

Preventative maintenance on electrosurgical units: how to increase your productivity

If you have ever performed preventive maintenance (PM) on an electrosurgical unit (ESU), you know it requires significant background and proper information to do so. In the past, opting for manufacturers' contracts may have alleviated these concerns. When presented with a problem or failure, you would call for a technician visit or loaner unit. Your ESU was sent for maintenance and later returned repaired and/or fully inspected for a flat-rate cost. ESUs were considered dangerous equipment and regardless of contract cost, only the manufacturer would touch the device. Yearly maintenance contracts were typically proposed by manufacturers.

Since that time, the safety of ESU devices has increased dramatically. During the same period, increased budget restrictions have required careful scrutiny and/or cancellation of expensive maintenance contracts. Most hospitals have purchased newer, safer ESU analyzers and initiated inhouse preventive maintenance for those devices. You now send an ESU for repair only after confirmation of fault or defect.

How does this system work for you today? Do you find preventative maintenance on ESU devices easy to perform? How long does it take for you to perform preventive maintenance on an ESU?

Fluke Biomedical developed the Ansur-automated version of the QA-ES Electrosurgical Analyzer with simplification and productivity in mind. With this system, all measurements are performed and documented within 12 to 15 minutes. A customizable report (shown in Fig. 2) is automatically created at the end of the PM and can be exported in PDF format using any PDF creator software.

Step by step test guide

There are several advantages for a biomedical department to adopt an automation solution. Cumbersome PM procedures for devices with only periodic PM schedules are difficult to remember and necessitate a reliance on service manuals to remember step-by-step details related to the task. Each model has a different procedure, and sometimes one model has different procedures depending of its version. This is a wasteful system.

Ansur test automation allows you to precisely define in a template every step to be performed. Pictures and diagrams can be added to these templates to help you visualize how to do the job, as shown in the example below.





Needed service manual information can be input into the Ansur template so bulky print manuals no longer need to be carried or stored nearby.

Each template can be named for the exact model it refers to. Because Ansur templates are stored in a PC, there is no limit to the number of PM procedures you can automate.

For teams that employ specialized technicians, automated procedures can allow non-specialized technicians with minimum training to successfully perform a PM with ease. These new technicians are guided step by step while the software minimizes risk of human error by applying pre-defined pass/fail criteria.



Test element		Т	est typ e			Fai	
Bipolar Output -Med (S	tandard) 10 W	<i>Pc</i>	wer distribution test				
Test Conditions	•	Results	T	C	TT-L T-L		
Power 10 W	Load	Power	201	Current 210.0mA	Ligh Linu 240		
10 W	100 Onns	9.00	201	510.0mA	349		
ipolar Output - Macro	10W	Pe	ower distribution test				
Test Conditions		Results					
Power	Load	Power	Low Limit	Current	High Limit		
10 W	100 Ohms	10.0W	301	317.0mA	349		
/lonopolar Output Cut 7	75W(Pure)	P	ower distribution test				
Test Conditions		Results					
Power	Load	Power	Low Limit	Current	High Limit		
75 W	300 Ohms	73.0W	536	492.0mA	612		
Ionopolar Output Cut 7	75W (Low cut)	P	ower distribution test				
Test Conditions	· · · ·	Results					
Power	Load	Power	Low Limit	Current	High Limit		
75 W	300 Ohms	73.0W	536	491.0mA	612		
vlonopolar Output Cut ?	75W (Blend)	B	ower distribution test				
Test Conditions		Results					
Power	Load	Power	Low Limit	Current	High Limit		
75 W	300 Ohms	74.0W	536	494.0mA	612		
Monopolar Output Fulg	urate 30W	P	ower distribution test				
Test Conditions		Results					
Power	Load	Power	Low Limit	Current	High Limit		
30 W	500 Ohms	27.0W	256	236.0mA	294		
Monopolar Output Spra	y 30W	P	ower distribution test				
Test Conditions		Results					
Power	Load	Power	Low Limit	Current	High Limit		
30 W	500 Ohms	28.0W	256	238.0mA	294		
H.F. 1eakage test - Mono	opolarmodes	Н	IF. leakage test				
Test Conditions		High Limit	-	Results			
Power	Mode	Act	Neu	Act.1	Neu.1		
300W	Pure	100 mA	100 mA	73.0 mA	69.0 mA		
300W	Low	100 mA	100 mA	41.0 mA	39.0 mA		
200W	Blend	100 mA	100 mA	70.0 mA	67.0 mA		
H.F. leakage test - Bipol	ar modes	Н	IF. leakage test				
Test Conditions		High Limit		Res ults			
Pow er	Mode	Act	Neu.	Act 1	Neu.1		
70W	Precise	60 mA	60 mA	20.0 mA	24.0 mA		
70W	S tand and	60 mA	60 mA	16.0 mA	19.0 mA		
/U W	Macio	00 IIIA	00 IIIA	34.0 Inc.	40.0 mm		

