

**10 CFR Part 26
Work Hour Rule
Data Summary**

The enclosed material was provided by selected licensees following a review of readily available historical human performance data maintained by the licensee. Two areas related to the draft rule were evaluated:

- Actual human performance for selected outages to evaluate the impact of outages that exceeded 8 weeks in length.
- Actual human performance for operational schedules that included more than 6 days in a row on shift without a break.

Material provided with this Enclosure includes:

Attachment 1: Survey letter for outages greater than 8 weeks.

Attachment 2: Summary of data analysis from plant responses for Outages.

Attachment 3: Survey letter for operating plants with shift rotations exceeding 6 days.

Attachment 4: Summary of data analysis from plant responses for Operating periods.

Attachment 5: Spreadsheets used in the evaluation of licensee submissions.

**Special Survey
Outage Work Hours
Human Performance
August 22, 2005**

Issue: Does human performance data from a plant in an extended outage indicate degraded performance after week 8 of the outage.

Request: Conduct a detailed analysis of human performance indicators for the indicated group and provide that analysis with supporting data to NEI for your Operations and Maintenance Department workers that supported these outages.

1. Background Information: Please provide Company, Plant Site, Contact Name, E-mail, and Phone Number.
2. Provide a description of the Shift Rotation Schedule for Operations and Maintenance during the outage. Identify periods, if any, when crews went to a "Normal" non-outage rotation cycle during the outage period.
3. Provide for the outage, on a week by week basis an analysis of human performance events specifically including each of the following:
 - a. Human Performance Data (Index or Even)
 - b. Industry Safety Data (Lost time, OSHA reportable, number of reports, and/or minor injuries.)
 - c. Number of Corrective Action Reports (e.g. Level A and Level B—the top two tiers)
 - d. Mispositionings (Components Out of Position)
 - e. Events reported in the Corrective Action Program
 - f. Apparent Cause Reports
 - g. Rework
 - h. Schedule Adherence

This specific data is to address NRC perceptions that Human Performance, Safety, Efficiency and Production suffer significantly in longer outages with greater work schedules.

Expectations are that each of the above be addressed separately. If for some reason no data is available or no analysis can be done please explain why.

A data summary is needed in understandable format such as graphs or numbers by outage week. Also, clearly identify what each data set represents, such as how your company has defined the element that is plotted.

4. Provide the impact on your site of having to comply with the rule provision of:

a. Limiting outage exclusion period from Group Work Hours to 56 days and having to manage to an average group work limit of 48 hours/ week starting on Day 57 through the end of the outage.

b. Requirement to provide, after day 14 of the outage, a 48 hour break for each individual every 14 days and 24 hour break for each 7 days.

For each identify:

- Length increase
- Estimated cost associated with the projected outage length increase. (e.g. contracts cost, replacement power cost, etc.)
- Estimated cost of the change to the schedule itself. (e.g. labor cost)
- Any other costs, or safety issues that would result.

5. The Work Hour Task Force is considering an alternative proposal that would replace the 24 hour in 7 days and 48 hour in 14 day requirement. Under the alternative, each individual would be required to be provided 4 days off in a 28 day period during outage as well as extending the outage exclusion to 10 weeks.

Please provide the impact on your site of having to comply with this alternative provision, considering the same issues addressed in item 4 above.

6. Is the alternative a workable solution? If not, please describe the concerns.

Summary of Outage Human Performance Data September 14, 2005

1. Plant 1:

Plant 1 provided a detailed response for a recent outage. The outage had been planned for 55 days and extended to 95 days.

OPPD Response to Items 3a, 3c, 3d, 3e, 3f, 3g:

Notes:

- 1) Following table lists the week by week analysis of human performance events for both utility and supplemental workers during the spring 2005 refueling outage.
- 2) Item 3a – Number of human performance errors by outage week
- 3) Item 3c – Number of corrective action reports (level 1-4 CRs) by outage week
- 4) Item 3d – Number of confirmed mispositionings by outage week
- 5) Item 3e – Number of events reported in the corrective action program (level 1-2 CRs) by outage week
- 6) Item 3f – Number of apparent cause reports (level 3 CRs) by outage week
- 7) Item 3g – Number of identified rework issues by outage week
- 8) Plant 1 did not maintain any data on schedule adherence (item 3h).

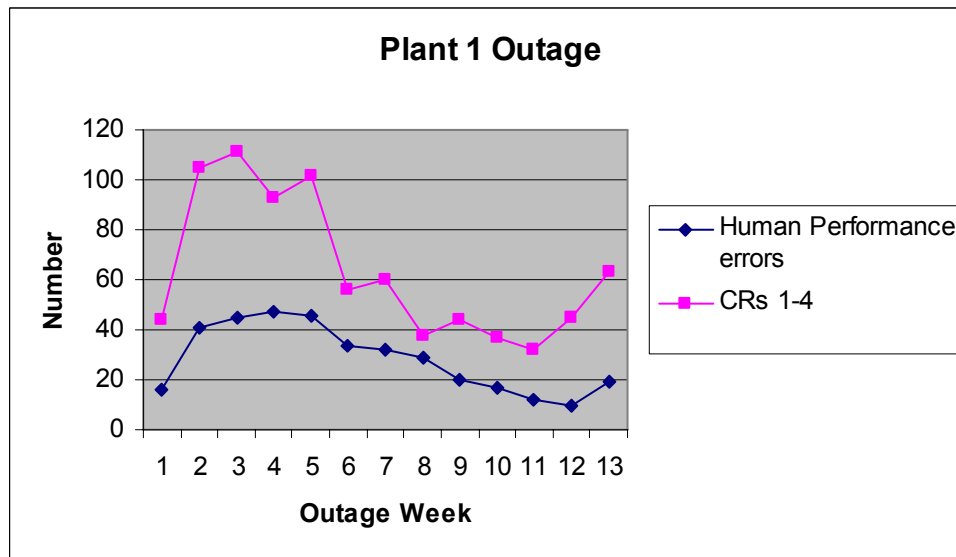
<i>Week</i>	<i>3a</i>	<i>3c</i>	<i>3d</i>	<i>3e</i>	<i>3f</i>	<i>3g</i>
1	16	44	1	1	0	2
2	41	105	0	3	0	6
3	45	111	0	1	4	4
4	47	93	1	1	5	2
5	46	102	3	0	2	2
6	34	56	0	0	4	6
7	32	60	0	1	3	7
8	29	38	0	0	1	1
9	20	44	0	0	1	3
10	17	37	0	0	0	3
11	12	32	0	0	0	2
12	10	45	1	0	1	0
13	19	63	3	0	2	8

Response to Item 3b (industrial safety data):

