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OWNER-OPERATOR PROCESS AND FUNCTIONAL REQUIREMENTS INTERIM MODIFICATIONS FOR IMPROVED COOLANT BACKUP 100-B, C, D, DR, F, AND H REACTORS. PROJECT CGI-905

AUTHOR

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INTERIM MODIFICATIONS FOR IMPROVED COOLANT
BACKUP 100-B, C, D, DR, E and H REACTORS
PROJECT CGI-905

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OWNER-OPERATOR PROCESS AND FUNCTIONAL REQUIREMENTS
INTERIM MODIFICATIONS FOR IMPROVED COOLANT
BACKUP 100-B, C, D, DR, F AND H REACTORS
PROJECT CGI-905

I. INTRODUCTION

This document defines the user's process and functional requirements which shall be used as the basis for the preparation of the design for Project CGI-905, Interim Modifications for Improved Coolant Backup 100-B, C, D, DR, F, and H Reactors.

The objective in making these modifications is to provide improved reliability and adequacy in the last ditch reactor cooling systems for current and short-range forecast conditions. Performance requirements for the last ditch cooling system are based on the reactor cooling system criteria set forth in Document HW-66929. These performance criteria require that the last ditch cooling system be independent of both the primary and secondary cooling system, including piping to the reactor manifold, and that it must be capable of providing shutdown flow indefinitely, assuming instantaneous loss of power to the primary system and concurrent failure of the secondary system to provide its rated flow.

II. PURPOSE

The purpose of this document is to define the process requirements of the modifications and additions to the last ditch cooling systems and to outline the functional descriptions of the proposed equipment.

The objective in making these changes is to eliminate current deficiencies of the high tank and export raw water systems in order to assure conformance with the established safety criteria for reactor cooling systems.

The document is divided into four major sections. Section III defines the basic process requirements which must be fulfilled in the design of the system modifications. Section IV defines the functional requirements of the physical changes which must be made to the existing system in order to meet the basic process requirements. Section V contains codes and standards that must be observed in the design and the reference documents upon which these design requirements are based. Section VI contains technical supporting data and drawings to amplify the description of the requirements.

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III. BASIC PROCESS REQUIREMENTS

3.000 General Requirements and Considerations

The last ditch cooling system for each of the 100-B, C, D, DR F and H Areas consists of two 300,000 gallon capacity high tanks at each reactor and the export water system. Upon loss of both the primary (190 Building electrical driven pumps) and the secondary (190 Building steam driven pumps) coolant supplies, the last ditch system must automatically supply sufficient coolant flow to prevent reactor damage. Under this condition, the process water flow initially decays according to the characteristics of the primary system pump flywheels. At approximately 48 psi top of riser pressure the check valves in the high tank discharge piping open and the tanks supply filtered water to the reactor. Before depletion of the high tank storage, a parallel raw water supply is furnished to the reactor from the export system by the automatic opening of a control valve (Grove valve). Required reactor shutdown flow must be continuously available from the export system for an indefinite period. The existing export system arrangement is shown by Figure 2.

3.100 High Tank Requirements

3.110 High Tank Flow Rates

High tank flow rates obtainable with a clean system are assumed adequate for the current and short-range forecast reactor operating conditions considered by this Project. Values for high tank flow rates shall be based on test data included in HW-71165.

3.120 High Tank and Discharge Piping Corrosion

Rust accumulation in the high tanks, discharge piping and strainers could cause excessive pressure drop in the system and consequently reduce the high tank flow rates below the values indicated under Paragraph 3.110. Cleaning of high tank discharge lines will be complete during 1961 by plant maintenance forces. Under this project, rust and scale now present in the high tanks shall be removed and the tanks protected to retard further corrosion. Existing strainers in the high tank discharge piping shall be modified to reduce flow resistance particularly due to possible accumulation of rust scale in the strainer baskets.

