


*memorandum*

*NEN-3 International Threat Reduction  
Off-Site Source Recovery Program (OSRP)*

To: Justin M. Griffin, OSRP (E539)  
From: J. Andrew Tompkins, CHP   
Phone: 404-388-3631  
Symbol: NEN-3: 19-041  
Date: August 21, 2019

**OSR-SF-009: Special Form Character of Amersham XN240 Sealed Sources**

History/Background

In October 2015, the U.S. DOT issued a new Special Form COCA for QSA-Global model XN240 radioactive sealed sources (Cert. No. USA/0726/S-96). The new COCA contained a peculiarity of recent QSA Global certifications, in that it was valid only for sources manufactured on or after February 10, 1971.

Since 1970, over 6,500 XN240 sources were manufactured and distributed. One customer, Industrial Dynamics (ID), purchased several Amersham Model XN240 sealed sources and welded them into 304 stainless steel housing assemblies. These assemblies are known as Model FT-12 devices with external dimensions of 2"x2"x1.4" as described under Industrial Dynamics Drawing No. 06110).

The size and shape of these FT-12 devices poses a challenge for potential shippers of assemblies manufactured prior to February 10, 1971, because they no longer have a corresponding special form certificate.

The FT-12 assembly exceeds the internal size limit of all OSRP field-sealable special form capsules.

Furthermore, FT-12 devices are not readily disassembled because of robust methods of construction.

To further complicate matters, the Specification 6M Type B packages previously used by OSRP to transport unwanted XN240 sources (as Normal Form) became obsolete on October 1, 2008. This combination of events leaves QSA-Global, Industrial Dynamics, FT-12 users, waste brokers, and OSRP with no viable way to ship FT-12 (XN240) sources manufactured prior to February 10, 1971.

Special Form Character of Model XN240

One solution to this challenge is to evaluate the performance of the XN240 capsules (Amersham Product Code AMCQ505) over an extended working lifetime, say beginning in 1970.

In April 2000, Industrial Dynamics requested a 10-year extension to the original 30-year recommended working lifetime (RWL) for the XN240, thus increasing it to 40 years. AEA Technology undertook a working lifetime extension review which was completed in April 2000. The AEA design review was documented in DRAMCQ505. The design review included evaluation

of the product description, application, specification, manufacturing & testing procedures, evaluation of aged product at 10 and 20 years, and a design assessment for extended use.

DRAMCQ505 states in part that, "The key feature of the design that requires assessment is the internal pressure resulting from build up of helium resulting from alpha particle decay. The bursting pressure has been determined experimentally at ambient temperature to be 7,500 psi (57.1 MPa) ref. QATM 053, Issue 1. This is in agreement with calculated bursting pressure... Calculations have been performed for 40 years for a source containing 100 mCi of Am-241. In summary the results are: ...at 800 C for 40 years of decay are... a shear stress in the source window of 11.2% of the windows shear strength at 800°C. Conclusion: The calculated stresses at 800°C after 40 years are well within the design capabilities of the source capsule."

The document goes on to state that, "No deterioration of the product which would affect the integrity of the product in use or in transport accident conditions as defined by IAEA Special Form Material definitions were noted during inspection. On the basis of this design review, the inspection results and the pressure calculation it is recommended that the RWL is extended to 40 years." To document this extension a certificate of radioactive source working life extension was issued for the XN240, as documented in RLC519, Issue 1 on 12 October 2001."

Since the special form tests requirements for IAEA and the US DOT are almost identical, under the conditions of the US CFR173.469 QSA Global model XN240 sealed radioactive sources are special form for at least 40 years after manufacture.

It is instructive to note that a pressure Safety Factor of "9" exists for the XN240 capsule after 40 years of sealed source decay. The ASME Pressure Vessel Code requires only a Safety Factor of "4" for metallic pressure vessels, like the XN240 cladding. An additional 20 years of source decay would increase the shear stress in the capsule wall to 16.8% (5.6% + 11.2%) of the theoretical yield strength at 800 °C and a Safety Factor of about "6".

Using a Safety Factor of "6" as the minimum would give an overall special form lifetime of these sources of 60 years. Meaning that all should be out of service as of March 2030. This additional time as Special Form radioactive material should be used to ensure that as many of these sources as possible are collected and sent to final disposition.

