br>20 A circuit                          | AC power for monitoring system                         | Plant electrical contractor | Plant electrical contractor |
| Orange                       | Data output to control room                  | 3/4 in (2 cm)      | N/A            | Dependent on data output type (Modbus TCP/IP, RTU, or [optional] 4–20mA)     | Monitoring output to plant's control room              | Plant electrical contractor | Plant electrical contractor |



| Part | Name                                                                  |
|------|-----------------------------------------------------------------------|
| A    | Shaft Rotation Direction                                              |
| B    | Shaft Grounding Assembly                                              |
| C    | Cutsforth Assurance Monitoring System                                 |
| D    | (Red) Signal and Ground Cable from SGA to Junction Box                |
| E    | Junction Box                                                          |
| F    | (Black) 8 AWG from Junction Box to Unit Case Ground                   |
| G    | (Purple) 3/4 in (2 cm) Conduit from Junction Box to Monitoring System |
| H    | (Green) 12 AWG from Monitoring System Enclosure to Unit Case Ground   |
| I    | (Orange) 3/4 in (2 cm) Conduit for Data Output to Control Room        |
| J    | (Blue) 3/4 in (2 cm) Conduit for Plant Power Input                    |

### 6.2.1. Painted Steel Enclosure

| Catalog Number | A                 | B                 | C                | Steel Type                 | Door/Body Gauge | Latch Qty |
|----------------|-------------------|-------------------|------------------|----------------------------|-----------------|-----------|
| SNB-3734       | 11.81 in (300 mm) | 11.81 in (300 mm) | 7.87 in (200 mm) | Painted Steel, Cold Rolled | 16              | 1         |

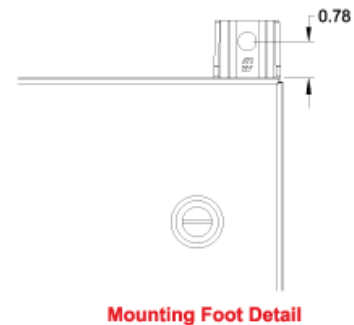
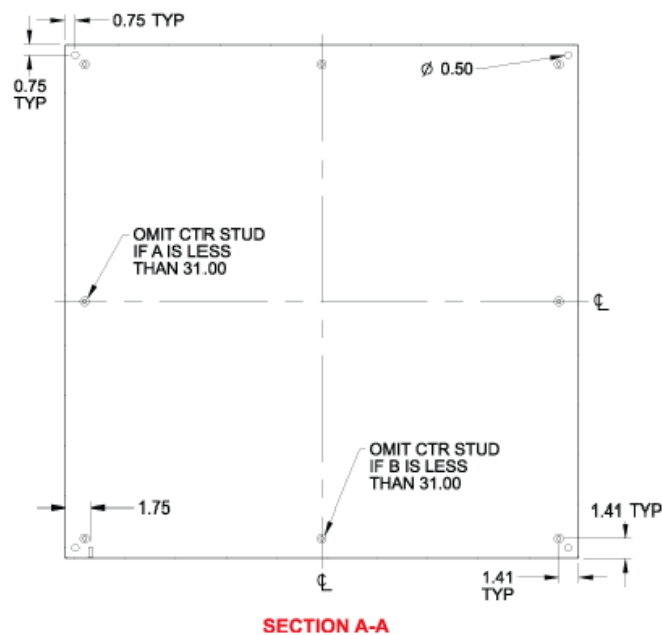
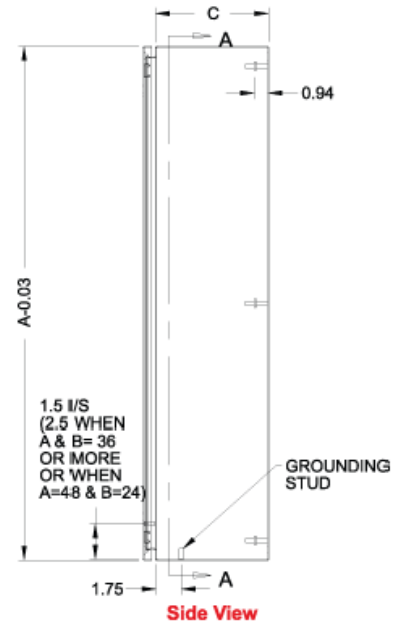
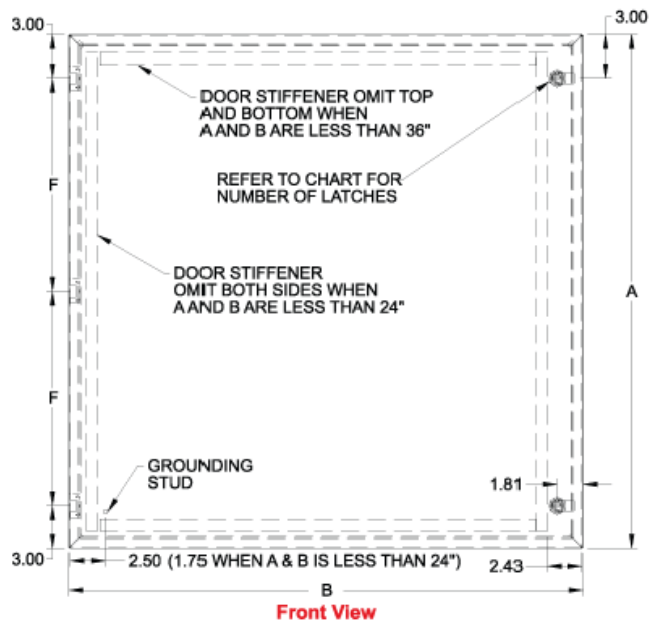