Fig. 2: report example obtained with an Ansur-automated QA-ES

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₹ Vi	isual Inspection	
	Inspecting the Generator, Accessories an	d
	Internal Components	
	Equipment required: • Bipolar footswitch or monopolar footswitch • Bipolar instrument cords (handswitching and footswitching) • Monopolar instrument cords (handswitching and footswitching) Turn off the generator, and disconnect the power cord from the wall rec Rear Panel 1. Check the rear panel footswitch receptacles for obstructions or dama Check for a secure fit by inserting the bipolar footswitch or monopolar footswitch connector into the appropriate receptacle. 2. Remove the fuse and verify correct voltage and current rating. Refer to Section 3, Performance Characteristics. If either connection is loose, replace the footswitch board assembly. Ref Section 7, Footswitch Board Replacement. Front Panel 1. Check the bipolar instrument receptacle for obstructions or damage. bipolar instrument connector (footswitching and handswitching) into the percendition of the provide a correct of the footswitch or damage. bipolar instrument connector (footswitching and handswitching) into the percendition of the provide a correct of the footswitch or damage. bipolar instrument connector (footswitching and handswitching) into the	eptacle.
	A Test results	n Fail
	Bipolar receptacles DK?	
	Monopolar receptacles DK?	
1	Patient Return receptacle OK ?	
	Footswitch receptacles OK ?	
	Power cord OK ?	
	nternal components DK ?	
*	🚱 📀 Next 🕕 🕥 start 🗹 NA 🌯 Skip 🥢 Viser d	efined D

Checklists are easy to create and perform as shown in the opposite view. Diagrams and pictures can be added.

Additional columns such as "Not Applicable" can also be included and can be useful when, for example, an accessory is missing.

The automation software automatically collects the test measurements and checks if they are within the specified limits.

The limits can be set on power, current, voltage peakto-peak, or crest factor. In this example, the limits are set to current.

For power, limits can be set either in % of the nominal power or in absolute values (watts).

If a QA-ES internal footswitch is used, the operator even doesn't have to press the ESU footswitch.

The QA-ES closes a relay when needed, which generates the HF signal and automatically collects the result and stops the generator. With one single click, the measurement is performed, collected, and documented.

User-friendly Ansur test automation secures your work

Click on "Next" to go to the next step or on "Start" again if, for example, you forgot to set the proper mode on the ESU because the phone rang in the middle of your test. The new measurement for this step will overwrite the

