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SANITIZED VERSION OF EXTRACT FROM CRD DOCUMENT OM-49 OPERATING MANUAL

Compiled by
S. G. Thornton
Environmental Management Division
OAK RIDGE K-25 SITE
for the Health Studies Agreement

October 19, 1995

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Oak Ridge K-25 Site

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OPERATING MANUAL

BUILDING AND BUILDING UTILITIES FOR K-27 PLANT

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OM 49 7 A

VOLUME XXXI

FIRST EDITION

October 22, 1945

This document contains information affecting the national defense of the United States within the meaning of the Espionage Act, 50 U.S.C., 31 and 32. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

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Approved:

Compiled and edited by
THE OPERATING DEPARTMENT

For the Kellex Corp. [signature]
D. K. Finlayson

R. F. Benenati
R. F. Benenati

For Carbide & Carbon Chemicals Corp. C. N. Rucker
C. N. Rucker, Jr.

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II. UTILITIES

1. Ventilation

(a) Function and Design

The prime function of the ventilating system is the dissipation of heat. In the performance of this primary function the ventilating system supplies an air circulation greatly in excess of breathing requirements.

Much of the heat to be dissipated comes from within the cells for the coolant system carries off only the heat of adiabatic compression, and the pump casings, cell converters, and process piping run sufficiently hot to liberate large quantities of heat. Other heat is generated in transformer windings, motor windings and lights. Solar heat enters through the roof.

DESIGN REQUIREMENTS

The two principal requirements of the ventilating system are:

(1) Removal of sufficient heat under maximum summer temperature conditions to maintain within the cells the stipulated temperature of the process material, and to maintain a temperature outside the cells in the alleys and the operating floor that can be tolerated by the operating crew.

(2) Retention within the buildings of as much heat as possible under extreme winter conditions, or all that is desirable during spring and fall, with undisturbed maintenance of the stipulated temperature within the cells.

It has been found that the first of the above requirements is the more difficult to meet, and all calculations of air quantity have been made on that basis. The maximum assumed average condition of atmospheric air has been taken at 100°F and 70% relative humidity.

The general design calls for the circulation of an ample quantity of air over heat generating equipment. This air will absorb heat and be discharged through ventilators in the roof.

For the discussion of ventilation a building may be considered as divided into four areas. There is a basement which is well sealed from the converter floor. The converter floor, in turn, is sealed from the pipe gallery floor and withdrawal alleys. Finally, the operating floor is sealed from the rest of the building. It is possible to get an air flow between these different areas by using combinations of dampers and louvres. The operation and location of these will be mentioned as they apply to the ventilation requirements.

The building ventilating system may be divided into two parts:

(1) Cell ventilation

(2) Operating floor ventilation

Each part contains its own fan and duct assembly, but the two may be operated together.

The transformer vault and battery room has an independent ventilating system.

(b) Air Filtering System

All of the air entering the ventilating system is cleaned by passing through a filter system. The same filtering units are used by the two parts of the building ventilating system. The transformer vaults have separate filter systems.

CELL AND OPERATING FLOOR AIR INTAKE

At the rear of each of the buildings are two penthouses extending from the building. They contain the filter banks used in filtering the air supplied to the cell and operating floor ventilating systems. The penthouses and the filtering arrangement within them are shown on Figure II.1-1. These extensions occur between column lines B and C on the left of the building and J and K on the right. They are 17'-8" wide, 16'-1" high at the ends, and extend 8'-8-1/2" from the end of the building. A sloping roof extends from the building proper at approximately the cell floor level. The three exposed sides of the extension contain 1/2" stationary louvre blades covered by 1/2" mesh G.I. wire screen. This combination serves as an initial precaution against large foreign objects reaching the filtering units.

Inside the penthouses are a number of filter banks arranged in a zig-zag pattern in order to allow for a greater filter area. Each bank comprises a number of 20" x 20" x 2-3/4" frames. The banks are nine frames high and vary in width due to the pattern arrangement. Each frame contains two 20" x 20" x 1" filter cartridges in series. The cartridges are Owens-Corning Fiberglas Dustop No. 1 and are constructed of interlaced glass fibers in a grille frame. Each penthouse contains 225 frames requiring a total of 450 cartridges.

The flow of air is through the screened louvres in the penthouse walls, through the filter cartridges, and directly into the basement area and the suction of the ventilating fans.

TRANSFORMER VAULT AIR INTAKE

The transformer vault ventilating system has an independent air intake system as shown on Figure II.1-2. This system consists of two intake air chambers at the back of the transformer vault.

Each chamber contains a 50 frame filter bank. Each fram is 20" x 20" x 2-3/4" and carries two Owen-Corning Fiberglas Dustop #1 cartridges.

Ducts from the filter units join to a common distribution duct underneath the floor.

The filter banks are designed to allow a maximum velocity through the filters of 300 ft per minute. The average resistance of two filters in series when clean is approximately 0.14 inches of water at the above velocity.

The filter cartridges should be regularly inspected to check cleanliness. From time to time, depending on the amount of dust in the air, they should be cleaned or, if necessary, replaced. Filters that are clogged and dirty are inefficient. The cleaning process consists of removing the filter and rapping out loose dust and dirt by tapping the sides of the filter against a solid surface. This procedure may be repeated three or four times. When the intake filter becomes too dirty to be cleaned, it should be discarded and the Number 2 filter moved up into its place. The new filter is then installed in the Number 2 position.

(c) Cell Ventilation

The cell ventilating system performs a dual job:

(1) It helps maintain the correct ambient temperature within the cell.

(2) It provides for keeping the motor alley and withdrawal alley air at a temperature suitable for the pump motors and the operating crew.

