



# Gammatec NDT Supplies SOC Ltd

<b>Group</b>	<b>Logistics</b>	<b>Drive Cable Assembly and Repair</b>		
<b>Document</b>	<b>Work Instruction</b>			
<b>Document no.</b>	<b>5.1.58.0</b>			
<b>Revision no.</b>	<b>5</b>	<b>Effective from</b>	<b>1 November 2019</b>	<b>Page 2 of 25</b>

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## 1. **PURPOSE/OBJECTIVES**

The objectives of this Work Instruction are:

- 1.1 To outline the different steps taken in the Assembly of Drive Cables.

## 2. **SCOPE**

This procedure is applicable to all personnel within Gammatec NDT Supplies SOC Ltd.

## 3. **RESPONSIBILITIES AND AUTHORITIES**

### 3.1 **Managing Director**

It is the responsibility of the Managing Director to ensure that the necessary responsibilities and authorities are defined, assigned and communicated to the applicable personnel within the company.

### 3.2 **MWS Manager/Supervisor**

- Is responsible for ensuring that the necessary responsibilities and authorities are assigned and communicated to the applicable personnel.
- Is responsible for ensuring that this work instruction is available at point of use.
- Is responsible for ensuring that tools and resources are identified and provided as required.
- Is responsible for the training, and certification of technicians in accordance with the approved QC Policy and Work instructions.
- Is responsible for regular reviewing and updating of this Work Instruction to ensure that it remains current.
- Is responsible for the prompt implementation of corrective/preventive measures regarding any non-conformances originating from the MWS.

### 3.3 **MWS Technician**

- Is responsible for adherence to the requirements this work instruction.
- Is responsible for ensuring that the required resources and tools are correctly maintained.
- Is responsible for prompt reporting of any non-conforming situation to the MWS Manager for advice or resolution.

### 3.4 **QC Supervisor**

- Is responsible for ensuring that the necessary responsibilities and authorities are understood and adhered to.
- Is responsible for ensuring that this work instruction is available at point of use.
- Is responsible for supervision and delegation of tasks to the QC Inspectors.
- Is responsible for ensuring that the required resources and tools are correctly maintained.

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- Is responsible for prompt resolution of any reported QC problems reported.
- Is responsible for prompt reporting of any non-conforming situation to the SHEQ Manager for advice or resolution.

## 3.5 QC Inspector

- Is responsible for adherence to the requirements of this work instruction.
- Is responsible for ensuring that the required resources and tools are correctly maintained.
- Is responsible for prompt reporting of any non-conforming situation to the QC Supervisor for advice or resolution.

## 3.6 Company Accountant

Is responsible for authorising the disposal of any records that have reached their maximum retention period.

## 4. REFERENCES

- 4.1 ISO 9001 Quality Management Systems
- 4.2 Applicable procedures and work instructions within Gammatec NDT Supplies SOC Ltd.
- 4.3 Regulatory requirements applicable to Gammatec NDT Supplies SOC Ltd.

## 5. DEFINITIONS

- 5.1 Responsible person – Names listed as per “crimping block control sheet”.

## 6. PROCEDURE

### 6.1 Discussion of the process – Assembly of Drive Cables

- 6.1.1 Stores issue a Production Order requesting the assembly of Drive Cables. The Stock Code and Descriptions of the Drive Cable required for the assembly are reflected under the “Item Details” section of the Production Order. **(Refer to WI\_GSA\_LOG-003.01.016.000 Production Order)**
- 6.1.2 The Production Order is signed and dated by the Storeman and handed over to the MWS Staff together with the relevant Spares. The MWS Staff verify that the Spares are correct and “issued” on the Production Order. The assembly is now “Work in Progress”.

**NB: Serial number Transaction Sheet must be attached with Production Order to ensure that serialized spares are correctly issued for assembly.**

- 6.1.3 On completion of the work the MWS Staff stamp and sign off the Production Order and request QC to verify that the work is done correctly.

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6.1.4 Once QC has checked the items and they are found to be correct, QC stamps and signs the Production Order as “QC Passed” and hands it back to the MWS Staff. The MWS staff now handover the goods back to Stores together with the Production Order.

