JAN 10 2000

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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		10 System/Bldg./Facility 241-SY-101
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1	RPP-5610		0	SY-101 RAPID TRANSFER PROJECT LOW TEMPERATURE OPERATIONS REVIEW AND RECOMMENDATIONS TO SUPPORT LOWER TEMPERATURE LIMITS	SQ			

16 KEY

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(G) Reason	(H) Disp	(J) Name	(K) Signature	(L) Date	(M) MSIN
1	1	Design Authority RW Reed	RW Reed	4 Jan 2000	T4-07
1	1	Design Agent GL Hickman		1/4/00	B3-67
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1	1	Cog Mgr ~~RW Reed~~ RE Larson	RE Larson	1/6/00	T4-07
1	1	QA ML McElroy		1/21/00	S7-07
1	1	Safety CD Jackson	CD Jackson	1/6/00	
		Env			

(G) Reason	(H) Disp	(J) Name	(K) Signature	(L) Date	(M) MSIN
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1	1	Operations JR Biggs		1/4/00	S7-70
		per Telecon GLH 1/4/00		Reviewed Attachments C-E did not review other parts	

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Signature of EDT Originator — Date 12/21/99	Authorized Representative for Receiving Organization — Date 4 Jan 2000	Design Authority/ Cognizant Manager — Date 4 Jan 2000	Ctrl No ( ) Approved ( ) Approved w/comments ( ) Disapproved w/comments

S

SY-101 RAPID TRANSFER PROJECT LOW TEMPERATURE OPERATIONS REVIEW AND RECOMMENDATIONS TO SUPPORT LOWER TEMPERATURE LIMITS

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Abstract The lower temperature limit for the 241 SY-101 RAPID transfer project is currently set at 20°F Based on the analysis and recommendations in this document this limit can be lowered to 0°F

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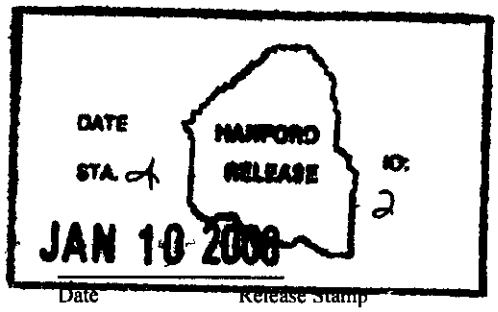

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SY-101 RAPID TRANSFER PROJECT LOW TEMPERATURE OPERATIONS REVIEW AND RECOMMENDATIONS TO SUPPORT LOWER TEMPERATURE LIMITS

1 0 Introduction

The SY-101 RAPID Mitigation System Design Team has completed a review of the system's equipment and documentation, and has made recommendations of changes necessary to lower the operating temperature limit from 20°F to 0°F This report documents the review and the changes necessary to equipment and design to achieve this objective Although not explicitly stated, conditions and changes described for components in the tank farm are applicable to the corresponding element in the cold test facility This document provides a brief background followed by conclusions, analysis of existing systems, and recommendations for changes

2 0 Background

HNF-3885 *Functional Requirements and Technical Criteria for the 241 SY-101 RAPID Mitigation System* Section 4 3 1 11 specifies ambient temperature extremes as per HNF-SD-WM-BIO-001 Rev 1-A, *Basis for Interim Operation* and designates limiting temperatures for the operation of the system to be 20°F to 100°F One factor in the establishment of that temperature limit was the understanding that the initial transfer was to take place in the late summer or early fall when low temperatures are not a concern In addition, lower temperature limits require specialized equipment with longer delivery times Extended delivery times were considered an unacceptable risk during the initial design and order phases of the project

It is desirable to perform transfer and back dilute operations throughout the year Normal winter temperature ranges in the tank farms fall well below 20°F with an historical low of -23°F in 1944 Thus, it is necessary to amend the lower limit of this operational band to allow system operation during lower ambient conditions found in the winter

3 0 Conclusions

Analysis of all structures systems and components (SSCs) indicate that a reduction in operating temperature may be achieved with minor modifications to field-installed equipment Following implementation of these changes it is recommended that the system requirements be amended to specify a temperature range for transfer or back dilute evolutions of 0°F to 100°F

4 0 Analysis

The following data on major SSCs utilized in the RAPID System provide a basis for the operating range recommended in the conclusion section above

4 1 New Generation Transfer Pump (NGTP)

WHC-S-0238 *Specification for Prototype Transfer Pumps with Submersible Motors* is the guiding document for the transfer pump installed in SY-101 This specification requires the pump be operable when exposed to a temperature of 2°F (lower limit) inside the pump pit in which it is installed Also this document requires the pump meet the requirements of ANSI/ASME B31 3 It is noted that the only components of the pump design which are contained within the pump pit are those related to conducting fluid to and from the submersible pump itself, and the pump's mounting flange All other operating components are contained within Tank 241-SY-101

Waste contained within the tank self-generates heat and ranges from 117°F to 130°F (per HNF-3885) We conclude therefore by inspection, that pump components within the tank are not affected by low ambient temperature excursions Since the pump s fluid handling components within the pit are fabricated from austenetic stainless steel per ANSI/ASME B31 3, said components are operable to a lower temperature limit of –20°F (as specified by ANSI/ASME B31 3 para 323 2 2) The pump s mounting flange is fabricated from Type 304L stainless steel and its functions are to provide structural support and a static sealing surface for mating with a gasket The mechanical properties of this material are effectively unchanged by exposure to a temperature of –20°F Further, its ability to provide a gasket sealing surface is unchanged by exposure to this temperature Therefore we conclude that the NGTP installed in SY-101 is operable to a lower limit ambient temperature of –20°F

4 2 Prefabricated Pump Pit (PPP)

HNF-4169 *Specification for 241 SY 101 RAPID Mitigation Prefabricated Pump Pit* requires materials of construction for the PPP to be steel and stainless steel By inspection these materials are suitable for operation in an ambient temperature of 0°F

Parts utilized during system operation in the PPP of other than stainless steel or carbon steel construction include a riser gasket and a pump flange gasket The pump flange gasket material is EPDM rubber in conformance with ASTM D2000 suffix F17, which specifies the material be tested for sealability to a low limit temperature of –40°F The riser gasket is EPDM rubber in accordance with ASTM D1056 While this specification is silent on requiring low temperature testing of this closed cell foam-style material, the compound utilized is generally recognized by published literature to remain flexible in ambient environments as low as –40°F

An operational concern exists related to the potential for freezing fluids within the PPP s seal loop assembly This assembly is filled with a minimum of 9 inches of water during system operation Since this component is within the tank s head space, it remains continuously exposed to waste As previously indicated waste temperatures remain above 117°F under any ambient temperature conditions As a consequence of its continuous exposure to this heat source we conclude ambient temperatures as low as 0°F will not result in freezing of the seal loop fill fluid

4 3 Transfer Pump Piping Manifolds

HNF-4170 *Technical Specification for 241 SY 101 RAPID Mitigation Transfer Pump Piping*, requires that piping manifold assemblies installed within the pump pit be fabricated from per ANSI/ASME B31 3 Further the specification directs that the manifolds be fabricated from austenetic stainless steel components As noted above paragraph 323 2 2 of ANSI/ASME B31 3 specifies that such a piping system is operable to a lower temperature limit of –20°F

Non-stainless steel materials utilized in the manifolds construction include soft seals contained within installed valves and gasket materials utilized to seal flanged and PUREX connector joints Manufacturer s literature contained in Certified Vendor Information (CVI) file 50071 specifies soft goods installed in the valves consists of G2000 PEEK, a proprietary polymer and graphite Per published information on file at the valve manufacturer s facility G2000 PEEK is suitable for operation to an ambient temperature of –40°F (though a marginal increase in valve operating torque may result) Graphite gaskets utilized in valve construction are suitable for ambient temperatures equal to or below –20°F by inspection due to the low coefficient of thermal expansion associated with this material Sealing material utilized in PUREX connectors is virgin TFE Per data published by its manufacturer TFE is suitable for applications exposed to temperatures as low as –450°F Gasket materials are Garlock Blue-gard Style 3000 and EPDM per ASTM D2000, including suffix F17 The Garlock material is certified by its manufacturer to be appropriate for use in ambient temperatures to –40°F ASTM D2000 suffix F17 specifies material is to be tested for sealability to a low temperature limit of –40°F

An operational concern exists related to the potential for freezing fluids within the manifolds This concern is addressed by procedures now in place which dictate the process fluid introduced into the manifolds is maintained well above the freezing point (low dilution temperature alarm) and that manifolds be drained after transfer flushing or back dilute evolutions