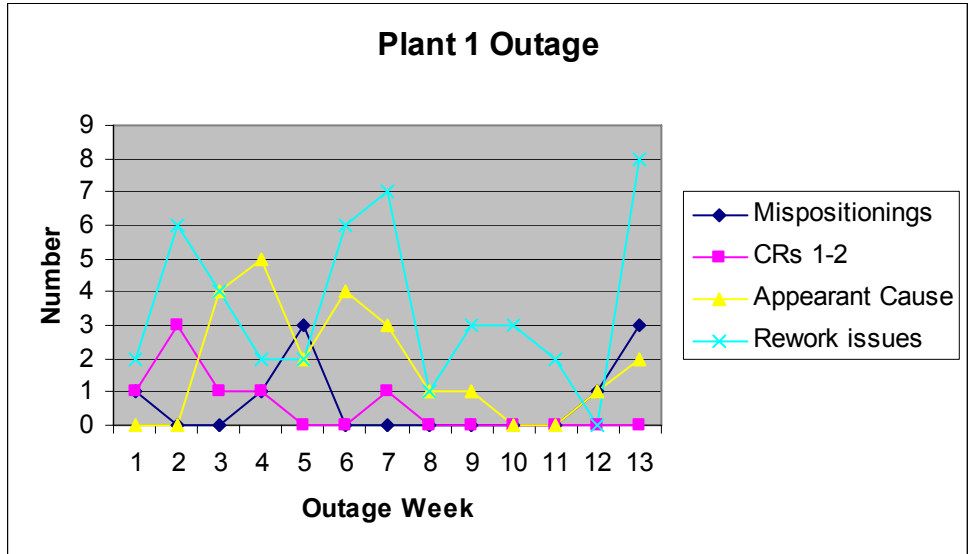
Note: Injury date includes utility and supplemental workers.

<i>Week</i>	<i>First Aid</i>	<i>Recordable</i>	<i>Lost/Restricted-Time</i>
Week 1 (2/26 – 3/4/05)	4	1	0
Week 2 (3/5 – 3/11/05)	13	3	0
Week 3 (3/12 – 3/18/05)	16	4	0
Week 4 (3/19 – 3/25/05)	7	1	0
Week 5 (3/26 – 4/1/05)	8	0	0
Week 6 (4/2 – 4/8/05)	9	1	0
Week 7 (4/9 – 4/15/05)	11	0	0
Week 8 (4/16 – 4/22/05)	0	0	0
Week 9 (4/23 – 4/29/05)	0	0	0
Week 10 (4/30 – 5/6/05)	0	0	0
Week 11 (5/7 – 5/13/05)	0	0	0
Week 12 (5/14 – 5/20/05)	1	1	0
Week 13 (5/21 – 5/27/05)	3	0	0
Week 14 (5/28 – 5/31/05)	0	0	0

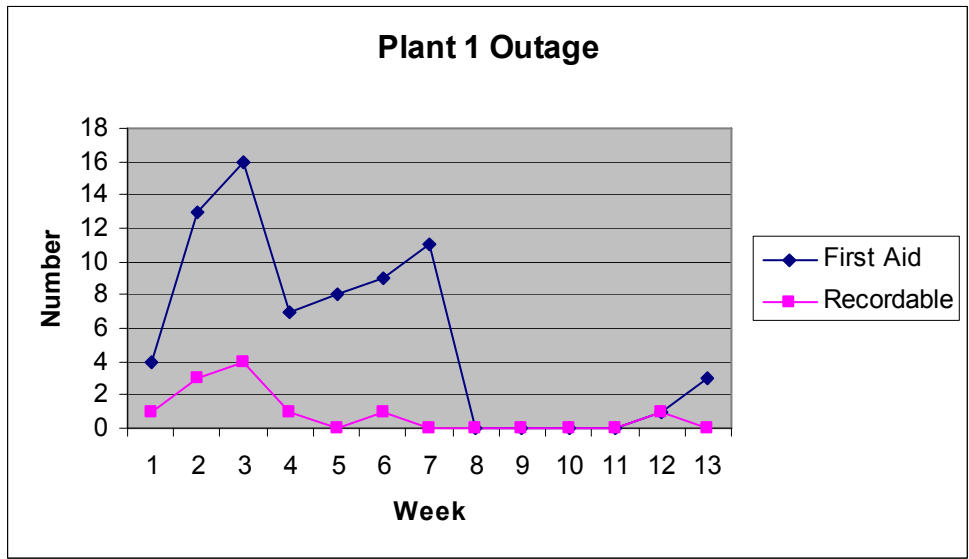
The following graphs summarize the data:



A summary of all human performance events and all CRs shows the downward trend during the outage seen at other facilities.



The low numbers in this category makes it hard to draw any firm conclusions.



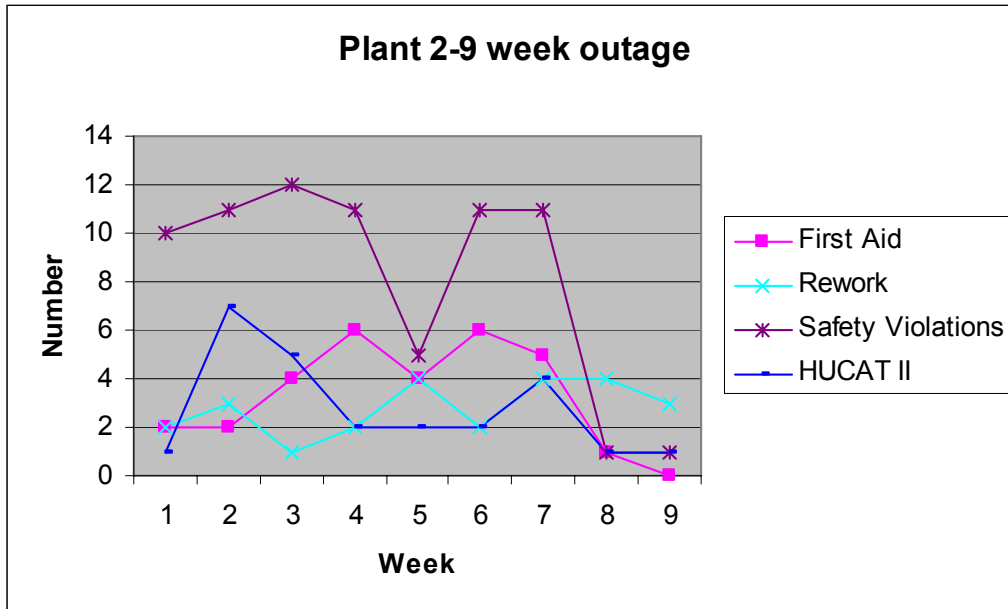
This graph also shows a downward trend.