## 6.2 Preparation

Equipment required:

- Belt Sander or Bench Grinder
- Bench Vice
- Small Hammer
- Crimping Blocks (as specified below)
- Crimping block plate
- Hydraulic Press
- Inspection Gauges (as specified below)
- Latex Gloves
- Tissue paper
- Lacquer Thinners
- Calibrated 150mm Vernier Calliper
- Pliers
- 300mm x 300mm sealable Plastic bag (labelled accordingly)
- PVC or Masking tape



- Always wear Eye Protection when working with Hand Tools, Thinners, grinding or sanding!!
- Beware of “pinch points” when using the vice, pliers and Hydraulic Press.
- Keep Thinners away from open flames and heat sources.
- Use Latex gloves when handling or working with Thinners.

- All Blank Drive Cables need to be washed with Lacquer Thinners prior to starting the assembly process. Use compressed air to displace all excess Thinners.

**Important: Ensure that the Drive Cable remains clean and dirt free during the entire assembly process, if in doubt, wash it again after assembly.**

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## 6.3 Blank Drive Cable Length

All Drive Cable shall be tested by winding it through a Gearbox prior to cutting the Blank length.


- Feed the Bulk Cable (SC0007) into the Drive Hose of an Assembled Winding Mechanism until the Cable reaches the end of the Return Hose.
- Hold the Cable where it protrudes from the Coupling and pull a 150mm length of the Cable out of the Coupling.
- Cut the Cable where it protrudes from the Coupling with a side cutter.

The above process will produce Blank Drive Cables of the following approximate lengths:

Drive Hose Length (m)	Drive Cable Stock Code Length (m)	Blank Drive Cable Approx. Length (m)
5	10	10.26
7.62	15.2	15.46
10	20	20.26
15	30	30.26

## 6.4 Exertus & Gammamat Type Drive Cable

Applicable to the following Stock Codes:

<i>Item</i>	<i>Stock Code</i>	<i>Bill of Material</i>
	CABLE-NCC0017	1x) CABLE-SC0074 + 1x) BALLPOINT-SB0133
	CABLE-NCC0030	1x) CABLE-SC0075 + 1x) BALLPOINT-SB0133
	CABLE-NCC0119	1x) CABLE-SC0002 + 1x) BALLPOINT-SB0133
	CABLE-NCC0173	1x) CABLE-SC0103 + 1x) BALLPOINT-SB0133

**Table 1**

Follow the steps in the sequence as described below:

- 6.4.1** Use a Belt Sander to dress one end of the Blank Drive Cable to a flat surface (Figure 1).



Figure 1

- 6.4.2** Fit the serialized Ballpoint (Figure 2) over the Drive Cable end that has been ground flat. Ensure that the Ballpoint slides over the Drive Cable the entire length (10mm) of the drilled section (Figures 2, 3 & 4).

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Figure 2

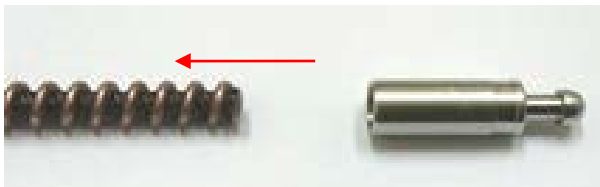


Figure 3



Figure 4

## 6.4.3 Request the correct crimping block as follows:

- 6.4.3.1 A Production Order or a Job Card must be presented to the controller (Responsible Person) to obtain the Crimping Block.
- 6.4.3.2 The Crimping Block Control Sheet (**Appendix 1**) needs to be completed and signed by the Responsible Person and the Technician.
- 6.4.3.3 The Crimping Block is accompanied by a Plate having the same Stock Code number as the Crimping Block (Figure 5).



Figure 5

- 6.4.3.4 Place the Ballpoint in the Crimping Block marked "SB0133" ensuring that the groove diameter protrude with the edge of the Crimping Block (Figure 6). Fit the plate marked "SB0133" to the Ballpoint groove ensure that the face remains flush with the Crimping Block (Figure 7).

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Figure 6



Figure 7

- 6.4.3.5** Place the Crimping Block with the Ballpoint in place (ensure the Drive Cable is still fully inserted and keep the pressure on the Drive Cable with the Plate against the edge of Crimping Block) into the Press and apply pressure on the Crimping Block until the two halves of the Block are completely closed. (Figure 8).



