Deer Park Plant
NARRATIVE REPORT

Power Failure and Zebra Poly Relief Valve VCM Release

July 14, 1997

Summary

At 0406 on 7/14/97, a plant power failure occurred due to a voltage dip on both electrical feeders supplying the plant, with subsequent failure of the plant control system uninterruptible power supply (UPS). All eight polys were emergency short-stopped with AMS, but Zebra poly, one of five polys in reaction at the time, overpressured and the relief valve lifted three times for approximately one second each time. Total VCM released was 57 pounds. All agencies were notified within 15 minutes of the first discharge. It is not conclusive from the data whether the cause of the overpressure was a hydrofull poly or continued reaction. There were no injuries or exposures.

Board of Inquiry

A meeting was held at 7:30 am on 7/14/97 to discuss the incident. The following were in attendance:

Manuel Araujo	Shift leader
	Geon operator
	Geon operator
Steve Johnson	Sr.Process Control Engineer
Bill Lindstrom	Supervisor, Process Reliability
Mark Reynolds	Environmental engineer
Byron McWhirter	Plant Manager
Val O'Keefe	Sr.Process Engineer
Bob DesJardins	Sr.Safety Engineer
Brion Cann	"A" Line engineer
Joe Schwarz	"B" Line engineer
Alex DeSantis	Utilities engineer
Charlie Franks	Sr. Engineering Specialist

Corrective Actions

1. Install startup instruction plaque on the UPS panel and review with all shift leaders and head operators. (S. Johnson by 8/1/97).
2. Replace three low voltage batteries on the UPS. (Complete 7/17/97).
3. Replace all 30 UPS batteries with a new 30 battery set. (L. Henderson by 8/1/97).
4. Recommend rewiring the UPS bypass source to a motor control center on a different feeder (S3 or S5). (C. Franks, plan by 8/15/97, due by 12/31/97).
5. Install a second on-line 30-battery set to minimize exposure to a battery failure. (C. Franks, plan by 8/30, due by 12/31/97).

REDACTED

6. Review PM scheduling and content. Add individual battery check to PM in addition to overall set. (L. Henderson by 8/1/97).
7. Investigate UPS internal revision to change fail state. Requires manufacturer agreement and re-design. (S. Johnson by 8/30/97).
8. Evaluate timing allowance on overdue PM work orders based on PM frequency. (B. Lindstrom by 8/30/97).
9. Request follow-up report on transformer failure from Oxychem-Deer Park. (Complete).
10. Develop a procedure for start-up of critical utilities after a power failure. (E. McKinley by 8/30/97).
11. Refine procedures for dealing with excess AMS after plant power failure of this magnitude. (B. Cann by 8/30/97).
12. Review AMS shortstop effectiveness with regard to the catalyst package, timing, and agitation. (B. Cann by 9/30/97)
13. Evaluate radio base station back-up power needs. (McKinley by 9/30/97)

Narrative

At 0406 on 7/14/97, a power failure occurred at the Deer Park plant. All screens in the control room went dark, and virtually all equipment stopped running. All polys were shortstopped automatically with AMS, and verified in the field by , Geon operator. (At about 0420, a call was received from Oxychem's rectifier control room asking if Geon experienced a power failure. Oxychem at that time thought there had been a momentary blip from Houston Lighting & Power). During the course of manually restarting critical equipment, the relief valve on Zebra poly lifted at approx. 0445 for 1 second or less. Subsequent to this first release, Zebra poly relief valve lifted for two more times, one second each, at about 0505 and 0520. . Two operators noticed the local pressure gauge reading on Zebra was 200+ psig just before the second release. The laboratory technician, Jimmy Mitchell, reported the release to all appropriate agencies at 0500.

The emergency generator to supply power for critical controls and equipment did not start automatically on initial loss of power. Although most of the power to plant equipment appeared to be restored by 0500, there was still no power in the control room, and all computer screens were inoperative. At 0526, power was restored to the control room by restarting the inverter on the UPS panel for the control room. At that time the poly pressure was seen for the first time since 0400 on the DCS and the reading was 192 psig on Zebra poly.

No personnel were injured during the incident. All systems were back in operation by approx. 0545, and procedures were initiated to deal with the excessive amounts of shortstop added to the system as a result of the power failure.

Facts Surrounding the Incident

1. Geon operator, verified that all 24 AMS pot levels were OK at 1930 on 7/13/97, the start of the night shift.
2. Three polys had low AMS pot pressures at the start of the shift but were topped up to 350 psig per procedure.