After March 2030, all model XN240 sealed sources should be carefully examined for their relationship to a 60 year special form lifetime in order to establish their special form character for transportation purposes. This specifically applies to those XN240 capsules, which were manufactured prior to February 10, 1971 which were not covered under the current COCA (USA/0726/S-96).

JAT

**Attachments:**

- COCA for QSA-Global, Inc. Model XN240, USA/0726/S-96, Rev. 3
- Design Review for Extension of Recommended Working Life Product Code AMCQ505 for Industrial Dynamics, DRAMCQ505: Issue 1

- Certificate of Radioactive Source Working Life Extension, RLC519, Issue 1
- Industrial Dynamics drawing No. 06110

OSRP File, MS E539  
NEN-3 File, MS



U.S. Department  
of Transportation  
**Pipeline and  
Hazardous Materials  
Safety Administration**

**IAEA CERTIFICATE OF COMPETENT AUTHORITY  
SPECIAL FORM RADIOACTIVE MATERIALS  
CERTIFICATE USA/0726/S-96, REVISION 3**

East Building, PHH-23  
1200 New Jersey Avenue Southeast  
Washington, D.C. 20590

This certifies that the source described has been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency<sup>1</sup> and the United States of America<sup>2</sup> for the transport of radioactive material.

1. Source Identification - QSA Global, Inc. Model XN240 (Manufactured on or after February 10, 1971).
2. Source Description - Rectangular single encapsulation made of stainless steel and seal welded. Approximate outer dimensions are 34.93 mm (1.375 in.) in height, 50.01 mm (1.969 in.) in depth, and 114.3 mm (4.5 in.) in length (shutter open or closed) including the attached extension and knob. Minimum wall thickness is 0.13 mm (0.005 in.). Construction shall be in accordance with attached Industrial Dynamics Co., LTD. Drawing Nos. 06110, Rev. 7; and 06110-1, Rev. 4.
3. Radioactive Contents - No more than 3.7 GBq (100.0 mCi) of Americium-241. The Am-241 is in the form of an oxide incorporated into a ceramic enamel.
4. Quality Assurance - Records of Quality Assurance activities required by Paragraph 310 of the IAEA regulations<sup>1</sup> shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the applicable requirements of Subpart H of 10 CFR 71.
5. Expiration Date - This certificate expires on October 31, 2020.

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<sup>1</sup> "Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), No. TS-R-1 (ST-1, Revised)," published by the International Atomic Energy Agency(IAEA), Vienna, Austria.

<sup>2</sup> Title 49, Code of Federal Regulations, Parts 100-199, United States of America.

**CERTIFICATE USA/0726/S-96, REVISION 3**

This certificate is issued in accordance with paragraph 804 of the IAEA Regulations and Section 173.476 of Title 49 of the Code of Federal Regulations, in response to the October 08, 2015 petition by QSA Global, Inc., Burlington, MA, and in consideration of other information on file in this Office.

Certified By:



Dr. Magdy El-Sibaie  
Associate Administrator for Hazardous Materials Safety

**Oct 19 2015**  
(DATE)

Revision 3 - Issued to extend the expiration date.

