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10CFR21 REPORT

Report To: NRC Operations Centre
By Fax: 301 816 5151

By Mail: NRC Document Control Desk
US Nuclear Regulatory Commission
1 White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Report Filed By: Rotork Controls Inc.
675 Mile Crossing Blvd
Rochester NY 14624

Date of Report: June 10, 2002

Originated By: Karen Black
Quality Manager

Approved By: Bob Arnold
President

Signed K. C. Black

Date June 10, 2002

Signed

Date June 10, 2002

1.0 Basic Component Affected

Rotork NA1 type Electric Valve Actuators fitted with an Add-on-Pak 1 (AOP1) Assembly, manufactured between 1978 (post 78 build) and October 2001, that have a safety function and are used for *end of travel indication*. If used for mid travel indication, with the switches are set to trip in the range of 7.5% to 92.5% of set travel, then the function of the AOP will not be affected. This range depends on the gear ratio within the AOP1 and could increase to 3.7% to 96.3% as indicated in Attachment A.

The basic control of the Rotork NA1 type actuator is through the torque switch and end of position switches (three for the close direction and three for the open direction) that are present in the main switch mechanism. This is described in Rotork publication AE1/4. The AOP1 is an optional assembly, fitted with either six or twelve switches, whose design is best suited for use in mid travel i.e. for indication and for torque switch bypass.

Rotork NA4, NA5, NA1E and NAE5 type Electric Valve Actuators are not affected.

IE20

2.0 Nature of the Defect and Associated Safety Hazard

It has recently been identified that the moulded (PPS) components within the AOP1 assembly have a low level of crystallinity and it cannot be confirmed that they are to the same specification as those originally tested and qualified at Wyle in 1978 (refer test report 43979-1 Rev A).

The AOP1 components have been supplied by the same sub-contractor for many years and record's go back to the mid 80's. The sub-contractor does not anneal the components and the tool is not heated hence the components have a low level of crystallinity. The WYLE test monitored the trip point of the AOP1 switches through out the qualification program and was reported to be acceptable. This would imply that either that the AOP1 components tested were annealed or, more probable, that the thermal aging process during the test program annealed the components. An annealing process was added to the AOP1 components in October 2001 to preclude recurrence of this condition.

Recent testing has revealed that moulded PPS AOP1 components with a low level of crystallinity could distort in extreme circumstances, causing the switches to reset or fail to operate. For the distortion to occur, the following conditions must exist simultaneously:

1. The actuator is held in the fully open or closed condition and the AOP1 is set within zero and a minimum of 3.5% of end of travel, maximum 7.5% of end of travel. This is dependent on the gear ratio as detailed in Attachment A.

2. The AOP1 components reach temperatures above 80°C (176°F) and are maintained at this temperature for more than 10 minutes.

Affect on Functionality

- Prior to reaching 80°C (176°F) and for a period of 10 minutes at this temperature, the AOP1 will function correctly regardless of the valve position and the trip position of each switch.

- If the AOP1 switches are set to trip in mid travel and are in this state when exposed to 80°C (176°F) for a period of 10 minutes or more, there is no effect on function. The PPS components may distort but the trip point for the switches and the indication will not change.

Attachment 2 details typical scenarios and the corresponding affect this condition will have on AOP1 function.

3.0 Date of Discovery

April 15, 2002

4.0 Number and Location of Components (Valve Actuators) Affected

NA4 and NA5 type Electric Valve Actuators have a maximum ambient temperature rating of 70C (160F) and are not affected.

NA1 type Electric Valve Actuators have the same ambient temperature rating but can be subject to a loss of coolant accident (LOCA) and are required to operate after this event. The condition reported will only affect Valve Actuators in plant locations where

- the LOCA and Operational temperature specifications, as defined in the Design Basis Document for each facility and location, exceed 80°C (176°F) **and**
- the AOP1 fitted was manufactured between 1978 and October 2001 **and**
- the AOPI is exposed to the two conditions outlined in section 2.0.

5.0 Corrective Action

This condition can be corrected without removing the actuator from service, or the AOP1 from the actuator, by annealing "in situ" as documented in Rotork procedure NEP01. Alternatively the AOP1 can be removed from the actuator and annealed as a separate assembly as documented in Rotork Procedure NEP03. The effect on Qualified Life of the annealing process is documented in Rotork procedure ER244.

The documents referenced above are enclosed in the FedEx package sent June 10, 2002.

6.0 Recommended Actions

Each utility must assess whether there are any NA1 actuators installed, fitted with an AOP1 manufactured between 1978 and October 2001, with a safety function and used in the end of travel position, that could be exposed to the two conditions described in section 2, and whether AOP1 malfunction would compromise plant operation.

Please report the results of this assessment to Karen Black in writing who will contact you to establish the rework schedule.

Attachment A

Ref. ER250
Issue 2
Date 6/6/02

NUCLEAR NA1 AOP. % CHANGE IN SWITCH TRIP POSITION.

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		Actuator output turns range using 'LOW' limit switch ratio																							
Actuator	L/S RATIO	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1 to 16NA1	3.125	1.16	1.25	1.26	1.55	1.56	1.90	1.91	2.35	2.36	2.55	2.56	3.15	3.16	3.95	3.96	4.75	4.85	5.20	5.25	6.40	6.45	8.00	8.10	9.60
Camshaft movement Degree		89.09	96.00	96.77	119.04	119.81	145.92	146.69	180.48	89.50	96.70	97.08	119.46	119.84	149.80	150.18	180.13	90.82	97.38	98.31	119.85	120.78	149.81	151.68	179.77
% Change		7.48	6.94	6.88	5.59	5.56	4.56	4.54	3.69	7.44	6.89	6.86	5.58	5.56	4.45	4.43	3.70	7.33	6.84	6.77	5.56	5.51	4.45	4.39	3.70
30NA1 to 90NA1	5	1.88	2.00	2.01	2.50	2.51	3.00	3.01	3.75	3.81	4.10	4.11	5.10	5.11	6.10	6.11	7.60	7.71	8.30	8.35	10.25	10.26	12.50	12.51	15.50
Camshaft movement Degree		90.24	96.00	96.48	120.00	120.48	144.00	144.48	180.00	90.30	97.18	97.42	120.88	121.12	144.58	144.82	180.13	90.24	97.14	97.73	119.96	120.08	146.30	146.41	181.41
% Change		7.38	6.94	6.90	5.55	5.53	4.63	4.61	3.70	7.38	6.85	6.84	5.51	5.50	4.61	4.60	3.70	7.38	6.86	6.81	5.55	5.55	4.55	4.55	3.67
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 21337		0								2								4							
Number os spacers 21338		5								4								3							