3. Power to the plant was not actually lost, but only a power "dip" occurred, so the emergency generator was not called upon to start.
4. The emergency AMS quick-kill system switches, valves, etc., are PM'd on an annual basis.
5. The rupture discs on Zebra poly are rated for 211 psig; the relief valves are set at 215 psig.
6. When Zebra poly was opened after the incident, the direct steam injection valves were checked and found not leaking by.
7. A meeting with Oxychem engineering and maintenance was held on 7/18/97. Their investigation revealed the power dip was caused by the internal fault of "A2" transformer, which affects the high voltage feeders supplying Geon. The transformer was on a regular and appropriate PM schedule, and is only 12 years old. A bushing failure allowed the transformer to leak oil and create an internal fault.
8. Response from Geon operations personnel, maintenance and technical staff was timely and effective.
9. The base radio station in the control room was inoperative during the event and no backup was available, hampering communications.
10. See Addendum I, UPS Failure Investigation 7/15/97, and Addendum II, Zebra poly #828 Hydrofull Analysis 7/21/97 for additional details.

Conclusion

A voltage dip on both primary feeders to the Deer Park plant shut down virtually all critical equipment on July 14, 1997. Due to the nature of this event, the UPS system supplying power to the control room computers, instruments, and displays shut down power and, due to failure of the battery set, did not supply backup power as designed. Although incoming line power was restored rather quickly, the UPS "fail state" did not allow it to switch back to line power after it saw the power dip. The requirement at that point is to manually restart the UPS inverter, something the control room personnel were unaware of and not trained for.

Without electronic instrumentation and control of computer operated devices, the control operators were "blind" for almost 90 minutes, during which time Zebra poly overpressured, the rupture disc failed, and the relief valve lifted three times. Although the theoretical calculations do not predict either a hydrofull condition nor a runaway reaction, the nature of the overpressure and the behavior of the relief devices during the event indicate a hydrofull condition, but at this time, the data does not conclusively support either cause.

ADDENDUM I p.1 of 2

From: DPK100::MCWHIRTERB "Byron McWhirter" 27-JUL-1997 17:24:56.43
To: MCWHIRTERB
CC: MCWHIRTERB
Subj: boi

DEER PARK UPS FAILURE INCIDENT - JULY 14, 1997

REVIEW/INVESTIGATIVE MEETING - JULY 15, 1997

MEETING PARTICIPANTS:

C FRANKS
D HRUSKA
S JOHNSON
J WHITESIDE
S MCGINLEY
L HENDERSON
G RUBERT - DELTECH REP(UPS MFGR)

INCIDENT DESCRIPTION

At ~0406 on July 14,1997, a power dip was experienced on both primary and secondary power feed to the UPS. In addition, there were three batteries out of the 30 battery backup set that had low voltage, making the total battery voltage too low to operate the UPS.The result of this three point failure was that the UPS was in a zero output mode requiring a manual restart. There was and normally is no one on site during off hours qualified or knowledgeable in starting the UPS. At ~ 0515, S Johnson arrived on site and started the UPS.
The consequence of this UPS shutdown was total loss of instrument power to the plant computer systems including Provox as well as business systems. During the Provox outage, the ability to see and control the following items was lost(most valves fail closed and motors fail to off):

virtually all electronic instrumentation
most electric motors over 25hp
all computer controlled valves

A NESHAPS release occurred due to the inability to see and react to a pressure problem in one reactor.

BACKGROUND

NGC 13607

The UPS was installed ~3.5 years ago with the Provox computer installation. The UPS has had no previous failure, switching properly during numerous source power problems.
UPS preventative maintenance is done on 12 month intervals for system internal checks(last one in January 1997) and battery checks are part of the monthly pm (last done on May 21, 90 days currently allowed for overdue PMs).

The batteries were scheduled for replacement at year end, per manufacturers recommendation (mfg recommendation for PM is annual, we check quarterly).
At UPS installation time, the plant substation operated with tie breakers closed between motor control center pairs. Expansions and additions have added load beyond 50% of each MCC requiring the tie breakers to be normally open. This is standard practice at

GEON plants.

CONCLUSIONS

1. The primary cause of the UPS failure was the battery failure. Battery power is the only way the UPS can stay online in this situation and all others except battery failure.