06110 7

REACTIVE DRAWING, DRAWING OF  
 CAL. SPECIFICATIONS 774 0110-3

06110 7

INDUSTRIAL DYNAMICS CO., LTD.  
 TORRANCE, CALIFORNIA

ASSY. SOURCE HOUSING CERAMIC

DATE 8/82  
 FILE 7-15-82  
 DRAWN BY 7-15-82

NO. 06110

FT 1

CONFIDENTIAL

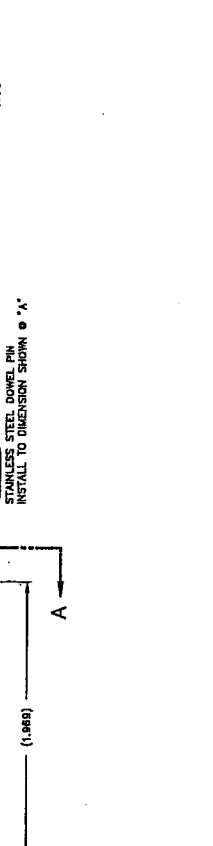
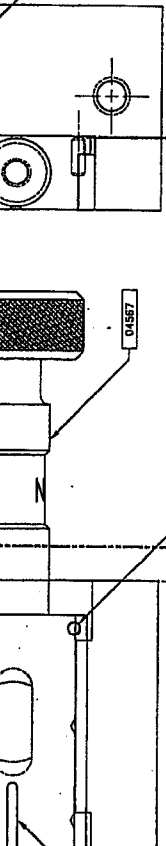
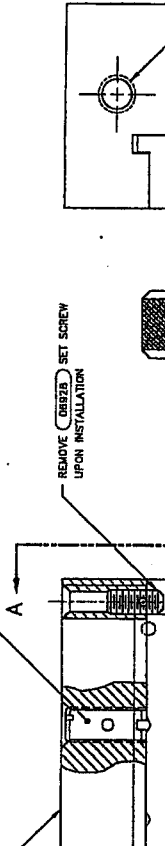
INDUSTRIAL DYNAMICS CO., LTD.  
 TORRANCE, CALIFORNIA

ASSY. SOURCE HOUSING CERAMIC

DATE 8/82  
 FILE 7-15-82  
 DRAWN BY 7-15-82

NO. 06110

FT 1



4. FOR SHIPPING PURPOSES THE TWO DOWEL PINS (P/N 04567), SHUTTER (P/N 04569) AND SOURCE HOUSING (P/N 04568) MUST BE ASSEMBLED AS SHOWN, SO SHUTTER AND SOURCE HOUSING WILL REMAIN CLOSED. THE SHUTTER MUST BE CLOSED AND LOCKED DURING SHIPPING PROCESS. THE SET SCREW IS BACKED OUT OR REMOVED UPON INSTALLATION OF SOURCE IN DEVICE.
  5. SHUTTER MAY BE INSTALLED OPPOSITE HAND TO THAT SHOWN.
  6. SOURCE TO BE SENT TO RADIO CHEMICAL CENTER, FOR LOADING AND WELDING.
  7. 100 MILLICURIES AMERCIUM 241 IN CERAMIC FORM.
- NOTES: UNLESS OTHERWISE SPECIFIED

REV.	NO.	DESCRIPTION	DATE	BY
1	1	ISSUED FOR PRODUCTION	7-15-82	
2	1	ISSUED FOR PRODUCTION	7-15-82	

INDUSTRIAL DYNAMICS CO., LTD.  
 TORRANCE, CALIFORNIA

ASSY. SOURCE HOUSING CERAMIC

DATE 8/82  
 FILE 7-15-82  
 DRAWN BY 7-15-82

NO. 06110

FT 1

REV	DATE	BY	CHKD	APPV
4	3/75	JH	SG	DK
RE-CREATED NEW CAD FILE UPDATED PART NUMBERS ON WITH E.O.M. - REMOVED WELD SYMBOL (2).				

NO	REV	DATE	BY	CHKD	APPV
4		3/75	JH	SG	DK
RE-CREATED NEW CAD FILE UPDATED PART NUMBERS ON WITH E.O.M. - REMOVED WELD SYMBOL (2).					

NO	REV	DATE	BY	CHKD	APPV
4		3/75	JH	SG	DK
RE-CREATED NEW CAD FILE UPDATED PART NUMBERS ON WITH E.O.M. - REMOVED WELD SYMBOL (2).					