		Actuator output turns range using 'LOW' limit switch ratio																							
Actuator	L/S RATIO	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1 to 16NA1	3.125	9.80	10.50	10.55	13.00	13.10	16.00	16.10	19.50	19.55	21.00	21.10	26.00	26.10	33.00	33.10	40.00	40.10	43.00	43.10	53.00	53.10	66.00	66.10	80.00
Camshaft movement Degree		90.62	97.09	97.55	120.21	121.13	147.95	148.87	180.31	89.26	95.89	96.34	118.72	119.17	150.68	151.13	182.64	90.41	96.95	97.18	119.50	119.72	148.81	149.03	180.37
% Change		7.35	6.86	6.83	5.54	5.50	4.50	4.47	3.69	7.46	6.95	6.91	5.61	5.59	4.42	4.41	3.65	7.37	6.87	6.85	5.57	5.56	4.48	4.47	3.69
30NA1 to 90NA1	5	15.56	16.80	16.85	20.75	20.80	26.00	26.10	31.00	31.50	34.00	34.10	42.00	42.10	52.00	52.10	63.00	64.10	69.00	69.10	85.00	85.10	105.00	105.10	127.00
Camshaft movement Degree		89.93	97.09	97.38	119.92	120.21	150.26	150.84	179.16	90.18	97.03	97.31	119.86	120.14	148.39	148.68	179.79	90.33	97.23	97.37	119.78	119.92	147.96	148.10	178.96
% Change		7.41	6.86	6.84	5.55	5.54	4.43	4.42	3.72	7.39	6.86	6.84	5.56	5.54	4.49	4.48	3.70	7.37	6.85	6.84	5.56	5.55	4.50	4.50	3.72
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 21337		6								8								10							
Number of spacers 21338		2								1								0							

This sheet is based on NA1 gear selection chart 40064 issue 101.(POST 1978 NA1)

% Change is derived assuming maximum deformation of the Ryton AOP1 cam resulting in a 6.66 degree change in switch trip position.

Example - 7NA1 with 10 actuator output turns
3.125 : 1 'Low' limit switch ratio will use 6 gears (37/26 teeth) & 2 spacers.
% change in switch trip position 7.35% - 6.86%.

Ref. ER250
Issue 2
Date 6/6/02

NUCLEAR NA1 AOP. % CHANGE IN SWITCH TRIP POSITION.

rotork

Actuator	L/S RATIO	Actuator output turns using 'MEDIUM'/'HIGH' limit switch ratio																							
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1/11NA1	8.333	3.09	3.33	3.36	4.13	4.16	5.07	5.09	6.27	6.29	6.80	6.83	8.40	8.43	10.53	10.56	12.67	12.93	13.87	14.00	17.07	17.20	21.33	21.60	25.60
Camshaft movement Degree		89.00	95.91	96.77	118.95	119.81	146.02	146.60	180.58	89.45	96.71	97.13	119.46	119.89	149.76	150.18	180.19	90.80	97.40	98.32	119.88	120.79	149.79	151.69	179.78
% Change		7.48	6.94	6.88	5.60	5.56	4.56	4.54	3.69	7.45	6.89	6.86	5.57	5.56	4.45	4.43	3.70	7.33	6.84	6.77	5.56	5.51	4.45	4.39	3.70
14NA1/16NA1	15	5.57	6.00	6.05	7.44	7.49	9.12	9.17	11.28	11.33	12.24	12.29	15.12	15.17	18.96	19.01	22.80	23.28	24.96	25.20	30.72	30.96	38.40	38.88	46.08
Camshaft movement Degree		89.12	96.00	96.80	119.04	119.84	145.92	146.72	180.48	89.51	96.70	97.10	119.46	119.85	149.80	150.19	180.13	90.82	97.38	98.31	119.85	120.78	149.81	151.68	179.77
% Change		7.47	6.94	6.88	5.59	5.56	4.56	4.54	3.69	7.44	6.89	6.86	5.58	5.56	4.45	4.43	3.70	7.33	6.84	6.77	5.56	5.51	4.45	4.39	3.70
30NA1/40NA1	20	7.52	8.00	8.04	10.00	10.04	12.00	12.04	15.00	15.24	16.40	16.44	20.40	20.44	24.40	24.44	30.40	30.84	33.20	33.40	41.00	41.04	50.00	50.04	62.00
Camshaft movement Degree		90.24	96.00	96.48	120.00	120.48	144.00	144.48	180.00	90.30	97.18	97.42	120.88	121.12	144.58	144.82	180.13	90.24	97.14	97.73	119.96	120.08	146.30	146.41	181.41
% Change		7.38	6.94	6.90	5.55	5.53	4.63	4.61	3.70	7.38	6.85	6.84	5.51	5.50	4.61	4.60	3.70	7.38	6.86	6.81	5.55	5.55	4.55	4.55	3.67
70NA1/90NA1	25	9.40	10.00	10.05	12.50	12.55	15.00	15.05	18.75	19.05	20.50	20.55	25.50	25.55	30.50	30.55	38.00	38.55	41.50	41.75	51.25	51.30	62.50	62.55	77.50
Camshaft movement Degree		90.24	96.00	96.48	120.00	120.48	144.00	144.48	180.00	90.30	97.18	97.42	120.88	121.12	144.58	144.82	180.13	90.24	97.14	97.73	119.96	120.08	146.30	146.41	181.41
% Change		7.38	6.94	6.90	5.55	5.53	4.63	4.61	3.70	7.38	6.85	6.84	5.51	5.50	4.61	4.60	3.70	7.38	6.86	6.81	5.55	5.55	4.55	4.55	3.67
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 21337		0								2								4							
Number os spacers 21338		5								4								3							

Actuator	L/S RATIO	Actuator output turns using 'MEDIUM'/'HIGH' limit switch ratio																							
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1/11NA1	8.333	26.13	28.00	28.13	34.67	34.93	42.66	42.93	52.00	52.13	56.00	56.26	69.33	69.60	88.00	88.26	106.66	106.93	114.66	114.93	141.33	141.59	175.99	176.26	213.32
Camshaft movement Degree		90.61	97.10	97.55	120.22	121.13	147.93	148.87	180.32	89.26	95.89	96.33	118.71	119.18	150.68	151.13	182.64	90.41	96.95	97.18	119.50	119.72	148.80	149.03	180.37
% Change		7.35	6.86	6.83	5.54	5.50	4.50	4.47	3.69	7.46	6.95	6.91	5.61	5.59	4.42	4.41	3.65	7.37	6.87	6.85	5.57	5.56	4.48	4.47	3.69
14NA1/16NA1	15	47.04	50.40	50.64	62.40	62.88	76.80	77.28	93.60	93.84	100.80	101.28	124.80	125.28	158.68	158.88	192.00	192.48	206.40	206.88	254.40	254.88	316.80	317.28	384.00
Camshaft movement Degree		90.62	97.09	97.55	120.21	121.13	147.95	148.87	180.31	89.26	95.89	96.34	118.72	119.17	150.94	151.13	182.64	90.41	96.95	97.18	119.50	119.72	148.81	149.03	180.37
% Change		7.35	6.86	6.83	5.54	5.50	4.50	4.47	3.69	7.46	6.95	6.91	5.61	5.59	4.41	4.41	3.65	7.37	6.87	6.85	5.57	5.56	4.48	4.47	3.69
30NA1/40NA1	20	62.24	67.20	67.40	83.00	83.20	104.00	104.40	124.00	126.40	136.00	136.40	168.00	168.40	208.00	208.40	252.00	256.40	276.00	276.40	340.00	340.40	420.00	420.40	508.00
Camshaft movement Degree		89.93	97.09	97.38	119.92	120.21	150.26	150.84	179.16	90.18	97.03	97.31	119.86	120.14	148.39	148.68	179.79	90.33	97.23	97.37	119.78	119.92	147.96	148.10	178.96
% Change		7.41	6.86	6.84	5.55	5.54	4.43	4.42	3.72	7.39	6.86	6.84	5.56	5.54	4.49	4.48	3.70	7.37	6.85	6.84	5.56	5.55	4.50	4.50	3.72
70NA1/90NA1	25	77.80	84.00	84.25	103.75	104.00	130.00	130.50	155.00	158.00	170.00	170.50	210.00	210.50	260.00	260.50	315.00	320.50	345.00	345.50	425.00	425.50	525.00	525.50	635.00
	33			127.10	137.28	137.28	171.60	172.26	204.60	208.50	224.40	225.00	277.20	277.86	343.20	343.86	415.80	423.00	455.40	456.00	561.00	561.66	693.00	693.66	838.20
Camshaft movement Degree		89.93	97.09	97.38	119.92	120.21	150.26	150.84	179.16	90.18	97.03	97.31	119.86	120.14	148.39	148.68	179.79	90.33	97.23	97.37	119.78	119.92	147.96	148.10	178.96
% Change		7.41	6.86	6.84	5.55	5.54	4.43	4.42	3.72	7.39	6.86	6.84	5.56	5.54	4.49	4.48	3.70	7.37	6.85	6.84	5.56	5.55	4.50	4.50	3.72
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 21337		6								8								10							
Number of spacers 21338		2								1								0							