3.130 High Tank Water Temperatures

The effectiveness of the high tank coolant supply depends on its temperature in addition to flow capacity. High tank temperatures vary with weather conditions and have been observed to be as high

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as 37 degrees centigrade during summer months. In order to obtain full effectiveness of the high tank coolant supplies the temperature of the stored water shall be controlled to not exceed 4 degrees centigrade above the process water inlet temperature.

3.200 Export System Requirements

3.210 Export System Flow Rates

The flow from the export system shall exceed the minimum required reactor flow rates at the time of depletion of the high tank supplies and shall be automatically available. The export system shall be adequate for an emergency condition of the following magnitude: a total electric power failure to all 100 Areas and a concurrent steam plant failure in one dual reactor area. The minimum required flow rate to each reactor shall be determined by use of the following equation:

$$Q_{\theta} = \frac{f_d P}{2.64 \times 10^{-4} (t_0 - t_1)}$$

Q_{θ} - required flow to the reactor
 θ minutes after power loss
in gpm

f_d - heat generation decay factor
for θ minutes after power
loss

P - reactor operating power level
before power loss in MW.

t_0 - bulk outlet water temperature,

t_1 - inlet water temperature,

The maximum allowable bulk outlet temperature, t_0 , for shut down conditions shall be taken as 90 degrees centigrade and the minimum temperature of the inlet water, t_1 , supplied from the export system shall be taken as 27 degrees centigrade. The heat generation decay factor, f_d , will be available from the results of the reactor heat decay tests which will be conducted in the near future under Production Test IP-338-A.

The reactor operating power level, P , shall be taken as that corresponding to a bulk outlet temperature of 95 degrees centigrade and reactor water flows as tabulated on the next page.

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<u>Reactor</u>	<u>Flow. gpm</u>
B	91,500
C	102,000
D	92,000
DR	89,500
F	92,000
H	94,000

3.220 Export System Reliability

To assure that the required flow capabilities of the export system are available with a high degree of reliability, certain existing deficiencies shall be corrected.

3.221 Surge Suppressors

Two Pelton surge suppressors are located at each of the 182 Building pumping stations which supply the export system. The surge suppressors open to bypass water to the 182 Building reservoir during a flow transient in order to prevent water hammer damage to the export system piping. At present, surge suppressor actuation may be initiated by loss of electrical power to the control solenoids. The opening of these surge suppressors during the time the export system is furnishing last ditch cooling water could reduce this supply below the minimum required. Thus, the surge suppressors shall be modified to be actuated directly by pipe line pressure surges which could result in structural damage rather than by electrical power failure. Hydropneumatic accumulators are also required at each modified surge suppressor to supply the necessary operating pressure to open the surge suppressors during low pressure portions of a flow transient.

3.222 Starting of Steam Driven Pumps

The four export system emergency steam driven pumps must now be started manually. Most of these pumps are in normally unmanned buildings and a time delay in excess of twenty minutes could occur in their manual starting.

Control systems for these pumps shall be modified to provide automatic starting after an electrical power failure. Automatic starting of the steam driven pumps will permit the export system to augment the high tank flow rates during the initial period of emergency operation and will insure maximum export system capability at the time of high tank depletion.

3.223 200 Area Reservoir Control Valves

The normal function of the export system is to supply water to the 200 Area reservoirs. At present control of flow to the reservoirs is by manual setting of the 282 Building cone valves. If these valves happen to be open wide at the time of an emergency, considerable export flow may continue to the 200 Areas rather than be diverted to the last ditch cooling of a reactor. Automatic closure shall be provided for the 200 Area control valves to insure that sufficient water is available to a stricken area if only steam driven pumping is available in other areas to supply the export system. Provision shall be made to supply the minimum emergency flows of about 2700 gpm to 200-E Area and 850 gpm to 200-W Area.