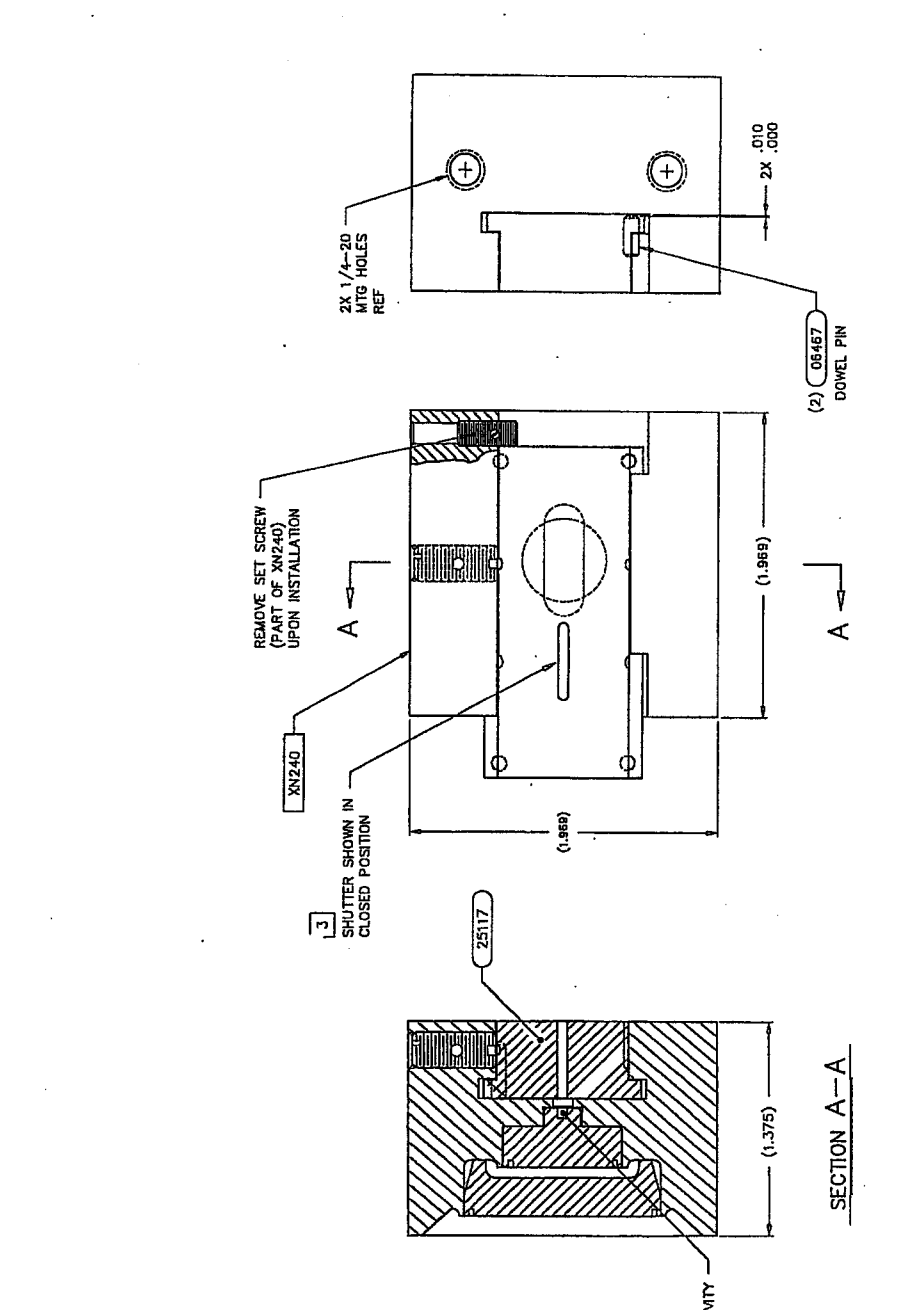
NO	REV	DATE	BY	CHKD	APPV
4		3/75	JH	SG	DK
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NO	REV	DATE	BY	CHKD	APPV
4		3/75	JH	SG	DK
RE-CREATED NEW CAD FILE UPDATED PART NUMBERS ON WITH E.O.M. - REMOVED WELD SYMBOL (2).					



4. FOR SHIPPING PURPOSES TWO DOWEL PINS (06467), SHUTTER (04567) AND SOURCE HOUSING (04568) MUST BE ASSEMBLED AS SHOWN, SO SHUTTER CAN BE PLACED IN CLOSED POSITION AND RETAINED BY SET SCREW (06828). SHUTTER MUST BE CLOSED AND LOCKED DURING SHIPPING PROCESS. SET SCREW IS BACKED OUT OR REMOVED UPON INSTALLATION OF SOURCE IN DEVICE.
  3. SHUTTER MAY BE INSTALLED OPPOSITE HAND TO THAT SHOWN.
  2. SOURCE TO BE SENT TO RADIO CHEMICAL CENTER, FOR LOADING AND WELDING.
  1. 100 MILLICURIES AMERICIUM 241 IN CERAMIC FORM.
- NOTES: UNLESS OTHERWISE SPECIFIED