4 4 Hose and Hose Assembly

According to published manufacturer s literature incorporated in CVI file 50071, the materials of construction of the hose and hose assembly utilized as an above-ground transfer line in the RAPID System are suitable for use at temperatures ranging from –40°F to 220°F Additional literature in the CVI file supplement related to this component indicates the current draw requirements for start-up of the transfer line's heat tracing do not exceed the selected circuit breaker's rating (30 A) until ambient temperatures fall below 0°F

4 5 Drop Leg Assembly

The primary stainless steel and concrete materials utilized in the construction of this component are suitable for ambient temperatures as low as –20°F by inspection As with piping manifolds described above piping components within the drop leg are fabricated from austenitic stainless steel and in accordance with ANSI B31 3 As such metallic components within the drop leg assembly are suitable for use to ambients as low as –20°F

Soft goods utilized in the construction of the assembly include Garlock s Blue-gard gasketing material (see transfer piping manifold comments above) suitable to –40°F, and a sealing insert in the bulkhead conduit fitting which allows pass-through of the drop leg s leak detector cable According to the Hanford site s NEC inspector, this electrical component is intended for outdoor use in installations throughout North America, and is by his inspection acceptable for use to an ambient temperature of –20°F

4 6 Instrumentation and Control Equipment

Instrumentation and control equipment utilized in the RAPID system consists of multiple components installed in several locations We anticipate no problems with temperatures as low as 0°F provided heat is added to the SY101-WT-CP-350A and POR32-RW-CP-401 panel as proposed in ECN 656866 and work package 2W-99-01661/M Detailed analysis of each component is given below organized by mounting location A summary of the temperature limits of these components is found in Attachment A

Indicating lights relays switches terminal blocks and pushbuttons are not individually considered These devises are resistive or conductive in nature, and have no credible failure mode due to low temperatures in the range of -20°F

4 6 1 MCC (SY272) and Equipment mounted in panel SY461 WT CP 350B in the DACs Trailer

As the variable Frequency Drive and the supervisory control panel are installed within temperature controlled buildings maintained at a nominal temperature of 70°F, low ambient temperatures have no impact on these components

4 6 2 Leak Detector Stations, Including the Local Panel, Alarm, and Leak Detection Element

This project utilizes two leak detector stations labeled SY101-WT-LDSTA-101 located near the Prefabricated Pump Pit and SY102-WT-LDSTA-102 located near Riser 007 on SY-102 Leak Detector Stations are the subject of an environmental analysis contained in HNF-SD-WM-ER-736, Rev 0 *Intrinsically Safe Leak Detector Circuit Design Description* which concludes the leak detector stations are suitable for use in ambient temperatures down to –20°F

4 6 3 Prefabricated Pump Pit (PPP)

Four types of instruments are installed within the PPP These include pressures switches temperature elements pressure elements, and a flow element The two pressure switches SY101-WT-PS-370 and PS-371 are manufacturer rated to a low ambient temperature limit of -30°F The pressure element SY101-WT-PE-368 is rated to a low ambient temperature limit of -40°F A magnetic flow meter element, SY101-WT-FE-367 is rated to a low ambient temperature limit of -4°F Each of the referenced manufacturer rating can be found in CVI file 50071 Two temperature elements SY101-WT-TE-369 and 373 are both RTD type elements This type of element is not affected by low temperatures in the -20°F range

4 6 4 Field Control Panel, SY101-WT CP 350A

A number of components warrant consideration of the effects of low ambient temperature These include the annunciator, pressure temperature, and flow indicators, and temperature transmitters Annunciator SY101-WT-ANN-350A has a low ambient temperature limit of -40 °F Flow and temperature indicators SY101-WT-FI-367A SY101-WT-FI-419 SY101-WT-TI-369A and SY101-WT-TI-373 are rated to -40°F Temperature transmitters SY101-WT-TT-369 and SY101-WT-TT-373 have a limit of 14°F Pressure indicators SY101-WT-PI-368 and SY101-WT-PI-420 is rated to a low ambient limit of 32°F Mounted outside the cabinet is SY101-WT-FQIT-367 which is rated to -4°F The low temperature ratings listed above are found in manufacturers literature found in CVI file 50071

Analysis performed during the design phase determined that the components within this cabinet provide sufficient self heating to maintain a minimum of 32°F with an outside ambient of 20°F For ambient temperatures lower than 20°F heaters would have to be added to the panel ECN 656866 and work package 2W-99-01661/M is to add 400W of heat to SY101-WT-CP-350A This is sufficient heat to maintain a minimum temperature of 32°F inside the cabinet with an ambient temperature of 0°F (See Attachment B)

The two pressure indicators have a low temperature limit of 32°F These instruments are mounted with their faces somewhat exposed Concerns have been raised that the LED display and the controlling circuitry could be exposed to temperatures sufficiently low to affect the instrument Three factors mitigate this concern First, a clear, NEMA 4 cover is placed over the face of these instruments This helps hold the heat being generated within the cabinet by these and other pieces of equipment Second, phone conversations with the manufacturer s engineers indicate that the instruments should be functional to ambient temperatures as low as 0°F Last in addition to the heaters being added cold temperature functional testing found these indicators performed satisfactorily with temperatures as low as -10°F See Attachments C and D

4 6 5 Water Skid

Instrumentation contained on the water skid includes temperature sensing elements, a temperature controller a pressure indicating transmitter and a flow element with integral indicator Temperature elements POR32-RW-TE-410 TE-412 TE-413 TE-414 and TE-415 are all type J thermocouples These elements are unaffected by the temperatures in the range of -20°F According to the manufacturer temperature elements POR32-RW-TE-411A and 411B as well as the temperature controller POR32-RW-TC-411 are rated to -40°F

The pressure indicating transmitter POR32-RW-PIT-417 is rated to -22°F The flow element and transmitter, POR32-RW-FE-418 and POR32-RW-FQIT-418 are rated to -40°F This information is found in CVI file 50071

4 6 6 Valve and Instrument Stand

The valve and instrument stand has a pressure element, POR32-RW-PE-420 and a flow element and transmitter POR32-RW-FE-419 and POR32-RW-FQIT-419 Based on information contained in CVI file 50071 all three instruments are rated to -40°F

4 6 7 Water Skid Control Panel, POR32 RW CP-401

Control panel POR32-RW-CP-401 houses several instruments requiring review of operability in cold conditions These include four temperature controllers a temperature indicator, a panel cooler flow total flow and pressure indicators, a power supply a back up uninterruptible power supply (UPS) two run time meters a PLC, and two variable speed drives (VFDs) In addition, a transformer is located behind the panel

According to the vendor the transformer, POR32-RW-XFMR-401 has no lower temperature limit as it has no liquid cooling system The UPS POR32-RW-UPS-401 is rated for -40°F The power supply is rated for 32°F The cabinet cooling thermostat, POR32-RW-TC-401 is adjustable from 30°F to 150°F and is impervious to damage from low temperatures in the ranges in question The power supply is rated to -4°F The run time meters POR32-RW-HM-401 and 402 the PLC, and the two VFDs POR32-RW-MC-401 and 402 are all rated to 32°F With the exception of the transformer, all of these components are entirely contained within the control panel which will be maintained at a minimum of 32°F

Analysis performed during the design phase determined that the components within this cabinet provide sufficient self heating to maintain a minimum of 32°F with an outside ambient of 20°F For ambient temperatures lower than 20°F heaters would have to be added to the panel ECN 656866 and work package 2W-99-01661/M is to add two 200W heaters to POR32-RW-CP-401 This is sufficient heat to maintain a minimum temperature of 32°F inside the cabinet with an ambient temperature of 0°F

All of the indicators and indicator controllers are rated to 32°F These instruments are mounted with their faces somewhat exposed Concerns have been raised that the LCD/LED displays and the controlling circuitry could be exposed to temperatures sufficiently low to affect either the indication or the switching functions of these instruments To allay these concerns heaters are being added and cold temperature functional testing has been performed Testing found these indicators performed satisfactorily with temperatures as low as -10°F See Attachments C and D

4 7 Water Skid

Major systems on the Water Skid include the structural components piping hoses, regulators and valves The water skid piping, tank, and accumulator were analyzed for low temperatures in HNF-4359, Rev 0C The analysis concluded that these components were sufficiently heat traced to start up at 0°F and operate

at -20°F By inspection, the manual valves on the water skid are capable of withstanding temperatures as low as -20°F and additionally are heat traced Based on information in CVI file 50071 the pressure relief valves POR32-RW-PRV-401 and 402 are rated for temperatures between -60°F and 406°F Neither POR32-RW-REG-402 nor POR32-RW PCV-401 have operating temperature ranges established by their manufacturers Both the regulator and PCV are simple mechanical devices with no anticipated failure modes due to temperatures in the range of –20°F Conversations with the vendors concurred with that assessment