There are ten fans in the cell floor ventilating system of each building. They are located in the basement in two rows of five fans each. The fans are installed directly under each row of cell enclosures. Each row of fans discharges into its own supply system. FANS

The cell floor ventilating fans were supplied by the Buffalo Forge Company. Table II.1-1 lists their characteristics. Figure II.1-3 is a drawing of the fans and Figure II.1-4 is the performance curve.

These fans are #6 Buffalo Limit Load Type LL Fans, with single inlet and single width. They are of centrifugal type and of heavy Class 1 construction with horizontal shaft and vertical discharge. They contain self-aligning Fafnir ball bearings.

The operating characteristics of each fan is such that

any number of fans, from two to five, may be operated in parallel in any one system without hunting, and, under any condition of multiple operation, each fan will automatically assume its proportionate share of the total load. All fans have characteristics which prevent overloading at their rated speed. The rotors of the fans and motors are statically and dynamically balanced and run at their rated speed substantially free from vibration.

Each fan is provided with an automatic louvre type damper at the outlet, which substantially prevents flow when fully closed and which closes automatically when the fan it serves is not operating. These dampers are also provided with limit opening stops which permit limiting the discharge flow from zero to maximum opening.

The cell fan motors are 20 hp, 1740 rpm, 440 volt, 3 phase, 60 cycle Westinghouse motors. They are Type "CS", line start, Class I, squirrel cage, constant speed, horizontal, open, continuous, rated for 40°C temperature rise. Sealed sleeve bearings are used in these motors.

In any one building, the cell floor ventilating fans normally operate in two sets or systems of five fans each, in parallel arrangement. Each row of fans operates as a separate group to supply ventilating air to the row of cell enclosures and sections of the alleys above it. All fans of a system discharge into a common duct. In case one or more fans are shut down, air is supplied to the system so affected by the remaining fans in that system. Therefore, no spare fans are used. The system supplied by only one group of fans is discussed below, but the information applies to either group.

AIR FLOW

The filtered air passes through the fans and is discharged into a transverse duct. The transverse duct makes a cross connection between two longitudinal ducts, one 2'-6" x 3'-0", and the other 1'-6" x 2'-0". These longitudinal ducts run the full length of the cells below the cell floor. The larger duct is located just below the cell outer walls, next to the withdrawal alley. The smaller duct is just below the cell inner walls, next to the motor alley. All the fans in one row are tied together by these longitudinal ducts. From these supply ducts, air is distributed through smaller branch ducts to a series of three locations for each row of cells as follows:

(1) Across the top of the cell enclosures from the withdrawal alley side.

(2) In the motor alley at the cell floor level.

(3) At the curbing between the withdrawal alley and the cell floor.

Figure II.1-5 is a typical cell cross section showing the location of the two rows of cell ventilating fans, the duct distribution system, and the air outlet locations above listed. A longitudinal section of a typical cell and the front and rear ends of the building are shown on Figure II.1-6.

The horizontal duct at the withdrawal alley side supplies ventilating air to the top of the cell enclosure in order to maintain the cell ambient temperature at the desired level. Two 3'-0" x 6" ducts extend from the supply duct to the top of the enclosure at either end of the cell. They connect to a 1'-0" x 1'-6" slotted duct which extends the length of the cell along the top of the casing. The slotted outlet of the duct is 5/16" wide and is designed to provide an air velocity across the top of the cell casing of 4000 ft per min with all fans operating. The object of this high velocity and consequent scrubbing action is to increase the overall heat flow from the metal ceiling of the cell. This, together with exposed cell surfaces, produces equilibrium heat flow. Dampers are provided in the branch ducts connecting to the slotted duct. These dampers are located at the withdrawal alley curbing and serve to regulate air flow to the slotted duct.

Air exhausted from the slotted ducts passes into the motor alley, mixes with the motor alley ventilating air, and rises to a 5'-0" x 12'-0" outlet duct located directly above the motor alley in the pipe gallery floor. This duct passes through the pipe gallery and operating floor to the roof where it vents to the atmosphere. There are ten of these outlet ducts located down the center of the building in four sets of two with one at each end of the building. They are designated as "A" ducts and terminate in six "A" roof ventilators.

The horizontal duct toward the center of the building supplies ventilating air to the motor alley risers and outlets. This air serves to cool the pump motors and to keep the motor alley at a suitable temperature for the operators. Two 6" x 2'-0" and two 6" x 12" risers connect the longitudinal supply duct with registers in the motor alley floor along each cell. Dampers are provided in the risers to the floor registers to limit the flow, if necessary. Air exhausted from the motor alley registers passes over the pump motors, mixes with the air from the top of the cell enclosures, and is vented to the atmosphere through the ventilators at the top of the motor alley.

Air is supplied to the withdrawal alley from the large horizontal duct at the withdrawal alley side. This air serves to provide a suitable working temperature in the alley for the operating crew. Four branch ducts per cell connect from the supply duct to dampered openings in the withdrawal alley curbing. One duct and outlet at either end of the cell enclosure measures 6" x 1-7". The two other ducts and outlets, evenly spaced along the cell

length, measure 6" x 3'-3". The air from these curbing outlets travels up through the pipe gallery floor girders over the withdrawal alley, and passes to a ventilator intake which is located in the operating floor. A number of 4'-0" x 10'-0" ducts between the operating floor intake and the roof conduct the air to the atmosphere. There are ten of these exhaust ducts per row of cells through the operating floor to the atmosphere. They are designated as "C" ducts and terminate in "C" roof ventilators.

Because all process ventilating requirements are handled by one set of fans per row of cells, and because the high velocity required at the cell ceiling slots imposes a high pressure on the whole system, it is necessary to meter the flow at the withdrawal alley and motor alley outlets by a set of orifices. These orifices, one in each duct, are located in the flange where the ducts connect to the main horizontal supply ducts. The area of these orifices limits the flow at the respective points to the maximum calculated quantity. As previously stated, lesser quantity may be delivered by the system according to requirements by operating dampers located in each withdrawal alley and motor alley outlet.