This sheet is based on NA1 gear selection chart 40064 issue 101.(POST 1978 NA1)

% Change is derived assuming maximum deformation of the Ryton AOP1 cam resulting in a 6.66 degree change in switch trip position.

Ref. ER250
Issue 2
Date 6/6/02

NUCLEAR NA1/NA1E AOP. % CHANGE IN SWITCH TRIP POSITION.

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		Actuator output turns range using 'LOW' limit switch ratio																							
Actuator	L/S RATIO	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1 to 16NA1	3.125	1.16	1.25	1.26	1.55	1.56	1.90	1.91	2.35	2.36	2.55	2.56	3.15	3.16	3.95	3.96	4.75	4.85	5.20	5.25	6.40	6.45	8.00	8.10	9.60
Camshaft movement Degree		89.09	96.00	96.77	119.04	119.81	145.92	146.69	180.48	89.50	96.70	97.08	119.46	119.84	149.80	150.18	180.13	90.82	97.38	98.31	119.85	120.78	149.81	151.68	179.77
% Change		7.48	6.94	6.88	5.59	5.56	4.56	4.54	3.69	7.44	6.89	6.86	5.58	5.56	4.45	4.43	3.70	7.33	6.84	6.77	5.56	5.51	4.45	4.39	3.70
30NA1 to 90NA1	5	1.88	2.00	2.01	2.50	2.51	3.00	3.01	3.75	3.61	4.10	4.11	5.10	5.11	6.10	6.11	7.60	7.71	8.30	8.35	10.25	10.26	12.50	12.51	15.50
Camshaft movement Degree		90.24	96.00	96.48	120.00	120.48	144.00	144.48	180.00	90.30	97.18	97.42	120.88	121.12	144.58	144.82	180.13	90.24	97.14	97.73	119.96	120.08	146.30	146.41	181.41
% Change		7.38	6.94	6.90	5.55	5.53	4.63	4.61	3.70	7.38	6.85	6.84	5.51	5.50	4.61	4.60	3.70	7.38	6.86	6.81	5.55	5.55	4.55	4.55	3.67
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 44190		0								1								3							
Number os spacers 21338		5								4								3							
Drive gear 44191		0								1								1							

		Actuator output turns range using 'LOW' limit switch ratio																							
Actuator	L/S RATIO	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1 to 16NA1	3.125	9.80	10.50	10.55	13.00	13.10	16.00	16.10	19.50	19.55	21.00	21.10	26.00	26.10	33.00	33.10	40.00	40.10	43.00	43.10	53.00	53.10	66.00	66.10	80.00
Camshaft movement Degree		90.62	97.09	97.55	120.21	121.13	147.95	148.87	180.31	89.26	95.89	96.34	118.72	119.17	150.68	151.13	182.64	90.41	96.95	97.18	119.50	119.72	148.81	149.03	180.37
% Change		7.35	6.86	6.83	5.54	5.50	4.50	4.47	3.69	7.46	6.95	6.91	5.61	5.59	4.42	4.41	3.65	7.37	6.87	6.85	5.57	5.56	4.48	4.47	3.69
30NA1 to 90NA1	5	15.56	16.80	16.85	20.75	20.80	26.00	26.10	31.00	31.60	34.00	34.10	42.00	42.10	52.00	52.10	63.00	64.10	69.00	69.10	85.00	85.10	105.00	105.10	127.00
Camshaft movement Degree		89.93	97.09	97.38	119.92	120.21	150.26	150.84	179.16	90.18	97.03	97.31	119.86	120.14	148.39	148.68	179.79	90.33	97.23	97.37	119.78	119.92	147.96	148.10	178.96
% Change		7.41	6.86	6.84	5.55	5.54	4.43	4.42	3.72	7.39	6.86	6.84	5.56	5.54	4.49	4.48	3.70	7.37	6.85	6.84	5.56	5.55	4.50	4.50	3.72
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 44190		5								7								9							
Number of spacers 21338		2								1								0							
Drive Gear 44191		1								1								1							

This sheet is based on NA1 gear selection chart 40064 issue 2.

% Change is derived assuming maximum deformation of the Ryton AOP1 cam resulting in a 6.66 degree change in switch trip position.

Example - 7NA1 with 10 actuator output turns
3.125 : 1 'Low' limit switch ratio will use 6 gears (5 x 44190 + 1 x 44191) & 2 spacers.
% change in switch trip position 7.35% - 6.86%.

Ref. ER250
Issue 2
Date 6/6/02

NUCLEAR NA1/NA1E AOP. % CHANGE IN SWITCH TRIP POSITION.