3.224 Strainer at 105-C Reactor

The existing export system connection to the 105-C Reactor is equipped with a single strainer. During a period when the export system is the sole water source for C Reactor, plugging of the existing strainer could reduce the reactor coolant flow below the minimum required. There would be no way of restoring adequate flow without first removing all flow for a period long enough to clean the strainer. To assure a continuous shut down coolant flow from the export system, the single strainer at this reactor shall be replaced with a dual type strainer.

3.225 Testing of Export System

The export system shall be extensively tested under both transient and steady state conditions in order to demonstrate satisfactory operating characteristics after completion of the modifications covered by this project. Testing under transient conditions may indicate the need for installation of slow closing air admission valves at critical points along the export system piping.

IV. FUNCTIONAL REQUIREMENTS

This section defines the functional requirements of the modification which shall be made to the existing system in order to meet the basic process requirements.

4.100 High Tank Modification

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4.110 High Tank Corrosion Control

4.111 High Tank Cleaning

The interior of each high tank shall be thoroughly cleaned of existing rust and scale by sandblasting. At the same time the standpipe interior shall be cleaned, either by sandblasting or by chemical cleaning. Consideration shall be given to applying a protective coating to the tank interior. However, such a coating must not require excessive time to apply, and on deterioration must not peel off in such a way that screen plugging could result.

4.112 Chemical Inhibitor Addition

A system shall be provided for the addition of sodium silicate to each high tank for the inhibition of future corrosion in the high tank and discharge piping.

The silicate addition system must be capable of supplying sufficient inhibitor to maintain a concentration of about 30 ppm in the high tank water for the first month, and about 10 ppm thereafter. The desired concentration must be maintained while filling an empty tank, or while bleeding water from the tank continuously for temperature control. Large deviations from the desired concentration are permissible for a short period, but the system must be capable of adjusting the concentration to the specified level within a reasonable time. Automatic control is not required.

The inhibitor system should be designed to use commercially available sodium silicate solution with an alkali to silica ratio of 1:3.22 and with a density of approximately 41⁰ Baume. The inhibitor concentrations in the preceding paragraph are expressed in terms of solid $\text{Na}_2\text{O} : 3.22 \text{ Si O}_2$. Sufficient storage capacity should be provided so that tank truck delivery can be utilized. A single delivery could be shared among several reactors. This storage will supply six to twelve months silicate requirements.

The silicate addition equipment shall be located so that it is readily accessible for operation and maintenance. Suggested locations are in the 105 valve pit at reactors where space is available, or in the 190 Building if 105 space is not available.

4.120 High Tank Strainers

Flow resistance of high tank strainers shall be reduced by use of new strainer baskets of increased surface area and lower pressure drop. Consideration shall be given to parallel operation of both sections of the twin type strainers.

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4.130 High Tank Water Temperature Control

4.131 Temperature Sensing Elements

Water temperature sensing elements shall be installed in each high tank and connected to indicators (or recorders of comparable cost) mounted in the 105 Control Rooms. Typical arrangements for the installation of the temperature sensing elements are shown by Figures 3 and 4.

4.132 High Tank Water Cooling

Each high tank shall be provided with piping designed to bleed 100 gpm from the tank to control the temperature of water stored in the tank. The bleed line shall be connected to the tank discharge piping as far downstream as possible to draw inhibited water through the discharge piping. To prevent the waste of this volume of filtered water, the bleed piping shall be run to the 105 Storage Basin.

4.200 Export System Modifications

The following modifications shall be made to the export system in order to increase its reliability and supply capacity to individual reactors as set forth in the basic process requirements, Paragraph 3.20. These modifications will result in improved last ditch coolant flow rates as typified by Figure 1.

4.210 Grove Valve Sensing Lines

The Grove Flex-Flow valve shall be opened to supply export water to the reactor in parallel with high tank flow approximately twelve minutes after the high tanks start to drain. This shall be accomplished by extending each Grove valve sensing line to a higher elevation in the tank. This change is required to permit the export system to augment and extend the high tank water supply until the export system can more adequately supply the required reactor coolant flow alone. The exact elevation to which the sensing line will be extended shall be the elevation of the water surface in the tank twelve minutes after draining starts. It shall be assumed that the water surface is three feet below full at the start of draining and high tank flow rates shall be based on test data in HW-71165.