The design data for the cell floor ventilating system are listed below.

Atmospheric Air Temperature	100°F
Atmospheric Relative Humidity	70%
Air Flow per Fan	24,000 cfm
Total Air Flow	240,000 cfm
Pressure Rise Over Fan	3.33" H_2O
Cell Ambient Air Temperature	
Air to Top of Cell Enclosure per Cell	6,000 cfm
Air to Motor Alley per Cell	7,000 cfm
Air to Withdrawal Alley per Cell	11,000 cfm
Motor Alley Air Temperature, Max.	120°F
Withdrawal Alley Air Temperature, Max.	110°F

Figure II.1-7 shows the duct outlets of the cell floor ventilating system, marked with the above design characteristics.

There are no dampers in the longitudinal ducts, but each fan is provided at its outlet with an automatic damper which is closed when the fan it serves is not running. By reason of this

AIR CONTROL

[redacted]

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design, the static pressure in the basement plenum ducts can be varied and the total amount of air supplied correspondingly increased or decreased by operating any number of fans from one to five. Control of a complete row of fans may, therefore, be accomplished by starting or stopping fans. The fans are controlled by individual switches, located on a panel board in the basement.

By means of dampers at each outlet, the flow may be proportioned to any part of the ventilating system. If a cell is inoperable due to repairs or replacements, the dampers in the risers to the slotted duct will be closed, prohibiting the flow of air to the top of the cell. Dampers in the outlets to the motor alley and withdrawal alley will be adjusted to allow a smaller flow since the heat to be dissipated from the pumps and motors will be decreased. One of the fans may be shut down because of the smaller quantity of air required.

The temperature of the discharged cell ventilating air indicates ambient temperature conditions within the cell. By regulating the cell ventilating system in conjunction with the electric heaters located within the cell, the cell ambient temperature is completely controlled. When a cell is to be placed in operation, the required minimum ambient temperature is reached by means of the electric heaters and the cell is started. The heaters are on thermostatic control and disconnect automatically as soon as equipment within the cell is generating sufficient heat. From this point on, the cell is maintained at the process requirement by regulating, through damper control and the number of fans in operation, the amount of air fed to the ducts at the top of the cell and in the motor alley. The quantity of air depends on the temperature of the available air supply.

Heat flow from the exposed outside surfaces of the cells will be in equilibrium with the heat generated inside the cells at the maximum ambient cell temperature given above when the average temperature rise of maximum summer air (100°F)

When atmospheric temperatures are lower than 100°F, the air fed to the cell enclosures is throttled and a larger temperature rise of the ventilating air occurs. Under such conditions, the ambient cell temperature is less than the maximum but sufficient ventilation must be provided to keep the temperature above the minimum.

Resistance thermometer elements are located at the entrance of the cell ventilating ducts "B". These are the ducts which exhaust from the top of the motor alley through the roof. There are four resistance units per building, one located at the bottom of each pair of ducts throughout the length of the motor alley. The temperature of the combined exhaust streams from the slotted ducts and the motor alley registers are indicated on the building instrument board. A selector switch permits readings of each resistance element to be made.

Under maximum summer conditions of 100°F, these thermometers

[redacted]

The ratio of the heat gain of ventilating air passing over exposed enclosure walls is proportional to the ratio of the difference between cell ambient and atmospheric temperatures. For lower atmospheric temperature condtions the heat pickup will be proportionally greater but a somewhat lower motor alley temperature will be indicated.

From the thermometer resistance elements, the operator is informed as to the effects on cell ventilating conditions of changes in atmospheric temperature and quantity of air supplied. If atmospheric temperature drops, the effect is noticed on ventilating air temperatures. Since the temperature is lower, a smaller amount of air is required. The dampers at the fan and duct outlets are regulated to allow less air to circulate. If the temperature should continue to drop, one or more fans are shut down. If the temperature rises, the opposite procedure is followed. The dampers are adjusted to allow a greater amount of air to circulate, and, if necessary, additional fans are started. Thus, a fairly constant temperature is maintained within the cell casing. Except for maximum summer conditions, at least one fan in each group is held as a spare. Operation of the fans should be so regulated that wear is distributed evenly over all of the fans.

Following is a list of reference drawings pertaining to cell floor ventilation not contained in this manual because of space limitations. They show details of duct work, ventilators, louvres and dampers.

Kellex Dwg. No.	Title
402-1-K-37-AA	Basement Plan One Cell Length Ventilation.
402-1-K-37-BA	Stage Cell Floor Plan One Cell Length Ventilation.
402-1-K-37-FA	Front End of Basement Ventilation.
402-1-K-37-GA	Front End of Stage Cell Plan Ventilation.
402-1-K-37-LA	Rear End Basement Ventilation.
402-1-K-37-MA	Rear End Stage Cell Floor Plan Ventilation.
402-1-K-37-VA	Arrangement of Ventilating Ducts In Cell Area.
402-1-K-37-WA	Arrangement of Ventilating Ducts In Driveway Area.

[redacted]

Kellex Dwg. No.	Title
402-1-K-37-XA	Details and Connections for Branch Ducts Sheet #1 of 2.
402-1-K-37-YA	Details and Connections for Branch Ducts Sheet #2 of 2.

(d) Operating Floor Ventilation

The function of the operating floor ventilating system is to maintain a suitable working temperature in that area for the operating staff. It must fulfill two requirements.

(1) The removal of generated and solar heat during the warmer seasons.

(2) The retention and possible addition of heat during the colder seasons.