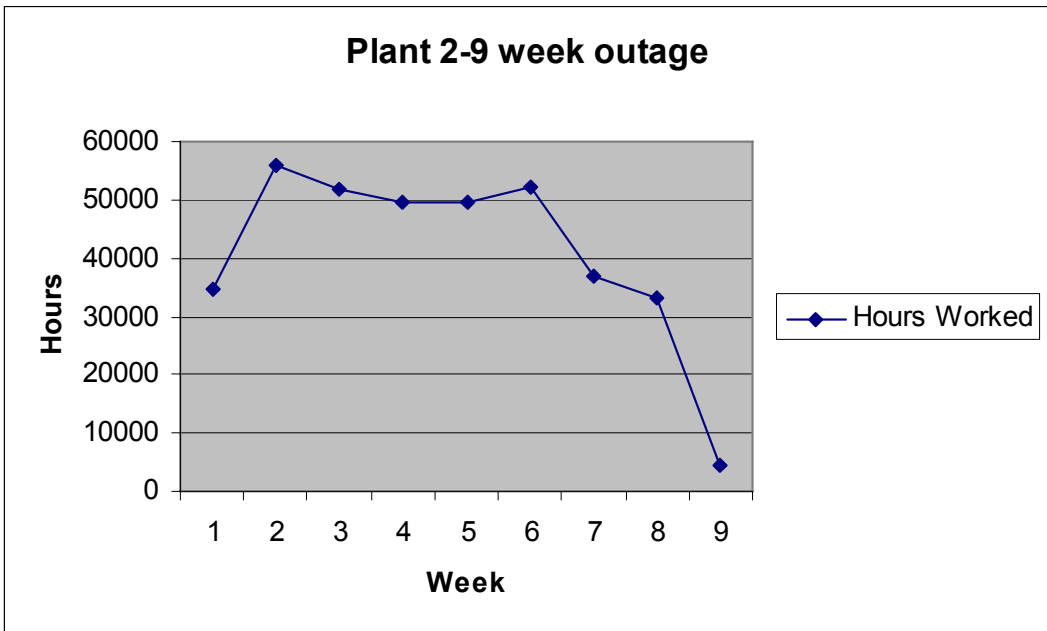
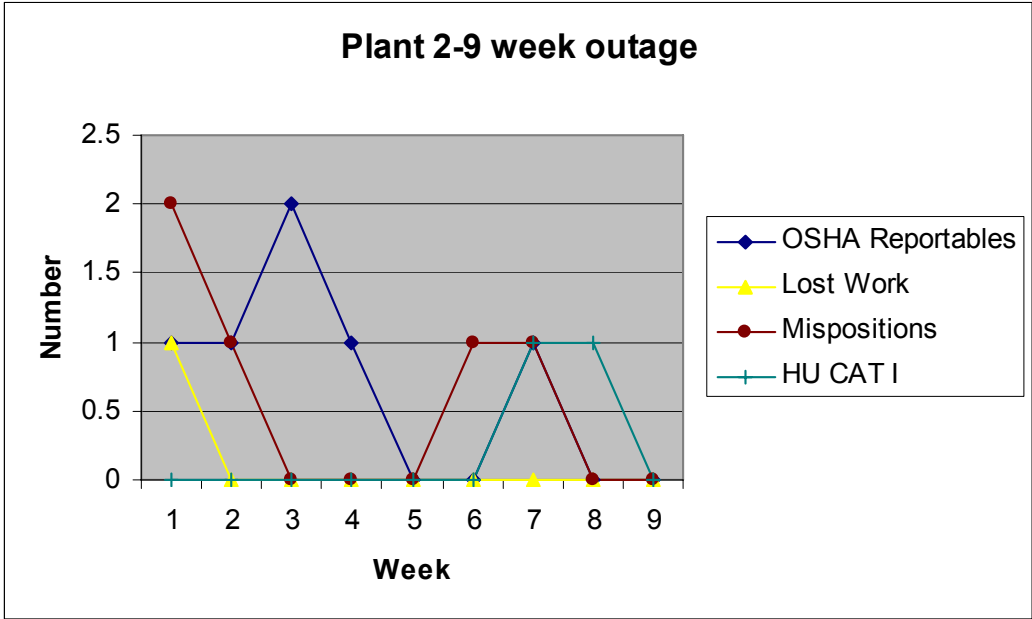
There were no lost/restricted time events.

2. Plant 2:

Plant 2 reported data for a 9-week outage that included a steam generator replacement. None of the data provided would indicate a negative trend of any human performance indicator during the outage.

Week	1	2	3	4	5	6	7	8	9
OSHA Recordable	1	1	2	1	0	0	1	0	0
First Aid	2	2	4	6	4	6	5	1	0
Lost Work Case	1	0	0	0	0	0	0	0	0
Quality/Worker practices/rework	2	3	1	2	4	2	4	4	3
At Risk behavior/Safety violation	10	11	12	11	5	11	11	1	1
Mispositioning	2	1	0	0	0	1	1	0	0
HU CAT I	0	0	0	0	0	0	1	1	0
HU CAT II	1	7	5	2	2	2	4	1	1
Weekly Schedule Variance (Hrs)	33	71	75.5	131	45	78	48	21	-21
Actual Man-hrs worked per week	34698	56073	51745	49750	49578	52141	36896	32988	4636

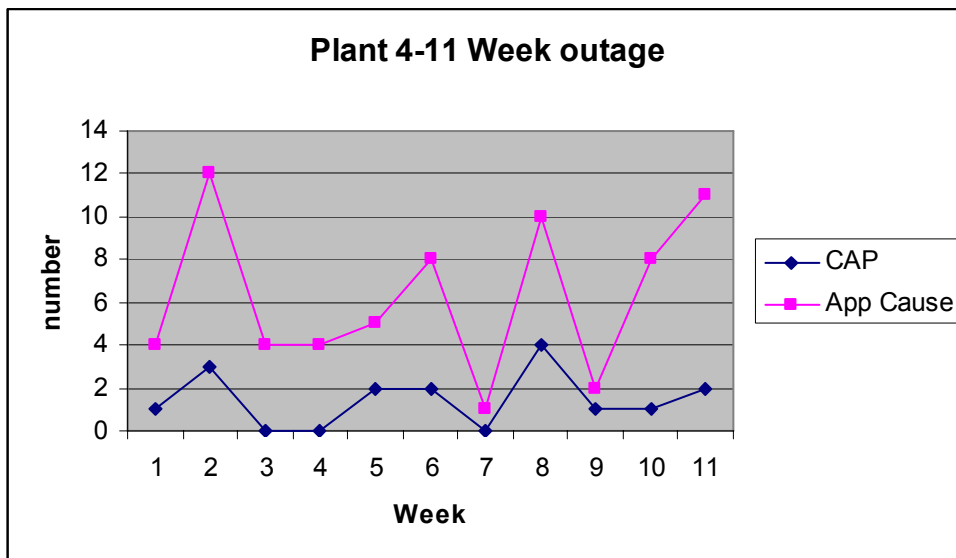
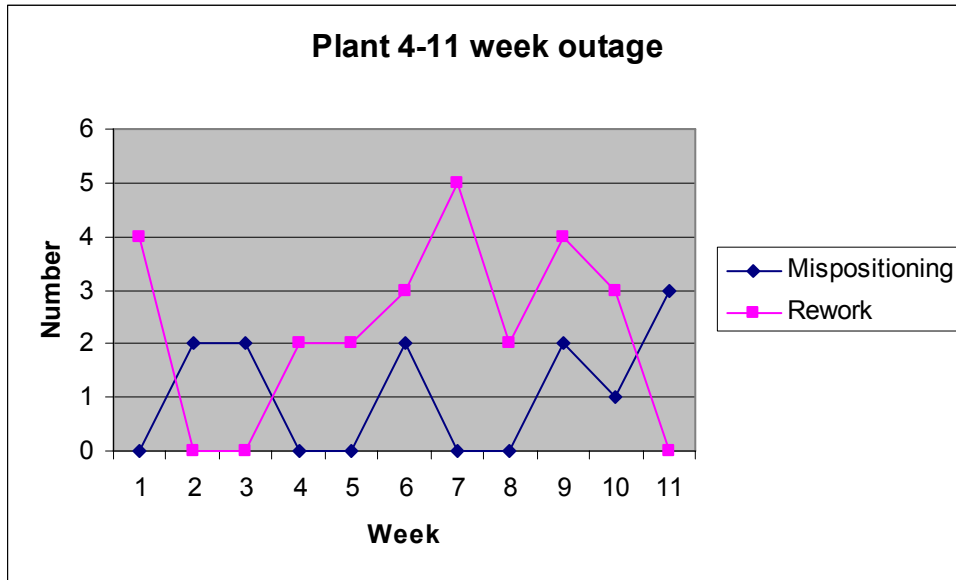