2. The problem extended due to lack of startup knowledge of off-hour personnel. The need for this was unforseen due to a misunderstanding of the UPS state resulting from a three point failure such as this. It was thought that the the UPS would stay in BYPASS and startup when bypass source power was restored; this was not correct, a manual restart of the inverter is required.

3. The change in normal tie breaker state probably did not affect this incident but does make the UPS more suseptable to loss of both 480v sources as they are both on the same incoming power feeder from Oxy.

4. Addition of an external automatic bypass switch was considered and is not recommended due to complexity and functionality would not cover all possible failures. (cost ~$35k)

5. When the UPS loaded up, one battery failed and prevented the whole set from operating since they are wired in series.

RECOMMENDATIONS/CORRECTIVE ACTION

See Narrative Report

Zebra # 828
Hydrofull Analysis

PRELIMNARY REVIEW – 7/21/1997

On Monday, July 14th at approximately 04:06, there was a critical power failure, which lead to the AMS quick kill system being triggered on all 8 reactors. At approximately 04:45, Richard Rayon and James Peters heard what they thought to be a relief valve that had "popped" and reseated immediately afterwards. Subsequent reliefs were also heard at approximately 05:05 and 05:20.

After analysis of the events and data surrounding the incident, it is the general consensus that the Zebra reactor rupture disc blew and relief valve lifted as the result of a hydrofull condition in the reactor. Although the possibility of an uncontrolled reaction does exist, the nature of the release does not support this theory. The following observations were made before, during and after the incident:

1. The AMS pots were confirmed to be full earlier in the shift.
2. The AMS pots were confirmed to be empty after the power failure had triggered the system to activate.
3. There was no residual resin found in the Relief Valve after it was removed from the reactor.
4. There was no slurry found in the stack.
5. The period of relief was approximately 1 second.
6. The first DSI valve was not leaking (there is a double block).
7. The amount of AMS was sufficient to kill the reaction.
8. The AMS worked sufficiently in the other reactors.
9. Instrumentation was unavailable for approximately 1 hour and 20 minutes.
10. Zebra is equipped with 3 temperature probes – each showed a significantly different temperature after the agitator was restarted.
11. Zebra was not burped after the initial R/V lift.
12. The R/V for slurry or residual VCM at 0615.
13. The AMS pots fired immediately.
14. Calculations show that we had enough residual agitation to properly mix the AMS and subsequently kill the reaction.

14 July 1997
Zebra # 828
Hydrofull Calculation

Poly Input	Provox Tag	Time Start	Time End	Time Total	Rate	Unit	Metered Amount Quantity	Metered Amount Unit	Adjusted Volume Quantity	Adjusted Volume Volume	Notes:
VCM (Fresh and Reclaim)	FQI102	2:23:15	2:40:15	0:17:00			8500.0	gallons	9220.6	gallons	Temp Compensated from 70F to 141F
Water	FQI103	2:21:45	2:32:45	0:11:00			8097.1	gallons	8213.0	gallons	Temp Compensated from 70F to 141F
Solution Make-up Water				0:00:00			2100.0	pounds	255.9	gallons	Weigh Tank Measured
Emusifiers/Initiators				0:00:00			15.0	gallons	15.0	gallons	Estimated Volume
Solution Tank Flush				0:00:00			500.0	gallons	505.4	gallons	Temp Compensated from 70F to 141F
Solution Line Flush				0:00:00			200.0	gallons	202.2	gallons	Temp Compensated from 70F to 141F
Seal Water	FI48303Z	2:21:45	4:06:30	1:44:45	3.34	gpm	349.9	gallons	354.9	gallons	Temp Compensated from 70F to 141F
Injection Water	FIC48301Z	2:21:45	4:06:30	1:44:45	5.39	gpm	564.6	gallons	572.7	gallons	Temp Compensated from 70F to 141F
DSI Steam Condensate	FI48007	2:47:30	3:00:45	0:13:15	17680	#/hr	3904.3	pounds	475.8	gallons	Assumes a baseline of 37800 lb/hr
Displacement from Poly Build-up		N/A	N/A	N/A	N/A		N/A	N/A	50.0	gallons	Estimated Volume
Nitrogen		N/A	N/A	N/A	N/A		N/A	N/A	1.0	gallons	Estimated Volume
AMS		N/A	N/A	N/A	N/A		N/A	N/A	15.0	gallons	Estimated Volume
Seal Water after Pump Restart		4:30:00	4:45:00	0:15:00	10	gpm	150.0	gallons	152.1	gallons	Estimated Volume
Total Volume of Inputs		N/A	N/A	N/A	N/A		N/A	N/A	20033.6	gallons	
Reaction Shrinkage		3:01:00	4:06:30	1:05:30	N/A		N/A	N/A	(510.9)	gallons	18% Conversion based on Model
Actual Poly Volume					N/A		N/A	N/A	20525.0	gallons	
Calculated Hydrofull Volume									20023	gallons	Difference in Volumes