All instrumentation components are covered in the instrumentation section

The sight glass has been a point of concern regarding cold temperatures During operation the water temperature is in the 120 to 130°F range, providing a convective heat source for the sight glass The tank manufacturer has never had a reported failure of the sight glass similar in design to ours using water at temperatures in the 120 to 130°F range as the process fluid The sight glass is an Excelon R-4000 clear tubing material, which would tend to crack rather than shatter should the tube freeze Upon thawing, a slow leak would ensue and the sight glass can be isolated with an insulated valve ECN 656862 and work package 2W-99 01600/M, adding heat trace to the sight glass have been completed Furthermore the tank is drained per standard operating procedures during disuse and cold temperatures

POR32-RW-SOV-401 a general service component has a recommended cold temperature limit of 40°F According to the vendor, the concern is potential condensation initiating shorts in the motor operator controlling the valve position The valve is heat traced and insulated The motor operator is in a NEMA 4 enclosure directly above the valve The path for moisture is through the conduit Under operating conditions, the warmth of the process fluid and/or heat trace provides sufficient heat to prevent condensation in the motor operator When the skid is not in use the valve is left open and the storage tank is left empty During the initial operation of the skid, water is run through the system to fill the tank This is a process that should take several minutes providing sufficient time to warm up the motor operator and drive off any condensation present In this application condensation is not considered a credible issue

4 8 Valve and Instrument Stand

The Valve and Instrument Stand frame and other structural components are fabricated from structural steel which is, by inspection, suitable for use in ambient temperatures as low as –20°F The valve installed on the Instrument Stand is fabricated from carbon steel per the requirements of ANSI B31 3 All instrumentation components are covered in the instrumentation section

5 0 Equipment changes required

Based on the analysis detailed above, the following field modifications will be necessary to implement the recommended revision to the system's operating temperature range These modifications include installing heaters in field control panel SY101-WT-CP-350A and Water Skid control panel POR32-RW-CP-401 per the requirements of ECN 656866 and work package 2W-99-01661/M to ensure internal temperature is maintained above 32°F under ambient conditions at or below 0°F

ATTACHMENT A

SUMMARY TABLE FOR LOW TEMPERATURE LIMITATIONS OF INSTRUMENTATION USED IN SY-101 RAPID PROJECT

(CONSISTING OF 3 PAGES, INCLUDING THIS ONE)

Inst	CP 350A	Newport Electronics	558B ET IS1 SPC18	SY101 WT FI 367A			
Inst	CP 350A	Newport Electronics	558B ET IS1 SPC18	SY101 WT FI 419			
Inst	CP 350A	Newport Electronics	558B ET IS1 SPC18	SY101 WT TI 369A			
Inst	CP 350A	Newport Electronics	558B ET IS1 SPC18	SY101 WT TI 373		40 to 185F	Vendor Specification Sheet
Inst	CP 350A	Omega	CCT 20-0/100C	SY101 WT TT 369			
Inst	CP 350A	Omega	CCT 20-0/100C	SY101 WT TT 373	22 to 176F	14 to 140F	Vendor Specification Sheet
Elec	CP 350A	Ronan	4 4X11SNLR 4000 N4	SY101 WT ANN 350A	40 to 185F	40 to 140F	Vendor Specification Sheet
Inst	CP 350A	Sensotec	AE213 56a	SY101 WT PI 368			
Inst	CP 350A	Sensotec	AE213-56a	SY101 WT PI 420	20 to 200F	32 to 130F	Vendor Specification Sheet
Inst	CP 350A	Yokogawa	AE14 DA1A/BR/FF1/FN1	SY101 WT FQIT 367	4 to 140F	4 to 140F	Vendor Specification Sheet
Inst	CP 401	Hoffman	A TEMNO	POR32 RW TC 401	N/A	N/A	Vendor Specification Sheet Set between 30 and 150F uses bimetalic strip which is impervious to temperatures in the 20 to 100F range
Elec	CP 401	PC Connection	56168	POR32 RW UPS-401	5 to 120F	32 to 104F	Vendor Specification Sheet
Elec	CP 401	Phoenix	2939043	Power Supply	13 to 185F	4 to 140F	Vendor Specification Sheet
Inst	CP 401	Red Lion	CUB4LP00	POR32 RW FI 418			
Inst	CP 401	Red Lion	CUB4LP00	POR32 RW PI 417	40 to 176F	32 to 140F	Vendor Specification Sheet
Inst	CP 401	Red Lion	PAXP0000	POR32 RW FQI 418	40 to 140F	32 to 122F	Vendor Specification Sheet
Elec	CP 401	Siemans	C3-A30X/120V	PLC Level Control	40 to 158F	32 to 131F	Vendor Phone Call and Specification Sheet
Elec	CP 401	Siemens	6SE32224DG40	POR32 RW MC 401			
Elec	CP 401	Siemens	6SE32224DG40	POR32 RW MC 402	40 to 158F	32 to 104F	Vendor Specification Sheet
Elec	CP 401	Square D	50S3H	POR32 RW XFMR 401	N/A	N/A	Vendor indicates no lower limit
Inst	CP 401	Watlow	V4TH CDAA AARG	POR32 RW TI 412			
Inst	CP 401	Watlow	V4TH CDAA AARG	POR32 RW TIC 410			
Inst	CP 401	Watlow	V4TH CDAA AARG	POR32 RW TIC 413			
Inst	CP 401	Watlow	V4TH CDAA AARG	POR32 RW TIC 414			
Inst	CP 401	Watlow	V4TH CDAA AARG	POR32 RW TIC 415	40 to 185F	32 to 149F	Vendor Specification Sheet
Inst	CP 401	Yokogawa	240-211 AAAB	POR32 RW HM 401			
Inst	CP 401	Yokogawa	240-211 AAAB	POR32 RW HM 402	14 to 122F	32 to 104F	Phone call to Vendor
Inst	H2O Skid	Brooks	3525C3B1B111A	POR32 RW FQIT 418			
Inst	H2O Skid	Brooks	7402D5A1N1AAAA	POR32 RW FE 418	40 to 185F	40 to 165 F	Vendor Specification Sheet
Inst	H2O Skid	Cobra Wirer and Cable	jl6spfa alpfa	POR32 RW TE 410			

Inst	H2O Skid	Cobra Wirer and Cable	jl6spfa alpfa	POR32 RW TE 415	N/A	N/A	Type J Thermocouple no impact at temperature range
Inst	H2O Skid	Hotfoil	C 4058	POR32 RW TC 411		40F to ?	Phone call to Vendor
Inst	H2O Skid	Justin	UE 55	POR32 RW TE 411A			
Inst	H2O Skid	Justin	UE 55	POR32 RW TE 411B		40F to ?	Phone call to Vendor
Inst	H2O Skid	Magnetrol	842 100-C00	POR32 RW LE 416		40 to 160F	Phone call to Vendor
Inst	H2O Skid	Watlow	70XJTUD012	POR32 RW TE 414			
Inst	H2O Skid	Watlow	72XJWGB012	POR32 RW TE 413			
Inst	H2O Skid	Watlow	AFGMOTFXXXVJ300	POR32 RW TE 412	N/A	N/A	Type J Thermocouple no impact at temperature range
Inst	H2O Skid	Yokogawa	EJA 430A EAS4B 92EA/FF1/D1	POR32 RW PIT 417		22 to 176F	Vendor Specification Sheet
Inst	PPP	Pyromation	RBF185RG3 3-9300 3	SY101 WT TE 369			
Inst	PPP	Pyromation	RBF185RG3 3-9300 3	SY101 WT TE 373	N/A	N/A	RTD no impact at temperature range
Inst	PPP	Sensotec	FPG1CN 2U5B6A 1Y	SY101 WT PE 368		40 to 240F	Vendor Specification Sheet
Inst	PPP	SOR	6AP JF2 U8-C1A X	SY101 WT PS 370			
Inst	PPP	SOR	6AP JF2 U8-C1A X	SY101 WT PS 371		30 to 400F	Vendor Specification Sheet
Inst	PPP	Yokogawa	AE205DN CB2 ESA/FF1/FN1	SY101 WT FE 367	22 to 140F	4 to 140F	Vendor Specification Sheet
Inst	V&I Stand	Brooks	3525C3B1B111A	POR32 RW FQIT 419			
Inst	V&I Stand	Brooks	7402D5A1N1AAAA	POR32 RW FE 419	40 to 185F	40 to 165F	Vendor Specification Sheet
Inst	V&I Stand	Sensotec	FPG1CN 2U5B6A 1Y	POR32 RW PE 420		40 to 240F	Vendor Specification Sheet

