

Richard K. Struckmeyer
Office of Nuclear Material Safety & Safeguards
Materials Safety Licensing Branch
United States Nuclear Regulatory Commission
11545 Rockville Pike
Rockville MD 20852

7 November, 2014

Re: e2v Inc License 31-23630-02E License Renewal Report / NRC Response

Dear Mr. Struckmeyer:

I acknowledge receipt of your letter dated 11/3/14 which was in response to submission of our License Renewal Report dated 10/23/14.

I was confident that all the information I had supplied in the report should have satisfied all the requirements stipulated by the regulations in 10 CFR 32.14 & 10 CFR 32.15 for the Renewal of the License. I believe I had included the latest documents (wherever possible – however, please note that we do not refresh our documents if there are no changes in the product). I am enclosing another copy for reference purposes.

In your letter, you mentioned License # 20-23630-01E, which is not our e2v License #. Our License # is 31-23630-02E. In your letter you also listed it as 31-23630-01E. Could these have any bearing on confusing our renewal application with someone else?

Nevertheless, since our previous License was set up 10 years ago, it would make sense that some of the documents might be out of date. I will review all the details and endeavor to provide a new document that will include the latest information or cross-reference to previously submitted information (in case, no changes have been made).

I look forward to your response. Thank you for your assistance in this matter

Sincerely,



Dominic Piarulli
Radiation Safety Officer

e2v General Terms and Conditions of Sale

1. **General**
 - a. The sale or provision of all goods and any related services ("Products") by an e2v Group company ("e2v") (the specific company will be designated on the Quotation) to the Customer shall be subject to these terms and conditions and the written quotation ("Quotation") (together these terms and conditions and the Quotation form the "Contract") all of which shall prevail over and apply in precedence to any other document, term or condition. These terms and conditions form a part of all Quotations for Products issued by e2v, and any Customer's issuance of a Contract is expressly limited to acceptance of these terms and conditions; any other additional or differing terms and conditions proposed by the Customer in any Contract issued for Products or other contractual vehicle issued by Customer shall be deemed proposals for modification of these terms and conditions, but shall be deemed objected to and of no effect unless expressly agreed-to in writing by an authorized representative of e2v. No Contract shall come into existence unless and until a written acknowledgement of order is issued by e2v. Where there is conflict between any provisions of these terms and conditions and a Quotation, the provisions in the Quotation shall prevail.
 - b. Products are only available and prices are only valid as stated in a Quotation. Unless otherwise stated, a Quotation is valid for 30 (thirty) days from the date of the Quotation unless it is withdrawn or extended in writing; notwithstanding the foregoing, e2v shall have the right, at any time, increase the price of any Product with respect to which e2v's cost of raw materials and purchased components included in the Product increases by 5% or more. Any such price increase shall become effective upon written notice to the Customer accompanied by a certificate from e2v confirming that such costs have increased by 5% or more.
 - c. In the event that the Customer requests amendments to the description of Products in the Quotation issued by e2v, such requested amendments shall only be accepted if e2v, in e2v's sole discretion, provides the Customer an order acknowledgement endorsed "Amended". The quantity, quality and description of the Products shall be as set out in the Quotation or Amended Quotation, if any, issued by e2v.
 - d. If any provision of the Contract is held by a court or other competent authority to be invalid or unenforceable in whole or in part the validity of the other provisions of the Contract and the remainder of the provision in question shall not be affected.
 - e. No waiver by e2v of any breach of the Contract by the Customer shall be considered as a waiver of any subsequent breach of the same or any other provision.
2. **Payment**
 - a. Payment shall be in the currency specified in the Quotation and, unless otherwise agreed, shall be due and payable in full in cleared funds within 30 (thirty) days of the date of the invoice. The invoice shall be sent on the date of delivery of the Products (or, if the Products are services, upon commencement of those services), or, if e2v is unable to reasoner of instructions or lack of instructions from the Customer to deliver the Products, e2v shall invoice the Customer upon the intended date of delivery. Upon subsequent delivery of the delayed Products, e2v shall invoice the Customer for storage in accordance with Clause 3c.
 - b. If e2v at any time determines, in its sole and absolute discretion, that the Customer is not financially sound or responsible or may be unable to pay, in full and in a timely manner, all amounts due to e2v, e2v shall have the right to require payment in full, in cleared funds, before delivery of any Product, without liability to e2v and without prejudice to any other rights e2v may have.
 - c. In the event the Customer orders other quantities of Products with associated price breaks and fails to take these quantities within the agreed timescales for delivery then e2v reserves the right to amend the prices according to the actual quantity of Products delivered to the Customer.
 - d. The Customer is not entitled to withhold, set off or counterclaim any sums due under invoices received from e2v.
 - e. The Customer must raise any dispute relating to an invoice within 15 (fifteen) days of the date of invoice. If the Customer's dispute is held valid, e2v shall credit the Customer the disputed amount.
 - f. If the Customer fails to pay any sum due to e2v by its due date, the Customer shall pay to e2v, in addition to such sum or sums due, interest thereon at the prevailing Statutory rate for interest on late payment, calculated on a daily basis together with any additional costs and expenses incurred by e2v and e2v may at its sole discretion and without liability postpone delivery or cancel all or part of the Contract or any other contract between the Customer and e2v without prejudice to any other right or remedy which e2v may have against the Customer in respect of such default. Where in accordance with Clause 17 below, the Contract is governed by French law, the Statutory interest rate shall be understood as the main refinancing rate of the European Central Bank increased by 10%, and interest shall be payable automatically, without request by e2v. The Customer shall indemnify e2v against all costs and expenses (including any legal costs and expenses on a full indemnity basis) incurred by e2v in recovering sums due from the Customer or exercising its rights pursuant to Clause 5a.
 - g. All payments due under the Contract are expressed free of all taxes, duties and charges of whatsoever nature. In the event any such taxes, duties and charges are levied on e2v the price of the Products shall be increased by an amount equivalent to such taxes, duties and charges.
 - h. Time of payment shall be of the essence of any Contract.
 - i. If payments received from the Customer are not stated to a particular invoice e2v may apply such payments to any outstanding invoice.
3. **Delivery and Transfer of Risk of Loss**
 - a. The times, places and terms of delivery are as specified in the Quotation. Delivery shall be EXWorks e2v site Incoterms 2010, unless otherwise specified. Quoted delivery times shall be regarded as estimates and time is not of the essence in relation to them. e2v may ship and deliver the Products in instalments and no partial shipment or delivery shall constitute a breach by e2v. Risk against loss or damage to all or any of the Products shall transfer from e2v to the Customer upon delivery in accordance with the specified Incoterm.
 - b. Delivery will be subject to receipt by e2v of any necessary export licences, documentation or requirements. In the event these cannot be obtained by e2v, e2v will be entitled to terminate the order with immediate effect without any liability.
 - c. If the Customer fails to take delivery of the Products or any part thereof on the due date or fails to provide instructions or documents required to enable the Products to be delivered on the due date, e2v may, on giving written notice to the Customer, store or arrange for the storage of the Products, and on the service of such notice: (i) risk in the Products shall pass to the Customer; (ii) the delivery of the Products shall be deemed to have taken place; and (iii) the Customer shall pay to e2v all costs and expenses including storage and insurance charges arising from their failure.
4. **Inspection and Acceptance**
 - a. The Customer shall inspect the Products upon delivery and may reject any Products that do not conform to the Contract, provided written notification of such rejection is submitted to e2v, within 15 (fifteen) days of delivery. Products not notified as rejected within 15 (fifteen) days of delivery will be deemed to be accepted.
5. **Transfer of Title**
 - a. Title in Products will transfer from e2v to the Customer only upon receipt by e2v of payment in full in cleared funds for the Products, except for e2v shipments from, to or within the United States in which title for products will transfer at shipping point. e2v will be entitled to recover payment of the Products notwithstanding that title in any of the Products has not passed from e2v.
 - b. Until such time as the title in the Products passes to the Customer: (i) the Customer must not destroy, deface or obscure any identifying mark or packaging on or relating to the Products and must maintain the Products in a satisfactory condition insured for the benefit of e2v for their full price against all risks; and (ii) e2v may, without prejudice to any other rights or remedies available to it, repossess any or all of the Products. For the purpose of so taking possession, the Customer hereby grants e2v irrevocable authority without notice to enter the Customer's premises for the purpose of collecting and removing the Products.
6. **Warranty**
 - a. e2v warrants the Products in accordance with the conditions of e2v Standard Warranty Leaflet (ref no. 11555A). All other warranties are excluded to the extent permitted by law.
 - b. The Customer warrants that it will be responsible for (and will finance the costs of) the collection, treatment, recovery and environmentally sound disposal of all product waste at its end-of-life for any product supplied by e2v, in accordance with all applicable legislation.
7. **Limitation of Liability**
 - a. Subject to Clause 7(c), e2v shall not be liable to the Customer by reason of any breach of contract or of statutory duty or by reason of tort (including, but not limited to, negligence of any degree) for any loss of profit, loss of revenue, loss of use, loss of production or opportunity, loss of contracts or for any financial or economic loss or for any consequential, incidental or indirect loss, howsoever arising, that may be suffered by the Customer or by any third party.
 - b. Subject to Clause 7(c), in no event shall e2v's total liability under or in connection with the Contract exceed 15% of the Contract price, in full and final settlement of all Customer claims arising hereunder, and the Customer and e2v expressly agree that this limitation is an adequate remedy in any such case.
 - c. No provision of the Contract shall limit or exclude the liability of e2v for death or personal injury caused by negligence, for any matter which it would be illegal for e2v to exclude or to attempt to exclude its liability or for its fraudulent misrepresentation.
8. **Modifications**
 - a. e2v reserves the right, without notice to or consent by the Customer, to make minor modifications to Product specifications, design or materials as e2v deems necessary. No alteration or modification to a Product which affects the price to be paid or time of delivery shall be made without the prior agreement of the Customer, which shall not be unreasonably withheld.
9. **Assignment**
 - a. The Customer shall not, without e2v's prior written consent, assign or pass any of its rights or obligations under the Contract to any other person or company, including whether in connection with any change of control, the sale, transfer, merger, assignment or other reorganization affecting Customer to any degree or all (or substantially all) of Customer's assets or capital stock, whether by way of merger, sale, consolidation, or otherwise. Any attempted assignment in violation of this provision shall be void, and shall be considered as a breach of Contract by Customer subject to the provisions of Clause 14a. e2v may assign any of its rights and obligations under the Contract.
10. **Force Majeure and Extension of Time**
 - a. e2v shall not be liable for any failure to perform its obligations that are due to any circumstances beyond its reasonable control ("Force Majeure Event") including, without limitation, acts of God, governmental actions, war or national emergency, acts of terrorism, protests, riot, civil commotion, fire, explosion, flood, epidemic, lock-outs, strikes or other labour disputes (whether or not relating to either party's workforce), or restraints or delays affecting carriers or inability or delay in obtaining supplies of adequate or suitable materials, or any inability to obtain any necessary import or export licences or other consents of any government. If any Force Majeure Event occurs e2v shall automatically be entitled to an extension of time for such period as is necessary to perform its obligations under the Contract and the Customer shall have no claims whatever against e2v in respect of such delay in performance.
11. **Confidential Information**
 - a. The Customer agrees that it has not provided e2v with any confidential information and that e2v has no confidentiality obligation to the Customer. No obligations of confidentiality will be accepted by e2v other than in pursuance of a formal written agreement.
 - b. The Customer shall keep confidential all confidential information provided to the Customer by e2v.
12. **Intellectual Property**
 - a. All intellectual property rights (including patent and design rights) relating to Products or parts thereof supplied by e2v shall remain e2v's absolute property. The Customer shall not reproduce or disclose e2v's designs, drawings, specifications or information to any third party or copy or reverse engineer (or cause or enable any third party to copy or reverse engineer) any of the Products.
13. **Indemnity**
 - a. e2v will indemnify the Customer against any claim by third parties that the ordinary use or sale of the Products or part thereof supplied by e2v to the Customer infringes the intellectual property rights of the third party, and against all reasonable costs and damages which the Customer incurs in any resultant action, provided always that this indemnity shall not apply to any infringement:
 - (i) which is due to e2v having followed a design or instruction furnished or given by the Customer, or to the use of the Products or part thereof in a manner or for a purpose or in a country not specified or disclosed to e2v, or
 - (ii) which is due to the use of the Products or parts thereof together with or in combination with any other article, material or apparatus, or
 - (iii) where e2v procures for the Customer the right to continue to use the Products or parts thereof or e2v has modified or replaced the Products or parts thereof.
 - b. The indemnity in Clause 13a is conditional upon:
 - (i) the Customer giving to e2v the earliest possible notice in writing of any claim being made or action being threatened or brought against the Customer;
 - (ii) the Customer permitting e2v at its own expense to conduct any litigation that may ensue and/or all negotiations for a settlement of a claim; and
 - (iii) the Customer not making any admission which is or may be prejudicial to e2v.
 - c. The indemnity in Clause 13a is given in lieu of any or all liabilities which e2v might otherwise have in relation to any infringement or alleged infringement of any patent or other right.
 - d. The Customer shall indemnify e2v regarding the use of designs or instructions furnished by the Customer to the same extent as e2v's indemnity in Clause 13a above.
14. **Termination**
 - a. For cause: If (i) the Customer commits any breach of its obligations; or makes any arrangement with its creditors or any other arrangement or situation which has a like effect including without limitation a change of company control, commits any act of bankruptcy or becomes insolvent; or (ii) e2v has reasonable grounds to suspect the Customer has violated any applicable law or regulation, including, but not limited to the UK Bribery Act; then in e2v's sole discretion it may, without any liability, terminate, cancel or suspend its performance of the Contract or any other contract between the Customer and e2v immediately, or postpone delivery of all or any part of the Products or all or any part of any other order placed by the Customer with e2v. e2v also may terminate the Contract, upon written notice to the Customer, if e2v suffers any Force Majeure Event. In the event of a termination, it shall be treated as a Customer termination for convenience and the parties shall proceed in accordance with Clause 14c, except that e2v shall retain any and all additional rights and remedies available under the Contract and at law which may include indemnification for liabilities incurred by e2v arising from the Customer's act or omission.
 - b. For e2v's Convenience: e2v may terminate any Contract on giving 90 (ninety) day's notice to the Customer, and Customer shall remain liable for payment of: (i) the Contract price for all Product delivered to Customer prior to such termination and the actual cost incurred by e2v, plus a mark-up of 12 percent (12%) of such cost, for partially completed Products and associated work-in-process which, upon payment, shall be delivered to Customer.
 - c. For Customer's Convenience: The Customer may cancel or terminate the Contract only with the prior written consent of e2v and only upon such terms as e2v, in its sole and absolute discretion, may agree. In the event of termination within 30 (thirty) days prior to the acknowledged delivery date the Customer will be liable to e2v for the full Contract value terminated. In the event of termination outside one month but within 60 (sixty) days prior to the acknowledged delivery date the Customer's liability will be the higher of, (i) the costs incurred by e2v, including those incurred as a result of the termination, or (ii) 50% of the Contract price for the terminated Products. In the event of termination outside 60 (sixty) days prior to the acknowledged delivery date the Customer will be liable for all the costs incurred by e2v as a result of the termination, including the work in process for all Products not previously accepted by Customer (Customer shall remain liable for the full Contract price of all Product delivered prior to Termination).
 - d. For e2v default: e2v shall be liable for the Customer's reasonable and demonstrable excess procurement costs up to the maximum liability detailed in Clause 7b for the terminated portion of the Contract, in full and final settlement of all claims arising hereunder. All other remedies by law are hereby expressly excluded.
 - e. e2v may exercise any of the rights herein without any liability and without prejudice to any other right or remedy to which e2v may be entitled by operation of law or otherwise, including without limitation the right to recover e2v's costs with respect to work in progress and incidental costs. In addition, if any Force Majeure Event occurs and e2v terminates the Contract, e2v shall be entitled to retain any deposit or other amount paid by the Customer as of the date on which notice of such termination is provided, it being the express intent of e2v and the Customer that the Customer shall bear the risk of loss of its deposit or other amounts paid to e2v prior to delivery as a result of any Force Majeure Event.
15. **Amendments**
 - a. All changes, modifications and amendments to the Contract must be agreed by the parties in writing. In the event that Customer representatives provide any direction, guidance or advice of any nature that e2v deems to constitute a change to the requirements of the Contract, e2v shall notify the Customer and a written modification shall be made to the Contract prior to e2v having any obligation to proceed.
16. **Interpretation**
 - a. In the event of a conflict between the English version of these terms and conditions and any other language version, the English version shall prevail.
17. **Law and Jurisdiction;**
 - a. The Contract shall in all respects be governed and construed in accordance with the following laws:
 - a. When concluded with e2v group companies in California - the laws of that state, excluding its conflicts of laws provisions. Any unresolved disputes shall be finally settled under the international arbitration rules of the American Arbitration Association. The seat of arbitration shall be Santa Clara, California, USA.
 - b. When concluded with e2v group companies in all other states of the USA and Canada - the laws of the State of New York, USA, excluding its conflicts of laws provisions. Any unresolved disputes shall be finally settled under the international arbitration rules of the American Arbitration Association. The seat of arbitration shall be New York, New York, USA.
 - c. When concluded with e2v group companies in France - the Laws of France and subject to the exclusive jurisdiction of the French courts unless it is otherwise agreed between the parties that any unresolved disputes between them shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce. The seat of arbitration shall be Paris, France.
 - d. When concluded with all other e2v group companies - the laws of England and Wales and subject to the exclusive jurisdiction of the English courts unless it is otherwise agreed between the parties that any unresolved disputes between them shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce. The seat of arbitration shall be London, England.