The fans used in the operating floor ventilating system are located in a single row down the center of the basement floor, between the two rows of cell floor ventilating fans, as shown in Figure II.1-5. Each building contains five operating floor fans. FANS

The operating floor fans are 23,000 cfm units supplied by the Buffalo Forge Company. Table II.1-2 lists the operating characteristics. Figure II.1-8 is a drawing and Figure II.1-9 shows the performance curves for these fans.

The operating floor fans are No. 6-1/2 Buffalo Limit Load Type LL Fans, with single inlet and of single width. They are a centrifugal type of heavy Class I design with horizontal shaft and vertical discharge. They contain self-aligning oil ring sleeve bearings.

The operating characteristics of each fan are such that any number of fans, from two to five, may be operated in parallel in each system without hunting, and, under any condition of multiple operation, each fan will automatically assume its proportionate share of the total load. All fans have a characteristic which will permit overloading at rated speed. The rotors of the fans and motors are statically and dynamically balanced and run at rated speed substantially free from vibration.

Each fan is provided with an automatic louvre type damper at the outlet, which substantially prevents flow when fully closed and which closes automatically when the fan it serves is not running. These dampers are also provided with limit opening stops which permit limiting the discharge flow from zero to maximum opening.

The fan motors are 10 hp., 1740 rpm, 440 volt, 3 phase, 60 cycle Westinghouse motors. They are type "C.S.", line start, Class 1, squirrel cage, constant speed, horizontal, open, continuous, rated for 40°C temperature rise. Sealed sleeve bearings are used in these motors.

As in the cell floor system, all five fans of the operating floor ventilating system discharge into a single horizontal plenum duct. The five fans operate as a group. In the event one or more fans in the group is shut down, air is supplied to the system by the fans remaining in operation. For this reason, no spare fans are required.

AIR FLOW

After passing through the basement filters, atmospheric air enters the suction of the operating floor fans and is discharged vertically upward to a horizontal supply duct, 2'-6" x 5'-0" in cross section. This duct runs the length of the building at approximately six feet under the cell floor and six feet to the right of the motor alley. At a point about twenty feet on each side of each fan, the horizontal duct discharges into a 1'-6" x 4'-0" duct extending horizontally approximately six feet to an elbow, and from the latter rising vertically to the pipe gallery level. At this point, the duct changes to 2'-0" x 3'-0" and rises to the operating floor ceiling, there branching into two horizontally opposed ducts, each 30'-0" long and having initial cross section of approximately six square feet. These horizontal ducts are tapered and each side of the duct is provided with thirteen dampered outlets on grilles for proportioning flow, each having an area of one square foot. There are ten of these transverse ducts and connected supply ducts in each operating floor.

Through this system, a continuous supply of air is available to the operating floor. The warmer air at the ceiling is discharged to the atmosphere through a series of ten roof ventilators. These ventilators extend down the center of the building and connect from the ceiling to the outside atmosphere. They are designated as "B" roof ventilators.

The design conditions for the operating floor ventilating system are as follows:

Atmospheric Air Temperature Max.	100°F
Atmospheric Relative Humidity	70%
Air Flow per Fan	23,000 cfm
Total Air Flow	115,000 cfm
Air Flow per Transverse Duct	11,500 cfm
Pressure Rise over Fans	1.37" H_2O

AIR CONTROL

The air control of the operating floor system is very flexible. Any combination of the operating floor fans can be run at one time. Since the horizontal supply duct in the basement is so large, and the pressure drops small, the pressure at all the risers remains fairly equal, regardless of what fans are running.

As previously mentioned, an automatic damper is installed at the discharge of each fan. The object of these dampers is to prevent return flow or by-passing through any fan which is not running, and to that end, these dampers will automatically close when any fan is shut down. In addition to this, these automatic dampers are provided with limit stops so that the flow can be limited with all fans running.

In each riser to the outlet ducts, at a point convenient for manipulation from the operating floor, there is a damper. These dampers control the amount of air to the operating floor. An approximately equal flow should be taken at each riser to prevent objectionable cross currents.

Each of the exhaust ventilators at the ceiling of the operating floor has a louvre damper which opens directly into the operating room. These dampers will be opened wide for maximum summer conditions and a lesser amount in other seasons.

Under maximum summer conditions with inlet air at 100°F, the system is designed to discharge air at a temperature This temperature is based on absorbing heat transmitted to the operating floor through the roof, through the floor (air of the pipe gallery heat) and from lights.

Following is a list of reference drawings not included in this manual showing details of ductwork, louvres, and ventilators pertaining to operating floor and pipe gallery ventilation.

Kellex Dwg. No.	Title
402-1-K-37-CA	Pipe Gallery Floor Plant One Cell Length Ventilation
402-1-K-37-DA	Operating Floor Plan One Cell Length Ventilation
402-1-K-37-EA	Roof Plan One Cell Length Ventilation
402-1-K-37-HA	Front End of Pipe Gallery Ventilation
402-1-K-37-JA	Front End of Operating Floor Ventilation
402-1-K-37-KA	Front End of Roof Plant Ventilation
402-1-K-37-NA	Rear End Pipe Gallery Floor Ventilation
402-1-K-37-PA	Rear End Operating Floor Ventilation
402-1-K-37-QA	Rear End Roof Plan Ventilation

(e) Roof Ventilators

There are thirty-six roof ventilators in each building. Six "A" ventilators exhaust air from the cell floor, ten "B" ventilators exhaust air from the operating floor and twenty "C" ventilators exhaust air from the withdrawal alley.