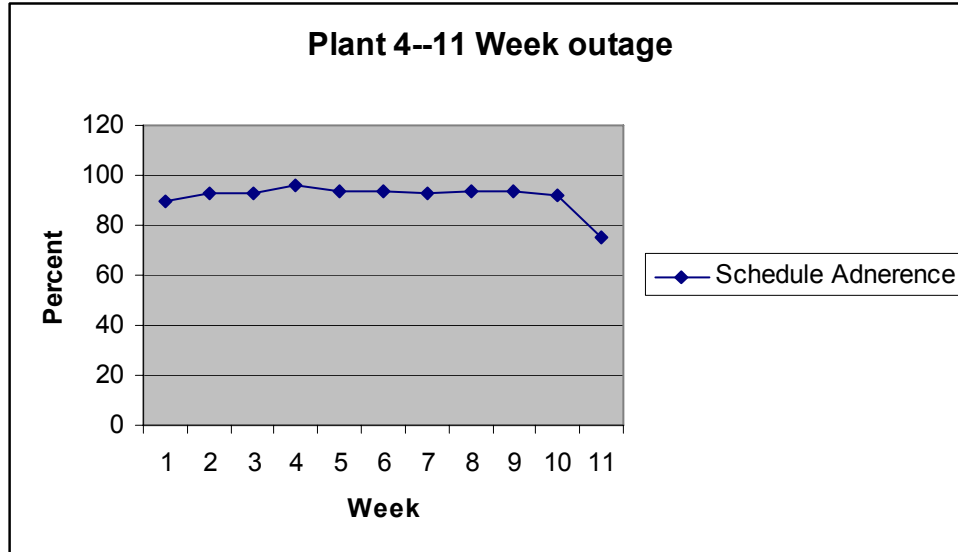


3. Plant 4:

Plant 4 conducted an eleven week outage. A majority of the indicators evaluated were very small would provide no trend. There were no OSHA reportable events or Human Performance related LERS during the three month period that included the outage. The graph is as follows.

Areas with enough data to warrant plotting included: mispositionings, rework, Corrective Action Program entries and apparent cause..



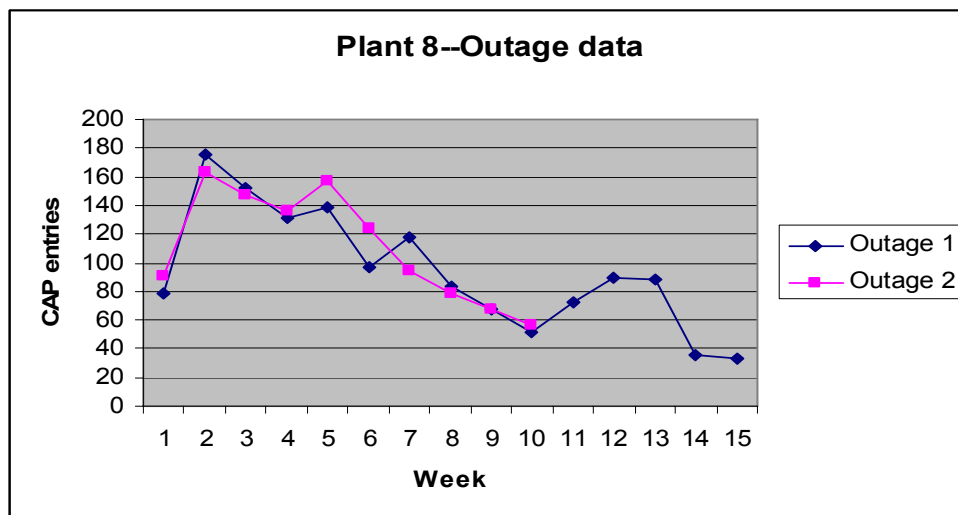


Note: Plant reports that in week 11 75% adherence was management decision to delay work to focus on plant startup activity.

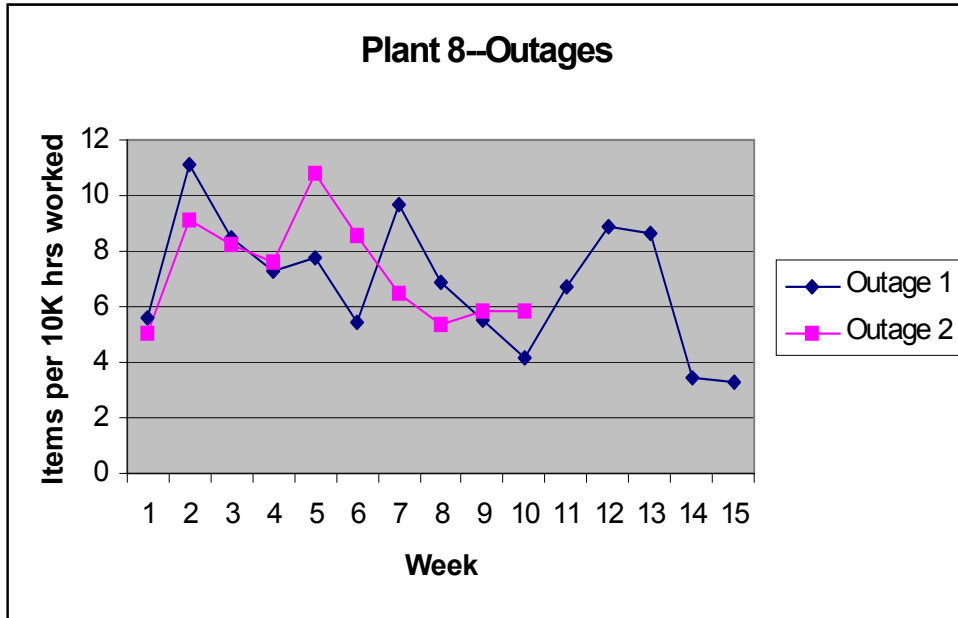
4. Plants 8 and 9:

Prior to the survey, two plants reported overall corrective action program entries for two outages each. This broad based information was plotted and evaluated. The significance of individual events was not considered in this plot. For example for the 14 week outage a total of 1413 items were recorded. Of these only 20 were considered significant, with no more than 2 in any week and no trend over the period.