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 3, 2014

E2V INC.
ATTN: Dominic Piarulli
Radiation Safety Officer
520 White Plains Road, Suite 450
Tarrytown, NY 10591

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION

Dear Mr. Piarulli:

This refers to your license renewal application request dated October 23, 2014, (Agencywide Documents Access and Management System (ADAMS) No. ML14300A136) for Nuclear Regulatory Commission (NRC) exempt-distribution license number 20-23630-01E. Item 13 of your existing license lists documents that are mostly more than ten years old. The intention of this letter is to request that you provide an up-to-date document that contains all of the information required by the regulations in Title 10, Code of Federal Regulations, Part 32 (10 CFR 32), sections 32.14 and 32.15. It is acceptable to reuse previously submitted documents as long as they are provided as attachments to a new document describing your current program. The new document should provide the answers to each of the questions in the enclosure to this letter, either as a statement within the new document itself, or by referring to an attached, previously-submitted document.

We will continue our review upon receipt of this information. If we do not receive your reply within 30 calendar days from the date of this letter, we will consider your application as having been abandoned by you. This action would be without prejudice to the resubmission of another application with the required information.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>.

Any correspondence regarding this renewal application should reference control number 585131.

D. Piarulli

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If you have any questions, please feel free to contact me at (301) 415-5477 or by electronic mail: Richard.Struckmeyer@nrc.gov.

Sincerely,

A handwritten signature in cursive script, reading "Richard K. Struckmeyer".