ITEM NO.	NO. REV.	PART NUMBER	DESCRIPTION	REMARKS
06467			INDUSTRIAL DYNAMICS CO., LTD. TORRANCE, CALIFORNIA	
DESIGNER		DATE	CAD AVAILABLE	FINISH
HOAI NGUYEN		1/20/95	ASSY, SOURCE HOUSING, 100MC	
CHECKER		DATE	DATE	DATE
STEVE GRAY		3/03/95	7/17/92	06110-1
APPROVER		DATE	SCALE	
DAVID KRIEBEL		3/20/95	2X	
DRAWN		DATE	BY	
F.L. CALHOUN		8/22/88	W. BRECKENRIDGE	



U.S. Department  
of Transportation

East Building, PHH-23  
1200 New Jersey Avenue SE  
Washington, D.C. 20590

**Pipeline and  
Hazardous Materials  
Safety Administration**

**CERTIFICATE NUMBER:** USA/0726/S-96, Revision 3

**ORIGINAL REGISTRANT(S):**

Ms. Lori Podolak  
Manager, Regulatory Affairs/Quality Assurance  
QSA Global, Inc.  
40 North Avenue  
Burlington, MA 01803

Mr. Michael Fuller  
Regulatory Compliance Associate  
QSA Global, Inc.  
40 North Avenue  
Burlington, MA 01803



To Michele ALVARADO.  
 Company FD  
 From GARRY SENIOR  
 Company ASA  
 Tel No. FAX 310 257 3202 No. of Pages 5  
**FAX**  
**Post-it Fax Note**  
 Ref No: 7688

DRAMCQ505: Issue 1

Quality and Safety Assurance

Design Review for

Extension of Recommended Working Life  
XN240 Capsule: Product Code AMCQ505 for Industrial Dynamics

Reviewed By: B J Senior

Checked By: M. Shepperson

Date: 17.4.2000

Approved By: D G Hunt

Date: 17-4-2000

Design

A Senior  
 Quality Assurance

Date: 17.4.2000

Summary:

An extension of the Recommended Working Life from 30 years to 40 years is recommended on the basis of this review, inspection of samples following use 'in the field' and calculated acceptable internal pressure with resultant stresses which are well within the design requirements and capabilities.

CONTENTS

1. Preliminaries
2. Product Description
3. Application
4. Specification
5. Manufacturing and Test Procedures
6. Evaluation of Product ex use
  - 6.1 Historical Use Data
  - 6.2 History of Use Records
  - 6.2 Inspection
7. Customer Feedback
8. Design Assessment for Extended RWL
9. RWL Assessment Conclusions and Recommendations

1. **Preliminaries**

This Design Review has been carried out at the request of Industrial Dynamics who have provided the samples for inspection and conditions of use data. Initially, an extension of the Recommended Working Life (RWL) from 30 years to 40 years is sought for their application.

2. **Product Description**

Product Code AMCQ505                      US Model No: Not registered by QSA  
 Capsule Type XN240

The source consists of Americium-241 incorporated in an enamel which is held in an insert and encapsulated in 316L stainless steel cell and sheath. Both capsules are sealed by autogenous TIG welding.

3. **Application**

This source design is used in devices installed in beverage and food plants as density gauges for the measurement of fill levels in various container types. Ingress of contamination to the gauge is prevented by the use of air purge systems. The gauges are typically mounted in clean, non-corrosive environments at ambient temperatures in the range 10°C to 38 °C. The equipment is mounted to the floor to reduce vibration to a minimum. The BS/ISO/ANSI performance recommendation for these applications is 33222.

4. **Specification**

The AMCQ505 is specified on its product specification sheet issue 2 dated 5 February 96

In summary the key product performance related data is:-

Activity:	3.7 GBq (100 mCi) Maximum	
Output: (60 KeV)	45 x 10 <sup>6</sup> to 60 x 10 <sup>6</sup> photons /sec/steradian.	
ISO/ANSI Rating:	C64634	QCS: 519 Issue: 7
Special Form:	GB/070/S-85	QCS: 382 Issue: 8

Customer's own drawings as follows

Drawing GA:	06110 issue 7, or 06110-1 issue 4 or 06765 issue 5
Details:	04568 issue 7 04565 issue 3 06930 issue 3

5. **Manufacturing and Test Procedures**

The applicable manufacturing and test procedures are:-

MP 086	Industrial Dynamics Sources Code AMCQ505
MP 378	Manufacture of Am-241 sources
QCP 039	Visual Examination of welds
QCP 054	Cleaning of source capsule components
QCP 113	Helium leak test
QCP 116	Visual examination
QCP 130	Wipe Test Protocols
QCP 131	Immersion Testing
RS 841	Route card
HI 001	Handling Instructions

A review of these procedures indicates that no changes have been made on up which materially changes the performance or functionality of the product. Changes that have been made have been for operational reasons or for increased clarity.

