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ORGDP VENTILATION SYSTEMS

1981-2000 LONG RANGE PLAN

R. E. Cassell

UNION CARBIDE

OAK RIDGE GASEOUS DIFFUSION PLANT
OAK RIDGE, TENNESSEE

prepared for the **U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION**
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UNION CARBIDE CORPORATION
NUCLEAR DIVISION

Oak Ridge Gaseous Diffusion Plant
Oak Ridge, Tennessee

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A B S T R A C T

Past operating and maintenance records have been reviewed as a basis for projecting the cost of maintaining the ORGDP ventilation systems from 1981 to 2000. Historical records and maintenance experience have been used to estimate cost of maintaining present and additional ventilation equipment.

INTRODUCTION

The numerous axial flow compressors used in the gaseous diffusion process generate a large volume of heat that must be removed for efficient operation. Part of the heat of compression is transferred to the water cooling towers for dispersal while the remainder is dissipated to the equipment ambient within the building. Additional heat is generated by the compressor motors and the associated transformers within the building.

The function of the ventilation system is to remove the excess heat from the operating equipment and ensure acceptable conditions inside the building. The projected cost of maintaining the system from 1981 through the year 2000 is the purpose for this report. A review of past operating and maintenance records provided the basis for the projected costs.

SUMMARY

Long range plans are being generated to predict the cost of maintaining various facilities and equipment in an acceptable operating mode at ORGDP through the year 2000. This report encompasses the plant ventilation systems. Historical records and maintenance experience were used to estimate maintenance costs of the present ventilation systems and to predict the cost of maintaining equipment which will be added to uprate the systems for CUP operation (Table 1).

DESCRIPTION OF SYSTEMS - K-31 AND K-33

Present System

The K-31 and K-33 ventilation systems are very similar in construction and operation. Each system is separated into two plenums, the operating floor and the cell floor.

Air is drawn into the operating floor plenum by the supply fans. The incoming air mixes with the heated air given off by the transformers and is discharged through ducts to the cell floor plenum. Most of the cell floor air is used to cool the stage motors. Air which enters the end bells of the motors and exits through the motor base to the exhaust duct is discharged to the outside of the building by the exhaust fans. Waste heat from the cell enclosures aids in maintaining acceptable temperatures in the cell and unit bypass pipe housings. The housings are connected to the cell enclosures and to the outside of the building. A positive pressure is maintained in the cell floor plenum in relation to pressure outside the building. This differential forces the heated cell air through the housing to the outside of the building. Some air also escapes through the gravity louvers in the building roof.

TABLE 1

ESTIMATED MAINTENANCE COSTS - 1981-2000
(Based on 1974 $)

Facility	1981-1985	1986-1990	1991-1995	1996-2000	Total 1981-2000
K-33	255,750	255,750	255,750	255,750	1,023,000
K-31	194,350	194,350	194,350	194,350	777,400
K-29	47,550	47,550	47,550	47,550	190,200
K-27 (Start 1984)	6,950	34,750	34,750	34,750	111,200
ORGDP	504,600	532,400	532,400	532,400	2,101,800

Thermostats located on the operating floor modulate the building air inlet and recirculating louvers to maintain the building temperature at prescribed levels. The roof louvers are controlled manually to maintain a positive cell floor pressure for bypass housing heating.

Uprated Systems

A substantial amount of heat will be produced by cascade equipment operating at CUP conditions. To assure equipment and personnel protection during and following CUP installation, the ventilation systems are scheduled to be uprated by June 1, 1977.

K-31 System

Heat load increases of 115% on the operating floor and 50% on the cell floor are predicted for this building. The uprated system will increase the air flow through the building by about 90% which should negate about 95% of the predicted heat load increase.

The increased air flow will be accomplished by installing additional inlet air filters, additional supply fans and new wall mounted exhaust fans on the operating floor. New fans will be installed to provide a positive flow through the cell exhaust system. Additional gravity type roof ventilators will be installed and a majority of the motor exhaust fans will be uprated to exit more air from the cell floor. An increase of 60% in maintenance prone equipment will result in a proportional cost increase.

K-33 System

The heat load in the K-33 building will increase 55% on the operating floor and 30% on the cell floor when operating at CUP loads. A 65% increase in the air flow through the building to remove 95% of the additional heat load will be accomplished by installing additional air inlet filters, additional supply fans and new wall mounted exhaust fans on the operating floor. New fans will be installed on the cell floor to provide a positive flow through the cell exhaust system. Two large capacity fans located outside the building will be connected to the unit bypass housing and the K-31 - K-33 tie line housing will also remove air from the cells. A 25% increase in maintenance prone equipment will result in an increase in related costs.

Release Detection System

A release detection system is being installed in the K-31 and K-33 cell exhaust systems with automatic isolation of the affected cell enclosure from the ventilation system in the event of a process gas release.

K-29 System

The equipment on the K-29 cell floor is not separated by cell enclosures. The building walls above the cell floor level are insulated and form one large enclosure for the process equipment, piping and stage motors.

Air to cool the stage motors is brought into the operating floor by thirty supply fans which discharge air through ducts to each end of each motor at cell floor level. The heated air is removed at a controlled rate through gravity roof ventilators to assure a temperature compatible with cascade operating conditions while removing as much heat as possible from the motors. Some of the cell floor air is recirculated to the operating floor for heating purposes when needed.