rotork

		Actuator output turns using 'MEDIUM'/'HIGH' limit switch ratio																							
Actuator	L/S RATIO	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1/11NA1	8.333	3.09	3.33	3.36	4.13	4.16	5.07	5.09	6.27	6.29	6.80	6.83	8.40	8.43	10.53	10.56	12.67	12.93	13.87	14.00	17.07	17.20	21.33	21.60	25.60
Camshaft movement Degree		89.00	95.91	96.77	118.95	119.81	146.02	146.60	180.58	89.45	96.71	97.13	119.46	119.89	149.76	150.18	180.19	90.80	97.40	98.32	119.88	120.79	149.79	151.69	179.78
% Change		7.48	6.94	6.88	5.60	5.56	4.56	4.54	3.69	7.45	6.89	6.86	5.57	5.56	4.45	4.43	3.70	7.33	6.84	6.77	5.56	5.51	4.45	4.39	3.70
14NA1/16NA1	15	5.57	6.00	6.05	7.44	7.49	9.12	9.17	11.28	11.33	12.24	12.29	15.12	15.17	18.96	19.01	22.80	23.28	24.96	25.20	30.72	30.96	38.40	38.88	46.08
Camshaft movement Degree		89.12	96.00	96.80	119.04	119.84	145.92	146.72	180.48	89.51	96.70	97.10	119.46	119.85	149.80	150.19	180.13	90.82	97.38	98.31	119.85	120.78	149.81	151.68	179.77
% Change		7.47	6.94	6.88	5.59	5.56	4.56	4.54	3.69	7.44	6.89	6.86	5.58	5.56	4.45	4.43	3.70	7.33	6.84	6.77	5.56	5.51	4.45	4.39	3.70
30NA1/40NA1	20	7.52	8.00	8.04	10.00	10.04	12.00	12.04	15.00	15.24	16.40	16.44	20.40	20.44	24.40	24.44	30.40	30.84	33.20	33.40	41.00	41.04	50.00	50.04	62.00
Camshaft movement Degree		90.24	96.00	96.48	120.00	120.48	144.00	144.48	180.00	90.30	97.18	97.42	120.88	121.12	144.58	144.82	180.13	90.24	97.14	97.73	119.96	120.08	146.30	146.41	181.41
% Change		7.38	6.94	6.90	5.55	5.53	4.63	4.61	3.70	7.38	6.85	6.84	5.51	5.50	4.61	4.60	3.70	7.38	6.86	6.81	5.55	5.55	4.55	4.55	3.67
70NA1/90NA1	25	9.40	10.00	10.05	12.50	12.55	15.00	15.05	18.75	19.05	20.50	20.55	25.50	25.55	30.50	30.55	38.00	38.55	41.50	41.75	51.25	51.30	62.50	62.55	77.50
Camshaft movement Degree		90.24	96.00	96.48	120.00	120.48	144.00	144.48	180.00	90.30	97.18	97.42	120.88	121.12	144.58	144.82	180.13	90.24	97.14	97.73	119.96	120.08	146.30	146.41	181.41
% Change		7.38	6.94	6.90	5.55	5.53	4.63	4.61	3.70	7.38	6.85	6.84	5.51	5.50	4.61	4.60	3.70	7.38	6.86	6.81	5.55	5.55	4.55	4.55	3.67
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 44190					0								1								3				
Number os spacers 21338					5								4								3				
Drive gear 44191					0								1								1				

		Actuator output turns using 'MEDIUM'/'HIGH' limit switch ratio																							
Actuator	L/S RATIO	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
7NA1/11NA1	8.333	26.13	28.00	28.13	34.67	34.93	42.66	42.93	52.00	52.13	56.00	56.26	69.33	69.60	88.00	88.26	106.66	106.93	114.66	114.93	141.33	141.59	175.99	176.26	213.32
Camshaft movement Degree		90.61	97.10	97.55	120.22	121.13	147.93	148.87	180.32	89.26	95.89	96.33	118.71	119.18	150.68	151.13	182.64	90.41	96.95	97.18	119.50	119.72	148.80	149.03	180.37
% Change		7.35	6.86	6.83	5.54	5.50	4.50	4.47	3.69	7.46	6.95	6.91	5.61	5.59	4.42	4.41	3.65	7.37	6.87	6.85	5.57	5.56	4.48	4.47	3.69
14NA1/16NA1	15	47.04	50.40	50.64	62.40	62.88	76.80	77.28	93.60	93.84	100.80	101.28	124.80	125.28	158.68	158.88	192.00	192.48	206.40	206.88	254.40	254.88	316.80	317.28	384.00
Camshaft movement Degree		90.62	97.09	97.55	120.21	121.13	147.95	148.87	180.31	89.26	95.89	96.34	118.72	119.17	150.94	151.13	182.64	90.41	96.95	97.18	119.50	119.72	148.81	149.03	180.37
% Change		7.35	6.86	6.83	5.54	5.50	4.50	4.47	3.69	7.46	6.95	6.91	5.61	5.59	4.41	4.41	3.65	7.37	6.87	6.85	5.57	5.56	4.48	4.47	3.69
30NA1/40NA1	20	62.24	67.20	67.40	83.00	83.20	104.00	104.40	124.00	126.40	136.00	136.40	168.00	168.40	208.00	208.40	252.00	256.40	276.00	276.40	340.00	340.40	420.00	420.40	508.00
Camshaft movement Degree		89.93	97.09	97.38	119.92	120.21	150.26	150.84	179.16	90.18	97.03	97.31	119.86	120.14	148.39	148.68	179.79	90.33	97.23	97.37	119.78	119.92	147.96	148.10	178.96
% Change		7.41	6.86	6.84	5.55	5.54	4.43	4.42	3.72	7.39	6.86	6.84	5.56	5.54	4.49	4.48	3.70	7.37	6.85	6.84	5.56	5.55	4.50	4.50	3.72
70NA1/90NA1	25	77.80	84.00	84.25	103.75	104.00	130.00	130.50	155.00	158.00	170.00	170.50	210.00	210.50	260.00	260.50	315.00	320.50	345.00	345.50	425.00	425.50	525.00	525.50	635.00
	33			127.10	137.28	137.28	171.60	172.26	204.60	208.50	224.40	225.00	277.20	277.86	343.20	343.86	415.80	423.00	455.40	456.00	561.00	561.66	693.00	693.66	838.20
Camshaft movement Degree		89.93	97.09	97.38	119.92	120.21	150.26	150.84	179.16	90.18	97.03	97.31	119.86	120.14	148.39	148.68	179.79	90.33	97.23	97.37	119.78	119.92	147.96	148.10	178.96
% Change		7.41	6.86	6.84	5.55	5.54	4.43	4.42	3.72	7.39	6.86	6.84	5.56	5.54	4.49	4.48	3.70	7.37	6.85	6.84	5.56	5.55	4.50	4.50	3.72
Potentiometer Gear No. Teeth		26		32		40		48		26		32		40		48		26		32		40		48	
Number of gear clusters 44190					5								7								9				
Number of spacers 21338					2								1								0				
Drive Gear 44191					1								1								1				

This sheet is based on NA1 gear selection chart 40064 issue 2.

% Change is derived assuming maximum deformation of the Ryton AOP1 cam resulting in a 6.66 degree change in switch trip position.

Attachment B
POSSIBLE AFFECT ON FUNCTIONALITY

Before reaching 80°C (176°F)		After reaching and being held at 80°C (176°F) for more than 10 minutes	
Valve Position	**AOP1 switch trip position**	**Open/Close Action**	**Affected on Function**
CLOSE	Mid Travel*	Open On Limit OR Open On Torque	No affect
OPEN	Mid Travel*	Close On Limit OR Close On Torque	No affect
CLOSE	End of Travel	Open On Limit OR Open On Torque	AOP switches may reset or fail to operate
OPEN	End of Travel	Close On Limit OR Close On Torque	AOP1 switches may reset or fail to operate

* Mid Travel – within range of 7.5% to 92.5% of travel (worst case) dependent on the AOP gear ratio refer Attachment A
** End of Travel - within 3.7% to 7.5% of end of travel position dependent on the AOP gear ratio refer Attachment A

Title: Effect on qualified life of Annealing Nuclear NA1 Switch Mechanism and Add-on-Pak 1 sub-assemblies.

Distribution:
I Burnell
C Warnett
K Sweet
T Wittamore

Synopsis Only
All Directors

Revision 2		
Prepared	Checked	Approved
M Williams	K Sweet	I Burnell

Revision 3		
Prepared	Checked	Approved

Revision Notes:

Annealing temperature calculations changed to use 0.8 activation energy throughout and a maximum annealing temperature of 127°C(261°F).