ATTACHMENT B

HEAT REQUIREMENTS FOR CONTROL CABINETS SY101-WT-CP-350A AND WATER SKID POR32(33)-RW-CP-401

(CONSISTING OF 5 PAGES, INCLUDING THIS ONE)

FLUOR DANIEL NORTHWEST	CALCULATION IDENTIFICATION AND INDEX	Calc No E 1
		TO Job No RAPID
		Date Dec 7 1999

This sheet shows the status and description of the attached Calculation Sheets

Discipline ELECTRICAL

Project No & Title SY101 RAPID Mitigation Transfer

Calculations Heat Requirements for Control Cabinets SY101 WT CP 350A and Water Skid POR32(33)-RW CP-401

These calculations apply to

Drawing No H 14 103653 Sh 2 Rev No 1

Drawing No H 14 103672 Sh 2 Rev No 1

Other (Study CDR) N/A

Rev No

The status of these calculations is

- ☐ Preliminary Calculations
- ☒ Final Calculations
- ☐ Check Calculations on calculations dated
- ☐ Void Calculations (reason voided)

Were calculations incorporated into the final drawings? ☒ Yes ☐ No

Were calculations verified by independent check calculations? ☐ Yes ☒ No

Original and Revised Calculation Approvals

	Rev 0 Signature/Date	Rev 1 Signature/Date	Rev 2 Signature/Date
Originator	R E Merriman R E Merriman 12/7/99		
Checked By	C M Monasmith 12/7/99		
Independent Review * Approved By	C.L. Hickman Cary C Hick 12/7/99		
Checked Against Approved Vendor Data			

* Independen Review M F Erhart M F Erhart 12-7-99

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Calculation Sheet Page No	Description
1	Control Panel SY101 WT CP 350A Heat loss and Temperature Rise
2	Control Panel POR32(33)-RW-CP-401 Heat Loss and Temperature Rise
Appendix A	Hoffman Electric Heater, Sizing and Selection

FLUOR DANIEL NORTHWEST

DESIGN ANALYSIS

Calc No E 1
Revision 0
Page No 1 of 2

Client	RAPID SY101 Mitigation Transfer	Contract/Job No RAPID	
Subject	Heat Requirements for Control Cabinets SY101 WT CO 350A and Water Skid POR32(33)-RW CP-401	Originated By R E Merriman	Date Dec 7 1999
		Checked By C M Monasmith	Date Dec 7, 1999
Location	1200 Jadwin, Richland	Revised By	Date

Statement of Problem

Waste transfer from tank SY101 to SY102 may occur during cold weather The FSAR list a low temperature for the Hanford site as –23° F in 1944 An evaluation of cold weather effects on electrical equipment was conducted for temperatures as low as –20° F Common electrical equipment such as power and control cables plug ins enclosures operator controls (such as push buttons and indicator lights) warning lights conduits and supports are commonly subjected to winter conditions including the temperature level mentioned above It is commonly recommended by manufactures that equipment (cables and flexible fittings specifically) not be installed during low temperature conditions

Electrical Equipment considered for operation at –20° F ambient was as follows

A Variable Frequency Drive for Transfer Pump This equipment is located inside a heated building and thus will not be affected by low temperatures

B Circuit Breakers All circuit breakers are located in heated buildings and thus will not be affected by low temperatures

C Power and Control cables Suitable for operation at these temperatures but not for general handling

D Enclosures conduit systems push buttons and indicator/warning lights These systems have a minimum of moving parts and will not be affected by the low temperature Moving parts will be inside heated enclosure

E Electronic equipment (transducers indicting meters annunciators power supplies VFD s) have manufacture operating temperature low limits of 0° C (32° F) As such the control panels that contain these components and are located outside require supplemental heat Two control panels meet these conditions see temperature calculations #1 and #2 below Existing ambient heat supplied from component losses is a benefit during cold periods and is a factor in the calculations

Calculations are based on Hoffman Catalog 1997-1998 electric heater application section P 9 86 see Appendix A

1 Control Panel SY101 WT CP 350A

This panel contains indicating instruments transmitter power supply annunciator electro mechanical relays and an alarm horn

Sizing and Selection

Step 1 Enclosure (36 x30 x16) surface area = 2[(36 x30)+(36 x16)+(30 x16)]/144 /sq ft = 30 sq ft

Step 2 See Graph attached for uninsulated enclosure Desired temperature 32° F ambient –20° F results in a 52° F rise needed From graph approximately 700 Watts of heat is required

Equipment losses (estimated)	Indicating Meters	6 @ 20 W = 120 W	
	Annunciator	1 @ 20 W = 20 W	
	Power Supply	1 @100 W = 100 W	
	Relays	4 @ 5 W = 20 W	
	Temp Transmitter	2 @ 20 W = 40 W	
	Sub total (losses)		300 W

Step 3 Supplemental Heat required 700 W – 300 W = 400 W

Therefore Use one 400 W standard heating unit with built in thermostat and fan Hoffman 400 W 115 V 60 Hz 3 3 Amp 6 lb Cat. No D AH4001B

FLUOR DANIEL NORTHWEST

DESIGN ANALYSIS

Calc No E-1
Revision 0
Page No 2 of 2

Client RAPID SY101 Mitigation Transfer
Contract/Job No RAPID
Subject Heat Requirements for Control Cabinets SY101 WT-CO-350A and Water Skid POR32(33)-RW-CP-401
Originated By R E Merriman Date Dec 7 1999
Checked By C M. Monasmith Date Dec 7, 1999
Location 1200 Jadwin, Richland
Revised By Date

2 Water Skid Control Panel POR32(33) RW CP-401

This panel has a similar type of equipment as the panel above plus two Variable Frequency Drives (VFD) The VFD units have a minimum operating temperature requirement of 32 ° F which is the controlling temperature

Sizing and Selection

Step 1 Enclosure (62 x60 x12) surface area = 2[(62 x 60) + (60 x 12) + (62 x 12)] / 144 sq in/sq ft = 72 sq ft

Step 2 See Graph, attached for uninsulated enclosures Desired temperature 32° F ambient temp –20° f results in a 52 °F rise needed From graph approximately 1 000 Watts of heat is required

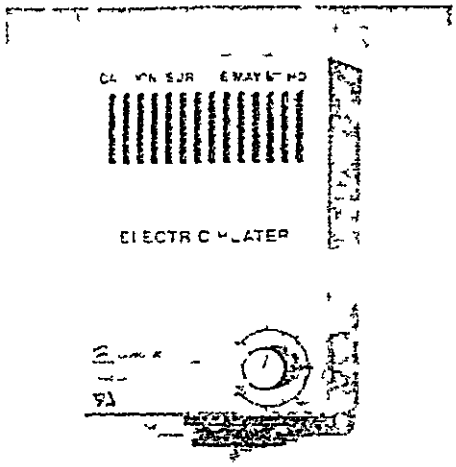
Equipment losses (estimated)	Temp controller	5 @ 20 W =	100 W
	Indicating Meters	2 @ 20 W =	40 W
	Flow Totalizer	1 @ 10 W =	10 W
	PLC	1 @ 10 W =	10 W
	Temp Controller	1 @ 40 W =	40 W
	Relays	7 @ 5 W =	35 W
	Power Supply	1 @ 100 W =	100 W
	Contactor	1 @ 10 W =	10 W
	VFD (2) 20 HP (90% eff)	1 @300 W =	300 W
	Hour Meter	2 @ 5 W =	10 W
	Power Dist Equip	1 @ 30 W =	30 W
	Subtotal (losses)		685 W

Step 3 Supplemental Heat required 1 000 – 685 W = 315 W

Therefore Use two 200 W standard heating units with built in thermostat and fan Hoffman 200 W 115 V 60 Hz 1 7 Amp 4 lb Cat. No D AH2001A

Appendix A -- Hoffman Electric Heater sizing and selection

Electric Heaters



Application

Designed to protect sensitive mechanical electrical and electronic equipment from the harmful effects of condensation corrosion and low temperatures Thermostatically controlled fan driven heater units maintain a stable temperature within enclosures so critical components can perform more reliably over a longer period of time