4.220 Control Orifices at 105 Buildings

Larger flow control orifices shall be installed in the export system at each reactor as determined by detailed design analysis of required versus available export system

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flow rates at the time of depletion of high tank supplies. McIlroy analyzer data for emergency operation of the export system presented in HW-67631, may be of assistance in sizing these orifices.

4.230 Automatic Starting Steam Driven Pumps

To decrease the time required to bring the export system into service during an emergency, provision shall be made to start all four steam driven pumps automatically approximately ten minutes after an electrical power failure. A ten minute delay in the starting of the steam driven pumps is required in order to conserve steam supplies for the acceleration of the secondary cooling systems at the instant of electrical power failure. Further information for these modifications is shown in Figure 5. Actuation of the pump starting circuit shall be by low export water pressure and by electrical power failure. Suitable annunciation of export pump status shall be provided in both 183 and 190 Building control rooms.

4.240 200 Area Reservoir Control Valves

Automatic closure shall be provided for the 12 inch cone valves in the export system supply to the 282-E and 282-W Reservoirs. This modification will insure that sufficient water is available to a stricken area if only steam driven pumping is available in other areas to supply the export system. The cone valves shall close slowly taking about ten minutes to prevent pressure surges. Normal positioning of the valve for control purposes shall be by manual operation as at present. An annunciator and indicating light shall be provided at the appropriate 200 Area control rooms to show valve position. The minimum emergency flows of about 2700 gpm to 200-E Area and 850 gpm to 200-W Area will be supplied through an orificed bypass line around the cone valve. Actuation of the valve closing mechanism shall be by low export system flow and by electrical power failure. McIlroy analyzer data in HW-67631 may aid in sizing the bypass orifices. Further information for these modifications is shown by Figure 6.

4.250 Surge Suppressors

Export system reliability shall be improved by modification of surge protection equipment. In order to eliminate a possibility for unnecessary surge suppressor actuation, the electrically operated control solenoid on each surge suppressor shall be replaced with a pressure actuated hydraulic diaphragm device. The surge suppressor would then be opened

only as a result of low or high pressure on the export system. This change would eliminate surge suppressor actuation by an electric power failure which would not affect export system pumping. Hydropneumatic accumulators are required at each modified surge suppressor to supply the necessary operating pressure to open the suppressors.

The modified surge suppressors shall be set to open when export system pressure drops to 80 psi. At the same time the existing surge suppressor high pressure trip should be adjusted to 300 psi and the suppressor closing time adjusted to 120 seconds. The suppressor settings shall be the same for all eight suppressors.

4.260 105-C Raw Water Strainer

The single strainer in the 105-C export line shall be replaced with a dual strainer so that export flow can be transferred from one strainer basket to the other without interrupting flow to the reactor.

The new strainer should be selected and installed to provide adequate seismic resistance. The strainer chest shall not be constructed of brittle material such as cast iron. Both the strainer and adjacent piping shall be anchored as necessary to prevent excessive stress caused by seismic-induced motion.

4.270 Slow-Closing Air Admission Valves

Slow-closing air admission valves shall be installed on the export system as required. The tests described in Section 3.225 are expected to determine whether any such valves will be required, and if so, at what location. Test results will indicate that air admission valves are required if, following a total pump stoppage at maximum export flow, the water column in the export system breaks at any point, and if existing equipment does not admit sufficient air to cushion the shock resulting from the water column rejoining. Although it is probable that the surge suppressors at the 182 Pump House and the Simplex air valves installed at summits along the export piping will function adequately in this respect, it must be demonstrated that the degree of protection afforded the main export piping and the branch lines to the reactor is sufficient.

4.280 Functional Testing

Following completion of all modifications the last ditch coolant system shall be tested as necessary to establish that all elements function as intended.