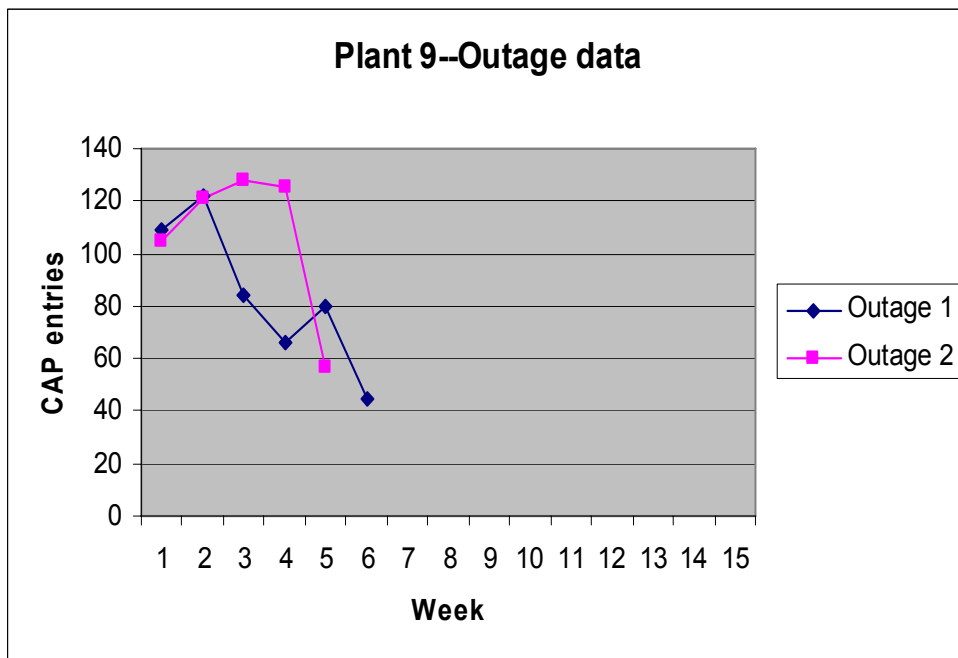
Plant 8 data for two outages:



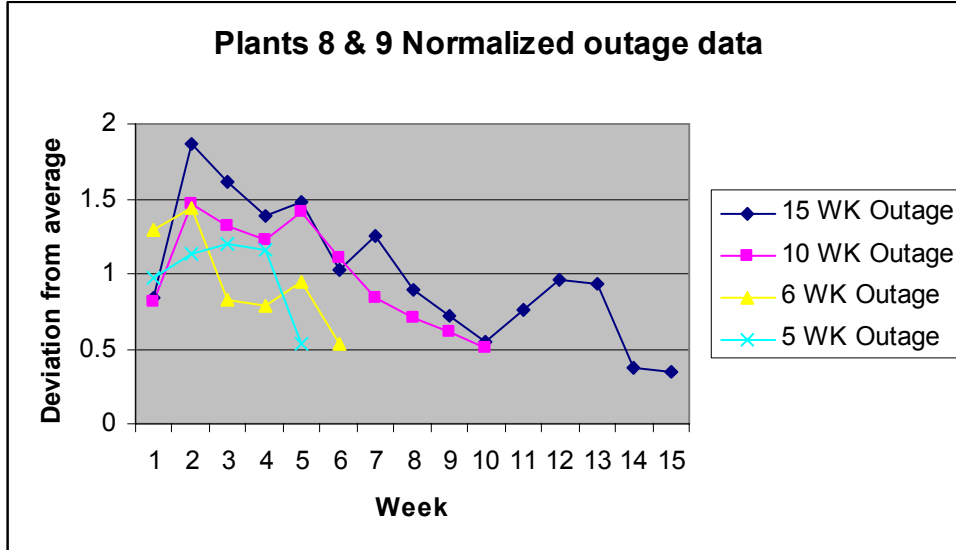
The significant downward trend was evaluated further to see if it might reflect a change in work load through the outage. The data was recalculated to a weekly number per 10,000 hours worked. This still shows a decrease in reported items.



Plant 9 data for two outages:



To allow comparison of the two outages the data was normalized to represent the deviation from the average for each week of the outage. The concern is that direct comparison was not possible because of differences in criteria on what is reported at each facility.



**Special Survey
Work Hours
Human Performance
August 22, 2005**

Issue: Does human performance data from an operating plant indicate degraded performance when individuals work more than 6 days in a row?

Request: Conduct a detailed analysis of human performance indicators for the indicated group and provide that analysis with supporting data to NEI for your Operations Department, Maintenance Department, Health Physics, and/or Chemistry shift workers that are currently working routine schedules that have been identified as not meeting the Work Hour Rule as proposed.

Note: The following information was site specific based on the April 2005 Survey— response shown is typical of those selected for the special survey.

From the April Survey:

2. Normal Operations: Impact of requirement for a 48 hour break every 14 days and 24 hour break every 7 days. The TF believes that this provision will significantly impact the ability of the maintenance organization to respond to emergent work.

2.a. Are there any workgroups covered by Subpart I for whom the normal operating schedule does not provide for at least one day off every 7 days and two days off every 14 days for every member for the group? If yes provide the schedule.

Yes. Operations schedule provides for a minimum of seven straight days on all shifts. Midnight (A) shift (0000-0800) is seven consecutive days. Seven days of Day (B) shift (0800-1600) coupled with three days of training (0800-1600) is ten consecutive days. A Day of Training (0800-1600) coupled with C shift (1600-2400) is eight consecutive days.

2. Background Information: Please provide Company, Plant Site, Contact Name, E-mail, and Phone Number.

2. Provide the specific shift rotation schedule for the Maintenance Department and any other department that does not meet the work hour rule requirements showing the rotation of each crew.

3. If the data is not available on a Daily Basis then conduct a “Shift Period” analysis. It is important that a comparison be done that analyzes the greater than 6 day work periods with less than 6 day work periods (typically 3 or 4 days) in order to discern this impact, if any, the longer schedules are having. For each shift that

exceeds 6 consecutive days, conduct an analysis of human performance indicators and trend the data on a daily basis, based on the crew's days on shift. Include in this analysis:

- i. Human Performance Data (Index or Event)
- j. Industry Safety Data (Lost time, OSHA reportable, number of reports, and/or minor injuries.
- k. Number of Corrective Action Reports (e.g. Level A and Level B—the top two tiers)
- l. Mispositionings (Components Out of Position)
- m. Events reported in the Corrective Action Program
- n. Apparent Cause Reports
- o. Rework
- p. Schedule Adherence

Expectations are that each of the above be addressed separately. If for some reason no data is available or no analysis can be done, please explain why.