Construction

Attractive and durable housing is anodized aluminum

Thermostat and control unit is adjustable from 0 F to 100 F (18 C to 38 C)

Fan draws cool air from the bottom of the enclosure passes this air across the thermostat and heating elements before being released to maintain enclosure integrity

Heated air is discharged through the top of the heater unit

Four 10 32 x self tapping screws are included with each heater

Ball bearing fan runs continuously for even temperature distribution

Terminal block has three 6 32 screw terminals with barriers labeled for power and ground connections

Finish

Anodized aluminum

Industry Standards

UL Component Recognized
CSA Listed

Installation

Hoffman electric heaters should be centered as low as possible on an interior enclosure panel This permits the unit to heat the cool air located at the bottom of the enclosure For maximum efficiency the heater should be mounted in a vertical position with the terminal block to the bottom and the air outlet openings at the top However the unit will still effectively distribute heat if turned 90 degrees with the terminal block out the bottom and the air outlet at the side Although enclosure panels are preferable heaters may be installed on any flat sheet metal surface Do not install heaters on wood panels

Heat sensitive components should not be placed near the heater discharge area since this air can be quite warm The clearance range defines the space that must be kept free of these components for proper and safe operation of the heater

Sizing and Selection

Example

Which electric heater would most efficiently maintain a 60 F temperature in an uninsulated 24x24x10 enclosure that is exposed to a temperature not less than 30 F?

Step 1

Calculate the total enclosure surface area

Area (ft) = 2[(AxB)+(AxC)+(BxC)] ÷144
where A B C are the dimensions of the enclosure

In our example

Area = 2[(24x24)+(24x10)+(24x10)]÷144

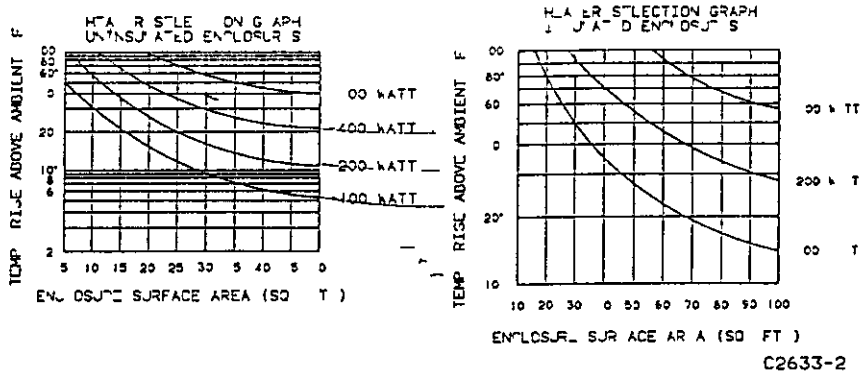
Step 2

Using the graphs draw a vertical line through the enclosure surface area and determine the temperature rise given by each heater

For enclosures exposed to windy conditions heaters should be oversized by approximately 50%

Step 3

Select the electric heater that achieves the desired temperature rise In our example the desired temperature rise is 30 F (60 F 30 F) The 200 watt heater should be selected since its temperature rise (35 F) exceeds the requirement.



C2633-2

Standard Sizes Electric Heaters

Catalog Number	Watts	Voltage	Hz	Amps	Weight lb	(kg)
D AH1001A	100	115	50/60	0 9	4 00	(1 81)
D AH1002A	100	230	50 60	0 6	4 00	(1 81)
D AH2001A	200	115	50/60	1 7	4 00	(1 81)
D AH2002A	200	230	50/60	0 9	4 00	(1 81)
D AH4001B	400	115	50/60	3 3	6 00	(2 72)
D AH4002B	400	230	50/60	1 7	6 00	(2 72)
D AH8001B	800	115	50/60	6 5	6 00	(2.72)
D AH8002B	800	230	50.60	3 3	6 00	(2 72)

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ATTACHMENT C

TEST PROCEDURE FOR COLD TEMPERATURE TESTING OF SY-101 RAPID MITIGATION PROCESS INSTRUMENTATION

(CONSISTING OF 6 PAGES, INCLUDING THIS ONE)

Test Procedure for Cold Temperature Testing of SY-101 RAPID Mitigation Process Instrumentation

Introduction

With the high probability of cold weather operation of the SY-101 RAPID Mitigation System at temperatures as low as 0° F investigation by engineering personnel into the capability of the system to operate at these cold temperatures has been undertaken As a result, heating devices in several instrument panels and on a water tank sight glass have been added to the design and are to be installed in the near future A question has arisen concerning the documented ambient temperature rating of several panel meters Specifically some of the meters have a stated operating temperature ranges from 0° to 60° C (32° to 140° F) but a conversation with one of the vendor s product engineers revealed that this temperature rating applies primarily to the electronics portion of the meters Since the panels in question have, or will have heaters installed which will maintain at least 32° F at all times, the same product engineer is of the opinion that the meters will operate below 0° F However no documentation to support this opinion is readily available

The Engineering Testing Laboratory 305 Bldg/300 Area, has a large environmental chamber which can be used to test these meters to as low as -15° F and probably to 20° A small steel test box (approximately 20" x 20" by 7) placed inside the environmental chamber can be used to hold the panel meters This steel box would have a thermostatically controlled heating device with a small interior fan to maintain the panel electronics at 32° F The temperature of the chamber (outside the steel box) could be incrementally lowered to at least 0° F while front panel indication of the meters could be viewed through a 20" x 20 viewing port An unchanging, controlled 4 20 ma signal could be looped through the panel meter(s) to also determine any inaccuracies at different temperatures This test would provide documented empirical evidence as to the operating range of the panel meters

Test Item

At least four different types of panel meters are to be tested These are

1) Red Lion Model CUB4LP Loop Powered Process Indicator
2) Red Lion Model PAXP Process Input Panel Meter
3) Sensotec Model GM Panel Indicator
4) Watlow Series V4 Temperature Controller

Test Description

Each of the test Items will be mounted in a 20" x 20 x 7 steel Hoffman Type 4 Instrument Enclosure per the layout shown in Figure 1 The enclosure shall be mounted inside the 3 x 3 x 3 environmental chamber

Each of the instruments inside the instrument enclosure shall have an external 4-20 ma loop circuit attached to it This loop shall originate outside the environmental chamber and shall act as an independent source signal by which to judge the performance of the instruments at different temperatures The Watlow controller may also be set up to have a thermocouple input in addition to the 4 20 ma loop also originating from outside the environmental chamber, which shall remain at a constant value

A thermostatically controlled heating device inside the enclosure shall maintain the temperature inside the enclosure at 32 +0/-4 °F A second thermostat shall control the temperature outside the enclosure (inside the environmental chamber) at preset temperatures ranging from 32° F to 20° F - or as low as the instrumentation will operate properly or as low as the environmental chamber will go (Note 20° F approaches the lower temperature limit of the environmental chamber due to the limiting refrigerant characteristics Also, the heat load introduced by the enclosure may make this temperature unreachable)

Instrumentation Setup

The instrumentation shall be set up to show a front panel indication of 0 with a 4 ma input signal and 100' with a 20 ma signal

The Watlow controller shall be setup to have a type K thermocouple input from an external temperature calibrator which can vary the input temperature signal between 100° F and 130° F The controller shall be programmed to activate an internal switching relay to turn on when the temperature reaches 120°F and to turn off when the sensed temperature reaches 125° F

Should the instrumentation being tested not perform properly at a low ambient (chamber) temperatures the option of increasing the enclosure interior temperature may be considered This option would allow engineering to upgrade existing equipment heating systems to sustain a higher interior temperature allowing the use of the existing instrumentation

A test data sheet attached shall be used for each test to document the pertinent equipment identification, test ID input signals temperatures and elapsed times for testing

Acceptance Criteria

An instrument will be considered acceptable if two conditions are met First, the panel indication agrees with the input signal within its documented accuracy Second the display is readable in normal daylight conditions The instrument shall be subjected to sequentially decreasing temperatures until 1) the instrument fails to operate or 2) the environmental chamber is unable to decrease the temperature any lower or 3) a temperature of 20°F is reached

Supporting Test Equipment

The following equipment will be needed for accomplishing the test

- Environmental chamber of sufficient size to contain 20 x 20 x 7" steel enclosure and have capability to develop temperatures as low as 0° F and possibly as low as 20°F
- Calibrated (NIST traceable) temperature gage with usable range as low 20°F
- Temperature controller capable of controlling the power supplied to the installed heating device (120VAC 5 amps) with ability to accept J or K type thermocouple inputs for temperature sensing
- Heating device of adequate size to maintain at least 32° F inside the enclosure which can be mounted in the bottom portion of the enclosure
- Small fan installed in the enclosure to provide adequate mixing of air around indicator electronics
- 36" x 36" x 36" environmental chamber with capability of temperatures as low as at least 0°F and as low as 20° F if possible

