



PUR-1 – DIGITAL I&C

Project Review & Lessons Learned

Clive Townsend – Purdue University



PROGRESS
WE'RE MOVING FORWARD
SO CAN YOU!

PUR-1 Overview


Reactor Data

- Materials Test Reactor built in 1962
- Plate Type Fuel – Completed LEU Conversion in 2007
- Originally Licensed at 1 kW, Completed 12 kW power uprate with license renewal in October 2016
- Four channels perform neutron flux measurements with two shim safeties and one regulating rod

PUR-1 Overview

The reactor went critical at 8:14 P.M.

There is considerable noise in the period circuits. As a result period meters give very little indication of value to the operator.



Mr. Thornburg of the AEC suggests that we compile a list of safety specifications for the reactor. Some time in the future, it is anticipated that all reactors will be so specified rather than being restricted ~~to hazard~~ to the specification shown in Hazards Reports.

PUR-1 Overview

18 Oct 62 0800 Equipment moved back into room.

18 Oct 62 0900 Instrument check OK.

Attempted start-up to check set-back and slow scram operation. Noise on SS#1 control circuit resulted in repeated scram and set-back. Attempted to find source of noise, unsuccessfully. By 1145 noise had practically disappeared. Possibly due to dirt on contacts some place. Reactor secured.

1545 - STARTED LOOKING FOR NOISE, RECORDERS ON - MAGNET KEY OFF. - CHECK OUT COMPLETED TO ITEM #10.

Broken connection found on LGR. Repaired Use-Calib switch.

Reactor secured 1732.

JRE

PUR-1 Overview

Inconducting part A, the ^{period}/setback meter on channel 1 was set to 20 seconds. Rod number 1 was then energized and withdrawal started. Almost immediately, the period meter went up to 12 or 15 seconds and the setback circuit operated.

PUR-1 Overview

There is, evidently, trouble in the drive mechanism or the drive circuits of rod number 1. With magnet current off, the operation of drive number 1 causes period indication in channel 1. In contrast, the operation of the drive of rod number 2 brings about no such influence on channel 1.

The remainder of the morning was spent in attempting to find the source of the noise on the control ~~wa~~ circuit of the shim rod number 1. This was ~~unsee~~ unsuccessful but the noise seemed to disappear of its own accord.

PUR-1 Overview

It is noted that when ^{The} ~~a~~ motor on rod number 1 is started, a strong signal appears on channel one. When the motor on rod number 2 is operated, no such behavior is observed.

Both shim rods were returned to lower limit. When withdrawal was started, the behavior of channel 1 was completely normal. It is possible that there was poor contact in some part of the motor circuit of rod number 1 which has disappeared by operation.

PUR-1 Overview



PUR-1 Digital I&C Replacement

Project Timeline

- Summer 2015 – Solicitation of Bids
- Fall 2015 – Bid awarded to Mirion Technologies
- Spring 2016 – Functional Requirements Specifications Complete
- May 2016 – Software and Hardware Design Locked
- August 2016 – Factory Acceptance Testing (Idaho Falls, ID)
- September 2016 – Delivery to Purdue

PUR-1 Digital I&C Replacement

Project Timeline



PUR-1 Digital I&C Replacement

Project Timeline

- Summer 2015 – Solicitation of Bids
- Fall 2015 – Bid awarded to Mirion Technologies
- Spring 2016 – Functional Requirements Specifications Complete
- May 2016 – Software and Hardware Design Locked
- August 2016 – Factory Acceptance Testing (Idaho Falls, ID)
- September 2016 – Delivery to Purdue
- December 2016 – Final Staging and Site Acceptance Testing