monopolar Ou	tput	Sut 75	w (Pure	9		
Step 1 - Check the A. Verify that the generato <i>Generator</i> in this section. B. Connect the test equipm (1) Connect one test cal connect its other end to th (2) Use a test cable to sl (3) Connect the second Return Electrode receptacl (4) The 300 ohm resistor (5) Connect the monopo	Output r successfi nent for mo ble to the le le QA-ES R hort the two test cable f e. r will autom blar footswi use the QA	for the C ully complete mopolar out ft jack in the ed input. o pins on the from the QA- natically be s itch to the M A-ES interna	ext Modes es the self-tes put. Monopolar 1 e Patient Retu ES Black inpu elected. Ionopolar 1 Fr 1 footswitch.	t as describ /CEM Instru m Electrode at to both pi	ed in <i>Testing t</i> ment receptace receptacle. ns of the Patie ceptacle on th	he cle, nt e rear
panel of the generator, OR						
panel of the generator, OR						
panel of the generator, OR Test results Measurement	Power	Crest	Current	Vp-p	High Limit	Low Limi

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previous erroneous one and, this time, the test will pass without having to restart the entire procedure from the beginning.

Testing the REM/ARM function

When it comes to this important function, we recommend using a decade box. Ansur test automation can accurately describe and easily implement this test, as shown below.



Power distribution curve

You may sometimes need to perform a concentrated analysis of your ESU performance. A surgeon may complain about perceived performance differences of a unit, requiring you check if the manufacturer specifications are still fully met. This may also be very helpful when evaluating a new device prior to purchase.

At these times, you will want to draw a power distribution curve showing what power is effectively generated as expected over an extended patient load selection. This data is required by standards (ANSI/AAMI/IEC 60601-2-2: 2006) for loads ranging from 100 Ω to 2000 Ω for all monopolar modes and is provided in the manufacturer's service manual.



Once the test template is created, Ansur test automation automatically captures a power distribution curve in approximately 20 seconds.

There are 128 load selections in the QA-ES, starting at 10 Ω , then from 25 Ω to 2500 Ω by 25 Ω increments and from 2500 Ω to 5200 Ω by 100 Ω increments. Going so high may seem unnecessary, but doing so corresponds to some real-life conditions. For example, when an organ is protected by a glucose solution the resistance becomes very high. You can include any one of these loads in a power distribution test in increasing or decreasing order.

Power output vs. setting

Another requirement from ANSI/AAMI/IEC 60601-2-2: 2006 is to show the power output versus the output control setting at a specified load, usually the nominal value for which the power reaches its maximum.

Despite not being a usual requirement in the manufacturer's preventive maintenance protocols, this is also easily achieved by the automated QA-ES.

As this test requires an adjustment of the ESU power setting for each step, it takes longer than a power distribution test; but when using the



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QA-ES internal footswitch to control the ESU this is still very convenient.

Measuring high frequency leakage current

Measuring high-frequency leakage current is probably standard in your test procedure. This is also conveniently performed with the Ansur-automated QA-ES.

The ability to upload diagrams and customized written instructions allow test visualization and minimized dependence on training resources.

The limits are freely set. For monopolar outputs, you would choose 100 mA, if not using the special table described in the standard. A lower limit is applicable for bipolar outputs (usually 50 mA to 70 mA) but the standard sets a formula based on the maximum power for a given bipolar mode. It should not exceed 1 % of the nominal power converted into current through the measurement resistor. This formula is included in the QA-ES Ansur automation software.

🕅 Checking High Frequency Leakage Current 📃 🗆 🔀								
	 HF Isolated Equipment Active Electrodes Active electrode test setup in compliance with IEC 601.2.2, sec 19.101b, fig 104 and sec. 19.102. (Adopted by ANSII/AAMI HF18-1993). show me OA-ES Eutimp Eutimp Eutimp Eutimp Eutimp Eutimp Black Neutral Electrodes Neutral electrode test setup in compliance with IEC 601.2.2, sec 19.101b, fig 104 and sec. 19.102. 							
	show me							
	8 Test results							
	Measurement Act. 1 Neu. 1 Act. High Neu. High							
	Power=300 Load=200 Mode=Pure 73.0 69.0 100 100 Power=300 Load=200 Mode=Low 41.0 39.0 100 100 Power=200 Load=200 Mode=Blend 70.0 67.0 100 100							
	< Interview of the second seco							

According to the standard, the HF leakage currents are measured through a 200 Ohm load, but Ansur allows the choice of any load when needed to reproduce a real-life problem.