**Specifications:**

- |                                                                                                                                                                                                                                |                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>UL 508A Listed: Type 1, 2, 4, 4X, 12, and 13</li> <li>UL File Number: E194432-20071011</li> <li>Meets NEMA 1, 2, 4, 4X, 12, 13 Requirements</li> <li>Meets IP66 Requirements</li> </ul> | <ul style="list-style-type: none"> <li>16 Gauge Cold Rolled Steel</li> <li>Light Gray Smooth Powder Coat</li> <li>Product Weight: 20 lb (9.1 kg)</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 6.2.2. Stainless Steel Enclosure

| Catalog Number | A                   | B                   | C                   | Steel Type    | Door/Body Gauge | Latch Qty |
|----------------|---------------------|---------------------|---------------------|---------------|-----------------|-----------|
| EN4SD12126S16  | 12.0 in<br>(305 mm) | 12.0 in<br>(305 mm) | 6.00 in<br>(152 mm) | 316 Stainless | 16              | 1         |



**Specifications:**

- |                                                                                                                                                                     |                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>▪ UL 508A Type 3R, 4, 4X, 12</li><li>▪ UL File: E65234</li><li>▪ CSA Type 3R, 4, 4X, 12</li><li>▪ CSA Cert: LR21001</li></ul> | <ul style="list-style-type: none"><li>▪ Meets NEMA 3R, 4, 4X, 12, 13 Requirements</li><li>▪ Meets IP 66 Requirements</li><li>▪ 16 Gauge Stainless Steel</li><li>▪ Product Weight: 20 lb (9.1 kg)</li></ul> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 7. Integration and Infrastructure

The Cutsforth Assurance Monitoring System has multiple data output options for integration into the plant's DCS and/or historian, as listed below.

- Modbus Output
  - RTU over RS485
  - TCP/IP
- 4–20 mA Outputs
  - Optional add-on. Not included in standard offering.

For details on how to program the Assurance Monitoring System's data outputs, please refer to the system's operations manual.

## 8. Responsibilities

The following tables summarize the responsibilities of Cutsforth and the Plant during the three project phases.

### 8.1. Planning Phase

| Task                                                                                                                                    | Cutsforth | Plant |
|-----------------------------------------------------------------------------------------------------------------------------------------|-----------|-------|
| Review this planning guide and share it with key plant personnel involved in the project.                                               |           | ✓     |
| Determine enclosure mounting position and conduit routes customized to the generator and ensure that they are within system guidelines. |           | ✓     |
| Select an electrical contractor and coordinate.                                                                                         |           | ✓     |

### 8.2. Preparation for Service Phase



#### NOTE:

The responsibilities listed in the following table are critical to technician safety and proper installation of the Cutsforth equipment. Failure to comply may result in significant delays and additional charges.