Richard K. Struckmeyer
Materials Safety Licensing Branch
Division of Material Safety, States, Tribal,
and Rulemaking Programs
Office of Nuclear Material Safety
and Safeguards
Washington, DC 20555

Docket No.: 030-32837
License No.: 31-23630-01E

Enclosure: As Stated

Enclosure

Information Needed for Renewal of E2V Inc. Exempt-Distribution License No. 20-23630-01E

1. Please provide details of chemical and physical form of, and maximum quantity in each product, as required by 10 CFR 32.14(b)(1).
2. Please provide details of construction and design of each product, as required by 10 CFR 32.14(b)(2).
3. Please provide the method of containment or binding of the radioactive byproduct material in the product, as required by 10 CFR 32.14(b)(3).
4. Please provide the radiation level and method of measurement for each product for which limits on levels of radiation are specified in 10 CFR 30.15. 10 CFR 30.15(a)(8) states that the levels of radiation from each electron tube containing byproduct material do not exceed 1 millirad per hour at 1 centimeter from any surface when measured through 7 milligrams per square centimeter of absorber.
5. Please describe the proposed method of labeling or marking each unit and its container with the identification of the manufacturer or initial transferor and the byproduct material in the product, as required by 10 CFR 32.14(b)(6) and 32.15(d)(1).
6. As stated in 10 CFR 32.14(c), each product will contain no more than the quantity of byproduct material specified for that product in 10 CFR 30.15. Please provide the quantity of byproduct material specified for your product.
7. Please describe how the byproduct material is properly contained in the product under the most severe conditions that are likely to be encountered in normal use and handling, as required by 10 CFR 32.14(d).
8. As stated in 10 CFR 32.15(a)(1), each person licensed under 10 CFR 32.14 shall maintain quality assurance practices in the manufacture of the part or product, or the installation of the part into the product. Please describe your quality assurance practices in the manufacture of the part or product, or the installation of the part into the product.
9. As stated in 10 CFR 32.15(a)(3), each person licensed under 10 CFR 32.14 shall visually inspect each unit in inspection lots. Any unit that has an observable physical defect that could affect containment of the byproduct material shall be considered as a defective unit. Please describe how you shall visually inspect each unit in inspection lots for defects.
10. As stated in 10 CFR 32.15(b), no person licensed under section 32.14 shall transfer to other persons for use under 10 CFR 30.15 or equivalent regulations of an Agreement State any defective part or product. Please describe how you shall prevent transfer to other persons for use under 10 CFR 30.15 or equivalent regulations of an Agreement State any defective part or product.

520 White Plains Rd., Suite 450, Tarrytown, New York 10591
T (914) 592-6050 F (914) 592-5148 e2v-us.com

e2v

October 23, 2014

Office of Nuclear Material Safety & Safeguards
Attn: Materials Safety Licensing Branch
United States Nuclear Regulatory Commission
11545 Rockville Pike
Rockville MD 20852

Re: e2v Inc. License 31-23630-02E, License Renewal

As a result of thorough review for Sealed Sources and Devices of Exempt Products handled by e2v Inc. namely electron tubes containing byproduct materials of a maximum of 150uCi of Tritium, we submit our License Renewal Report per 10 CFR 32.14.

If you any questions you may contact our office at your earliest convenience.

Best Regards,



Dominic Piarulli
Radiation Safety Officer, e2v Inc. NY

Procedure for the Receipt and Distribution of Sealed Sources & Devices for Distribution as Exempt Products

Overview:

Sealed Sources / Devices containing By-Product Materials are shipped from the manufacturer in England to E2V, Inc. c/o CoPhysics Corporation located at 1 Commercial Drive, Florida NY. E2V's New York State Department of Health Radioactive Materials License (C2554), E2V's USNRC exempt distribution license 31-23630-02E, and CoPhysics' NYSDOH Radioactive Materials License (C2691), all apply to this site.

E2V, Inc. has contracted with CoPhysics as its service provider for the receipt and distribution of sealed source and devices containing By-Product Materials. E2V Ltd, located in Chelmsford, England, manufactures the electron tubes for distribution, for which E2V, Inc. receives these devices for further distribution to US-based customers.

Under the guidance of NRC's guide 6.9 "QA Program for the Manufacture and Distribution of Sealed Sources & Devices Containing By-Product Materials" and within the NRC Regulations (10CFR); Chapter 32; Section 15 "Quality assurance, prohibition of transfer, and labeling", we have developed this distribution program.

Sealed Source Description:

2-Wire Electron Tubes, also known as spark gaps, contain a maximum of 150 μCi of Tritium (H-3) in the form of elemental gas. These devices are described within the NRC Regulations (10CFR); Chapter 30; Section 15: "Certain items containing byproduct materials".

When shipped, these devices are packaged in serialized groups of no more than 25 devices per packaging carton. The maximum Tritium content in a carton is 3.75 mCi. Several cartons may be overpacked into larger boxes for more efficient shipping.

Contamination Test Action Levels

For purposes of this procedure, the action levels are:

- Package Wipe Test Investigation Level: 100 DPM / cm²
- Packing Materials Release Limit: 1000 DPM / cm²
- Device Leak Test Investigation Level: 100 DPM / cm²
- Device Leak Test Rejection Level: 1000 DPM / cm²

Wipe and leak tests will be analyzed via Liquid Scintillation Counter per CoPhysics' Standard Operating Procedures.

Procedure for Receipt of Devices at CoPhysics

For those devices received by CoPhysics from the E2V, Ltd. manufacturing facility in the UK, CoPhysics personnel will perform an initial inspection of the carton(s) received, checking for any damage sustained during transport. Initial inspection will be noted on the E2V Package Receipt, Shipping, and Inventory Log under column header "Is Package Damaged".

Each received carton will then be wipe-tested per the standard procedure for performing a package wipe test.

Should the results of the wipe test conclude that no radioactive contamination is present (i.e., less than the Investigation Level), no leak tests will be required for the individual devices contained within the shipping carton. In addition, we will:

1. Proceed to verify that the contents agree with that listed on the packing slip and label of the carton – all three items should coincide.
2. Visually inspect the contents for breakage of seals, vials, or discoloration of packaging materials.

Should the results of the package wipe test conclude that there is radioactive contamination above the Investigation Level, we will:

1. Perform a leak test on all individual spark gap tubes in the shipping carton and take precautions to avoid spreading the contamination.
2. The package material and carton(s) will be monitored for contamination before discarding.
 - If contaminated above the Release Limit, the affected materials will be disposed of as radioactive waste in CoPhysics' normal laboratory radioactive waste container.
 - If not contaminated, the package materials will be de-labeled before discarding into the regular trash.

We will maintain records of the results from checking each incoming package using the "Radioactive Shipment Receipt Record" or similar form containing the same information. Damaged units will be returned to the manufacture.

Procedure for Shipments from CoPhysics to Customers

An E2V Inc. Delivery Note is sent to CoPhysics via email specifying the number, type and serial numbers of devices to be shipped to a Customer. After the carton(s) are prepared for shipment, a wipe test will be performed on the exterior of each carton prior to carrier pickup.

Should the results of the wipe test conclude no contamination above the investigation level, the shipment is processed.

Should the results of the wipe test indicate a contamination level greater than the investigation level, the shipment will be cancelled and the entire contents of the package will be leak tested to identify the Spark Gap devices that are leaking. Damaged units will be returned to the manufacture.

E2V Inc. Exempt Distribution Annual Transfer
Report for 2013 Reporting Period.


E2V Inc.
520 White Plains Rd. Suite 450
Tarrytown N.Y. 10591

License No. 31-23630-02E

The following items were transferred under 10 CFR 30.15 or equivalent
Agreement State regulations: (See attached spreadsheet)

If you have any questions please contact me at 914 593 6828 or
dominic.piarulli@e2v-inc.com

Best Regards,
Dominic Piarulli



Communications Products Technician / RSO
E2V Inc. NY

<u>E2V Model#</u>	<u>Description:</u>	<u>Radionuclide Contained Per Device:</u>	<u>Number of Units Transferred in 2013 Period:</u>
GAH25UL	2 Electrode Spark Gap	Tritium (3H), 0.11 MBq (3uCi) max	46
GAH31UL	2 Electrode Spark Gap	Tritium (3H), 0.11 MBq (3uCi) max	107
GXH18LFC	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	1
GXH20LFC	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	630
GXH28	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	4
GXH40	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	99
GXH50	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	21
GXH70	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	14
GXH60	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	1
GXH85	2 Electrode Spark Gap	Tritium (3H), 5.44 MBq (147uCi) max	101

Per the next 3 pages, please see copies of an actual e2v Inc. Delivery Note and actual corresponding Test Report from Co -Physics.

Delivery Note

In one 12/28/2013



Waterhouse Lane Chelmsford Essex CM1 2QU United Kingdom
 T +44 (0)1245 493 493 F +44 (0)1245 492 492 e2v.com


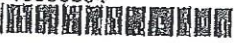



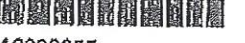


Shipping Address
 COPHYSICS
 1 COMMERCIAL DRIVE
 FLORIDA NY 10921
 USA

Information
Delivery Note Number 187136199

Delivery Note Date 18.12.2013
Purchase Order No. 4500207680

Our Order Number 33099789
Customer Number 52888
Incoterms EXW
 Chelmsford
Shipping Agent
Gross Weight 5.420 KG
Net Weight 3.700 KG
No of Packages 1

Invoice Address
 E2V TECHNOLOGIES INC
 520 WHITE PLAINS ROAD
 SUITE 450
 TARRYTOWN NY 10591
 USA

Item	Material/Description	Quantity	Weight
FedEx IPD Shipment Collected by FedEx on : 18.12.2013 FedEx Waybill No. : Details to Follow			
10	GXH20LFC  2 Electrode Spark Gap Commodity code: 8535301000 App. Switch/prot. HV Country of origin: GB Data Sheet: A1A-GXH_SER, Issue: 9, Date: May 2003 Serial numbers: 13380034  13390051  13390052  13390053  13390054  13390055  13390056  13390057	100 EA	3.700 KG

We cannot accept responsibility for damage occurring in transit or for non-delivery unless reported to the carriers and to us in writing within three days of receipt in the event of damage or 28 days from the date of despatch in the event of non-delivery. All returns must be advised quoting delivery note & date.

e2v General Terms and Conditions of Sale shall apply to this order (copy available on request).