- Loop 4 to 20 ma signal transmitter/indicator which is either calibrated to NIST traceable standards or able to verified by such equipment (secondary field calibration)

Test Procedure

1) With the instrument enclosure mounted inside the environmental chamber, apply power to the instrumentation the enclosure heater and the enclosure fan Set the enclosure internal thermostat setting to 32°F

2) Apply power to the signal transmitter(s) for the 4 20 mA signal and the thermocouple input Vary the signal input over the desired range to ensure the instruments are reading properly For the 4-20 mA signal, 4 mA input should indicate 0 and 20 mA should indicate 100 For the Watlow controller the thermocouple input should read directly the input temperature signal and should activate its switching relay at 120 and 125°F

3) With the environmental chamber door secured apply power to the chamber and set its temperature controller to 20° F

4) Monitor temperatures inside both the enclosure and inside the environmental chamber while the temperature drops and the chamber temperature reaches 20° F

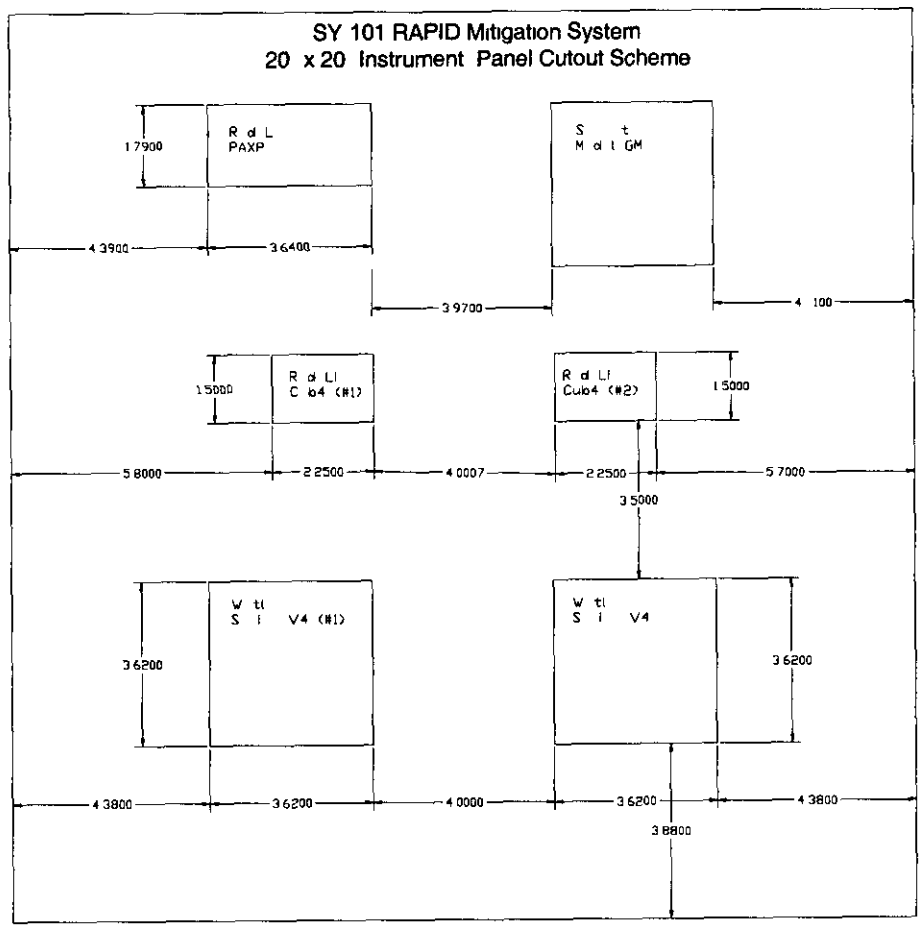
5) If no problems occur during the time required for the chamber temperature to drop to 20°F allow the chamber temperature to remain at 20°F for at least 30 minutes Ensure that the internal temperature of the enclosure stays at 32 +0/-5°F Vary the input signals as in step 2 and record pertinent information as required on the Test Data Sheet If the instruments fail to operate properly Attempt to increase the internal enclosure temperature in 2°F increments until the instrument begins to work properly Record this corrected temperature

6) If step 5 is successful repeat the step except set the chamber temperature to 0°F

7) If step 6 is successful repeat the step except set the chamber temperature to 20° F or as low a temperature as the chamber can go

8) Upon completion of the tests bring the chamber up to room temperature After the enclosure and the instrumentation reaches room temperature repeat steps 3 through 8 twice more

Figure 1
20" x 20" x 7" Enclosure Front Panel Layout



Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date_____ Test Number CTT-

Enclosure Temperature_____°F
Chamber Temperature_____°F
Test Duration_____Minutes

Instrument Indications

Input Signal (mA /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 _____°F Watlow #2 _____°F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 _____°F Watlow #2 _____°F

Test Equipment Information

Temperature Calibrator Manufacturer and Model Number
Temperature Calibrator Calibration # and Expiration Date

Loop Transmitter Manufacturer and Model Number
Loop Transmitter Calibration Expiration Date

Environmental Chamber Manufacturer and Model Number

Test Personnel Verification

Name/Title_____Signature

Name/Title _____Signature_____

ATTACHMENT D

TEST RESULTS FROM COLD TEMPERATURE TESTING OF SY-101 RAPID MITIGATION PROCESS INSTRUMENTATION

(CONSISTING OF 5 PAGES, INCLUDING THIS ONE)

Test Results From Cold Temperature Testing of SY-101 RAPID Mitigation Process Instrumentation

Introduction

This document describes testing recently carried out on SY 101 RAPID Mitigation System process instrumentation The testing follows the test plan Test Procedure for Cold Temperature Testing of SY-101 RAPID Mitigation Process Instrumentation (Attachment C) The purpose of the testing was to determine the performance characteristics of several process instruments used on the Mobile Water Support Skid (POR 32 and POR 33) as well as one instrument used on the 350A panel

With the high probability of cold weather operation of the SY-101 RAPID Mitigation System at temperatures as low as 0° F or lower investigation by engineering personnel into the capability of the system to operate at these cold temperatures was undertaken As a result heating devices in several instrument panels and on a water tank sight glass have been added to the design A question has arisen concerning the documented ambient temperature rating of several panel meters Specifically some of the meters have a stated operating temperature range from 0° to 60° C (32° to 140° F), but a conversation with one of the vendor s product engineers revealed that this temperature rating applies primarily to the electronics portion of the meters Since the panels in question have or will have heaters installed which will maintain at least 32° F at all times, the same product engineer is of the opinion that the meters will operate below 0° F However no documentation to support this opinion is readily available There is also a question of whether or not the front panel display which could be exposed to much lower temperatures than the heated internal electronics would fail to function properly

Specifically, this testing was performed to see 1) how much error would occur relative to a known signal input as seen on the front panel indication at various operating temperatures 2) the ability of the Watlow temperature indicator/controllers to switch internal relays at these various operating temperatures and 3) how the various temperature extremes would impact the performance of the front panel displays Additional details on the scope of the testing is found in the test plan

Test Method

The test methodology is found in the attached test plan however some changes were made as follows

Only the Red Lion PAXP and Cub4 indicators used a 4 20 mA external loop signal The Watlow Temperature indicator/controller used a type J thermocouple input exclusively while the Sensotec used a 0 to 5 VDC strain gage input The thermocouple input was provided by an Omega temperature calibrator which allowed a convenient adjustment of simulated temperatures The strain gage input was provided by a small thin beam load cell that was left in a constant non loaded condition during testing

Each of the four instrument types were set up or calibrated' at room temperature (approximately 72°F) In the case of the Red Lion indicators, the 4 20 mA signal was set to provide an indication of 0 with a 4 mA signal and 100 with a 20mA signal This gave an indicated span of 100 The Watlow indicators were set up with a span of 32 to 200°F - the lower limit of the device being 32°F The Sensotec indicator was set up so that a static, unloaded, condition corresponded to a front panel indication of 0

The Test Procedure described testing at temperatures below 32° F, however additional testing was done at temperatures up to 130° F