Please provide a data summary in understandable format such as graphs or number by day in the shift week. Also, clearly identify what each data set represents, such as how your company has defined the element that is plotted.

The comparison should also include a comparison to data for periods in which the crew is working less than 7 days in the normal rotation.

If alternative data for indicators other than those above are available, please provide these also.

4. Please provide the impact on your site of having to comply with the rule provision, including cost to track compliance with the provision, cost of changing the rotation schedule to comply, and any impact on total manning driven by this change. Please explain each cost element.

5. The Work Hour Task Force is considering an alternative proposal that would replace the 24 hour in 7 days and 48 hour in 14 day requirement. Under the alternative, each individual would be required to be provided 6 days off in a 28 day period. These days could be grouped, but there must be at least two break periods separated by a period of work. For example, an individual could work 8 days, have 3 days off, work 5 days, have 4 days off and work 8 days to meet this alternative.

Please provide the impact on your site of having to comply with this alternative provision, considering the same issues addressed in item 4 above.

Normal Operations Schedule

Five plants provided analysis of human performance errors for normal operating shift schedules that included periods that exceeded 6 days in length.

There is no adverse trend in crew performance beyond the sixth day for in any of the data reviewed.

In several cases the extra days were training days on the end of the cycle which did not produce useful information. The best data came from Plant 3 where the training is on the front of an 8-hour schedule resulting in 7, 8, and 10 day periods which results in 33% of the on shift time beyond the 6th day.

1. Plant 3

Both Operations and Chemistry have shift cycles that involve more than 7 days. (See Operations shift schedule at the end of this paper.) No trends could be developed for the Chemistry Department because of the low number of human performance events. Extensive data was provided for Maintenance with only one item reported that occurred beyond the 6th day. There clearly is no negative trend in Maintenance.

The Operations Department data was analyzed for a 13 month period that did not include any outages .

Human performance Data:

Over a 13 month period 15 Operations Department Human Performance Clock Rests were identified that could be attributed to a shift crew member.

Industry Safety:

Lost Time Accidents = 0

OSHA Reportable Injuries = 0

Number of reports and or minor injuries = 10 (1 was greater than 6th day)

Corrective Action Reports:

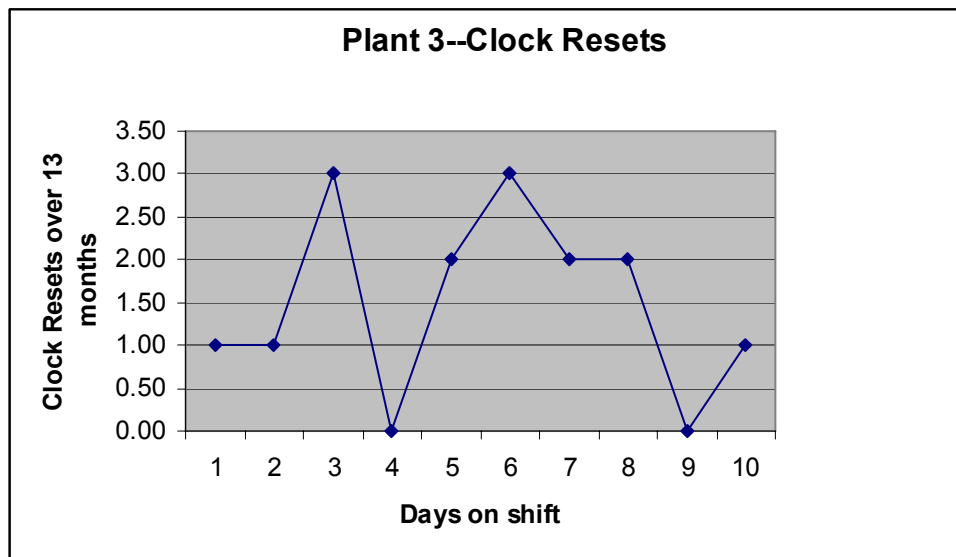
There were 10 reports, 5 of which are included in clock reset data. None of the other 5 exceeded the 6th day.

Mispositionings

There were 21 reports, 11 of which are included in clock reset data. None of the other 10 exceeded the 6th day.

Events reported in CAP, Apparent Cause and Rework are all captured in the clock reset data.

A plot of the 15 clock resets attributed to shift workers shows:



This raw data was corrected for the number of days on each shift during a cycle:

The crew rotation results in 33% of the on shift days being greater than the 6th day. This is expected to be at the high end for the industry and should provide one of the better data points. The department is in a 5 section, 8-hour shift rotation with 4 days of training, 21 days of on shift and 10 days off. Three days of training are conducted just before the day shift and one day of training before the afternoon shift. This results in:

- 3 Days Training, 7 days on shift 08-16, followed by 4 days off.
- 1 Day Training, 7 days on shift 16-24, followed by 2 days off.
- 7 Days of shift 00-08, followed by 4 days off.

NOTE: Over the 5 week cycle, any 5 section, 8-hour shift rotation will result in 21 days on shift. This is the result of the need for 3 of the 5 crews to stand a watch each day. This leaves 14 days of something else: with four days of training there will be 10 days off and with 5 days of training nine days off. If 24 hour periods are used, instead of calendar days, two additional “off” periods would result. For example, getting off day shift at 1600 one day and starting swing shift at 1600 the next day, results in a 24 hour off period.

$$[(35 \text{ days}) \times (3 \text{ shifts per day})] / 5 \text{ crews} = 21 \text{ shifts/crew}$$

$$(35 \text{ days}) - (21 \text{ days}) = 14 \text{ days}$$

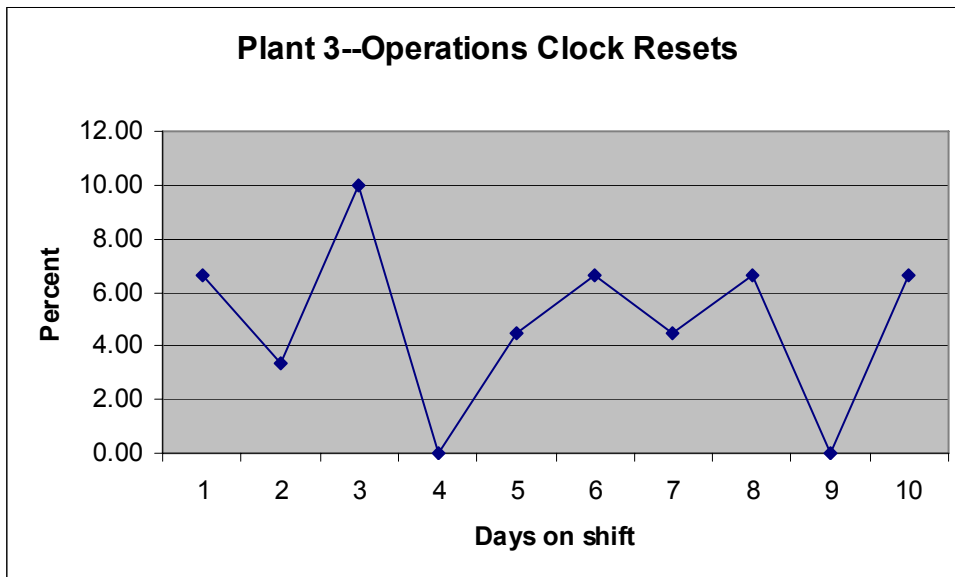
So with 4 days of training, this group is going to get 10 days off per cycle. It can be 4-2-4, or 3-3-3-1, or any other combination, but it will not exceed 10.