The location of roof ventilators is shown on Figure I.2-6. The six "A" and ten "B" ventilators are ranged along the center line of the building. There are two single and four double "A" ventilators. The former are located at the front and rear of the building. One "B" ventilator is connected lengthwise to each single "A" ventilator and two "B" ventilators are connected lengthwise to each double "A" ventilator. The one "B" and single "A" ventilator combination at the front of a building is designated as Type "AB1" ventilator. The similar combination at the rear of the building is designated as Type "AB1S" ventilator. The two "B" and double "A" ventilator combinations are designated as Type "AB2" ventilators. A partition the full height of the ventilators separates "A" and "B" flow.

The twenty "C" ventilators are ranged longitudinally, ten on each side of the building roof.

Ventilator information is tabulated below.

Type	No. per Building	Throat Area	Stack Height	Operating Temperature Differential	Minimum Guaranteed Total Capacity CFM
Double A (A2)	4	5' 8-3/4" x 27' 8"			
Single A (A1)	1	5' 8-3/4" x 12' 10"	20'		130,000
Single A (A1S)	1	5' 8-3/4" x 10' 6"			
B	10	5' 8-3/4" x 3' 6"	3'		115,000
C	20	4' 0" x 10' 0"	10"		110,000

All the above ventilators exhaust the minimum capacity listed above under gravity flow for the given conditions except the "B" ventilators which exhaust under slight pressure of the fans serving the operating floor.

(f) Recycling of Ventilating Air

The operation of the cell and operating floor ventilation systems together is necessary when atmospheric temperatures become

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[redacted]

such that the operating floor becomes too cool. A system of recycling the ventilating air has been incorporated into the design so that part or all the heat generated on the cell floor may be retained within the building. This is accomplished by the manual operation of various louvres and dampers, and by controlling the number of fans in operation.

The recycling control is achieved through regulation of dampers at four general locations throughout each building, as listed below and indicated on Figure II.1-7.

(1) The "D" dampers in the withdrawal alley curbing which connect the basement with the withdrawal alley.

(2) The louvres in the ventilator exhaust ducts leading from the top of the motor alley to the atmosphere. Louvres "F" allow heated cell ventilating air to flow to the operating floor. Louvres "G" allow air to flow to the pipe gallery area.

(3) The "K" dampers in the series of floor registers in the operating floor connecting the operating room with the withdrawal alleys.

(4) The dampers in the ventilators discharging to the atmosphere, dampers "H" control the motor alley discharge to the atmosphere, "I" the operating floor discharge to the atmosphere, and "J" the withdrawal alley discharge to the atmosphere.

The amount of air circulated is governed according to requirements by a reduction of fans operating and damper operation. The recycling is then accomplished by:

(1) Opening the dampers "D" in the withdrawal alley curbing.

(2) Opening to such extent as may be required louvres "F" and "G" in the exhaust duct from the motor alley.

(3) Opening the dampers "K" in the series of grilles connecting the operating floor and withdrawal alleys.

(4) Partly or fully closing the louvres "H", "I", and "J" to the atmosphere.

The first three operations must be performed before the louvres in (4) are closed, to prevent an undue rise in pressure.

As may be seen from inspection of Figure II.1-7, the above operations supply warm air from the converter cell floor to the pipe gallery and operating floors and withdraw cooled air from the latter areas to the suction of the basement fans.

After air flow equilibrium has been established, the amount of recycling will be determined by the degree to which the louvres "H", "I" and "J", in the exhaust ducts to the atmosphere, are open. Fresh air will be drawn into the basement through the intake filters only as replacement for air lost to the atmosphere through the ventilators.

Recycle operations under various temperature conditions are detailed in Section II.1-b of this manual.

(g) Heating of Ventilating Air

During extreme winter conditions, the retention of heat by the recycling process may not be sufficient to maintain desired temperatures for the operating crew. Heat may then be added to the buildings by means of unit type steam heaters, manufactured by the Trane Co. These heaters have been installed in separate suction ducts leading to the intake of each of three operating floor fans in each building. Figure II.1-10 shows the arrangement of these heaters and connected duct work. The fans are located in the two end and the center fans in each building operating floor fan row.

The Trane heaters for Buildings K-402-2 to K-402-8, inclusive are 24" x 54" x 6" thick, single row, Series 96 - Type "E" Blast Coils. Each coil will heat 9000 cfm from 60° to 95°F at 5 psig steam pressure. The heaters in Buildings K-402-1 and K-402-9 are 24" x 66" x 6", double tube row, Series 66 Type "E" Blast Coils. These heaters will heat 9000 cfm from 60° to 100°F at 5 psig steam pressure. The end buildings require the addition of 5°F more heat in order to maintain a standard temperature level throughout the operating floor area. All heaters are tagged with the building number in which they are used.

The air passes over the copper finned tubes of the heater and is heated by means of the 5 psig steam supply connected to the heater from the basement steam header.

The three fans of each building which are fitted with heaters and inlet ducts contain hinged panels which when closed effectively block off the regular fan inlet. This causes inlet air to enter through a special duct. The Trane Heaters are suspended from the cell floor by means of iron strap hangers and fit in a flange at the mouth of the special duct. During normal operation, the hinged panels are open and the fans receive air through the regular inlet. When it is desired to supply additional heat to the operating floor, the hinged panels are closed, and the valves

in the lines to the heaters from the steam main are opened. The fans then pull air down through the ducts in which the heaters are located instead of through the regular inlet, and distribute the heated air to the operating floor. Only fans containing heaters are to be operated in the event heat is desired on the operating floor. The other operating floor fans should be shut down. Any number of the fans which have heating units may be operated as desired.

(h) Operation of Ventilating System

The following discussion outlines a mode of operation of the cell and operating floor ventilating systems developed by the Carbide & Carbon Operating Staff. The procedure was originally developed for the 300 Section Buildings but is also applicable to those of Section 400.