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V. REFERENCE CODES, STANDARDS, BIBLIOGRAPHY

Codes and Standards

Unless otherwise stated, the design, the material used, and the work to be performed shall adhere to the requirements set forth in the latest edition of the Hanford Works Standards and the applicable codes approved by these standards.

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5. HW-64996 "Interim Report, Coolant Backup Study," W. J. Tupper, August 1, 1960.
6. HW-62861 "Adequacy of the Old Reactor Backup Cooling Systems," S. S. Jones, June 1, 1960.
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9. HW-67030 "Improved Coolant Backup 100-B, D, DR, F, H, and C Areas, Design Study," M. H. Schack and W. J. Tupper, October 31, 1960.
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11. HW-66929 "Performance Criteria for the Hanford Production Reactors," R. E. Trumble, September 1, 1960.
12. HW-68870 "Project Proposal CGI-905, Revision 1, "Interim Modifications for Improved Coolant Backup, B, C, D, DR, F, and H Reactors," T. H. Lyons, May 12, 1961.

13. HW-70186 "Summary Report on Transient Performance, Hanford Export Water System," C. T. Main, Inc., June 15, 1961.
14. HW-67997 "Design Study, Modification for Improved Coolant Backup 100, B, D, DR, F, H, and C Areas," M. H. Schack and W. J. Tupper, March 23, 1961.
15. HW-71165 "Numerical Results of PT IP-326-I, Low Flow Calibration Tests at DR and C Reactors, and of PT IP-395-I, Removal of High Tank Discharge Line Strainer Gates at B, D, F, Reactors," J. L. Benson, to be issued.
16. HW-67631 "Flow Distribution for Export System," C. C. Lomax, October 14, 1960

VI. GRAPHS AND REFERENCE DRAWINGS

- Figure 1 Typical High Tank - Export System Flow Rates.
- Figure 2 Export Water Lines and Pump Arrangement.
- Figure 3 Instrumentation, High Tank Water Temperature, Conduit Routing and Probe Installation.
- Figure 4 Instrumentation, High Tank Water Temperature, Control Panel Modification.
- Figure 5 Automatic Valve for Turbine Driven Export Water Pump.
- Figure 6 Slow Closing Export Line valve.

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FIG. 2

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EXPORT WATER LINES & PUMP ARRANGEMENT							
BLDG. NO.	901 & 2901	INDEX NUMBER	8500-01				
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		HW-71201

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FIG. 3

- NOTES:**
1. CABLE ROUTING: CONDUIT TO BE BURIED. EXACT ROUTING TO BE DETERMINED BY DETAIL DESIGN.
 2. ALL PROBES TO BE INSTALLED IN SOUTH SIDE OF TANK & CONDUIT INSTALLED AROUND TANK TO APPROPRIATE LEG OF HIGH TANK FOR DESCENT TO UNDERGROUND RUN AS INDICATED FOR EACH TANK

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COMMENTS**
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REV	NO	DESCRIPTION
5	SK-I-4246	UNDERGROUND PROC. WATER PIPING - 105-F
4	SK-I-4247	UNDERGROUND PROC. WATER PIPING - 105-H
3	SK-I-4245	UNDERGROUND PROC. WATER PIPING - 105-D
2	SK-I-4244	105-B
1	SK-I-4264	CONTR. ROOM PANEL MODIFICATION

NO.		DESCRIPTION		REV BY	APP'D BY	FOR	DATE
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ISSUED:		DATE:		PROJECT NO: DO-1266			
U. S. ATOMIC ENERGY COMMISSION HANFORD ATOMIC PRODUCTS OPERATION GENERAL ELECTRIC							
INSTRUMENTATION HIGH TANK WATER TEMP CONDUIT ROUTING & PROBE INSTALLATION DET.							
LAST DITCH COOLANT SYSTEM ELEC. 105-B DFD R H&C INDEX NUMBER 59001							
DWG. NO.		SK-I-4263		SHEET NO: _____ OF _____			