K-27 System

Nine direct drive fans in each unit remove air from the basement plenum and discharge the air along the motor aisle in the escape alley between cells. The heated air is exhausted from the building through gravity roof ventilators. One belt driven fan discharges air into the withdrawal alley motor aisle. The heated air is dispersed throughout the pipe gallery and through gravity type roof ventilators to the outside of the building.

Each unit has a belt driven fan in the north wall to move large amounts of air through an opening in the south wall and across the operating floor for summertime cooling. Heating the operating floor during cold weather is accomplished by diverting some of the heated air from the escape alley to the operating floor.

OPERATING COSTS

The operating cost is based on equipment failure or wear experienced during the previous years. In some cases there is sufficient documentation to substantiate the failure rates, while in others the experience of several persons closely involved with the systems was used in lieu of written records. For instance, the maximum life of the drive sheave on a supply or exhaust fan motor is documented at seven years; whereas, the repair of louvers in K-31 was so sporadic it was not documented until a complete renovation was necessary after some 20 years of operation.

The major maintenance items noted in Tables 2 through 5 were prorated to an annual base for ease in projecting future costs. The cost for labor was figured at $10.50 per man hour and material costs are given in 1974 dollars.

TABLE 2

K-31 BUILDING

	Replace in Five Years	Material Cost 1974 $	Manhours	Labor and Material Five Years
1974 System:				
Fan Repair (88 Total)				
Bearings	80	10,400	1,200	
Belts	150	6,000	1,350	
Sheaves	70	2,300	700	
Impeller	3 1/3	3,500	250	
Shaft	6 2/3	10,000	350	
Motor	10	9,000	160	
Louver	35	950	1,230	
Air Motor	95	1,425	455	
Solenoid	70	1,050	345	
Miscellaneous		9,000	1,250	
Total		53,625	7,290	130,170
Uprated Addition:				
Fan Repair (54 Total)				
Bearings	49	6,380	735	
Belts	92	3,680	630	
Sheaves	43	1,410	430	
Impeller	2	2,140	150	
Shaft	4	6,140	215	
Motor	6	5,525	100	
Louver	22	585	755	
Air Motor	58	875	280	
Solenoid	43	645	210	
Total		27,380	3,505	64,180
1974 + Addition		81,005	10,795	194,350

TABLE 3

K-33 BUILDING

	Replace in Five Years	Material Cost 1974 $	Manhours	Labor and Material Five Years
1974 System:				
Fan Repair (192 Total)				
Bearings	150	16,000	2,250	
Belts	325	12,250	2,850	
Sheaves	135	4,350	1,350	
Impeller	16 2/3	7,250	400	
Shaft	16 2/3	4,000	400	
Motor	15	13,500	260	
Louver	60	1,625	2,050	
Air Motor	165	2,475	660	
Solenoid	120	1,800	580	
Miscellaneous		12,500	2,125	
Total		75,750	12,925	211,462
Uprated Addition:				
Fan Repair (54 Total)				
Bearings	38	4,000	565	
Belts	81	3,060	715	
Sheaves	34	1,090	325	
Impeller	4 1/3	1,800	100	
Shaft	4 1/3	1,000	100	
Motor	4	3,375	75	
Louver	15	400	510	
Air Motor	41	625	175	
Solenoid	30	450	150	
Total		15,800	2,715	44,308
1974 + Addition		91,550	15,640	255,770

TABLE 4

K-29 BUILDING

	Replace in Five Years	Material Cost	Manhours	Labor and Material Five Years
Fan Repair (30 Supply Fans)				
Bearings	25	3,750	375	
Belts	50	2,000	45	
Sheaves	25	750	25	
Impeller	1 2/3	1,500	125	
Shaft	5	7,500	300	
Motor	5	4,000	80	
Louver	20	500	665	
Air Motor	50	875	235	
Miscellaneous		2,000	500	
Total		22,875	2,350	47,550

TABLE 5

K-27 BUILDING

	Replace in Five Years	Material Cost	Manhours	Labor and Material Five Years
Fan Repair (18 Belt Driven)				
Belts	20	800	80	
Sheaves	12 1/2	375	50	
Impeller	1 1/4	750	75	
Shaft	1 1/4	750	75	
Bearing	10	750	50	
Fan Repair (81 Direct Driven)				
Bearing	50	3,750	250	
Impeller	5	2,000	100	
Shaft	5	1,000	100	
Motor (99 Fans)	15	2,250	525	
Miscellaneous		750	750	
Total		13,175	2,055	34,750

CONCLUSIONS AND RECOMMENDATIONS

When the ventilation system is operating below specifications, the heat generated by the process equipment accumulates within the building to the degree that the system operates below design capacity. The increased ambient temperature results in higher operating temperatures which reduces the efficiency and the life of the equipment. Additionally, a heat stress problem could be encountered by personnel working in the affected building.

The loss of a minor, but strategic, block of the system could cause stage motor failures; and a 20% reduction of ventilation capacity would necessitate lowering the process load to protect equipment in the building.

To preclude intolerable outages, a preventive maintenance philosophy has been adopted. The equipment is routinely lubricated, worn parts are replaced prior to failure and failed equipment is returned to service as soon as practicable.

Prior to the 1981 starting period (1984 for K-27), the ventilation systems at ORGDP will be in an acceptable condition if the preventive maintenance philosophy is executed. This would assure an adequate ventilation system to continue operation past the year 2000.

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