The ventilating systems are designed to provide great flexibility of control of temperature. However, this control is a function of the air supply temperature in the basement. Inasmuch as no air cooling effect is provided, for a constant air throughput the rate of heat removal is directly proportional to the supply air temperature if no recycling of air occurs. The system is designed to regulate temperature through the following three principles:

(1) The amount of fresh air drawn into the building.

(2) The amount of air distributed to the individual duct outlets.

(3) The amount of recycling of air within the building.

Since the operating equipment is substantially at the same temperature throughout the year, the problem of maintaining a comfortable temperature in the operating room and alleys and a correct process temperature at the cells is one of regulating the above three factors with respect to the temperature of the air supply.

The recycling and throughput rates are regulated by the number of blowers operated, and by opening and closing the proper louvres and dampers. It is seen from this that maintaining open doors and windows, or indiscriminate changes in control dampers and louvres will destroy the control system and make proper regulation of the ventilating system difficult, if not impossible.

The method of control outlined below is not intended to be rigorously followed. Some experimentation by the operators will be required to adjust the system to provide suitable conditions. Figure II.1-7 (496 O.D.) shows the various parts of the system marked with the letters referred to in the following procedure.

[redacted]

Cell Floor Control Outside Temperatures Below 30°F.

(1) Set the number of blowers (A) operating under each cell row at from 3-4 as is necessary to maintain motor alley temperatures from 90°-100°F.

(2) Set all motor alley dampers (B) at about 1/4 to 1/2 open and just crack the withdrawal alley duct dampers (C).

(3) Open the louvres (G) in the pipe gallery outlets from the motor alley exhaust ducts. These louvres should be opened sufficiently to maintain comfortable conditions. Dampers (H) in the motor alley exhaust to the atmosphere should be closed.

(4) Readjust dampers (B) and (C) to provide even temperatures the length of the building.

(5) Adjust dampers (J) in the withdrawal alley exhaust ducts to a nearly closed position to retain building heat.

Outside Temperatures From 30° to 60°F.

(1) The number of fans (A) operating should be from 3-5 as required. Use as few as possible.

(2) Adjust dampers (B) and (C) to maintain even comfortable temperatures in the motor alley and withdrawal alley throughout the length of the building.

(3) The louvres (G) in the pipe gallery should be adjusted as required to supply warm air.

(4) Adjust dampers (H) and (J) partially to remove and partially to recycle air as is required.

Outside Temperatures From 60° to 80°F.

(1) The number of fans (A) needed will be 4-5 per row.

(2) The motor alley dampers (B) should be about 3/4 open. Dampers (D) should be opened only far enough to keep the withdrawal alleys at a comfortable temperature.

(3) Louvres (G) in the pipe gallery should be closed to exclude warm air and to prevent destroying the draft in the duct.

(4) The dampers (H) and (J) in exhaust ducts to the atmosphere should be opened.

Outside Temperatures Above 80°F.

(1) The number of fans (A) operating will probably be five.

(2) Open dampers (B) in the motor alley wide. Dampers (C) to the withdrawal alley should be opened sufficiently to provide a comfortable temperature:

(3) Louvres (G) to the pipe gallery should be closed.

(4) Dampers (H) and (J) should be opened wide.

The dampers in the vertical ducts which feed the horizontal slotted duct running the length of each cell along the top of the casing are always to be wide open except when a cell is shut down. For this reason, instructions on the operation of these dampers for varying conditions are not included.

Operating Floor Control Outside Temperatures Below 30°F.

(1) The number of fans (E) operating should be 2-3. This will provide adequate ventilation at a time when it is not desirable to remove large quantities of heat. The fans containing preheaters should be used.

(2) Open the withdrawal alley curbing dampers (D) to the basement. This will provide recirculation of warm cell air to the basement, thus retaining building heat.

(3) Open the floor registers (K) to recycle air from the operating floor to the cell floor.

(4) Open the motor alley duct louvres (F) to the operating floor.

(5) Close the ceiling louvres (I) from the operating floor to the atmosphere, thus retaining warm building air and forcing it to recirculate.

(6) If enough warmth has not been provided by operations, 1-5, the steam may be turned on to the fan preheaters in the basement as desired. The operator should make sure that the panel covers are placed over the normal fan suction of any fan whose preheater is supplied with steam.

(7) Adjust the individual duct dampers (L) to provide even ventilation throughout the building.

Outside Temperatures from 30° to 60°F.

(1) Increase the number of blowers (E) operating to 3 or 4 as required.

(2) Adjust the withdrawal alley curbing dampers (D) to the basement so that about 50% of them are open. This reduces the recirculation of warm building air, less being required for this temperature range.

(3) The floor registers (K) in the operating floor should be open.

(4) Open the motor alley exhaust duct louvres (F) wide and partly close the duct damper (H) overhead to provide warm air. Adjust to suit.

(5) Close ceiling louvres (I) and (J) as much as is necessary to maintain a comfortable temperature.

(6) All steam to the fan preheaters should be off as enough heat can be secured by proper recirculation.

(7) Adjust the operating floor riser dampers (L) to maintain uniform circulation throughout the building.

Outside Temperature 60° to 80°F.

(1) The number of operating floor fans (E) operating should be 4-5.

(2) Close all withdrawal alley curbing dampers (d) tightly to reduce circulation to a minimum.

(3) Adjust the operating floor registers (K) to provide the amount of recirculation to the cell floor as necessary.

(4) Adjust the motor alley exhaust duct louvres (F) and dampers (H) as is required to provide suitable temperatures.

(5) Adjust the ceiling louvres (I) and (J) as appears necessary for suitable temperatures.

(6) Adjust the operating floor riser duct dampers (L) to provide adequate circulation of air, and even temperatures over the operating floor.

Outside Temperatures Above 80°F.