Alpha Beta H-3 C-14

PROTOCOL : 10 Customer Samples
DATE : 2013/12/27
TIME : 13:08
ID : P10AS241

Wallac 1400 DSA ver 2.3 S/N 4150043

Counting mode : DPM
Quench index : SQP(E)
Isotope(s) : H3,C14,I125

H3 = ,12.43 y
C14 = ,5730.00 y
I125 = ,60.00 d

Protocol name : Customer Samples
Counting time : 180
Repeats : 0
Cycles : 1
Replicates : 1
2 sigma % : 0.01
Minimum cpm : 0.00 Checking time: 10
Sp. library of isotope H3 : Wallac
Sp. library of isotope C14 : Wallac
Sp. library of isotope I125 : Wallac
Vial type : Diffuse
Liquid system : HiSafe
Advanced modes : Chemlum,PAC,PSA
PSA level : 50
PAC level : 100

Output to Display :
POS,RACKPOS,CTIME,SQPE,SQPEer,PSALEVEL,
PACLEVEL,CPMw1,CPMw2,CPMw6,DPM1,CPM1,
EFF1,DPM2,CPM2,EFF2,DPM3,CPM3,EFF3,CPM
Additions to Display : Spectrum,Listing
Spectrum : PACRej,PACRej,Rnd.Cos,Alpha,Beta
Window 1 : 1-1024 /Alpha
Window 2 : 1-1024 /Beta
Window 3 : 1-1024 /Rnd.Cos
Window 4 : 1-1024 /PACRej
Window 5 : 1-1024 /PACRej
Window 6 : 400- 800 /Alpha
FNCT1 = Type : Wipe Test
FNCT2 = LSC : Walla 1415 S#4150043
FNCT3 = CalDate : Calibration Date 4/12/13
FNCT4 = Limits : InvesLev 100 dpm, DOT 6600 dpm

Total activity:

H3	6224.2 DPM	0.104 kBq
C14	10.2 DPM	0.000 kBq
I125	21.9 DPM	0.000 kBq

PO	C	PSALEVEL	SQPE	Alpha CPMW1	Beta CPMW2	H-3 DPM1	C-14 DPMER1	DPM2	DPMER2
----	---	----------	------	----------------	---------------	-------------	----------------	------	--------

PO	C	PSALEVEL	SQPE	CPMW1	CPMW2	DPM1	DPMER1	DPM2	DPMER2
1	180	50	790.07	0.30	24.00	11.40	EZV 100	4.10	
2	180	50	790.27	0.00	21.30	8.60	EZV 19	3.20	
16	180	50	733.79	16.10	1678.00	6210.80	ST	0.00	
17	180	50	646.11	4.80	12.30	0.00	BK	3.70	

Individual Labeling and Container:

Per the following 3 pages please see labeling specification and enlarged color copies of actual labels. All devices will be shipped with these labels on themselves. In addition, each device will be shipped in its own individual plastic bag (i.e. plastic zip lock bag) and each individual bag will have the same label on it (same label that the device itself has on it).

LABEL – SPARK GAP (5.5 MBq)

N26620E

Version 3
Page 1 of 2

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INSCRIPTION:

See sample & notes below

SIZE:

Height: 12.00
Width: 51.00

COLOUR:

Text : Black
Background : White & Yellow

MATERIAL:

Label blank N26034E

NOTES:

1. To print Label use Zebra / BarTender Software via the Company Network.
2. Highlighted text shall vary depending on Product type and serial Number.

SAMPLE:



e2v

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Registered Office: 106 Waterhouse Lane, Chelmsford CM1 2QU, UK
Holding Company: e2v technologies plc
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Approved

P. Robinson

LABEL – SPARK GAP (5.5 MBq)

N26620E

Version 3
Page 2 of 2

PRODUCT LIST:

GAH25UL
GAH29UL
GDH20
GXH10
GXH100
GXH100S
GXH10C
GXH12/2A
GXH120
GXH120C
GXH120M
GXH15C
GXH160C
GXH18LFC
GXH19/2A
GXH19ILV/DG50
GXH19ILV/DG60
GXH19ILV/DG70
GXH2-5
GXH20
GXH20/2
GXH20/2A
GXH20C
GXH20IEQ
GXH20IL
GXH20LFC

GXH23IEQL
GXH23IL
GXH24/2A
GXH25
GXH25C
GXH28
GXH28IEQL
GXH28ILV/DG72
GXH28ILV/DG79
GXH28ILV/DG81
GXH30
GXH30C
GXH40
GXH45CJ
GXH5
GXH5-5
GXH50
GXH50C
GXH60
GXH60C
GXH7
GXH70
GXH70C
GXH85
GXH90
GXHP80

DOCUMENT AMENDMENT RECORD

Version	Issue Date	Change Request	Reasons for Change
3	08 Oct 2014	117831	Update Logo and convert to BarTender software
2	03 Feb 2003	282G/2029	LOGO CHANGE



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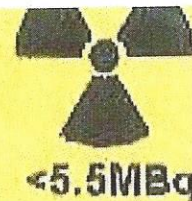
Approved P. Robinson

e2v

Made In UK

GXH20LFC

14410020

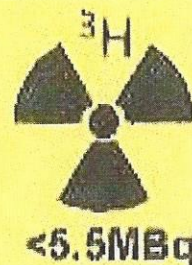


e2v

Made In UK

GXH20LFC

14410019

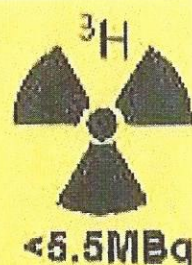


e2v

Made In UK

GXH20LFC

14410019

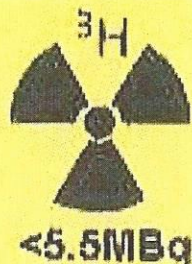


e2v

Made In UK

GXH20LFC

14410018

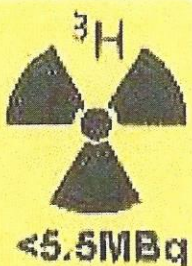


e2v

Made In UK

GXH20LFC

14410018

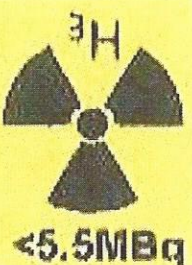


e2v

Made In UK

GXH20LFC

14410017



Packing, Shipping, Transportation:

When shipped, these devices are packaged in serialized groups of no more than 25 devices per packing carton. The maximum Tritium content in a carton is 3.75mCi. Several cartons may be overpacked into larger boxes for more efficient shipping. Please see attached e2v labeling spec and picture for packing cartons and overpacked larger boxes for our Thyratrons and Spark Gaps.

Per the packing cartons and overpacked larger boxes there will be no external markings indicating radioactive content, because all the consignments of spark gaps are shipped as exempt i.e. They contain less than 1GBq of tritium. Exempt consignments are not considered as radioactive material for IATA(air) and other shipping codes. Also see "Transportation Hazards" in The Product Safety Data Sheet (attached in the next section).

Packing Label (Thyratrons)

LA772698A

Version 3
Page 1 of 3

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INSCRIPTION:

See sample below

SIZE:

Height: 74.00
Width: 105.00
Corner Rad. 1.00

COLOUR:

Text & Logo: Black
Background: White



MATERIAL:

Label Blank N772031A

NOTES:

1. To print label use BarTender software via the company network, file name LA772698a.btw. File can be found in T:\Zebra\Packing Labels\Tyratrons.
2. Highlighted text shall vary dependant on part number and serial number.
3. See List below that this Label is for.

SAMPLE:

e2v	CX1536AX
e2v.com	
Device Type:	CX1536AX
	
Serial Number:	54546
	
Quantity:	1
LA772698A	MADE IN UK



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Approved
P. Robinson

Packing Label (Thyratrons)