1.0 SYNOPSIS

This report determines the reduction in qualified life of nuclear NA1 actuator when annealing Ryton components 'in-situ'.

Calculations using the Arrhenius law show that the annealing process has no impact on the 40 year 'qualified life' of the actuator.

2.0 OBJECTIVE

To determine the reduction in qualified life of nuclear NA1 switch mechanism and A.O.P.1 sub-assembly's when annealing Ryton PPS R-4 components 'in-situ'.

3.0 INTRODUCTION

Engineering report ER239 identified Ryton components that required annealing and a method of annealing components 'in-situ' (Ref. procedure NEP01) was developed.
Nuclear NA1 actuators have specified qualified life of 40 years and this has been demonstrated ref. Rotork test report TR3030 using a conservative activation energy of 0.8 eV in an ambient of 60°C (140°F).
The annealing process locally heats the switch mechanism and A.O.P.1 assemblies to a nominal temperature of 118°C (244°F) for 2 hours, thus the effect on 'qualified life' using the maximum activation energy for the switch mechanism/A.O.P.1 assembly needs to be considered.
Other areas of the actuator enclosure (terminal block and motor) do not need to be considered because there is no direct flow of hot air into these compartments and are only warm to the touch at the end of the annealing process.
Hot air enters one end of the switch mechanism cover at approximately 140°C (284°F) and is exhausted at the other end.
During initial trials of this process a heat sensitive strip was attached to a mounting pillar between the switch mechanism and the A.O.P.1, this indicated that a temperature of 121°C(250°F) had been achieved and 127°C(261°F) had not been exceeded.

The following calculations determine the 'qualified life' for an ambient temperature range of 40°C (104°F) to 60°C (140°F) after the annealing process has been applied assuming a maximum annealing temperature of 127°C(261°F).

4.0 CALCULATIONS

QUALIFIED LIFE OF SWITCH MECHANISM COMPONENTS USING THE ARRHENIUS LAW. Ref. Report TR3030

Boltzman constant $k := 0.0000861$

Ambient temperature range C in 2 degree steps. $Ta := 40, 42 .. 60$

Ambient temperature range K. $T1_{Ta} := Ta + 273$

Aging Temperature K $T_2 := 138 + 273$ $T_2 = 411$

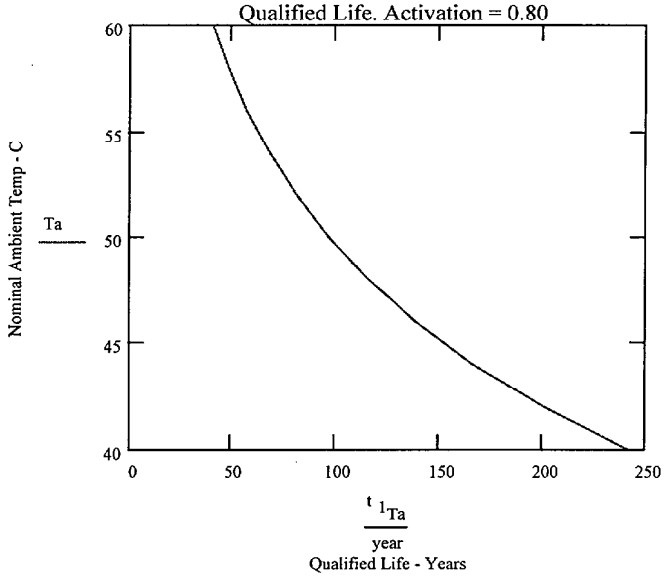
Aging time – hours $t_2 := 1797.6hr$

Switch mechanism activation energy (Nitrile seals) $\phi := 0.80$

Arrhenius calculation $t1_{Ta} := t_2 \cdot e^{\frac{\phi}{k}\cdot\left(\frac{1}{T1_{Ta}} - \frac{1}{T_2}\right)}$

$year := 365 \cdot day$

$T1_{Ta}$	$\frac{t1_{Ta}}{year}$
313	241.96
315	200.43
317	166.42
319	138.5
321	115.53
323	96.59
325	80.93
327	67.96
329	57.18
331	48.22
333	40.74



REDUCTION IN QUALIFIED LIFE DUE TO ANNEALING SWITCH MECHANISM COMPONENTS USING THE ARRHENIUS LAW

Boltzman constant $k := 0.0000861$

Ambient temperature range C in 2 degree steps. $Ta := 40, 42.. 60$

Ambient temperature range K. $T3_{Ta} := Ta + 273$

Nominal annealing Temperature K $T4 := 127 + 273$ $T4 = 400$

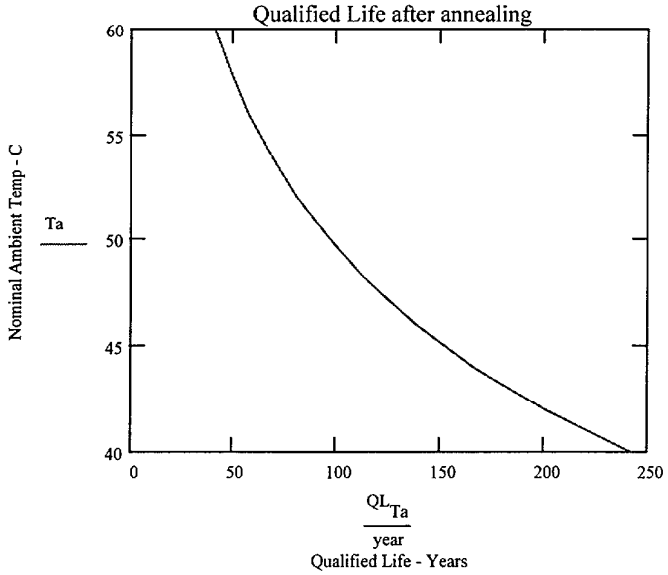
Annealing time – hours $t4 := 2 \cdot hr$

Switch mechanism activation energy (Nitrile seals) $\phi := 0.8$

Arrhenius calculation $t3_{Ta} := t4 \cdot e^{\frac{\phi}{k} \cdot \left(\frac{1}{T3_{Ta}} - \frac{1}{T4} \right)}$

Qualified life after annealing $QL_{Ta} := t1_{Ta} - t3_{Ta}$

QL_{Ta} / year
241.815
200.306
166.317
138.418
115.463
96.531
80.882
67.916
57.15
48.191
40.72



5.0 RESULTS

It can be seen from the above calculations that the switch mechanism and A.O.P.1 assembly has a qualified life in excess of 40 years in 60°C (140°F) ambient after the annealing process. Thus the annealing process has no impact on the 40 year 'qualified life' of the actuator.

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Approved by Engineering

Nuclear Engineering Procedure No. **NEP01** Issue 3 Date: 28th May 2002

DISTRIBUTION RECORD

INTERNAL			EXTERNAL		
LOCATION	**SIGNATURE**	**DATE**	**LOCATION**	**SIGNATURE**	**DATE**
Rotork Bath			**Rotork Inc**		
Tim Wood			Karen Black		

REVISION SHEET

ORIGIN	K Sweet
DATE OF ISSUE	20/02/2002
TITLE	Procedure for annealing Ryton switch mechanism components when assembled into an actuator & fitting of return springs N45367.