Figure 8

- 6.4.3.6** Release the pressure on the Crimping Block and remove the Drive Cable from the Block. (Figure 9).



Figure 9



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- 6.4.3.7** Straighten the crimped Ballpoint to be straight with the Drive Cable (Figures 10 & 11).



Figure 10



Figure 11

- 6.4.3.8** Use a Belt Sander to remove the burrs occurs during crimping. Remove as little material as possible in order to ensure that the edges are flush with the outer diameter of the crimped section. (Figure 12).



Figure 12

- 6.4.3.9** Use a Belt Sander to grind the other end of the Drive Cable to a sharp point. This will assist in easy engagement with the Gear when feeding the Drive Cable into the Gearbox. (Figure 13).



Figure 13

## 6.5 Quality Control of assembled Drive Cable:

- 6.5.1** Verify that the Drive Cable is clean by using a small piece of tissue paper to take a smear over any random part of the Drive Cable. The smear must be clean and oil free (100% of batch).
- 6.5.2** Use a Exertus GO/NOGO Gauge (NCG0061) to perform a “NOGO” test on the Ballpoint of the Drive Cable as described (Figures 14 & 15) (100% of batch):

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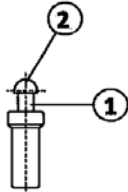


Figure 14

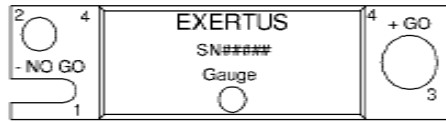


Figure 15

**6.5.3** Use the “NOGO” side of the gauge in conjunction with the above diagram by using their corresponding numbers on the Gauge to check the following:

- 6.5.3.1** The neck (1) of the Ballpoint must not fit into the slit.
- 6.5.3.2** The ball (2) of the Ballpoint must not pass through the hole.
- 6.5.3.3** Using a Vernier measure the diameter across the crimp. It must measure less than 5.8mm.

**Important: If the Ballpoint fails any of the three tests it must immediately be failed, labelled and quarantined accordingly.**

- 6.5.4** Visually inspect that there are no kinks or damage over the entire length of the Drive Cable. (100% per batch)
- 6.5.5** Perform a Pull Test on the Ballpoint as per: **WI\_GSA\_LOG-005.001.002.000 Pull Test for Winder Drive Cable.** (10% of Batch) Performed by QC only.
- 6.5.6** Verify that the “pitch” of the Drive Cable remains constant / correct by winding the full length of the Drive Cable through a test Gearbox. (10% per batch)
- 6.5.7** Record all results on the Drive Cable Examination Record (**Appendix 2**)

## 6.6 Sentinel Type Drive Cable

Applicable to the following Stock Codes:


<b>Item</b>	<b>Stock Code</b>	<b>Bill of Material</b>
	CABLE-NCC0049	1x) CABLE-SC0074 + 1x) BALLPOINT-SB0003
	CABLE-NCC0011	1x) CABLE-SC0075 + 1x) BALLPOINT-SB0003
	CABLE-NCC0118	1x) CABLE-SC0002 + 1x) BALLPOINT-SB0003

Table 2

Follow the steps in the sequence as described below:

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- 6.6.1. Use a Belt Sander to dress one end of the blank Drive Cable to be flat surface (Figure 16).



Figure 16

- 6.6.2. Fit the serialized Ballpoint (Figure 17) over the Drive Cable end that has been ground flat. Ensure that the Ballpoint slides over the Drive Cable the entire length (10mm) of the drilled section (Figure 18 & 19).



Figure 17



Figure 18



Figure 19

- 6.6.3. Request the correct crimping block as follows:

- 6.6.3.1 A Production Order or a Job Card must be presented to the controller (Responsible Person).
- 6.6.3.2 The Crimping Block Control Sheet (**Appendix 1**) needs to be completed and signed by the Responsible Person and the Technician.
- 6.6.3.3 The Crimping Block is accompanied by a Plate having the same Stock Code number as the Crimping Block (Figure 20).