PUR-1 Digital I&C Replacement

Project Timeline

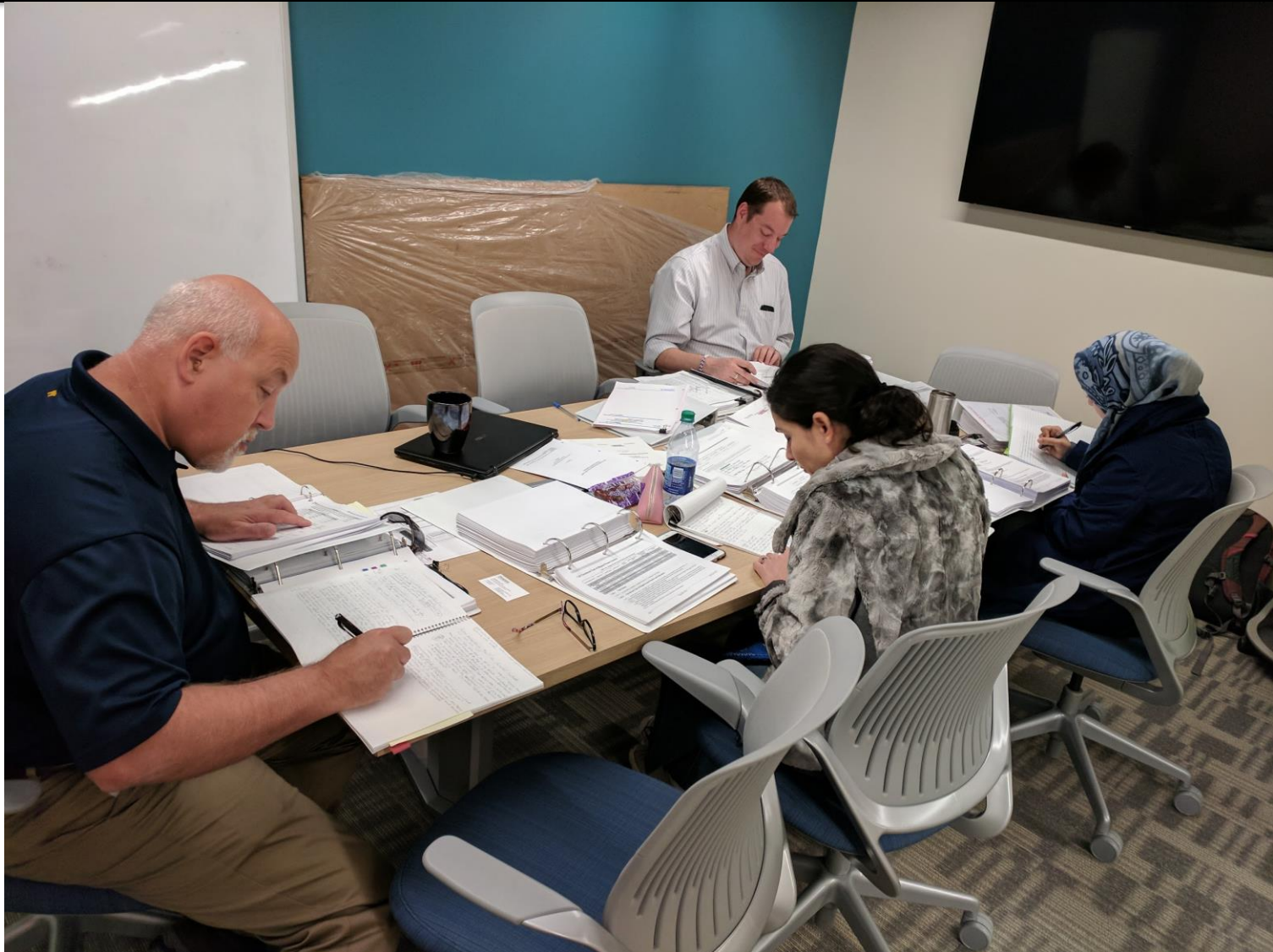


PUR-1 Digital I&C Replacement

Project Timeline

- Summer 2015 – Solicitation of Bids
- Fall 2015 – Bid awarded to Mirion Technologies
- Spring 2016 – Functional Requirements Specifications Complete
- May 2016 – Software and Hardware Design Locked
- August 2016 – Factory Acceptance Testing (Idaho Falls, ID)
- September 2016 – Delivery to Purdue
- December 2016 – Final Staging and Site Acceptance Testing
- February 2017 – License Amendment Request Submitted
- July 2017 – LAR Accepted for Review by NRC
- August 2017 – NRC Document audit in West Lafayette