For the above Operations Department schedule:

Day number	1	2	3	4	5	6	7	8	9	10
Days	T	T	T	D	D	D	D	D	D	D
Evening	T	S	S	S	S	S	S	S		
Night	N	N	N	N	N	N	N			
Days per cycle	1.00	2.00	2.00	3.00	3.00	3.00	3.00	2.00	1.00	1.00
Percent each	4.76	9.52	9.52	14.29	14.29	14.29	14.29	9.52	4.76	4.76

The above table shows that the data must be normalized to get a true picture. There is, for example, 3 times the exposure on day 3 or 4 compared to day 1 or 10 for this crew rotation.

The data is plotted as a percentage of the total each day to allow comparison of the day-to-day trend. If two years had been used instead of 1 year, the total would be expected to be in the 30 range instead of 15. The interest is in the distribution not the number.



From the graph—there is no adverse trend from days 7, 8, 9, and 10.

Looking at the aggregate, 33% of the crew shift time is greater than day 6. Since 5 of the 15 events (33%) were on days 7 to 10 there is also no adverse trend when viewed this way.

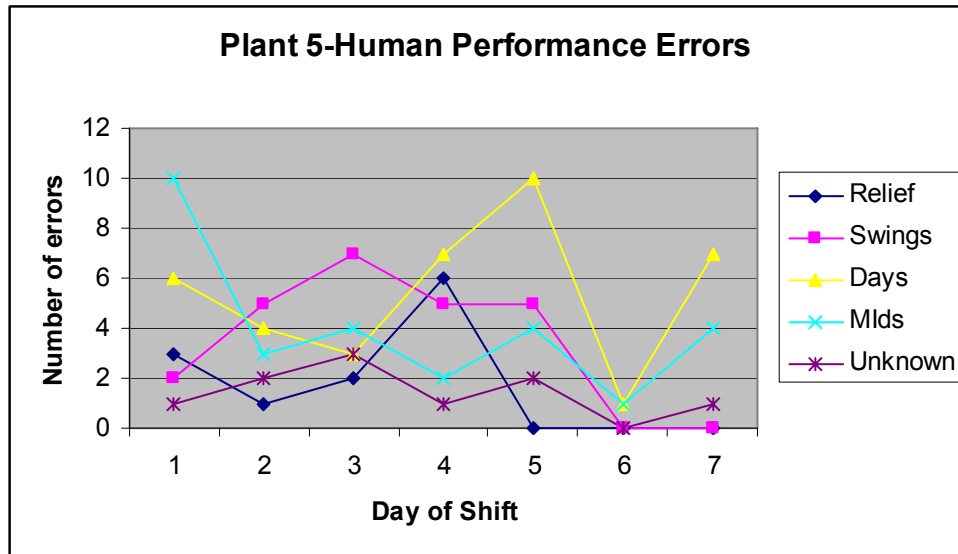
The company reports no lost time accidents, no OSHA reportable. For the 10 other items reports only 1 (20%) was greater than day 6.

2. Plant 2

Both Operations and Chemistry had schedules that exceeded 6 days in length. However, for operations most of those days were training days conducted at the end of the day shift schedule. There were no events in Operations or Chemistry on days worked beyond the 6th day. There was no data that warranted trending and there were no adverse trends.

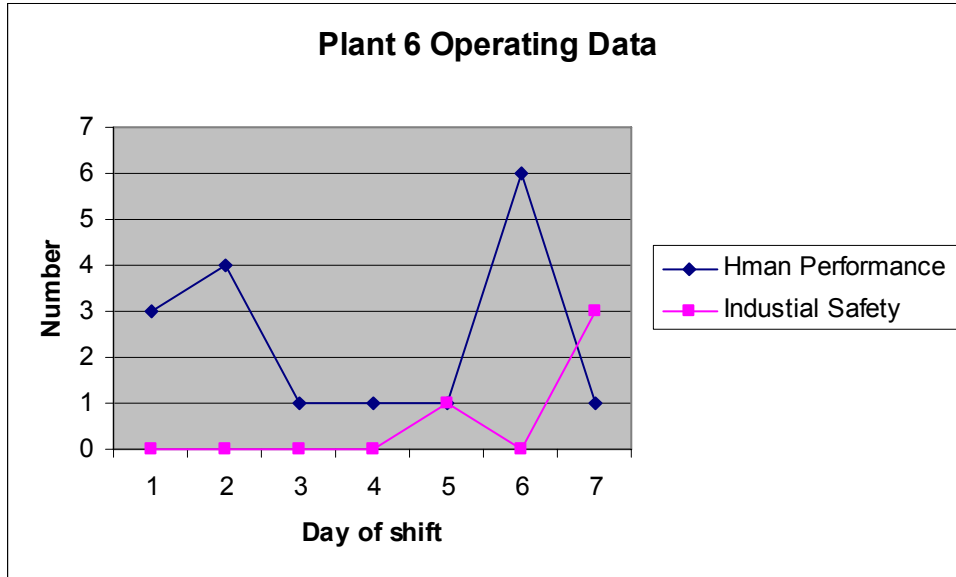
3. Plant 5

The crew is standing 8-hour shifts in 7 day blocks and has a relief crew week in the rotation. From the data shown below there are no adverse trends on the 7th day.