Issue No	Date	Revision	By
1	20/02/02	Original	KRS
2	24/04/02	Note added stating spring fitting procedure is only for NA1E actuators.	KRS
3	28/05/02	Attachment 'C' revised to latest details.	KRS

ANNEALING PROCESS FOR ASSEMBLED

NUCLEAR ACTUATOR SWITCH MECHANISMS

AND FITTING OF RETURN SPRINGS N45367

Index

1.0 PURPOSE.

2.0 SCOPE.

3.0 ANNEALING PROCEDURE.

4.0 SPRING FITTING PROCEDURE.
(Only for NA1E actuators)

Attachments

a) – Annealing certificate.
b) – Heat Gun details
c) – Modified cover detail.

1.0 PURPOSE

1.1 To define a procedure for annealing Ryton R-4 PPS components when assembled into a nuclear actuator switch mechanism assembly.

1.2 To define a procedure for fitting return springs N45367 if not already fitted. (Only applicable to NA1E actuators)

2.0 SCOPE

2.1 Applicable to all NA1 and NA1E actuators identified as requiring annealing as part of investigation ref. ER239.

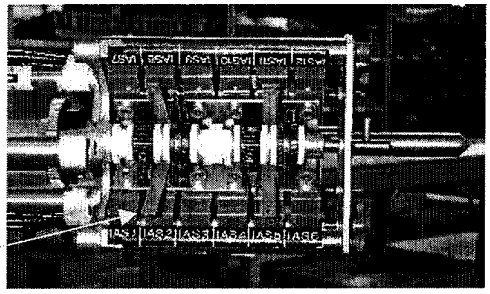
3.0 ANNEALING PROCEDURE

3.1 Remove switch mechanism cover.

3.2 Manually operate actuator until in 'mid-travel'. Ensure that the switch mechanism Ryton parts and the AOP1 Ryton parts are in a neutral position and are **not** 'loaded'.

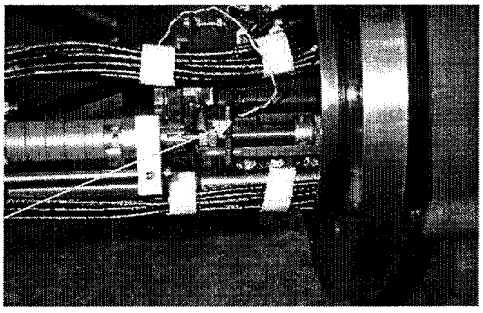
NB. If it is not possible to position the AOP1 cams to a neutral position the striker plates must be held away from the operating surface of the cams. This can be achieved by placing metal strips (part number 04301) between the camshaft and the striker plates as shown below –

Metal strip
04301



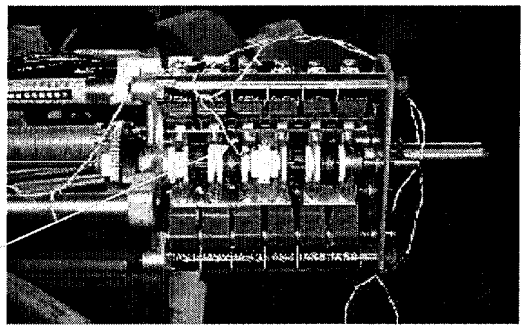
3.3 Fit a thermal couple to the switch mechanism by trapping between striker plate and over travel spring as shown below –

Thermal
Couple



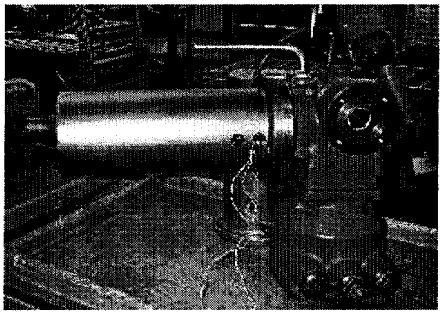
3.4 Fit a thermal couple to the A.O.P.1. by placing between a striker plate and a cam as shown below –

Thermal Couple



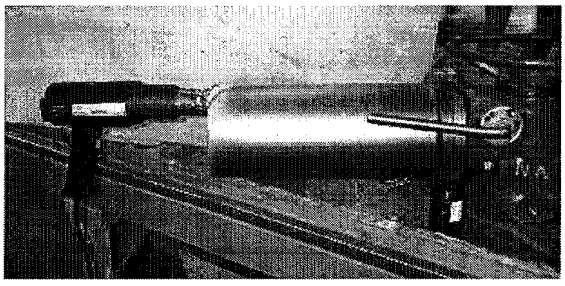
3.5 Fit specially adapted switch mechanism cover and pass thermal couple leads out through exhaust vents.

Insulation material removed for clarity.



3.6 Connect thermal couple leads to chart recorder for temperature logging. Record actuator serial number on chart.

3.7 Fit heat gun and set to maximum flow and temperature setting 4.



3.8 Heat until thermal couples indicate 110°C (Approximately ½ hour), reduce to temperature setting 3 ½ and leave for a minimum of 2 hours. Temperature must be in the range 110°C to 125°C for this period and must be logged for reference.
NOTE - Temperature setting of heat gun may need adjustment to suit ambient conditions.

3.9 Remove heat gun and leave to cool for ½ hour then remove heating cover.

3.10 When switch mechanism has fully cooled re-tighten A.O.P.1 cam locking nut to 10 lbs. in and visually inspect Ryton components for any sign of damage/cracks. Note switch mechanism Ryton components will have changed colour from a black appearance to a brown appearance.

3.11 NA1E type switch mechanisms only - Inspect switch mechanism switch packs for return springs, if not fitted apply spring fitting procedure as defined in section 4.0

3.12 Remove thermal couples, metal spacers 04301 (if fitted) and refit switch mechanism cover using a new 'O' ring seal.

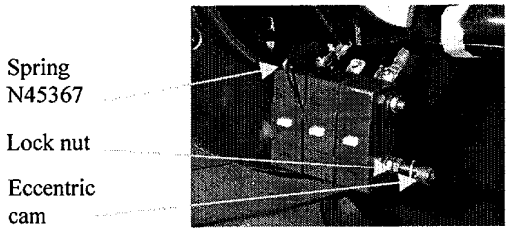
3.13 Complete certificate of site rectification & attach chart from recorder.

4.0 SPRING FITTING PROCEDURE – ONLY APPICABLE TO NA1E ACTUATORS

To improve the reliability of the switch mechanism two extra springs (N45367) are fitted as part the switch mechanism switch pack assembly. If these are not present then after the annealing process they must be fitted.

4.1 Remove the switch pack from the switch mechanism by holding the eccentric cam in position by use of a screwdriver and slacken and run back locking nut.
It is **not** necessary to disconnect wiring from the switches.
Note position and take care not to move eccentric cam as this will effect the calibration of the actuator.

4.2 Slide the switch pack out of the mechanism and clip return spring N45367 into position as shown and ensure spring is free to operate between switches.



4.3 Place switch pack back into position and retighten locking nut again ensuring eccentric cam isn't moved by holding it in place with a screwdriver.

4.4 Repeat operation for the other switch pack.

ATTACHMENT A

CERTIFICATION OF SITE RECTIFICATION

This is to certify that the actuator identified in section 1A has had the switch mechanism assembly annealed and return springs fitted (if required) as defined in procedure NEP01.