LA772698A

Version 3
Page 2 of 3

List of Products

Thyratrons			SPARK GAPS		ACCESSORIES
Ceramic Type	Glass Type	Metal Env Type	2 electrode Type	3 electrode Type	Type
CX1154	01-102139-01B	CX1525	GAH31UL	GX3500-500	JR200
CX1154C	8503	CX1525A	GDH20	GX3500-600H	JR200/HMT
CX1154D	8503AG	CX1525AW	GXF110C	GXG150L	JR200/HMT/L
CX1154E	8503B	CX1525AX	GXF300	GXG200L	JR200/SWT
CX1154L	8503C	CX1528	GXH100	GXG200LR	MA785A
CX1157	8503K	CX1528D	GXH100S	GXG250L	MA2235A
CX1168	CX1140	CX1535S	GXH12/2A	GXG300L	MA2235b
CX1168C	CX1140A	CX1536	GXH120M	GXG350L	MA2161A
CX1171	CX1140LE	CX1536A	GXH19/2A	GXG350L/HMT	MA2161B
CX1171A/2	CX1151	CX1536AX	GXH19ILV/DG50	GXG380L	MA2440B
CX1171A/5	CX1159	CX1536X	GXH19ILV/DG60	GXG400L	MA2709A
CX1171B/1	CX1159A/1	CX1547	GXH19ILV/DG70	GXG500L	
CX1171C	CX1191	CX1549	GXH20	GXG600L	
CX1174	CX1191D	CX1625	GXH20/2	GXT100B	
CX1174C	CX1551	CX1625A	GXH20/2A	GXT120B	
CX1175	CX1559	CX1625AS	GXH20IEQ	GXT250B	
CX1175C	CX1585	CX1625X	GXH20IL	GXT70B	
CX1175G	CX1622	CX1648X	GXH20LFC	GXT70BR	
CX1180	CX1622/1	CX1725	GXH20S	GXTC300BR	
CX1193C	CX1622/2	CX1725A	GXH23IEQL	GXTC300BR/HMT	
CX1194B/9	CX1622R	CX1725W	GXH24/2A	GXTC300BR/SWT	
CX1199B	CX1622RS	CX1725X	GXH25C	GXTC320BR	
CX1268	CX1622S	CX1736A	GXH28IEQL	GXTC320BR/SWT	
CX1268F	CX1686	CX1826A	GXH28ILV/DG72	GXY160	
CX1268F/8	CX1685	CX1828	GXH28ILV/DG81	GXY300	
CX1314	CX1685/1	CX1835	GXH40		
CX1570	CX1722	CX1836	GXH5		
CX1573	CX1722/2	CX1836A	GXH50		
CX1573C	CX1722/2STORZ	CX1836AP	GXH60		
CX1573C/5	CX1722/3	CX1836AX	GXH60C		
CX1574	CX1722/3STORZ	CX1836X	GXH70C		
CX1574C	CX1722F	CX1925X	GXH85		
CX1575	CX2523	CX1937	GXY50		
CX1575C	FX1585	CX1937A			
CX1575G	FX227	CX1937AX			
CX1588	FX2519A	CX1937X			
CX1592D	FX2524	CX2412A			
CX1640	FX2525	CX2668A			
CX1668	FX2530				
CX1671	FX2530D				
CX1671A	FX2535				
CX1671A/2	FX2572				
CX1671D	FX2619				
CX2003X/1	FX2648A				
CX2004					



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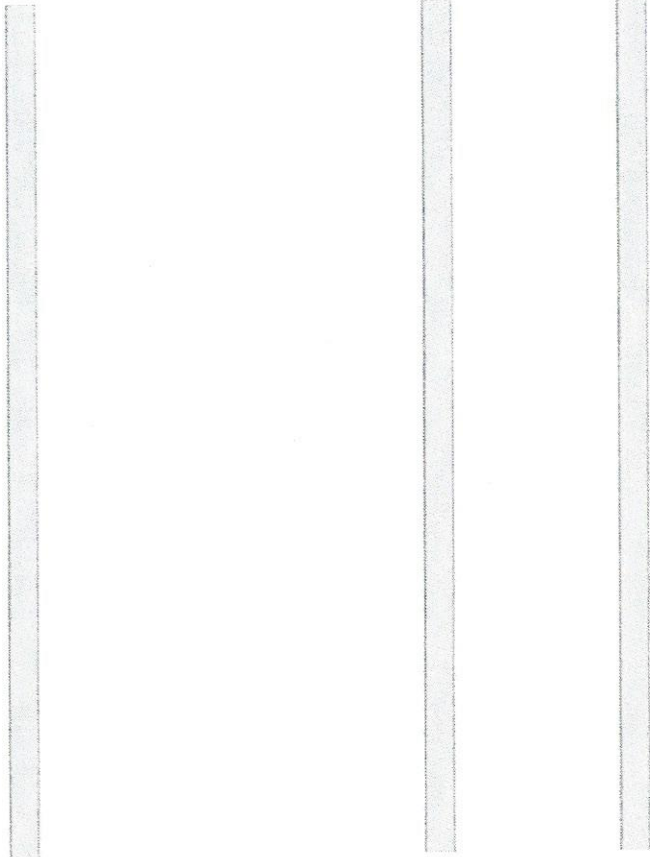
Approved
P. Robinson

Packing Label (Thyratrons)

LA772698A

Version 3
Page 3 of 3

CX2282
CX2284
CX2503X/1
CX2608
CX2608U
CX2610
CX2708
CX3575C
CX3608
FX11A
FX12A
FX2522
FX2522/8613
FX2533
FX2611
FX2890
HX2500
HX3002
HX3020



DOCUMENT AMENDMENT RECORD

Version	Issue Date	Change Request	Reasons for Change
3	08 Oct 2014	117831	Update product list and convert to BarTender
2	18 Mar 2014	117176	Added 8503C to list of products
1	31 Jul 2012	111487	New



Approved
P. Robinson

es2v technologies

ES2V	ES2V	ES2V
ES2V	ES2V	ES2V
ES2V	ES2V	ES2V

www.es2v.com

Individual Data Sheets, Two Electrode Spark Gap Preamble, Product Safety Data Sheet:

The data should be read in conjunction with the 2-electrode Spark Gap Preamble.

DESCRIPTION

The GAH Series of 2-electrode spark gaps are gas discharge tubes, hermetically sealed in a glass/metal envelope. Tubes with a DC breakdown voltage in the range 2 kV to 4 kV are available. This is signified by a numeral or numerals following the type letters and is expressed in hundreds of volts, e.g. GAH29U has a 2.9 kV DC breakdown voltage.

TYPICAL APPLICATIONS

- Turbine engine ignition circuits
- Single-shot pulse generators
- High energy switches.

NOTE

High energy versions may be available; these will be identified by the suffix letter L, e.g. GAH29UL. The need for these devices is application dependent.

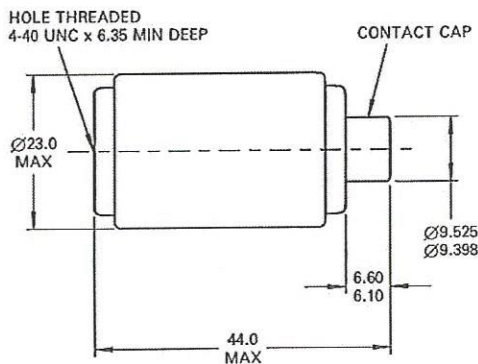
ELECTRICAL AND PHYSICAL CHARACTERISTICS

All ratings given in this data sheet are absolute, non-simultaneous ratings. It is the equipment designer's responsibility to ensure that they are not exceeded. The spark gap life depends on circuit conditions such as peak discharge current and duration, charge transfer per discharge and the repetition rate.

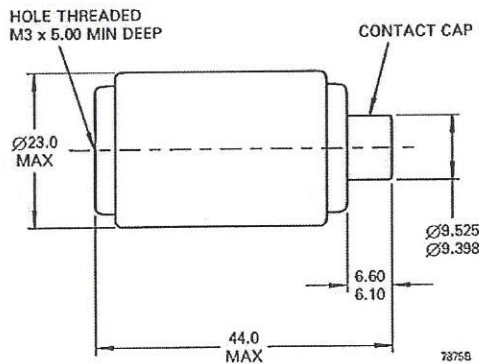
DC breakdown voltage range	2 kV to 4 kV
Breakdown voltage tolerance	±5%
Energy rating	2 J per discharge at 4 Hz unidirectional 6 J per discharge at 1.5 Hz unidirectional
Cumulative charge transfer	
at 1.3 mC per discharge, 4 Hz	76 000 C
Capacitance	5 pF max
Operating temperature	-54 to +170 °C
Mechanical shock, half-sine (to B.S. 2011 test Ea)	40 g for 4 ms
Mounting	screw mounted
Net weight	30 g max
Radioactivity	tritium (³ H), 0.11 MBq (3 µCi) max per device

OUTLINES (Actual size) (All dimensions in millimetres)

GAHxxU version with UNC connection



GAHxxM version with M3 connection



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 e-mail: enquiries@e2vtechnologies.us

e2v

e2v technologies

GXH Series 2-electrode Spark Gaps

The data should be read in conjunction with the 2-electrode Spark Gap Preamble.

DESCRIPTION

The GXH Series of 2-electrode spark gaps are gas discharge tubes, hermetically sealed in a glass/metal envelope. Tubes with a DC breakdown voltage in the range 250 V to 10 kV are available. This is signified by a numeral or numerals following the type letters and is expressed in hundreds of volts, e.g. GXH60 has a 6 kV DC breakdown voltage.

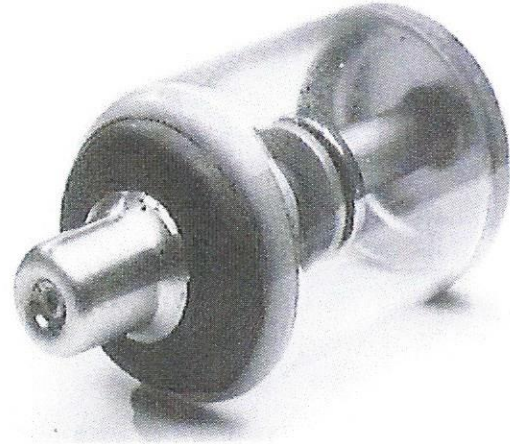
TYPICAL APPLICATIONS

- Single-shot pulse generators
- Turbine engine ignition circuits
- Medical lithotripsy
- High energy switches

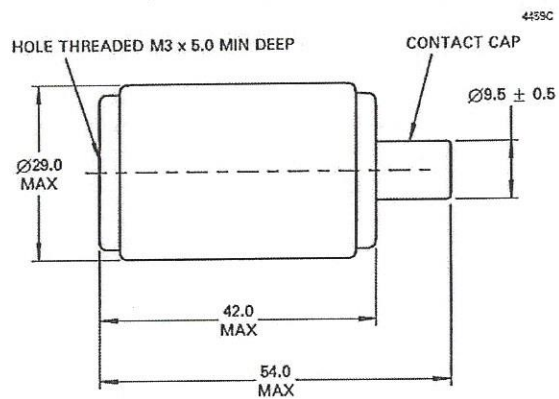
ELECTRICAL AND PHYSICAL CHARACTERISTICS

All ratings given in this data sheet are absolute, non-simultaneous ratings. It is the equipment designer's responsibility to ensure that they are not exceeded. The spark gap life depends on circuit conditions such as peak discharge current and duration, charge transfer per discharge and the repetition rate.