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Figure 20

- 6.6.4.** Place the Ballpoint in the Crimping Block marked “SB0003” ensuring that the groove diameter protrude with the edge of the Crimping Block (Figure 21). Fit the plate marked “SB0003” to the Ballpoint groove ensure that the face remains flush with the Crimping Block (Figure 22).

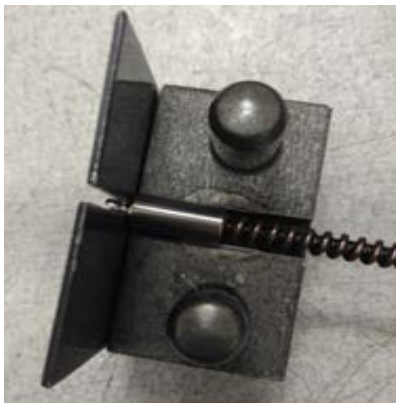


Figure 21



Figure 22

- 6.6.5.** Place the Crimping Block with the Ballpoint in place (ensure the Drive Cable is still fully inserted and keep the pressure on the Drive Cable with the Plate against the edge of Crimping Block) into the Press and apply pressure on the Crimping Block until the two halves of the Block are completely closed. (Figure 23).



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Figure 23

- 6.6.6.** Release the pressure on the Crimping Block and remove the Drive Cable from the Block (Figure 24)



Figure 24

- 6.6.7.** Straighten the crimped Ballpoint to be straight with the Drive Cable (Figures 25 & 26).

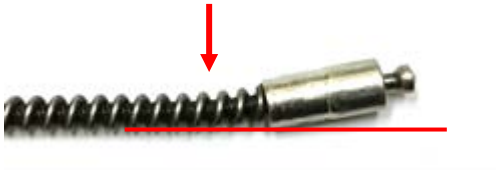


Figure 25



Figure 26

- 6.6.8.** Use a Belt Sander to remove the burrs occurs during crimping. Remove as little material as possible in order to ensure that the edges are flush with the outer diameter of the crimped section (Figure 27).



Figure 27

- 6.6.9.** Use a Belt Sander to grind the other end of the Drive Cable to a sharp point. This will assist in easy engagement with the Gear when feeding the Drive Cable into the Gearbox. (Figure 28).



Figure 28

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## 6.7 Quality Control of assembled Drive Cable:

- 6.7.1. Verify that the Drive Cable is clean by using a small piece of tissue paper to take a smear over any random part of the Drive Cable. The smear must be clean and oil free. (100% of batch)
- 6.7.2. Use a Sentinel GO/NOGO Gauge (NCG0004) to perform a “NOGO” test on the Ballpoint of the Drive Cable as described (Figure 29) (100% of batch):

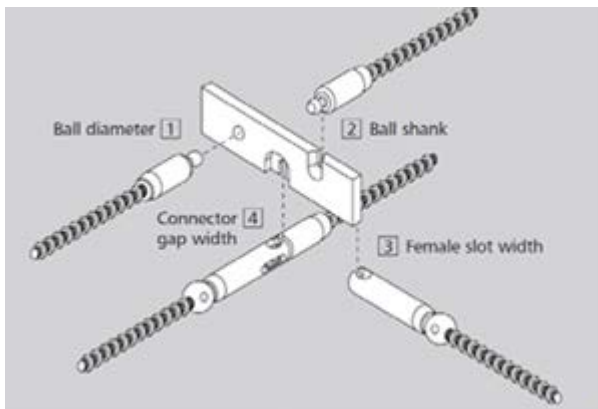


Figure 29

- 6.7.3. Use the “NOGO” in conjunction with the above diagram by using their corresponding numbers on the Gauge to check the following:

**Important: If the Ballpoint fails any of the three tests it must immediately be failed, labelled and quarantined accordingly.**

- The ball (1) of the Ballpoint must not pass through the hole of the gauge.
  - The neck (2) of the Ballpoint must not fit into the smaller of the two slits of the gauge.
  - Using a Vernier measure the diameter across the crimp. It must measure less than 6.0mm.
- 6.7.4. Visually inspect that there are no kinks or damage over the entire length of the Drive Cable. (100% of batch)
- 6.7.5. Perform a Pull Test on the Ballpoint as per: **WI\_GSA\_LOG-005.001.002.000 Pull Test for Winder Drive Cable.** (10% of Batch) Performed by QC only.
- 6.7.6. Verify that the “pitch” of the Drive Cable remains constant / correct by winding the full length of the Drive Cable through a test Gearbox. (10% of Batch)