PUR-1 Digital I&C Replacement



PUR-1 Digital I&C Replacement

Project Timeline

- Summer 2015 – Solicitation of Bids
- Fall 2015 – Bid awarded to Mirion Technologies
- Spring 2016 – Functional Requirements Specifications Complete
- May 2016 – Software and Hardware Design Locked
- August 2016 – Factory Acceptance Testing (Idaho Falls, ID)
- September 2016 – Delivery to Purdue
- December 2016 – Final Staging and Site Acceptance Testing
- February 2017 – License Amendment Request Submitted
- July 2017 – LAR Accepted for Review by NRC
- August 2017 – NRC Document audit in West Lafayette
- October 2017 – Original I&C Removal and Replacement
- Spring 2018 – Reactor Critical

BE AGGRESSIVE
PUBLICLY STATE YOUR GOALS
GENERATE
EXCITEMENT

PUR-1 Digital I&C Replacement



Documentation!

- Functional Requirement Specification
- Hardware & Software Requirement Specification
- Hardware & Software Design Document
- Detector Design Document
- Control System Interface

PUR-1 Digital I&C Replacement



Documentation!

- Configuration Management Plan
- Software Quality Assurance Plan
- Software Verification and Validation Plan
- Receiving and Inspection Control

PUR-1 Digital I&C Replacement



Documentation!

- Factory Acceptance:
 - Control Algorithm Test
 - HMI Function Test
 - Physical Inspection Plan
 - Rod Drop Timing Test
 - System Generation Plan
 - Governing Procedure

PUR-1 Digital I&C Replacement



Documentation!

- Site Acceptance:
 - Physical Inspection Testing
 - Parallel Installation
 - Hardware Integration Plan
 - Final Test Plan

DOCUMENTATION

...DO THE WORK EARLY

KNOW

EXPECTATIONS

PUR-1 Digital I&C Replacement

Licensing Approach

- See presentation on Thursday but...
- Communicate! Communicate! Communicate! Communicate!
- Early (and often) Phase 0 Meetings – First was October 2015
- Because very proficient in the Interim Staff Guidance to NUREG-1537
- Use the guidance to help your vendor
- Face to face meetings with vendor on site lessen unknowns
- Face to face meetings with regulator increase mutual understanding

Selected Lessons Learned

- Leverage advantage of License Amendment Request and abandon historic operational restrictions
- Interview other similar facilities early on to determine best practices and standards
- Carefully track progression of licensing and documentation
- Functional Requirement Specification is the single most important document in the project
- Define institutional metrics and goals to create a system which closely matches facility outlook

Selected Lessons Learned

- Walk a mile in the regulator's shoes
- A quality 10 CFR 50.59 can be equally challenging and more risky if there is dissent
- Its EASY to say licensing is difficult, but find a solution!
- Communicate, communicate, communicate, communicate!
- Attempt to minimize other major simultaneous projects

GRID PLATE
A B C D E F G H I J K

1
2
3
4
5
6
7

1	2	3	4	5	6	7	8	9	10	11	12
A	B	C	D	E	F	G	H	I	J	K	L
M	N	O	P	Q	R	S	T	U	V	W	X
Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AK
AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW
AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU
BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG
CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS
CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE
DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ
DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC
ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO
EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA
FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM
FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY
FZ	GA	GB	GC	GD	GE	GF	GH	GI	GJ	GK	GL
GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX
GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ
HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV
HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH
II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT
IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF
JG	JH	JI	JJ	JK	KL	KM	KN	KO	KP	KQ	KR
KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD
LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP
LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB
MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN
MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL
NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX
NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ
OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV
OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH
PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT
PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF
QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR
QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD
RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP
RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB
SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN
SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ
TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL
TM	TN	TO	TP	TQ	TR	TS	TT	TU	TV	TW	TX
TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ
UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV
UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH
VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT
VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG
WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS
WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE
XF	XG	XH	XI	XJ	XK	XL	XM	XN	XO	XP	XQ
XR	XS	XT	XU	XV	XW	XX	XY	XZ	YA	YB	YC
YD	YE	YF	YG	YH	YI	YJ	YK	YL	YM	YN	YO
YP	YQ	YR	YS	YT	YU	YV	YW	YX	YZ	ZA	ZB
ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN
ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ

1000



1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

13:46 20

00:00.00

SRO on call:
Robert Bean
208 520 9325



PUR-1 Digital I&C







PUR-1 – DIGITAL I&C

Project Review & Lessons Learned



SCHOOL OF NUCLEAR ENGINEERING

PURDUE
UNIVERSITY®