DC breakdown voltage range	250 V to 10 kV
Breakdown voltage tolerance	0 to +10%
Peak current, single discharge (8/20 μ s waveshape)	30 kA max
Charge transfer, single discharge (8/20 μ s waveshape)	0.5 C max
Cumulative charge transfer	6000 C at 0.81 mC per discharge at 3 Hz
Capacitance	5 pF max
Operating temperature	-40 to +125 °C
Mechanical shock, half-sine (to B.S. 2011 test Ea)	40 g for 4 ms
Mounting	screw mounted
Net weight	37 g approx
Radioactivity	tritium (^3H), 5.44 MBq (147 μ Ci) max per device



OUTLINE (All dimensions in millimetres)



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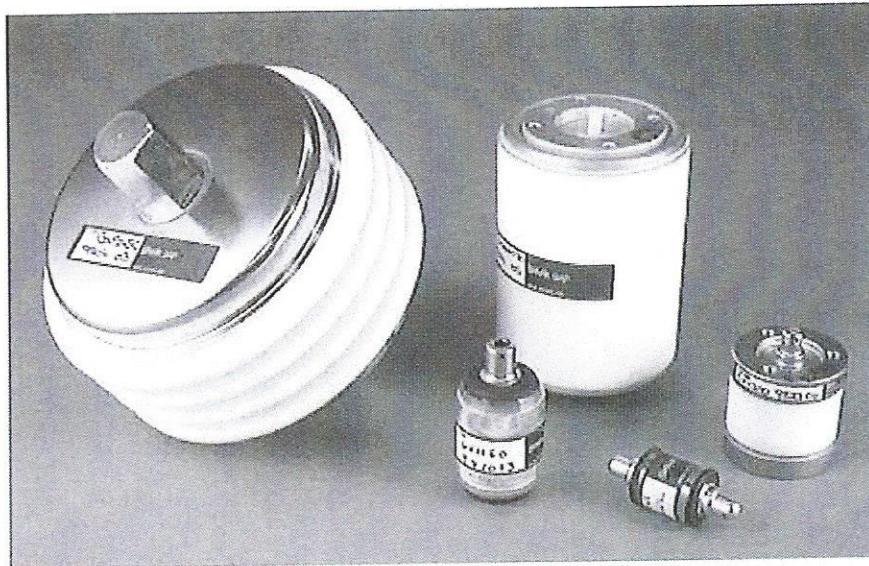
e2v technologies inc, 4 Westchester Plaza, PO Box 1482, Elmsford, NY10523-1482 USA Telephone: (914) 592-6050 Facsimile: (914) 592-5148
e-mail: enquiries@e2vtechnologies.us

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Printed in England

A1A-GXH Series Issue 9, May 2003

527/5949



INTRODUCTION

The range of two-electrode spark gaps offered by e2v technologies comprises hermetically sealed gas-filled switches available with DC breakdown voltages from 400 V to 50 kV.

Two-electrode spark gap applications include voltage surge protection, lightning protection, single-shot pulse generators, high energy switches and turbine engine ignition circuits.

PRINCIPAL FEATURES

- No Standby Power Consumption
- Consistent Breakdown Voltage
- High Current Capability
- Fast Switching
- Rugged and Reliable over Temperature Range
- Lightweight

TWO-ELECTRODE SPARK GAP SELECTION

When considering the choice of spark gap, the following factors should be taken into account:

- Application
- Peak Current and Waveform
- Coulombs per Shot
- Maximum Repetition Rate
- Main Gap Voltage
- Environmental Conditions

The e2v technologies two-electrode spark gap preamble should be read in conjunction with the relevant product data sheet to gain a general understanding of the spark gap performance characteristics.

e2v technologies provides a technical customer support service for any queries and assistance.

PRINCIPLES OF OPERATION

A simple two-electrode spark gap is shown in Fig. 1. At low voltages the gap is an insulator. As the voltage increases, the few free electrons (present in the gap as a result of cosmic radiation and other ionising effects) are accelerated to higher velocities, until they are able to ionise atoms of the gas filling. This leads to an avalanche effect as the additional electrons produce further ionisation and as the current builds up, the voltage falls (see Fig. 2). There is a range of current over which emission from the cathode takes the form of a glow discharge and the voltage is almost constant.

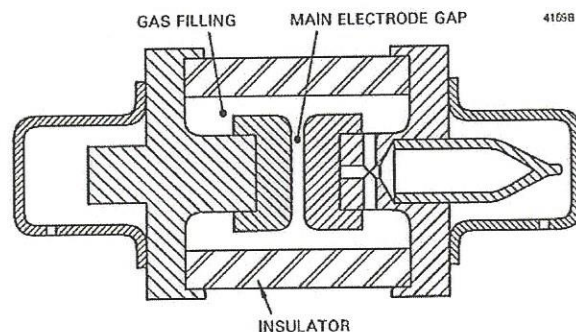


Fig. 1. Basic structure of a typical 2-electrode spark gap

A further increase in current produces cathode heating by ion bombardment, leading to the formation of emission sites and another voltage drop across the gap. The arc discharge formed in this stage is able to carry very high currents at a few tens of volts across the gap and the peak current value is determined by the external circuit.

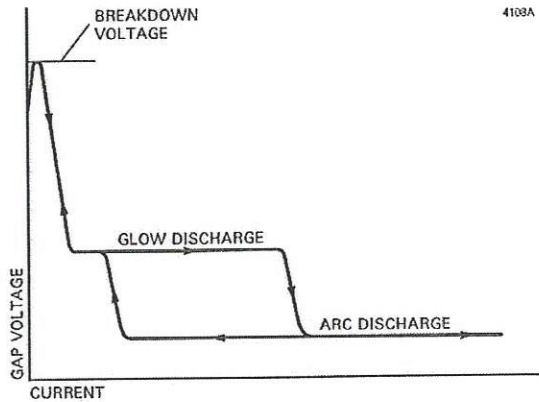


Fig. 2. Voltage-current characteristic of a 2-electrode spark gap

The arc persists until the current falls to a value insufficient to maintain arc conditions; this current is lower than that required to establish the arc initially. Current flow then ceases and the ionisation of the gas decays until the gap has returned to its original state.

The amount of natural ionisation present in the gap described above varies according to the intensity of ionising radiation and should normally be very small. This might cause wide variations in the breakdown voltage; for example the value in darkness might be double that when illuminated. The time taken to establish the arc would also be undesirably long and variable. The performance can be improved and stabilised by providing a consistent source of ionisation within the gas of the gap. One method is to maintain a small corona discharge at the normal operating DC voltage by providing sharp corners on the electrodes or including some high dielectric constant material. Another method frequently used is to include a small quantity of radioactive isotope, normally tritium gas, which emits high energy electrons continuously.

The value of the breakdown voltage is determined by the gap geometry, gas composition and pressure, ionisation conditions and the waveform of the gap voltage. A given type of spark gap can be made to break down at any given voltage selected from a wide range by appropriate adjustment during manufacture. Immediately after a current pulse, the voltage hold-off capability of the tube is limited by the residual ionisation. This decays rapidly by recombination, the recovery time depending on the gas composition, electrode material and pulse energy.

TWO-ELECTRODE SPARK GAP TERMINOLOGY

DC Breakdown Voltage

The voltage at which discharge occurs. This is normally the lowest voltage that will cause breakdown. The spark gap will break down within +10% of the specified voltage unless otherwise stated. A device can be manufactured to any voltage within the range stated.

Impulse Breakdown Voltage

The voltage at which discharge occurs when a rapidly rising voltage is applied across a spark gap. Impulse breakdown voltage normally increases with increasing rate of rise. A rate of rise of 15 kV/ μ s is usually used at e2v technologies.

Impulse Ratio

The ratio of the impulse breakdown voltage to the DC breakdown voltage.

Life

The passage of current through a gap has a cumulative effect, causing a gradual reduction of the DC breakdown voltage. The life of the spark gap can be expressed as the cumulative charge in coulombs that can be passed through the device without changing its breakdown voltage by more than 10%. Life shortens with increasing charge per discharge and increasing repetition rate. For further details see Operating Notes.

Maximum Charge Transfer

The proven charge transfer, single discharge handling capability of the spark gap with a defined pulse wave shape unless otherwise stated. The cumulative charge transfer figure used to express life is based on figures below this value specified at a relative pulse repetition discharge rate.

Recommended Repetition Rate

The maximum repetition discharge rate per second for optimum spark gap performance.

Capacitance

The inter-electrode capacitance is measured across the terminals and typical values for e2v technologies spark gaps are: GXK and GXN series typically 0.5 pF; GXH, GXS and GX2001 series typically 5.0 pF; GXF series 50 pF maximum.

Insulation Resistance

The resistance of a two-electrode spark gap measured at 100 V dc between the terminals is typically > 10,000 M Ω .

Radioactivity

Some devices contain tritium to ensure consistency of operation. The activity of the device will not exceed the limit stated.

Gas Content

The gas content of a spark gap might be inflammable when mixed with air. Devices should not be operated if damage to the envelope is evident.

FACTORS AFFECTING LIFE

Life

It might be possible to extend the life of a spark gap by operating the device well below the stated operating characteristics.

Peak Current

The life of a spark gap is governed primarily by the deposition of electrode material on the insulating surfaces. The rate of erosion of the electrodes may be related to peak current as follows:

$$\text{Rate of erosion} \propto (I_{pk})^{1.6}$$

Hence, limiting the peak current can increase spark gap life.

Pulse Duration

For a given peak current, longer life will be obtained with shorter pulses.

Current Reversal

Reasonable life can be achieved with high current reversal, but for maximum life a critically damped circuit is preferred.