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6.7.7. Record all results on the Drive Cable Examination Record (**Appendix 2**)

## 6.8 Teletron / Gammavolt Type Drive Cable

Applicable to the following Stock Codes:

<i>Item</i>	<i>Stock Code</i>	<i>Bill of Material</i>
	CABLE-NCC0008	1x) CABLE-SC0074 + 1x) BALLPOINT-SB0005
	CABLE-NCC0007	1x) CABLE-SC0075 + 1x) BALLPOINT-SB0005
	CABLE-NCC0380	1x) CABLE-SC0002 + 1x) BALLPOINT-SB0005
	CABLE-NCC0173	1x) CABLE-SC0103 + 1x) BALLPOINT-SB0005

The following steps need to be followed in the sequence as described below:

**6.8.1** Use a Belt Sander to dress one end of the blank Drive Cable to be flat surface. (Figure 30).



Figure 30

**6.8.2** Use a Belt Sander or Bench Grinder to remove the first 18mm of the outer coiled wire from the Drive cable. At 18mm grind the outer coil until it is almost through, take care not to grind or damage any of the inner strand wires. Use pliers to remove the outer coil. (Figures 31 & 32).

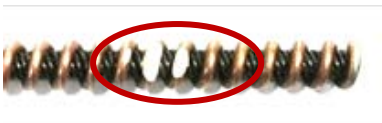


Figure 31



Figure 32

**6.8.3** Fit the Ballpoint over the inner strand wires of the Drive Cable. Clamp the Drive cable in a vice, with approximately 22mm of the Drive Cable protruding from the Vice and gently tap the Ballpoint over the Drive Cable with a small hammer until it has reached the back of the drilled hole. Notice that the first wire of the outer coil has also moved back slightly (Figure 33 & 34).



Figure 33



Figure 34

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6.8.4 Request the correct crimping block as follows:

6.8.4.1 A production order or a job card must be presented to the controller (Responsible Person).

6.8.4.2 The Crimping Block Control Sheet (**Appendix 1**) needs to be completed and signed by the Responsible Person and the Technician.

6.8.5 Place the Ballpoint in the Crimping Block marked "SB0005" with the face of the larger outer diameter flush against the outside of the Crimping Block. (Photo 35 & 36).



Figure 33



Figure 34

6.8.6 Place the Crimping Block with the Ballpoint in place (ensure the Drive Cable is still fully inserted) in the Press and apply pressure on the Block until the two halves of the Block are completely closed / against each other. (Figure 37).



Figure 35

6.8.7 Release the pressure on the Crimping Block and remove the Drive Cable from the Block. (Figure 38).



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Figure 36

**6.8.8** Straighten the Ballpoint to be straight with the Drive Cable (Figures 39 & 40).



Figure 37



Figure 38

**6.8.9** Use a fine File or Belt Sander to remove the burrs occurred during crimping. Take care to only remove as little material as possible in order to ensure that the crimped edges are flush with the outer diameter of the Ballpoint. (Figure 41).



Figure 39

**6.8.10** Use a Belt Sander to grind the other end of the Drive Cable to a sharp point. This will assist in easy engagement with the Gear of the Gearbox (Figure 42).



Figure 40

## 6.9 Quality Control of assembled Drive Cable:

**6.9.1** Use the “NOGO” in conjunction with the above diagram by using their corresponding numbers on the Gauge to check the following (Figure 43):

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Figure 41

**Important:** If the Ballpoint fails any of the three tests it must immediately be failed, labelled and quarantined accordingly.

- The ball (1) of the Ballpoint must not pass through the hole of the gauge.
- The neck (2) of the Ballpoint must not fit into the smaller of the two slits of the gauge.
- Using a Vernier measure the diameter across the crimp. It must measure less than 6.0mm.

**6.9.2** Visually inspect that there are no kinks or damage over the entire length of the Drive Cable. (100% of batch)

**6.9.3** Perform a Pull Test on the Ballpoint as per: **WI\_GSA\_LOG-005.001.002.000 Pull Test for Winder Drive Cable.** (10% of Batch) Performed by QC only.