6. **Evaluation of Product ex Use.**

Two sources serial numbers 150 and 162 with a history of use of 20 and 10 years in service respectively were provided by Industrial Dynamics for evaluation.

6.1 **Historical Use Data**

The sources that were inspected were supplied in 1970. Approximately 6500 gauges of this design have been installed world wide over the past 30 years.

6.2 **History of Use Records**

Over several million hours of operating time there have been no instances of failure in the integrity of the source housing or signs of deterioration of the sources.

During the initial 25 years or so the sources were leak tested every six months. No leakage has ever been reported. On the basis of this data the US NRC extended the leak test period to 36 months. Industrial Dynamics maintained a record of all sources shipped by them with maintenance and wipe test data where this is available.

6.3 Inspection

Inspection by Nycomed Amersham consisted of visual examination, wipe, immersion, He pressurisation leakage, and vacuum bubble tests.

Procedure	Issue	Title
QCP 113	6	Helium pressure test
QCP 116	2	Visual examination
QCP 130	7	Wipe test
QCP 131	6	Immersion test

Both sources passed all tests. The wipe test results were 0.01 nCi and the immersion test 0.18 nCi. Details of the test results are given in QATM 205. There was no evidence of mechanical damage and both sources were considered to be equivalent in appearance and condition to current 'as manufactured product'

7. Customer Feedback

There are no records of problems connected with this application of the product in the Customer Feedback files.

8. Design Assessment for Extended RWL

Radiation damage is not a consideration at the low dose rates involved.

The key feature of the design that requires assessment is the effect of internal pressure resulting from the build up of helium from alpha particle decay.

The bursting pressure for the window has been determined experimentally at ambient temperature as 7500psi (51.7MPa) ref. QATM 053 issue 1. This is in agreement with the calculated bursting pressure using:

$$P = 2t\sigma / b \quad - (1)$$

where t = window thickness, b = window width

Calculations have been performed for 40 years for a source containing 100 mCi of Americium-241.

In summary the results after 40 years are:-

Internal void volume	=	83.9 mm <sup>3</sup>
Internal pressure at 800 °C after 40 years	=	0.31 MPa
Stress in Capsule window (eqn. 1)	=	14.8 MPa
Percentage of UTS	=	8.7 %
Weld stress at 800 °C	=	9.52 MPa
Shear stress as percentage of shear strength	=	11.2 %

Conclusion: The calculated stresses at 800°C after 40 years are well within the design capabilities of the capsule.

9. **RWL Assessment Conclusions and Recommendation**

No deterioration of the product which would effect the integrity of the product in use or in transport accident conditions as defined by the IAEA Special Form material definitions were noted during inspection.

On the basis of this design review, the inspection results and the pressure calculations it is recommended that the RWL is extended to 40 years.

**CERTIFICATE OF RADIOACTIVE SOURCE**  
**RECOMMENDED WORKING LIFE EXTENSION**

**RLC 519 Issue 1**

**Title** : Americium-241 Low Energy Gamma Source  
**Assembly Code** : XN240  
**Assembly Drawing** : 06110 (Industrial Dynamics)  
**Radionuclide** : Am-241  
**Nominal Activity** : 3.7GBq (100mCi)

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**Classification** : BS 5288; ISO/99/; ANSI /97 **C64634**

**Recommended Working Life** : **40 Years**

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**Effective Date** : Date of manufacture of each source  
**Customer** : Industrial Dynamics Co Ltd  
**Application** : Fill level gauges  
**Product Approved** : AMCQ505.

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**Basis for extended RWL:** Design review DRAMCQ505 Issue 1.

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*DS Hunt*  
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Design

*10-12-01*  
.....  
Date

*B. Hendry*  
.....  
Quality Assurance

*10 December 2001*  
.....  
Date