Circuit Symmetry

Long life depends on even distribution of the discharge around the electrodes. The electromagnetic fields generated by the discharge may be sufficient to produce a preferred discharge path which in turn might lead to excessive local erosion and reduced life.

Recovery

Recovery time with low duty operation is very short (in the order of microseconds). However, as the charge transferred per discharge increases, thermal effects begin to dominate and the maximum repetition rate decreases. At high charge transfer levels, the recovery time may be many tens of milliseconds.

Charge Transfer

The life of a spark gap increases with decreasing charge transfer. For example, the cumulative charge life for the GXH series is 600 C at 1.0 C per discharge, rising to 6000 C at 0.8 mC per discharge. However, the relative peak currents and other circuit characteristics should be considered also.

For the ringing current pulse conducted by the spark gap (see Fig. 3), the charge transfer is the sum of the shaded areas, not the stored charge CV , where C = capacitance and V = charging voltage.

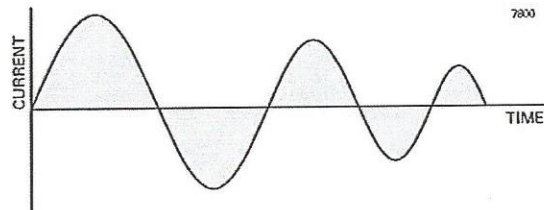


Fig. 3. A typical current pulse (circuit dependent)

Repetition Rate

The life of a spark gap increases with decreasing repetition rate. Burst or higher repetition rates may be acceptable but may shorten life.

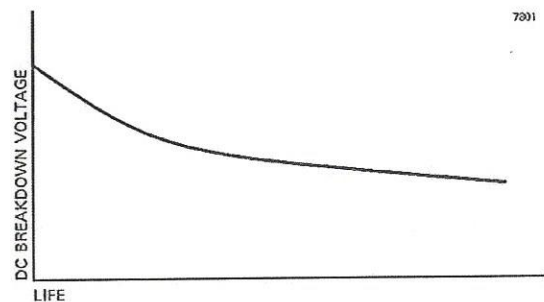


Fig. 4. Typical plot of spark gap breakdown voltage over operational life

End of Life Failure Modes

The DC breakdown voltage of the spark gap reduces slowly over operational life (see Fig. 4). This can be caused by coating the insulator surface with a metallic film. The reduction of the DC breakdown voltage can also be caused by erosion and the deposits of the electrode material onto the opposite parallel electrode surface.

APPLICATION NOTES

- Single-shot Pulse Generators
- Voltage Surge Protection Circuits
- Turbine Engine Ignition Circuits
- Medical Lithotripsy
- High Energy Switches
- Modulator Component Protection

Most types of spark gap, although they may have been developed for one particular set of operating conditions, are very adaptable. The current and energy ratings are related to the life of the spark gap, measured as the number of discharges before the voltage limit is no longer reached; the compromise between life and discharge ratings can be varied over a wide range for any given type.

Surge Protection

Voltage transients are an ever-increasing problem wherever electronic instrumentation and equipment is being used. External voltage transients might be caused by power surges, lightning strikes, general switching, etc. Internal voltage transients arise from arcing, component failures, switching of inductive loads, etc. It is difficult to predict the magnitude, waveform and frequency of these events, and impossible to prevent them, so some form of protection is necessary. One of the simplest and most effective ways is the use of gas-filled spark gaps. Generally, a spark gap will handle more energy than a solid-state component, is more durable and will respond faster to a voltage transient than an electro-mechanical device, thereby giving greater protection.

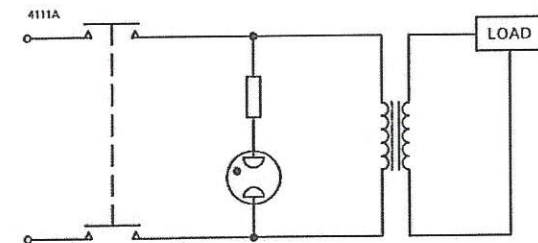


Fig. 5. Protection of a power transformer against voltage transients.

Fig. 5. shows a typical example of a power transformer and its load, protected against transient over-voltages by a 2-electrode spark gap in parallel with the transformer primary. Although a circuit breaker is included, this would not operate rapidly enough to provide protection against voltage surges with short rise times. When the gap is fired by a voltage surge, it will start to recover as the current falls to zero in the AC cycle, but may be ionised sufficiently to break down again in following half-cycles even if the voltage has returned to normal. The contactor must open the circuit before the spark gap can be destroyed, and must not re-close until the gap has recovered its hold-off voltage. The resistance shown in series with the gap

might be necessary for installations where very large currents can be drawn under fault conditions.

A more specialised application is shown in Fig. 6. In a radar transmitter, if the magnetron misfires once, the following pulse from the modulator may be at a much higher energy level than normal and this could cause rapid destruction of the pulse transformer and other modulator components. The spark gap connected across the secondary of the pulse transformer provides the necessary protection. Most pulse magnetrons operate at some thousands of volts, but the short-circuit current of the modulator is relatively small; similar types of gap may be used to protect other types of electron tube and equipment operating under similar conditions.

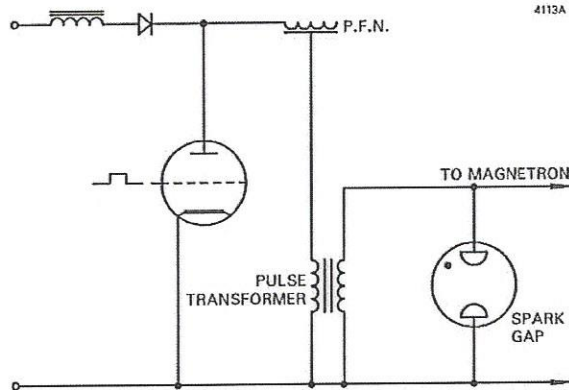


Fig. 6. Protection of a magnetron against misfiring

Pulse Generators

It is possible to use a spark gap as the switch tube in a pulse modulator up to very high peak power levels. The life of the gap will be very much less than that of a thyatron developed for the same conditions, but might still be sufficient for applications requiring only a short or very intermittent operation. The advantages of spark gaps for this purpose include zero standby power, zero warm-up time, a long non-operating life and low cost. Where the output of a modulator must be accurately timed or synchronised, a 3-electrode spark gap is used.

Environmental

The thermal, shock and vibration tolerances of most spark gaps are adequate for normal domestic and industrial applications, but certain types are especially rugged.

Where an industrial application involves a corrosive or abrasive atmosphere, spark gaps will require the same protection as most electronic equipment.

Storage

Spark gaps should be stored preferably in the original packing in a non-corrosive atmosphere. If removed from their packing, they should be protected from dust and industrial atmospheres until required.

The shelf-life is adequate for all normal storage requirements, although it is possible that the characteristics may change as the radioactive content decays. Since tritium has a half-life of twelve years, the change over normal storage periods is negligible.

The radioactive content used in most spark gaps is tritium gas, an isotope of hydrogen. Its emission consists of β particles (electrons) at relatively low energy. The total activity per tube is in the classification category band of <5.5 MBq, class 1 (code of practice Def. Stan. 59-60) and <37 MBq.

The spark gap should not be stored near photographic film and must be in a correctly marked package. There are some limitations on the action to be taken when large numbers of radioactive tubes (e.g. <5.5 MBq) are disposed of, broken or involved in a fire (consult relevant local authorities), but the handling of single tubes requires no special precautions.

Mounting and Connections.

The rise time of the arc current is determined mainly by the inductance of the external circuit and connections; where the fastest possible switching is required, the gap can be built into the end of a coaxial line, matched to the circuit impedance. In general, the connections should be kept short and well-spaced to minimise their inductance. For the same reason, the mounting position will be normally as close as possible to the load or protected equipment. In protection and single-pulse applications, the heat dissipated by the spark gap is not enough to require any assisted cooling, and the maximum temperature rating of the gap will not usually restrict the choice of mounting position.

Most spark gap applications involve high peak currents. Although the mean currents are relatively small, so that small section conductors can be used safely, the connections must be secure. Any poor or loose contacts will be eroded rapidly and are likely to fail completely.

Figs. 7 to 10 show examples of suitable mounting methods for several larger types of gap.