**6.9.4** Verify that the “pitch” of the Drive Cable remains constant / correct by winding the full length of the Drive Cable through a test Gearbox. (10% of Batch)

**6.9.5** Record all results on the Drive Cable Examination Record (**Appendix 2**)

## **6.10 Quality Control of assembled Drive Cable:**

Verify that the Drive Cable is clean by using a small piece of tissue paper to take a smear over any random part of the Drive Cable. The smear must be clean and oil free. (100% of batch)

### **6.10.1 Exertus/Gammamat Drive Cable**

**6.10.1.1** Use an Exertus GO/NOGO Gauge (NCG0061) to perform a “NOGO” test on the Ballpoint of the Drive Cable (Figures 44 & 45) (100% of batch):

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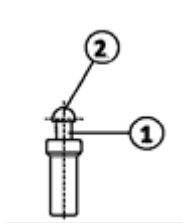


Figure 42

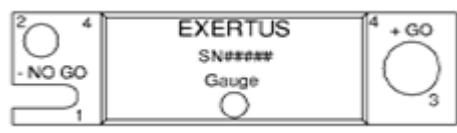


Figure 43

**6.10.1.2** Use the “NOGO” side of the gauge in conjunction with the above diagram by using their corresponding numbers on the Gauge to check the following:

- The neck (1) of the Ballpoint must not fit into the slit
- The ball (2) of the Ballpoint must not pass through the hole
- Using a Vernier measure the diameter across the crimp. It must measure less than 5.8mm.

**NB:** If the Ballpoint fails any of the three tests it must immediately be failed, labelled and quarantined accordingly.

## 6.10.2 Sentinel 880/Industrial Nuclear Drive Cable

**6.10.2.1** Use a Sentinel GO/NOGO Gauge (NCG0004) to perform a “NOGO” test on the Ballpoint of the Drive Cable (Figure 46) (100% of batch):

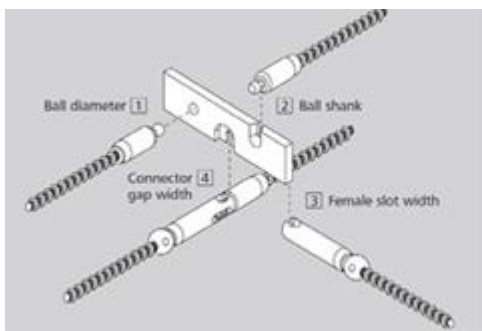


Figure 44

**6.10.2.2** Use the “NOGO” in conjunction with the above diagram by using their corresponding numbers on the Gauge to check the following:

- The ball (1) of the Ballpoint must not pass through the hole of the gauge.
- The neck (2) of the Ballpoint must not fit into the smaller of the two slits of the gauge.
- Using a Vernier measure the diameter across the crimp. It must measure less than 6.0mm.

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**NB: If the Ballpoint fails any of the three tests it must immediately be failed, labelled and quarantined accordingly.**

## 6.10.3 Teletron Drive Cable

- 6.10.3.1** Use a Teletron GO/NOGO Gauge (NCG0010) to perform a “NOGO” test on the Ballpoint of the Drive Cable as described (Figure 47) (100% of batch).

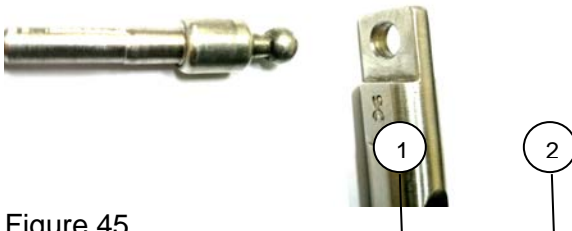


Figure 45

- 6.10.3.2** Use the “NOGO” side of the gauge in conjunction with the above diagram to check the following:

- The ball (1) of the Ballpoint must not pass through the hole (2)
- Using a Vernier measure the diameter across the crimp. It must measure less than 5.7mm.

**NB: If the Ballpoint fails any of the two tests it must immediately be failed, labelled and quarantined accordingly.**

- 6.10.4** Visually inspect that there are no kinks or damage over the entire length of the Drive Cable. (100% per batch)
- 6.10.5** Perform a Pull Test on the Ballpoint as per (10% of Batch) – Performed by the Quality Department.
- 6.10.6** Place the gearbox assembly in a vice and make is secured (Figure 48).