(1) Place all 5 operating floor fans (E) in operation.

(2) Close all withdrawal alley curbing dampers (D) to the basement tightly. No recirculation should be permitted in any way (i.e., all doors between floors are to be shut).

(3) Close the floor registers (K) tightly to prevent any recirculation to the cell floor.

(4) Close the operating floor louvres (F) from the motor alley exhaust ducts tightly to prevent hot air from being discharged into the operating floor or disturbing the draft within the ducts which remove hot air from the motor alley.

(5) Open all ceiling louvres (H), (I) and (J) completely, in order to remove warm air as fast as possible.

(6) Open all the dampers (L) wide in the riser ducts to the operating floor. Then adjust to obtain even temperatures the length of the floor by closing dampers near cool places and maintaining those near hot places wide open. This will distribute the air supply on the basis of need.

The temperature in the rear of the building is generally cooler than toward the center and front end. This is attributed to two things.

(1) Air is gradually heated as it passes along the basement. Since the rear fans receive the coolest air, the rear discharge ducts provide the coolest air to all floors.

(2) The rear section of the building has a cool wall to radiate to.

Thus, it is advantageous to distribute more air to the center and front of the buildings than toward the rear to assist in evening the temperature throughout the building. This is easily accomplished by throttling the ducts in the rear somewhat more than the others.

(i) Transformer Vault and Battery Room Ventilation

The function of the transformer vault ventilating system is to keep the vault ambient air temperature below a limit of 115°F under the extreme summer conditions of 95°F and 70% relative humidity. The design air flow of 80,000 CFM is estimated to exceed, by at least 10%, the maximum CFM needed under these conditions.

The three transformer vault ventilating fans are housed in a fan room at the front of the transformer vault. They each have a capacity of 40,000 CFM. FANS

The fans are No. 6-1/2 Buffalo Limit Load Type LLD with double inlet and of double width. The inlets are equipped with fixed inlet vanes. The fans are heavy duty Class 2 design, equipped with self-aligning SKF ball bearings.

Table II.1-3 lists the fan and motor characteristics. Figure II.1-11 is a drawing and Figure II.1-12 the performance curve of these fans.

Included with each fan are louvre type outlet dampers mounted on the fan discharge frame. The outlet dampers are reasonably tight when fully closed. The damper mechanism is provided with balancing weights and an adjustable stop.

The fans are driven by 40 HP, 1765 rpm, 440 volt, 3 phase 60 cycle, horizontal, open, General Electric triclad motors. The motors are equipped with Class A insulation, suitable for an ambient temperature of 115°F, are type K, have frame No. 404 and are rated for a 40°C temperature rise.

Two of the fans are sufficient to maintain the design temperature under most severe operating conditions. The third is a spare.

AIR FLOW

Outside air passes through the filter system and into a supply duct running through the center and length of the vault beneath the floor, and is distributed through a series of holes in the floor throughout the vault area. The heated air is exhausted from the vault ceiling into a duct having numerous grilles with simple slide dampers for uniform withdrawal. This suction duct connects to the fan suction chamber located at the opposite end of the building from the intake chambers. Air passes through the suction duct and fan chamber to the fans. Discharge from the fans flows to an exhaust plenum chamber from whence it is discharged to the atmosphere through an exhaust duct. The ducts for transformer vault ventilation are shown on Figure II.1-13.

Ventilating air for the battery room is supplied from a branch of the main supply duct. Exhaust air from this room joins the main exhaust stream through a branch duct.

AIR CONTROL

The three fans in each vault are controlled automatically by thermostats located in the vault and suction duct. The first of the three ventilating fans starts operating under the control of any one of the three thermostats equally spaced through the center of the vault and in the ceiling. Three thermostats in parallel connection are used as a precaution against unequal distribution of heat in case certain transformers are not in use. The second and third fans will operate under control of thermostats in the air duct at the ceiling near the fans. Under maximum summer temperatures, and full load conditions, the first fan thermostats will be set at 95°F to 100°F and the second at 115°F to 120°F, with the third used as a spare. The settings can be moved to meet any conditions that might arise.

It should be noted that the thermostats in ducts for #2 and #3 fans are of no use unless there is air flow in the duct. To remedy this situation an electrical control box has been included. In the event #1 fan should refuse to start under thermostatic control, the second fan is automatically connected to the room thermostats. In similar automatic fashion, the third fan receives control from these room thermostats in case the second fan fails to start. Any of the three fans can be rated #2 and #3 in order of operation.

(j) Fan Maintenance

The following information on maintenance and operation of the ventilating fans consists of excerpts from the Buffalo Forge Maintenance Bulletin.

CLEANING AND CHECKING

Fan balance is directly affected by dirt collecting on the rotor. As soon as a little has stuck to a fan blade, more dust, grease, and dirt will gather there. This coating may go as far as to change the blade curvature so as to affect fan performance. Pieces of dirt lodged on the fan blades can unbalance the entire rotor. Periodic cleaning by means of a hose, scraper, compressed air or a wire brush will prevent an unbalanced condition which in turn could distort and later completely break down the impeller. Bent shafts and ruined bearings are other troubles which may be headed off in this manner. The frequency of inspections and cleanings will be determined by the amount of dirt carried by the air stream.

REPAIR PARTS

If a fan wheel is allowed to wear out completely, it may collapse due to weakness of the blades or flanges. This may injure the fan housing, shaft, bearings or even the motor. For these reasons care should be taken to inspect the rotor frequently after cleaning, and before wear has become serious. Because of details of constructions, wheels should be returned to the factory for reblading or repairing of any kind.

LUBRICATION

Some of the ventilating fans in the process buildings run on sleeve bearings, and some on ball bearings. Lubrication for both will be discussed.