SECTION 1: IDENTIFICATION

A. **Actuator**
Serial Number: _____

Tag Number: _____

B. **Replacement Components**
_____

SECTION 2: RECORD OF WORK COMPLETED
Temperature log.
Chart recorder serial number _____

Chart reference number. _____

Date of work: _____

Work Completed by: _____
(Print Name)

_____
(Signature)

Customer QA Approval: _____
(Print Name)

_____
(Signature)

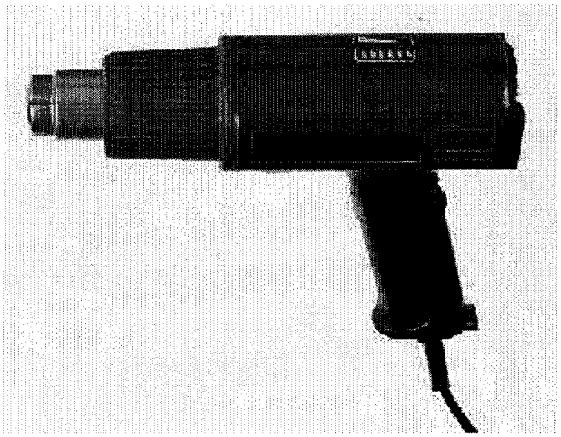
SECTION 3: ROTORK QA APPROVAL

Approved By: _____
Quality Manager

Date: _____

ATTACHMENT B

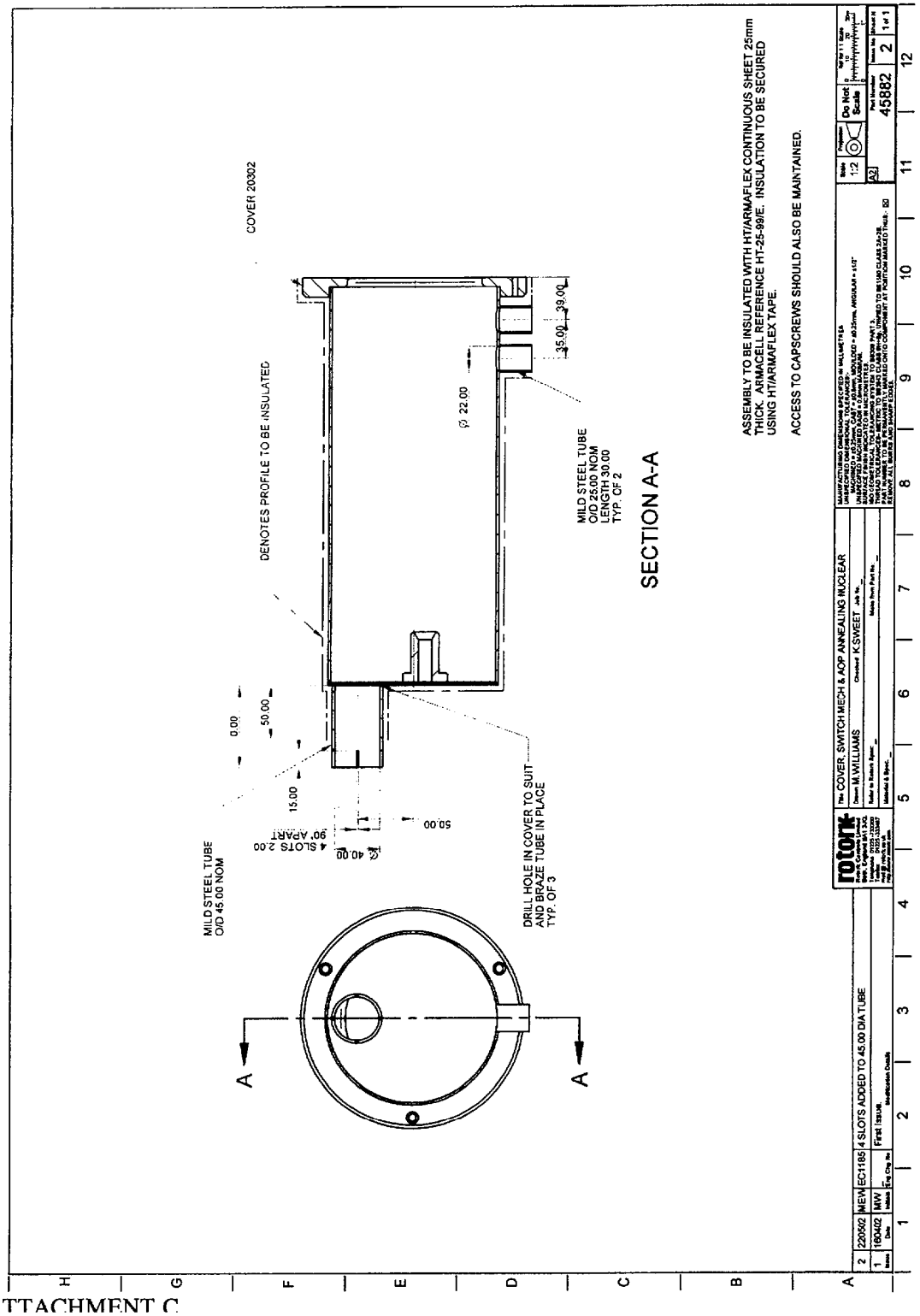
Steinel HG 3000 SLE Heat Gun



Continuously adjustable, electronically and optically monitored hot air guns. These high quality professional hot air guns feature a built-in temperature sensor which regulates and monitors the set temperature, LEDs to indicate temperature range selected and an adjustable air-flow regulator for precision working. They also have a selectable cool air stage which can be used for drying, cleaning or cooling.
Supplied complete with 1 reflector nozzle, 1 fishtail nozzle, 1×9mm reduction nozzle and instruction leaflet.

- Continuously variable air flow
- Optical temperature displays at 50, 100, 200, 350, 500 and 600°C
- Continuously variable temperature
- 50°C stage for drying, cleaning etc

Technical specification		
Power supply		110V a.c.
Output	110V a.c.	1,400W
Temperture	Stage 1	50°C
	Stage 2	50 to 600°c
Air flow	Minimum	200l/min.
	Maximum	500l/min.
Weight		885g