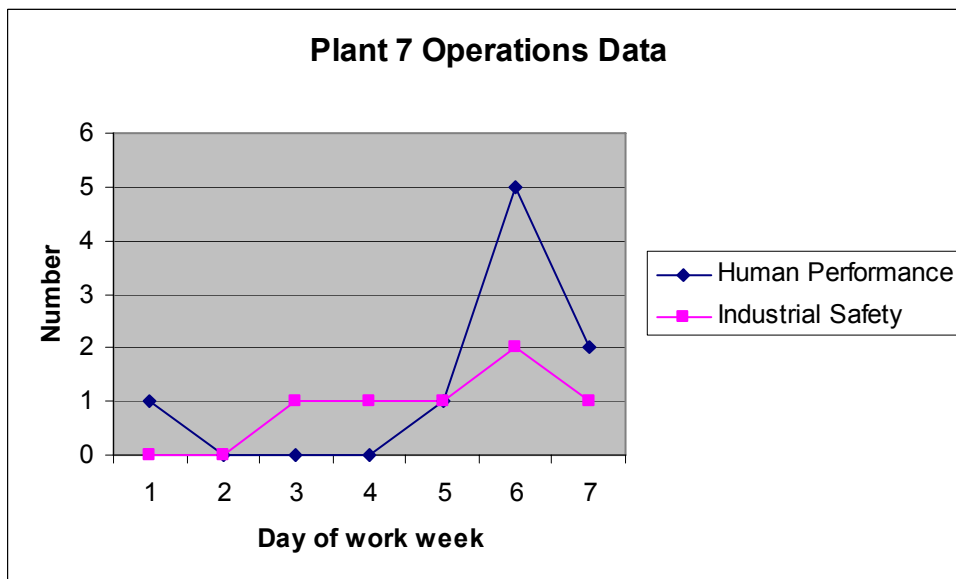
4. Plant 6

During the 21 month period evaluated period evaluated Plant 6 started with a 5 section rotation and near the end of the period shifted to a 6 section rotation. Both have 7 days on mids and swings. When evaluated over a one year period, the information is not statistically significant and there is no adverse trend.



5. Plant 7

A similar review at Plant 7 produced the following graph. Note that the errors peak at day six and drop off on day 7. The information was collected over a 21 month period and the variations are not considered to be significant. Again there is no adverse trend.



Plant 3

Plant Plant 3
 Group Operations
 Status Operating

D is 8 hour days
 S is 8 hour swings
 N is 8 hour nights
 T is 8 hour training

Crew/Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
A			T	S	S	S	S	S	S	S			N	N	N	N	N	N						T	T	T	D	D	D	D	D	D	D				T	S	S	S	S	S	S	S	S	S	S	N	N
B	N	N	N	N	N					T	T	T	D	D	D	D	D	D						T	S	S	S	S	S	S	S			N	N	N	N	N	N	N				T	T	T	D	D	
C			T	T	T	D	D	D	D	D	D						T	S	S	S	S	S	S	S			N	N	N	N	N	N	N				T	T	T	D	D	D	D	D	D	D			
D	D	D	D	D	D					T	S	S	S	S	S	S			N	N	N	N	N	N	N					T	T	T	D	D	D	D	D	D				T	S	S	S	S			
E	S	S	S			N	N	N	N	N	N	N					T	T	T	D	D	D	D	D	D					T	S	S	S	S	S	S	S			N	N	N	N	N	N	N			

Plant 5

Plant Plant 5--Six shift rotation
 Group Operations
 Status Operating

D is 8 hour days
 S is 8 hour swings
 N is 8 hour nights
 T is 8 hour training
 A is 12 hour days
 P is 12 our nights
 Average is 40 hrs/wk

Crew/Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42							
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
A		D	D	D	D	A	A	D			N	N	P	P	N	N	N					R	R	R	R				S	S	S	S	S				T	T	T	T	T								
B	T	T	T	T	T				D	D	D	D	A	A	D			N	N	N	P	P	N	N	N				R	R	R	R					S	S	S	S	S								
C	S	S	S	S	S			T	T	T	T	T			D	D	D	D	A	A	D				N	N	P	P	N	N	N					R	R	R	R										
D	R	R	R	R				S	S	S	S	S			T	T	T	T	T				D	D	D	D	A	A	D			N	N	P	P	N	N	N											
E	N	N	N					R	R	R	R				S	S	S	S	S				T	T	T	T	T			D	D	D	D	A	A	D				N	N	P	P						
F	D			N	N	P	P	N	N	N					R	R	R	R				S	S	S	S	S			T	T	T	T	T				D	D	D	D	A	A							

Plant 6

Plant Plant 6--5 shift rotation
 Group Operations
 Status Operating

D is 8 hour days
 S is 8 hour swings
 N is 8 hour nights
 T is 8 hour training

Average is 40 hrs/wk

	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Crew/Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35			
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S			
A	D	D	D	D	D					T	T	T	D	D	T			S	S	S	S	S	S	S			N	N	N	N	N	N	N	N				
B			T	T	T	D	D	T			S	S	S	S	S	S	S			N	N	N	N	N	N	N			D	D	D	D	D					
C	T			S	S	S	S	S	S	S	S			N	N	N	N	N	N	N			D	D	D	D	D				T	T	T	D	D			
D	S	S	S			N	N	N	N	N	N	N			D	D	D	D	D						T	T	T	D	D	T			S	S	S	S		
E	N	N	N	N	N			D	D	D	D	D					T	T	T	D	D	T			S	S	S	S	S	S	S			N	N			

Plant Plant 6--Six shift rotation
 Group Operations
 Status Operating

D is 8 hour days
 S is 8 hour swings
 N is 8 hour nights
 T is 8 hour training

Average is 40 hrs/wk

	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Crew/Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
A	D	D	D	D	D					T	T	T	D	D	T			S	S	S	S	S	S	S			N	N	N	N	N	N	N			R	R	R	R	R		
B			T	T	T	D	D	T			S	S	S	S	S	S	S			N	N	N	N	N	N	N			R	R	R	R	R			D	D	D	D	D		
C	T			S	S	S	S	S	S	S	S			N	N	N	N	N	N	N			R	R	R	R	R			D	D	D	D	D				T	T	T	D	D
D	S	S				N	N	N	N	N	N	N			R	R	R	R	R			D	D	D	D	D			T	T	T	D	D	T			S	S	S	S	S	
E	N	N	N	N	N			R	R	R	R	R			D	D	D	D	D			T	T	T	D	D	T			S	S	S	S	S	S	S			N	N		
F	R	R	R	R	R			D	D	D	D	D					T	T	T	D	D	T			S	S	S	S	S	S	S			N	N	N	N	N	N	N		

Plant 7

Plant Plant 7
 Group Operations
 Status Operating

D is 8 hour days
 S is 8 hour swings
 N is 8 hour nights
 T is 8 hour training
 A is 12 hour days
 P is 12 hour nights
 Average is 40 hrs/wk

Crew/Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	
A	D	D	D			N	P	P	N	N	N	N			T	T	T	T	T			S	S	S	S	S			R	R	R	R								D	D	A	A
B	P	N	N	N	N			T	T	T	T	T			S	S	S	S	S			R	R	R	R					D	D	A	A	D	D	D				N	P		
C	T	T	T	T	T			S	S	S	S	S			R	R	R	R							D	D	A	A	D	D	D			N	P	P	N	N	N	N			
D	S	S	S	S	S			R	R	R	R						D	D	A	A	D	D	D			N	P	P	N	N	N	N	N			T	T	T	T	T			
E	R	R	R	R							D	D	A	A	D	D	D			N	P	P	N	N	N	N			T	T	T	T	T			S	S	S	S	S			
F				D	D	A	A	D	D	D			N	P	P	N	N	N	N			T	T	T	T	T			S	S	S	S	S			R	R	R	R				