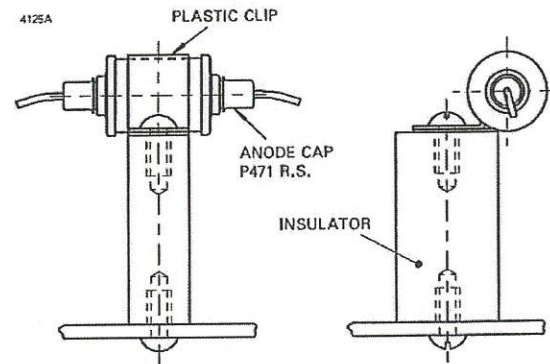


Fig. 7. Typical mounting arrangements for GXK Series

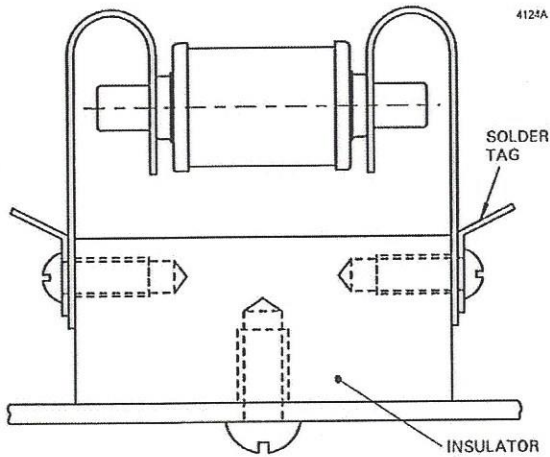


Fig. 8. Typical mounting arrangements for GXN Series

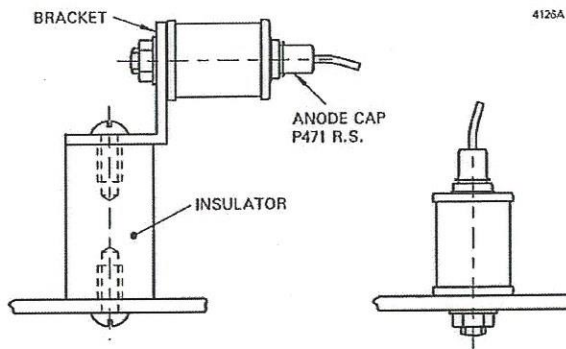


Fig. 9. Typical mounting arrangements for GXS Series

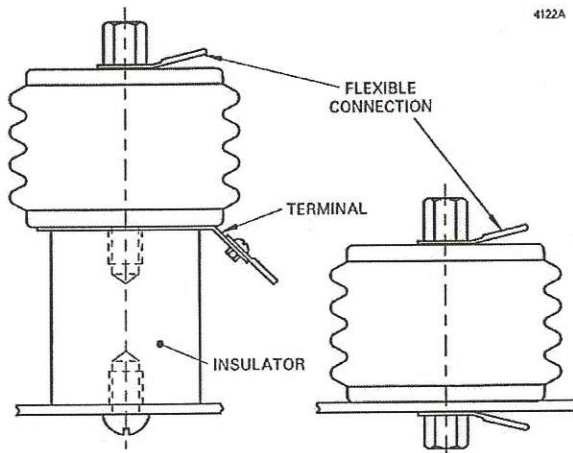


Fig. 10. Typical mounting arrangements for GXF Series

SPARK GAP ENQUIRY OPERATING PARAMETERS FORM

Overleaf is e2v technologies' Spark Gap Enquiry Operating Parameters Form. Please detach or photocopy, then complete and return the form as indicated to the address shown, and e2v technologies will recommend the most suitable spark gap. All information will be treated in the strictest confidence.

INFORMATION CHECK LIST

Answering the following questions will enable e2v technologies to select the most suitable 2-electrode spark gap.

What is/are the:

- application,
- required DC breakdown voltage,
- value of the charge storage capacitor,
- maximum charge transfer,
- cumulative charge transfer,
- typical life shots expected,
- peak current, waveshape and cycle time,
- maximum switching rate per second,
- required dimension limits,
- environmental parameters, e.g. operating temperature, shock, etc?

Whilst e2v technologies has taken care to ensure the accuracy of the information contained herein it accepts no responsibility for the consequences of any use thereof and also reserves the right to change the specification of goods without notice. e2v technologies accepts no liability beyond that set out in its standard conditions of sale in respect of infringement of third party patents arising from the use of tubes or other devices in accordance with information contained herein.

Spark Gap Enquiry Operating Parameters

Please complete as accurately as possible to allow the most suitable spark gap to be recommended.
 All information is treated in the strictest confidence.

Company Name and Address	
Contact Name	E-mail
Position	
Telephone No.	Fax No.
Application	
Discharge Circuit and Current Waveform (if known). Please sketch the discharge circuit below or attach a circuit diagram.	
Spark Gap Operating Conditions	
Operating Voltage Range	
Peak Current	
Repetition Rate	
Life Required	
Other Requirements	

OVERVIEW

The GXH, GAH and GDH series of spark gaps are sealed gas-filled switches with DC breakdown voltages from 250 V to 10 kV. Two-electrode spark gap applications include voltage surge protection, lightning protection, single-shot pulse generators, high energy switches and turbine engine ignition circuits.

INHERENT HAZARDS

Sharps – GXH, GAH and GDH Series Spark Gaps are sufficiently robust to withstand normal handling. However, they do employ a glass envelope that may be broken if knocked, dropped or subject to undue force during installation or removal. If the glass envelope is broken sharp edges of broken glass will be present. Follow all normal procedures for the handling of broken glass and other sharps, including use of tools and/or personal protective equipment.

Radioactivity – Most GXH spark gaps contain a small quantity of radioactive tritium gas. Tritium is an isotope of hydrogen and a low-energy beta emitter. The radioactive emissions are effectively contained by the envelope of the device, so present no hazard during normal handling. In the event of breakage, the gas will dissipate very rapidly in an upwards direction, and in any case does not expose persons in the vicinity to a hazardous level of radiation.

Local health, safety and environmental regulations for the holding of small sealed radioactive sources containing tritium should be followed.

The remaining material from a broken device may be swept up and disposed of in accordance with local regulations for very low level waste.

TRANSPORTATION HAZARDS

Radioactivity - Devices may be transported as "exempt" shipments under the IATA dangerous goods regulations, IMDG Code and ADR treaty providing the total consignment does not have an activity level exceeding 1 GBq. GXH series devices have an activity of <5.5 MBq, so up to 180 devices may be transported in a single consignment providing no other radioactive materials are included therein.

INSTALLATION HAZARDS

There are no additional hazards associated with installation, but care should be taken to avoid exerting undue force on devices that might result in breakage.



Breakage will result in exposure to the inherent hazards described above.

OPERATIONAL HAZARDS

High voltages – Spark Gaps operate at high voltages. Equipment should be designed with adequate creepage and clearance distances for the operating voltage and environmental conditions that will occur in use. Equipment should incorporate protective measures such as fail-safe interlocks, discharge circuits, and warning markings as required by relevant equipment safety standards.

X-rays – In common with all vacuum electron tubes, spark gaps produce X-rays when operated at voltages in excess of 5 kV. The level of emissions depends on the operating conditions, voltages, and currents. Equipment designers and manufacturers should include shielding, typically steel and/or lead, to reduce emissions to a safe level in accordance with local radiological protection guidelines. Manufacturers and operators of equipment must perform radiation measurements on their equipment under maximum operating conditions to ensure continued safety. Servicing procedures should advise of the risk of operating equipment with radiation shielding removed and include appropriate mitigation measures.

Hot surfaces – A spark gap that has just been in operation may still be hot, even once access panels or doors have been opened. Appropriate warnings should be placed in a prominent position for the protection of servicing personnel

DECOMMISSIONING

There are no additional hazards associated with decommissioning, but care should be taken to avoid exerting undue force on devices during removal that might result in breakage. Breakage will result in exposure to the inherent hazards described above. Used devices should be placed in a suitable container to reduce risk of breakage prior to being removed to a disposal facility.

DISPOSAL

Local regulations for the disposal of small sealed devices containing tritium should be followed.

MATERIAL DATA

The following table of material data provides information to enable disposal in accordance with environmental regulations.

PRODUCT	Approximate MASS (g)	Maximum Radioactivity (Tritium) (MBq)	COMPOSITION (% MASS)					
			Glass	Tungsten	Nickel Alloys	Other Metals	Magnesium Oxide Powder	Other non-hazardous materials
All GXH series spark gaps <i>except those listed below</i>	40g	<5.5MBq	<30%	<25%	<45%	<15%	<3%	<2%
GXH_I/2A series (e.g. GXH19/2A, GXH20/2A, GXH24/2A)	40g	<3.3MBq						
GXH_LFC series (e.g. GXH18LFC, GXH20LFC)	40g	<0.11MBq						
GXH20S, GXH110M/2	40g	nil						
GXH28ILV/DG79, GXH28ILV/DG81, 80412945	30g	<0.04MBq						
GDH20	40g	<0.11MBq						
GAH series (e.g. GAH25UL, GAH29UL, GAH31UL)	30g	<0.11MBq						

In the event of encountering difficulties in disposing of these products, contact e2v technologies for advice.

In the **United Kingdom**, the following regulations generally apply to the holding, use and disposal of e2v GXH, GAH and GDH series spark gaps containing tritium,

i) for health and safety aspects, "The Ionising Radiations Regulations 1999".

ii) for environmental aspects,

a. England and Wales:-

i. The Environmental Permitting (England and Wales) (Amendment) Regulations 2011

b. Scotland:-

i. The Radioactive Substances Exemption (Scotland) Order 2011,

ii. The Radioactive Substances Act 1993 Amendment (Scotland) Regulations 2011

iii. The Radioactive Substances Act 1993

c. Northern Ireland:-

i. The Radioactive Substances Exemption (Northern Ireland) Order 2011

ii. The Radioactive Substances Act 1993 (Amendment) Regulations (Northern Ireland) 2011

iii. The Radioactive Substances Act 1993

The exemptions in the Environmental Permitting Regulations and Radioactive Substances Orders allow most organisations to hold and dispose of e2v spark gaps containing tritium without an environmental permit (England and Wales) or radioactive substances registration and authorisation (Scotland and Northern Ireland).

In all other countries, local health, safety and environmental regulations must be followed.

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e-mail: enquiries@e2v.com Internet: www.e2v.com Holding Company: e2v technologies plc

From: (914) 593-6825
 Michael Juliano
 e2v inc
 520 White Plains Rd - Suite 450
 Tarrytown, NY 10591

Origin ID: CTXA



J142214092303uv

Ship Date: 07NOV14
 ActWgt: 0.5 LB
 CAD: 103807457/NET3550

Delivery Address Bar Code



SHIP TO: (301) 415-5477

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Richard Struckmeyer
OFFICE OF NUCLEAR MATERIAL SAFETY &
Materials Safety Licensing Branch
 Div of Material Safety, States,
 WASHINGTON, DC 20555

Ref # 6821/217400/PIARULLI
 Invoice #
 PO #
 Dept #

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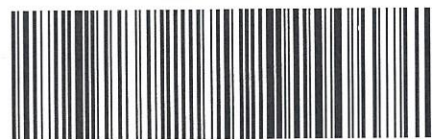
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