When testing an ESU with HF grounded neutral plate, you will need a second 200 Ohm load. This additional load is integrated into the QA-ES. The diagrams are also available in the test guide.

The order to execute the measurements is optimized so the wiring changes are minimized, again increasing your productivity.



H.F. leakage test - Monopolar modes	
Power: 300W Electrode: Active Electrode: 1 Mode: Pure	FLUKE. Biomedical
 Adjust the ESU to the required specific Generate continuously the H.F. signal (foot switch input) Click Ok to continue, or Cancel to stop Please make the wiring to measure the Hi Active Electrode: 1 to ground 	ations. (DO NOT use the QA-ES the test. F Leakage current from
	OK Cancel

Measuring low frequency leakage current

This is a major difference with other currently-available devices. If you are using one of the electrical safety analyzers listed below, you can include an automatic electrical safety test in the protocol:

- ESA620
- ESA612
- ESA601
- QA-90

This allows you to utilize one single digital document per ESU, including:

- Visual inspection
- REM/ARM function test
- Performance analysis
- HF leakage current
- Low frequency leakage current

Clear instructions appear on the PC screen in large characters while performing the tests describing which electrode, what mode, and what power to set up.

A similar screen appears when measuring a power distribution curve or a power output.

A performance printout can be viewed in the report shown on page 3.



🕅 General setup 🕨 Apply when 📶 Expected results							
Limit	High	Low	Unit	Ор			
User defined							
Body			uА				
Body Float			uА				
Cardiac Float			uА				
🔒 🗏 IEC 60601							
Body Float	5000		uА				
Cardiac Float	50		uА				

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The document can then be linked to your CMMS system, a process that can also be automated with the Ansur-automated QA-ES. The automated QA-ES gathers equipment data from the CMMS to document device under test (DUT) information and selects the correct test protocol to be used; after the test is performed, it automatically creates a link between the results and the equipment.