NGC 13610

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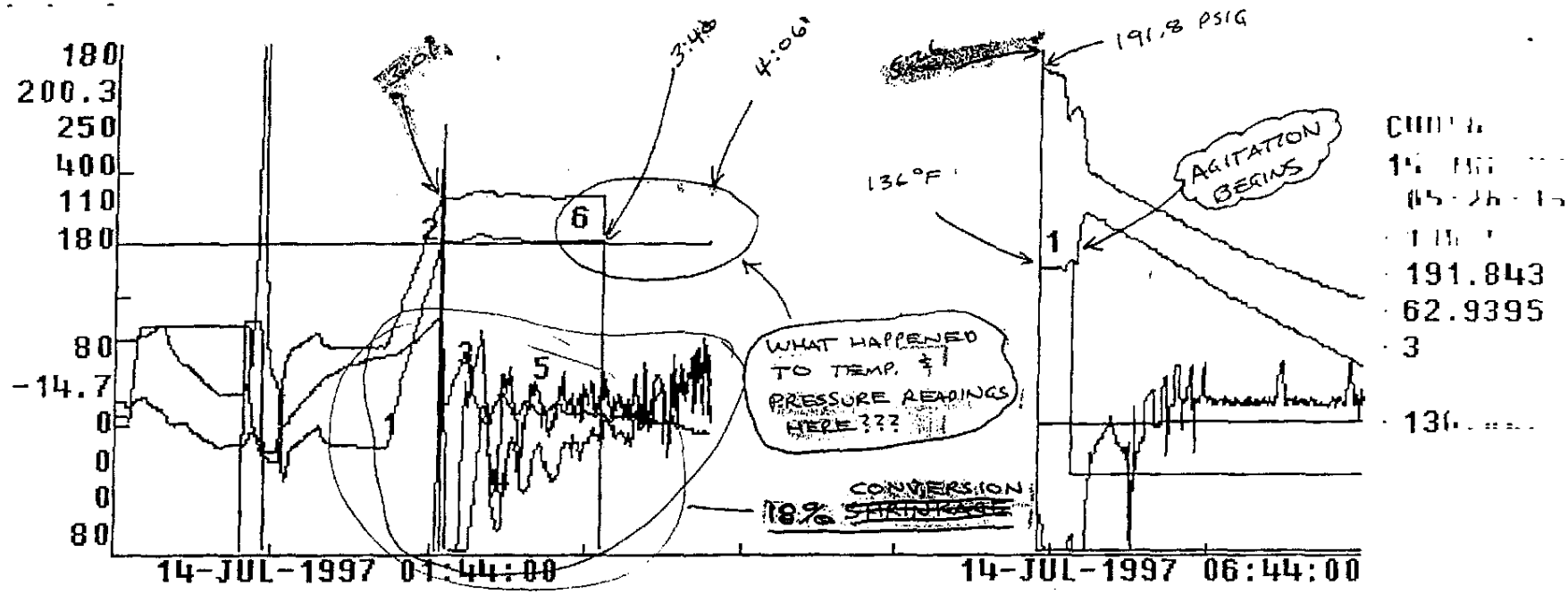
90 ZEBRA Zebra Poly Trend PROVOX TREND PLOT