Figure 46

# Gammatec NDT Supplies SOC Ltd

<b>Group</b>	<b>Logistics</b>	<b>Drive Cable Assembly and Repair</b>		
<b>Document</b>	<b>Work Instruction</b>			
<b>Document no.</b>	<b>5.1.58.0</b>			
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**6.10.7** Line the test cable through the gearbox and attach the ballpoint to the female receptor of the pigtail (Figure 49).



Figure 47

## **6.10.8 Tensile test**

### **6.10.8.1. Sentinel 880**

Clamp the dummy pigtail in the rubber jaw vice ensuring that it is tightly secured in place. Connect the ballpoint to the “dummy pigtail receptor” (Figure 50).

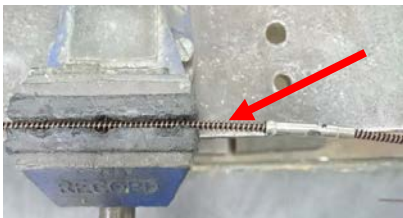


Figure 48

### **6.10.8.2. Gammamat/Exertus**

Use the crimping blocks marked “SB0133” to secure the ballpoint in. Secure the crimping block in the rubber jaw vice (Figure 51).



Figure 49

# Gammatec NDT Supplies SOC Ltd

<b>Group</b>	<b>Logistics</b>	<b>Drive Cable Assembly and Repair</b>		
<b>Document</b>	<b>Work Instruction</b>			
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## 6.10.8.3. Teletron

Clamp the ballpoint in the test fitting and secure in rubber jaw vice (Figure 52).



Figure 50

- 6.10.8.4. Set the torque wrench to 30Nm and insert the square drive pin in the gearbox.
- 6.10.8.5. Apply a tensile force gradually to the test cable to obtain 30NM after 10 seconds. Maintain the force for 5 seconds. Do the test 10 times.
- 6.10.8.6. Verify that the “pitch” of the Drive Cable remains constant / correct by winding the full length of the Drive Cable through a test Gearbox (10% per batch).
- 6.10.8.7. Record all QC findings on the Examination Record (Appendix 2).
- 6.10.8.8. Serial numbers of all ballpoints in the batch must be recorded by MWS; QC must verify 25% of ballpoint diameters.

## 6.11 Packaging of the Drive Cable

- 6.11.1. Coil the Drive Cable with a diameter of no less than 250mm and use PVC or masking tape to keep it in place. Do not cover the Ballpoint of the Drive Cable with tape as this will hamper easy identification of the Drive Cable.
- 6.11.2. Use Q20 Penetrating Spray and spray into a plastic bag for approximately 3 - 4 seconds to create a lubricated atmosphere inside the bag.
- 6.11.3. Place Drive Cable in the plastic bag, seal and label the outside of the plastic bag accordingly (Figure 53).



Figure 53

# Gammatec NDT Supplies SOC Ltd

<b>Group</b>	<b>Logistics</b>		<b>Drive Cable Assembly and Repair</b>	
<b>Document</b>	<b>Work Instruction</b>			
<b>Document no.</b>	<b>5.1.58.0</b>			
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## 7. RECORDS

Records generated by this Work Instruction are as follows:

<b>Record</b>	<b>Location/Responsible</b>	<b>Retention Period</b>
Production Order	Stores	3 years
Crimping Block Control Sheet	MWS	3 years
Examination Record – Drive Cable	Quality	3 years

## 8. RECORD OF REVISION / RECORD OF CHANGES

<b>RECORD OF CHANGES, REVISIONS AND CANCELLATIONS</b>		
<b>DATE</b>	<b>NATURE / DETAIL OF CHANGE</b>	<b>REV. NO.</b>
15 September 2005	New issue	0
2 April 2013	Revised	1
2 December 2015	Extensively revised	2
13 February 2017	QC Procedure amended to include Crimp Diameter	3
9 January 2018	Crimping plate and ballpoint serial number included	4
1 November 2019	6.3 Blank Drive Cable Length added, other sections revised	5