Standards performed						
Test passed						
ICSI passed						
05/12/2/08 14:19:51				_		
est setup Test template Result data						
to dement	Status	Value	High limit	Low limit	Unit	Flace
Visual Instantion	Test caused	1000		2011 810	0.101	
The second sector of the Construction and lateral Constructs	Testaneed					
Disels associates (20)	Tex parted	0				
Bipolar receptacies UK.7 Mananalis securitacies OK2		Pass				
Reinight Bakers under 04.2		Pass				
Fortunated in constantiate DK 2		Pare				
Poster conf OE 2		Parr				
Internal concentrate DK 2		Pass				
Testing the Generator	Test passed	1.000				
All virual infrators and direlase on the foot name iteminate	100-900000	Parr				
Activation tories sound to verify that the speaker is working respeky		Pass				
Indicators above the default mode buttons (Standard bipolar, Pure out, and Fulcauste coad) illuminate green		Paul				
Each display shows a power setting of one watt		Pass				
The REM Alam indicator illuminates red		Pass				
Verbying REM Function	Test passed					
Wething BIM Exercise	Test cased					
1. Set the emistance solution how to 120 obes. Connect the assistance how to the generator and confere that the BE	EM .	-				
 Sector Barringhas graves. 		Pass				
2. Slowly increase the resistance and verify that the REM alarm sounds at 135 ± 5 ohms.		Pass				
Decrease the resistance to 60 ohms and verify that the REM indicator illuminates green.		Pass				
Increase the resistance to 100 ohms and verify that the REM alarm sounds.		Pass				
5. Decrease the resistance to 30 ohms and verify that the REM indicator illuminates green.		Pass				
Decrease the resistance to 10 ohms and verify that the REM indicator illuminates green.		Pass				
Decrease the resistance to 3 ohms and verify that the REM alarm sounds.		Pass				
B. Switch to a connector without the pin, and increase the resistance from 3 to 24 ohms. Verily that the REM alarm sources	nds.	Pass				
Confirming Dutputs	Test passed					
Bipolar Output -Med (Standard) 10W	Test passed	310.0	339.0	291.0	mA	
Excel Bipolar Output - Macro 10W	Test passed	317.0	339.0	291.0	mA.	
Taby Monopolar Output Cut 79W (Pure)	Test passed	492.0	537.0	451.0	mA	
Monopolar Butput Cut 75W (Low cut)	Test passed	491.0	537.0	461.0	mA	
FEED Memorylan Dubred Cut 2500 (Blown)	Test caused	494.0	537.0	451.0	má	
New York Control Federate 2014	Test caused	236.0	264.0	226.0		
First Memory (a read Server 2017)	Test onced	229.0	264.0	226.0		
Checking Mich Exercises Lask and Current	Test second	2.00.0	204.0	660.0	1100	
Checking High Frequency Leakage Current	Tex passed					
Internet H.F. leakage test - Monopolar modes	Test passed					
Power=300 Load=200 Mode=Pure Act 1		73.0	100.0		mA	
Power-source-counted-c		41.0	100.0		mes.	
Power-dou Load-200 Mode-Biend Act. I		70.0	100.0		me.	
Power+300 Loads-200 Modes/ ov Nex 1		29.0	100.0		me.	
Provenue2001.coadu/200.Modes/Rievel Neur 1		62.0	100.0		mA.	
T STREET AND ADDREET AND FRANCES IN THE I	Test caused	67.0	100.0		me.	
Douge 201 and 200 Mode Durine Act 1	141.941100	20.0	60.0			
Property 201 April 200 Model Standard Let 1		16.0	60.0		me.	
Pourer 201 parts 200 Morte Marco Act 1		34.0	60.0		má	
Power=70 Load=200 Mode=Placine Neu 1		24.0	60.0		mA	
Powerv/70 Loads/200 Modes/Standard Neu 1		19.0	60.0		mA	
		13.0	00.0		-	

Preventive procedures on popular ESUs

We performed the recommended manufacturer's Preventive Maintenance procedures on several popular ESUs both in the USA and Europe using the Ansur-automated QA-ES and obtained "PASSED" reports.

Can you measure the output peak-to-peak voltage?

When using a current transformer, the RF signal is converted into a low voltage in order to be measured; but this voltage is an image of the current, not the HF output voltage generated by the ESU. The QA-ES measures the peak-to-peak voltage directly. This is useful when troubleshooting an ESU.

Some ESUs require a voltage measurement at low frequency, which cannot be accomplished with a current transformer. Such coils have a low-end frequency response at about 40 kHz. The QA-ES can handle this measurement.



Summary

The Ansur-automated QA-ES streamlines ESU preventive maintenance and allows you to gain productivity while increasing quality of work by:

- 128 non-inductive loads included in the unit
- Additional 200 Ω load integrated in the unit for HF grounded ESUs
- Step-by-step test guide including picture, diagram, and hyperlink capabilities to minimize the human-error risk
- Reproducible procedures including:
 - Checklists and user messages
 - o Output power, current, peak-to-peak voltage, or crest factor measurements
 - o Power distribution curves are automatically drawn
 - o Output power vs. setting curves are automatically drawn
 - Optimized HF leakage currents sequence to minimize the wiring changes
 - Low frequency leakage currents can be included when using an automationcompatible electrical safety analyzer
 - Measurements are automatically captured and compared to the specified limits to eliminate human error
- All the above are included in one single electronic file and easily converted into a .pdf document using on-the-shelf software
- The internal QA-ES footswitch allows controlling the HF generation (start and stop)
- Automatically generates comprehensive reports, including curves
- CMMS interface is available and automatable
- HF output peak-to-peak voltages are measured