Test Results

Eleven tests were run at temperatures ranging from 22 to 130°F The original test data is provided in Attachment E A summary of the instrument error is shown in Table 1 and as a graphical representation in Figure 1

The instrument error shown in Table 1 is an average (arithmetic mean) of the error at five data points at each different temperature given as a percentage of full scale For instance, in the case of Test CTT 001 the input signal of 10 mA was equivalent to indicated value of 37 5 The Cub4(#1) had an indicated value of 37 8 This gives a difference 0 3, or in terms of error as a percentage of full scale

The absolute value of [(37 5 37 8)/100] *100 = 0 3%

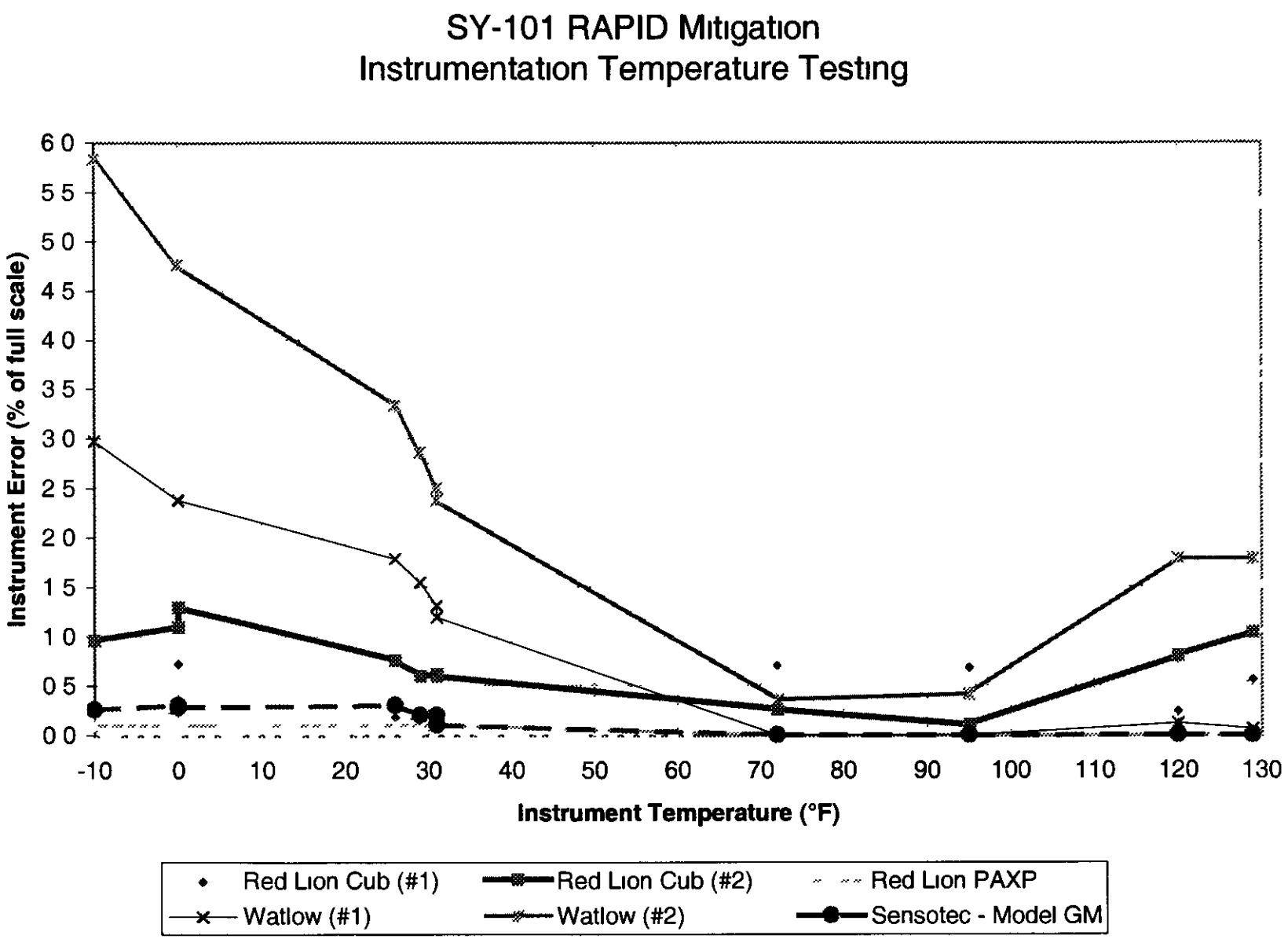
In the case of the Watlow (#1) in the same test the input signal was 130°F while the indicated value was 128°F, giving

The absolute value of [(130-128)/(200 32)] *100 = 1 19%

The error at each of the 5 data points was summed and an average was calculated This average error is what is shown in Table 1 and Figure 1

Table 1 – Summary of Instrument Error		**Test Number**										
		CTT 007	CTT 006	CTT 005	CTT 004	CTT 003	CTT 002	CTT 001	CTT 010	CTT 011	CTT 008	CTT 009
	Test Duration (minutes)	15	30	30	30	30	30	30	30	30	30	30
	Average Enclosure Temperature (°F)	10	0	0	26	29	31	31	72	95	120	129
	Average Environmental Chamber Temperature (°F)	22	20	17	12	8	0	+18	72	95	120	130
Instrument Error (% of full scale)	Red Lion Model Cub4 (# 1)	0 1	0 2	0 7	0 2	0 2	0 2	0 2	0 7	0 7	0 2	0 6
	Red Lion Model Cub4 (# 2)	1 0	1 1	1 3	0 8	0 6	0 6	0 6	0 3	0 1	0 8	1 0
	Red Lion Model PAXP	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 0	0 0	0 0	0 0
	Watlow (#1) Series V4	3 0	2 4	2 4	1 8	1 5	1 3	1 2	0 0	0 0	0 1	0 1
	Watlow (#2) Series V4	5 8	4 8	4 8	3 3	2 9	2 5	2 4	0 4	0 4	1 8	1 8
	Sensotec Model GM	0 3	0 3	0 3	0 3	0 2	0 2	0 1	0 0	0 0	0 0	0 0

Figure 1


SY-101 RAPID Mitigation
Instrumentation Temperature Testing
Instrument Error (% of full scale)
60
55
50
45
40
35
30
25
20
15
10
05
00
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Instrument Temperature (°F)
Red Lion Cub (#1)
Red Lion Cub (#2)
Red Lion PAXP
Watlow (#1)
Watlow (#2)
Sensotec - Model GM

Results

As can be seen, the instruments showed increasing error at decreasing temperatures The largest error 5 8% of full scale, was seen with the Watlow temperature controllers at a temperature of 10°F This corresponds to an error of almost 10°F In the case of the Watlow controllers the error was consistent for each signal input at a given temperature This means that the error was only an 'offset' error not a span error Or stated another way the instrument was still linear in its measuring capability

At 20°F if one extrapolates from the curve in Figure 1, the largest error would be some value less than 4% (6 7°F)

When the instruments were kept at or above 32°F, the largest error seen (Watlow) was 2 5% or approximately 4° F This is the lowest temperature that the Watlows should ever see during operation since the cabinet they are normally mounted in has heaters which will maintain temperature above 32°F

The front panel indication was readable at each temperature tested, from -23° F to 130°F (Environmental Chamber) At temperatures below approximately -15°F the Cub4 indicator LCD began to be a bit sluggish when changing values, but was still readable after 2 or 3 seconds

In the case of the Watlow switching function, no degradation in performance of the switching function was seen at any operating temperature The switching function which would turn on some external heating device, occurred within 1° F of the on or off' setpoint at each temperature tested

ATTACHMENT E

TEST DATA SHEETS FROM COLD TEMPERATURE TESTING OF SY-101 RAPID MITIGATION PROCESS INSTRUMENTATION

(CONSISTING OF 12 PAGES, INCLUDING THIS ONE)

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/10/99 Test Number CTT-001

Enclosure Temperature 31 °F
Chamber Temperature 17-19 °F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/130/0	0 2	0 6	0 0	128°F	126°F	-0 1
10/115/0	37 8	38 1	37 0	113	111	-0 1
16/100/0	75 2	75 6	75 0	98	96	-0 1
20/130/0	100 2	100 6	100 0	128	126	-0 1
4/115/0	0 2	0 6	0 0	113	111	-0 1

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130 F to 115°F
Watlow #1 126/124 °F (Signal in/Front Indication) Watlow #2 128/124 °F
Temperature at which Watlow Controller switched off with input raised from 115 F to 130°F
Watlow #1 128/126 °F Watlow #2 130/126 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russells Technical Products 6D-32-105