| Task                                                                                                                                                                   | Cutsforth | Plant |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------|
| Determine enclosure mounting position, customize conduit routes to generator, and ensure it is within system requirements.                                             |           | ✓     |
| Mount monitoring system enclosure with supporting strut channel, punch conduit holes in enclosure, and install required conduit, complete with conductors installed.   |           | ✓     |
| LOTO the following components: Main excitation system, ground detection system, and turning gear. LOTO needs to be in place prior to arrival of Cutsforth technicians. |           | ✓     |
| Provide 120V power (GFI-protected is preferred) for installation tooling.                                                                                              |           | ✓     |
| Provide adequate working access to installation site including scaffolding. Scaffolding must be erected prior to arrival of Cutsforth technicians.                     |           | ✓     |
| Ensure that the shaft is off turning gear and stationary.                                                                                                              |           | ✓     |
| Ensure that the shaft is fully coupled for installation .                                                                                                              |           | ✓     |
| Ensure that the bearing caps immediately adjacent to the shaft grounding area are in place.                                                                            |           | ✓     |

## 8.3. Cutsforth Service Phase – Cutsforth Technicians On-site

| Task                                                                                                                                                            | Cutsforth | Plant |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------|
| Provide shaft growth value at grounding location to Cutsforth technician.                                                                                       |           | ✓     |
| Indicate shaft rotation direction to Cutsforth technician.                                                                                                      |           | ✓     |
| Install Cutsforth shaft assembly.                                                                                                                               | ✓         |       |
| Run wiring in plant-completed conduit raceways.                                                                                                                 | ✓         |       |
| Identify main grounding termination point on the unit case.                                                                                                     | ✓         |       |
| Make system wiring terminations.                                                                                                                                | ✓         |       |
| Make grounding termination to unit case.                                                                                                                        | ✓         |       |
| Perform system testing and commissioning, including verification of sensor inputs and local system operation.                                                   | ✓         |       |
| Verify monitoring system data outputs using Cutsforth test equipment and standard communication checks.*                                                        | ✓         |       |
| Provide control room, server, network, and IT readiness required to test data communications beyond the monitoring system.                                      |           | ✓     |
| Complete configuration, acceptance, and validation of data communications between the monitoring system and plant systems (DCS, historian, server, or network). |           | ✓     |

\*Cutsforth's onsite testing and commissioning responsibilities are limited to verifying proper operation of the Assurance Monitoring System and confirming that valid data outputs are available at the monitoring system interface.

End-to-end validation of data communications to plant-owned systems (including servers, DCS, historians, networks, cabling, and permissions) requires that all plant systems be fully installed and operational at the time of service. If these systems are not ready during the site visit, Cutsforth technicians will complete system verification using internal tools and conclude the onsite work. Any remaining integration or data communications is the responsibility of the plant and may require additional services.

## 9. Glossary

|                                |                                                                                                                                                                  |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assurance Monitoring System    | A Cutsforth product which monitors shaft voltages and shaft currents to provide real-time data locally and data outputs for integration into a DCS or historian. |
| attenuation                    | The reduction of the amplitude of a signal due to excessive cable length.                                                                                        |
| AWG                            | American Wire Gauge                                                                                                                                              |
| ground conductor               | 8 AWG, green ground conductor that carries the shaft current to the unit case ground location.                                                                   |
| ground current                 | The electrical current between the shaft and the unit case ground through the ground conductor.                                                                  |
| ground rope                    | The left rope in the Shaft Grounding Assembly, which provides the primary path to unit case ground through the 8AWG ground conductor.                            |
| impedance                      | The resistance to change in the current of a circuit.                                                                                                            |
| LOTO                           | Lockout/Tagout                                                                                                                                                   |
| meter rope                     | The right rope in the Shaft Grounding Assembly which provides a shaft contact point at which shaft voltage readings are taken.                                   |
| Shaft Grounding Assembly (SGA) | A Cutsforth product designed to provide a best-in-class ground connection, as well as a shaft contact point at which shaft voltage can be measured.              |
| shaft voltage                  | The voltage potential between the shaft and the unit case ground as measured by the metering rope.                                                               |
| signal cable                   | Shielded cable that carries the voltage signals from the SGA and the SCA to the monitoring system.                                                               |
| unit                           | The equipment monitored by the Cutsforth monitoring system.                                                                                                      |
| unit case ground               | The lower half of the turbine case, generator case, or coupler case near the Shaft Grounding Assembly to which the shaft can be grounded.                        |