A=addtrace E=erasetrace P=prevtrace N=nexttrace S=save V=view

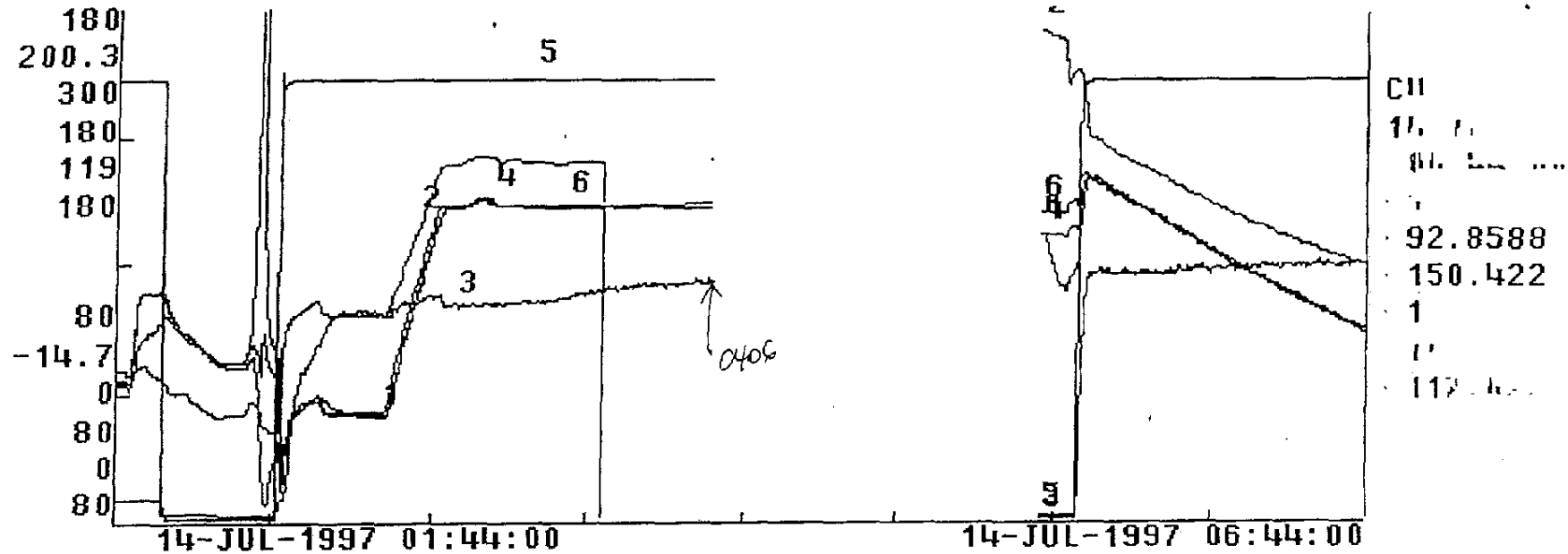


1	TIC503Z	PV	0	NUL	DGF	U+-H	Z POLY TEMP
2	PI3142-1	PV	0	NUL	PSI	UH	POLY PRESS
3	TIC504Z	PV	0	NUL	DGF	UH	Z JACKET OUTL
4	FIC4367Z	PV	0	NUL	LBM	U-H	Z NH3 TO BFL
5	TIC504Z	%IVP	0	NUL	DGF	U-H	Z JACKET OUTL
6	TIC503Z	SP	0	NUL	DGF	UH	Z POLY TEMP

NGC 13611

93 ZEBRA AGIT Zebra Agitator Amps PROVOX TREND PLOT

A=addtrace E=erasetrace P=prevtrace N=nexttrace S=save V=view



1	TIC503Z	PV	0	NUL	DGF	U+-H	Z POLY TEMP
2	PI314Z-1	PV	0	NUL	PSI	UH	POLY PRESS
3	II916Z-1	PV	0	NUL	AMP	UH	Z AGITATOR
4	TI48036Z-2	PV	0	NUL	DGF	UH	BOTTOMS TEMP
5	SIC100Z	PV	0	NUL	RPM	UH	Z AGIT SPEED
6	TI48036Z-1	PV	0	NUL	DGF	UH	BACKUP TEMP

NGC 13612

From: DPK100::CANNJ "J Brion Cann 281-930-9426" 18-JUL-1997 09:53:05.62
To: MCWHIRTERB, MCKINLEYE
CC: SCHWARZJ, ALGVAX::SCHONW,CANNJ
Subj: AMS Quantity

Byron and Ed:

Bill Schon and I discussed the Zebra Poly incident this morning. In response to the question - Did we have enough AMS to kill the reaction? After running through some numbers, the conclusion was - YES. I estimate that we add approximately 15 gallons (3 pots @ 5 gallons each) when this happens. According to Bill, this is equivalent to 432 moles of AMS compared to 52 moles of initiator (104 moles of free radicals). We could have killed this poly 4 times over even with NO previous initiator consumption. I think it is safe to say that poly was DEAD - this conclusion assumes that all the AMS got into the poly (it did...) and that it was true AMS that we're using (samples are on the way to verify.....). Let me know if you have any questions.

Thanks, J.Brion