Test Personnel Verification

Name/Title Keith Witwer/Test Eng Signature

Name/Title Don Powell/Eng Tech Signature Don Powell

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/10/99 Test Number CTT-002

Enclosure Temperature 31 °F
Chamber Temperature 0 °F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/130/0	02	06	00	128	126	-02
10/115/0	378	381	37	113	111	-02
16/100/0	751	757	750	97	95	-02
20/130/0	~~100.2 #4~~ ~~100.0~~	~~100.6 #4~~ ~~100.2~~	~~100.0 #4~~ ~~100.6~~	128	126	-02
4/115/0	02	06	00	113	111	-02

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 126/124 °F Watlow #2 128/124 °F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 128/126 °F Watlow #2 130/126 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer Test Eng Signature [signature]

Name/Title Don Powell / Eng Tech Signature [signature]

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/10/99 Test Number CTT-003

Enclosure Temperature ~~-8~~ 29-30 °F
Chamber Temperature ~~29-30~~ -8°F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/130/0	0 2	0 6	0 0	128	126	-0 2
10/115/0	37 8	38 1	38 0	112	110	-0 2
16/100/0	75 1	75 6	75 0	98	95	-0 2
20/130/0	100 1	100 6	100 0	127	125	-0 2
4/115/0	0 2	0 6	0 0	112	110	-0 2

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 126/124 °F Watlow #2 128/124 °F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 128/126°F Watlow #2 130/126°F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer/Test Eng Signature [signature]

Name/Title Don Powell/Eng Tech Signature [signature]

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/10/99 Test Number CTT-004

Enclosure Temperature 26 °F
Chamber Temperature -11 to -12 °F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/130/0	0 2	0 8	0 0	127	125	-0.3
10/115/0	37 7	38 2	37 0	112	109	-0.3
16/100/0	75 1	75 7	75 0	97	94	-0 3
20/130/0	100 2	100 8	100 0	127	125	-0 3
4/115/0	0 2	0 8	0 0	112	109	-0 3

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 128/125 °F Watlow #2 130 5/125 °F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 127/124 °F Watlow #2 130/124 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer /Test Eng Signature [signature]

Name/Title Don Powell / Eng Tech Signature [signature]

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/10/99 Test Number CTT- 005

Enclosure Temperature 0 °F
Chamber Temperature -16 to -18 °F
Test Duration 30 Minutes

Note: 1) LCD display slow to change values but still readable
2) As in each test, Watlow #1 is located directly above Fan & Watlow #2 is not

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/130/0	05	13	00	126	122	-0.2
10/115/0	379	388	38	111	107	-03
16/100/0	759	763	75	96	92	-03
20/130/0	1009	1014	1000	126	122	-03
4/115/0	09	12	00	111	107	-03

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 128/124 °F Watlow #2 132/124°F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 129/125 °F Watlow #2 133/125 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer Test Eng Signature

Name/Title Don Powell / Eng Tech Signature D Z Powell

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/10/99

Test Number CTT-006

Enclosure Temperature 0 °F
Chamber Temperature -20 °F
Test Duration 30 Minutes

Note LCD display on Red Lion Cubs slow to change values but still readable (3 to 4 seconds)

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/130/0	06	14	00	126	122	-03
10/115/0	37.5	389	380	111	107	-03
16/100/0	749	758	750	96	92	-03
20/130/0	1004	101	1000	126	122	-03
4/115/0	01	09	800 FSW	111	107	-03

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 129/125 °F (IN / DISPLAY) Watlow #2 132/124 °F
Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 130/126 °F Watlow #2 133/125 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002 7/1/00

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer/Test Eng Signature

Name/Title Don Powell/Eng Tech Signature D Z Powell

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/10/99 Test Number CTT-007

Enclosure Temperature −10 °F
Chamber Temperature −21 To -23°F
Test Duration 15 Minutes

Instrument Indications

Input Signal (ma / °F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/130/0	03	09	00	125	120	-02
10/115/0	37 5	38 5	37 0	110	105	-03
16/100/0	75 0	76 1	75 0	95	91	-03
20/130/0	~~3~~ 999	1010	100 0	125	120	-02
4/115/0	01	08	00	110	105	-03

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 128 5/124 °F Watlow #2 133/124 °F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 129 5/125°F Watlow #2 134 5/125 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002 ~~7/1/99~~ KSL 7/1/00

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer Test Eng Signature

Name/Title Don Powell / Eng Tech Signature D Z Powell

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/14/99 Test Number CTT-008

Enclosure Temperature 120 °F
Chamber Temperature 120 °F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/100/0	-01	-06	00	100	103	00
8/110/0	248	242	250	110	113	00
12/120/0	497	492	500	120	123	00
16/125/	74.7	741	750	125	128	00
20/130/0	997	991	1000	131	133	00

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 124.5/125 °F (Actual/Indicated) Watlow #2 122.5/124 °F (Actual/Indicated)
Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 124.5/125 °F Watlow #2 122.5/125 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002 7/1/00

Loop Transmitter Manuf and Model No FLUKE 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer/Test Engineer Signature [signature]

Name/Title Don Powell/Eng Tech Signature [signature]

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/14/99 Test Number CTT-009

Enclosure Temperature 129 °F
Chamber Temperature 130 °F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/100/0	-0 4	-0 8	0 0	100 5	10 3	0 0
8/110/0	24 5	24 0	25 0	110	11 3	0 0
12/120/0	49 4	48 9	50 0	1 20	12 3	0 0
16/125/0	74 4	73 9	75 0	125	128	0 0
20/130/0	99 3	98 8	100 0	130	133	0 0

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 124/124 °F Watlow #2 ~~132/125.5~~ °F (121.5/124.5) KSW

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 ~~124/124~~ °F (125/125.5) (Actual/Indicated) KSW Watlow #2 ~~(121.5/124.5)~~ °F (122/125.5) (Actual/Indicated) KSW

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002 7/1/00

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products GD-32-105

Test Personnel Verification

Name/Title Keith Witwer/Test Engineer Signature

Name/Title Don Powell/Eng Tech Signature DJ Powell

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/14/99 Test Number CTT- 010

Enclosure Temperature 72 °F
Chamber Temperature 72 °F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/100/0	07	02	00	100	100	00
8/110/0	25 7	25 2	25	110	110	00
12/120/0	50 7	50 3	50 0	120	119	00
16/125/0	75 7	75 3	75.0	125	124	00
20/130/0	100 7	100 3	100 0	130	129	

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 124 5/125 °F Watlow #2 122 5/124 °F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 125 5/125 5 °F Watlow #2 126/125 5 °F
(Actual/Indicated)

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russell's Technical Products 60-32-105

Test Personnel Verification

Name/Title Keith Witwer / Test Engineer Signature [signature]

Name/Title Don Powell / Eng Tech Signature [signature]

Attachment 2
Test Data Sheet for Cold Temperature Testing of SY-101 RAPID Mitigation System Process Instrumentation

Date 12/14/99 Test Number CTT- 011 KSW

Enclosure Temperature 95 °F
Chamber Temperature 95 °F
Test Duration 30 Minutes

Instrument Indications

Input Signal (ma /°F/mv)	Cub4 (#1) Indication	Cub4 (#2) Indication	PAXP Indication	Watlow (#1) Indication	Watlow (#2) Indication	Sensotec
4/100/0	0 7	0 1	0 0	100	100 5	0 0
8/110/0	25.6	25 1	25	110	111	0 0
12/120/0	50.7	50 1	50.0	120	120 5	0 0
16/125/0	~~100~~ 75.7 KSW	75.1	75 0	125	125.5	0 0
20/130/0	100 7	100.1	100 0	130	131	0 0

Watlow Switching

Temperature at which Watlow Controller switched on with input lowered from 130° F to 115°F
Watlow #1 124/124 °F Watlow #2 123 5/124 °F

Temperature at which Watlow Controller switched off with input raised from 115° F to 130°F
Watlow #1 125.5/126 °F Watlow #2 126/126 °F

Test Equipment Information

Temperature Calibrator Manuf and Model No Omega CL-505A
Temperature Calibrator Calibration # and Expiration Date 750-13-55-002

Loop Transmitter Manuf and Model No Fluke 702
Loop Transmitter Calibration Expiration Date Calibrated using Omega CL-505A

Environmental Chamber Manuf and Model No Russells Technical Products 6D-32-105

Test Personnel Verification

Name/Title Keith Witwer / Test Engineer Signature [signature]

Name/Title Don Powell / Eng Tech Signature [signature]