For the sleeve bearings, oil conforming to SAE specification No. 70 should be used. Too light an oil may cause leakage along the shaft, while if too heavy an oil is used, the bearing surface will not be properly lubricated.

The sleeve bearing reservoirs should not be overfilled, since leakage may result. The oil level should be maintained 1/8" below the top of the oil cup when the fan is standing still. Fluctuations in oil level when the fan is running will prevent true readings. Oil should be added only when the fan is not running.

It is desirable to inspect and clean bearings and bearing housings periodically. Since all lubricants have a tendency to deteriorate sooner or later, it will be necessary to change the oil. This should be done before oxidation makes cleaning too difficult. The bearings should be drained and flushed with kerosene before adding new lubricant.

Where ball bearings are used, a good grade of soda soap grease, free from chemically active material should be used. The bearings on a fan operating 24 hours a day at 1500 rpm will require lubrication once every three months.

The operator should be careful not to add too much grease. At no time should the housing be over half full.

COUPLINGS

Maintenance and repair work on the shaft couplings is negligible. Rubber bushings around the bolts that fasten the two halves together will wear out and should be replaced. The coupling clearance should be checked from time to time to see if the fan or motor shafts have been bent or otherwise thrown out of line.

V-BELT DRIVE

The tension on the V-belt drive will decrease as the belt stretches. The tension should be readjusted by the tension adjuster as required from time to time. New belts should be installed by slacking the tension, never by prying or forcing the belt into position.

The sheave alignment should be occasionally checked to prevent undue belt wearing. The drives should be protected from oil, dust and any foreign objects which might strike the belts or become lodged in the sheave grooves. Belt dressing should not be applied, since V-belts are designed for frictional contact between the sheaves and the sides of the belts. Dressing would reduce this friction and possibly injure the belts.

MOTORS

The maintenance of the electric motors consists chiefly of lubrication, replacement of worn bearings, and cleaning the interior and exterior of the motor from dirt, oil and grease. Motors should be occasionally disassembled for a general cleaning.

[redacted]

TABLE II.1-1

CHARACTERISTICS OF CELL FLOOR VENTILATING FANS

Order Sheet	400-K-520/2
Service	Cell and Alley Ventilation - Section 400
Number Required	90
Size	#6 LL
CFM	24,000
RPM	1,066
S.P. at 95°F and 70% R.H.	3.33"
B.H.P. at 95°F and 70% R.H.	19.55
Limit HP at 95°F and 70% R.H.	20.3
S.P. at 70°F and 29.92" Bar.	3.54
B.H.P. at 70°F and 29.92" Bar.	20.8
Limit HP at 70°F and 29.92" Bar.	21.8
Outlet Velocity Ft/min.	2,820
Static Efficiency	64.2
Wheel Diameter - Inches	36.5
Tip Speed - Ft/min.	10,170
Maximum Safe Speed - RPM	1,100
Motor - Make	Westinghouse
HP	20
RPM	1,740
Frame Number	364
V-Drive - Make	Allis-Chalmers
Motor Sheave - P.D.	9.4"
Fan Sheave - P.D.	15.4"
Number Belts	5
Size Belts	B-128"
Belt HP	27
Weight Unit - Lbs.	1,870

25

[redacted]

TABLE II.1-2

CHARACTERISTICS OF OPERATING FLOOR VENTILATING FANS

Order Sheet	400-K-508/9
Service	Operating Floor Ventilation - Section 400
Number Required	45
Size	6 1/2 LL
CFM	23,000
RPM	695
S.P. at 95°F and 70% R.H.	1.37
B.H.P. at 95°F and 70% R.H.	9.0
Limit HP at 95°F and 70% R.H.	9.15
S.P. at 70°F and 29.92" Bar	1.46
B.H.P. at 70°F and 29.92" Bar	9.56
Limit HP at 70°F and 29.92" Bar	9.74
Outlet Velocity Ft/min.	2,475
Static Efficiency	55%
Wheel Diameter Inches	40-1/4
Tip Speed Ft/min.	7,300
Maximum Safe Speed RPM	825
Motor - Make	Westinghouse
HP	10
RPM	1,740
Frame Number	324
V- Drive- Make	Allis-Chalmers
Motor Sheave - P.D.	7.4"
Fan Sheave - P.D.	18.4"
Number Belts	3
Size Belts	B - 144"
Belt HP	14.7
Weight Unit - Lbs.	1.700

TABLE II.1-3

CHARACTERISTICS OF TRANSFORMER VAULT VENTILATING FANS

Order Sheet	400-K-550/2
Service	Transformer Vault Ventilation Section 400
Number Required	15
Size	6 1/2 LL
CFM	40,000
RPM	903
S.P. at 115°F (0.0682 density)	3.85
B.H.P. at 115°F (0.0682 density)	33.4
Limit HP at 115°F (0.0682 density)	39.6
S.P. at 70°F and 29.92" Bar	4.23
B.H.P. at 70°F and 29.92" Bar	36.7
Limit HP at 70° and 29.92" Bar	43.5
Outlet Velocity Ft/min.	2400
Static Efficiency	72.5%
Wheel Diameter Inches	40-1/4
Top Speed Ft/min.	9,540
Maximum Safe Speed RPM	1,042
Motor - Make	General Electric
HP	40
RPM	1,765
Frame Number	404
V- Drive- Make	Allis-Chalmers
Motor Sheave - P.D.	10.2"
Fan Sheave - P.D.	20.0"
Number of Belts	5
Size of Belts	C-158"
Belt HP	55.5
Weight Unit - Lbs.	3,450

[redacted]

DISTRIBUTION

1. K-25 Site Records (RC)
2. ChemRisk/Shonka Research Associates
3. S. G. Thornton (K-25 EMD)
4, DOE Public Reading Room