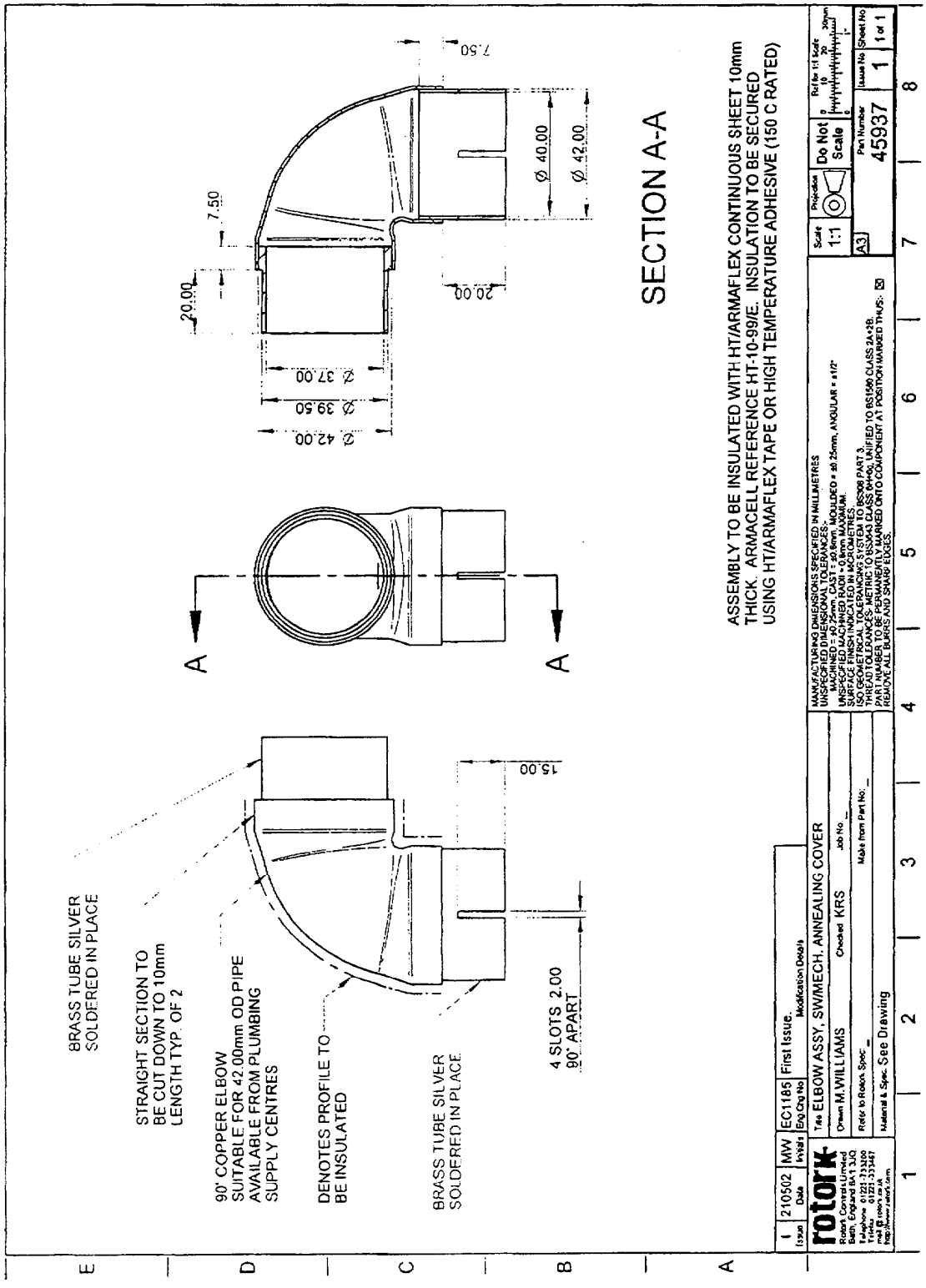


ATTACHMENT C

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Nuclear Engineering Procedure No. **NEP01** Issue 3 Date: 28th May 2002



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Nuclear Engineering Procedure No. **NEP01** Issue 3 Date: 28th May 2002

ANNEALING COVER BILL OF MATERIALS

Rotork Parts list REF. PL81286

27-247	CHART RECORDER KT655 (120VAC)
27-248	CHART 1 DAY 250 DEGREE
27-249	HEAT GUN STEINEL HG 3000 SLE 110VAC
37-749	CLIP HOSE NORMA TORRO 32-50/9 C7 W3
45882	COVER, SWITCH MECH & AOP ANNEALING
45937	ELBOW ASSY SW/MECH ANNEALING COVER
NEP01	ANNEALING 'IN-SITU' PROCEDURE

rotork
Rotork Controls Limited

Approved by Engineering

Nuclear Engineering Procedure No. NEP03 Issue 1

Date: 11th March 2002

DISTRIBUTION RECORD

INTERNAL			EXTERNAL		
LOCATION	SIGNATURE	DATE	LOCATION	SIGNATURE	DATE
Rotork Bath			**Rotork Inc**		
Tim Wood			Karen Black		

REVISION SHEET

ORIGIN K Sweet

DATE OF ISSUE 11/03/2002

TITLE Procedure for annealing Ryton components when assembled into an A.O.P.1 sub-assembly.

Issue No	Date	Revision	By
1	11/03/02	Original	KRS

ANNEALING PROCESS FOR AN ASSEMBLED

ADD-ON-PAK 1 (A.O.P.1)

Index

1.0 PURPOSE.

2.0 SCOPE.

3.0 ANNEALING PROCEDURE.

Attachments

a) – Annealing certificate.

1.0 PURPOSE

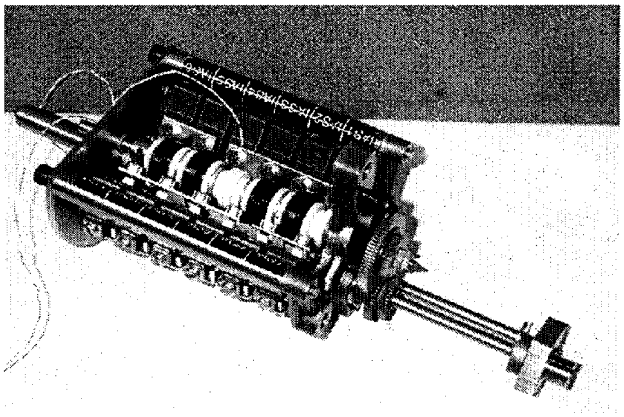
1.1 To define a procedure for annealing Ryton R-4 PPS components when assembled into an A.O.P.1 sub-assembly.

2.0 SCOPE

2.1 Applicable to all NA1 and NA1E A.O.P.1 sub-assemblies identified as requiring annealing as part of investigation ref. ER239.

3.0 ANNEALING PROCEDURE

3.1 Slacken A.O.P.1 cam locking nut and rotate cams so that they are in a neutral position and are **not** 'loaded'.



Cam Locking nut

3.2 Fit a thermal couple to the A.O.P.1. by placing between a striker plate and a cam.

3.3 Connect thermal couple leads to chart recorder for temperature logging. Record A.O.P.1 lot and order references on chart.

3.4 Heat until thermal couple indicates 110°C and leave for a minimum of 2 hours. Temperature must be in the range 110°C to 125°C for this period and must be logged for reference.

3.5 Remove A.O.P.1 assembly from oven and allow too cool naturally. When fully cool re-tighten A.O.P.1 cam locking nut to 10 lbs. in and visually inspect Ryton components for any sign of damage/cracks.

3.6 Operate A.O.P.1 mechanism and check that all switches change state when operated by the cam/striker plates.

3.7 Complete certificate of rectification & attach chart from recorder.

ATTACHMENT A

CERTIFICATION OF RECTIFICATION

This is to certify that the A.O.P.1 assembly identified in section 1A has been annealed as defined in procedure NEP03.

SECTION 1: IDENTIFICATION

A.

Order Reference: _____

Lot Reference: _____

SECTION 2: RECORD OF WORK COMPLETED

Temperature log.

Chart recorder serial number _____

Chart reference number. _____

Date of work: _____

Work Completed by: _____
(Print Name)

_____
(Signature)

SECTION 3: ROTORK QA APPROVAL

Approved By: _____
Quality Manager

Date: _____