STUDY

100-7-6-60

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FIG. 4

QTY.	REV.	DESCRIPTION
	X	1 PANEL ARRGT. 105 B, D & F
	X	2 PANEL ARRGT. 105 DR
	X	3 PANEL ARRGT. 105 H
X		4 PANEL ARRGT. 105 C
1	1	5 RECORDER
1	1	6 NAME PLATE 1/2 x 3 7/8 LETTERS

REF: 9

1 WEST INLET WATER PANEL
MODIFIES R.E.F. 9 (1)

4 MISCELLANEOUS INSTRUMENTATION
MODIFIES (CENTER PANEL)
(105 - C)

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INSTRUMENTATION HIGH TANK WATER TEMP. CONTROL ROOM PANEL MODIFICATION					
SK-105 BDF DR HEC					
SK-1-4264					

7-6-60

ONE LINE DIAGRAM
VALVE CONTROL POWER

NOTES

1. BATTERY SET & VENTILATED ENCLOSURE REQ. AT BLDGS. 1B2 B. D & F. EXISTING AT BLDG 1B2 H
2. STM DRIVEN PUMPS TO HAVE INDICATION OF IDLE & FULL SPEED OPERATION AT 1B3 BLDG. CONTROL PANEL.
3. LOW OIL PRESSURE FROM TURBINE OIL PUMP TO BE ANNUNCIATED AT 1B3 BLDG. CON.ROL PANEL.

SK-I-4450
STUDY

NO.	DESCRIPTION	REV. BY	DATE	APPROVED BY	FOR	DATE	REF. NO.	DWG. NO.	DRAWING TITLE
REVISIONS									
REFERENCE DRAWINGS									
NEXT USED ON									

CHECK PRINT	COMMENT PRINT	APPROVED FOR CONST.	U. S. ATOMIC ENERGY COMMISSION HANFORD ATOMIC PRODUCTS OPERATION GENERAL ELECTRIC
DATE 11/26/66	ISSUE NO. 2	DATE 11/26/66	
SCALE 1"=1'-0"	DATE 11/26/66	APPROVED FOR PURCHASE	
DESIGNED BY R. L. L. 11/26/66	DATE 11/26/66	APPROVED FOR DESIGN	
CHECKED BY R. L. L. 11/26/66	DATE 11/26/66		
PROJECT 10596			
CLASSIFIED BY	DATE 11-2-66	CLASSIFICATION NONE	
NO. 1B2 B.D.F.H	NO. 8510		
SK-I-4450

3AM VALVE CONTROL
LIC SYSTEM

CONTROL
M

GENERAL NOTES

1. PRESSURE SWITCH ACTIVATED FROM SIGNAL POINT ADJACENT TO 200 WEST "Y" AND IS A MANUAL RESET TYPE CIRCUIT.
2. ANY ELECTRICAL FAILURE OR PRESSURE DROP SIGNAL WILL CLOSE THE CLOSURE VALVE. THE BOOSTER PUMP WILL CONTINUE OPERATING AND PASS ON THROUGH THE RELIEF VALVE.
3. BY-PASS LINE TO BE TEST FOR CONTINUOUS EMERGENCY FLOW AS FOLLOWS 200-12700Z.P.M. 100-W 050 G.P.M.
4. CLOSURE VALVE TO CLOSE OR OPEN IN TEN MINUTES

SK 2.3417

STUDY

CHECK PRINT	COMMENT PRINT	APPROVED FOR CONSENT BY DATE TIME	U. S. ATOMIC ENERGY COMMISSION HANFORD ATOMIC PRODUCTS OPERATION GENERAL ELECTRIC	
TIME DATE	TIME DATE	APPROVED FOR PURCHASE BY DATE TIME	SLOW CLOSING EXPORT LINE VALVE	
SCALE 1'-0"		APPROVED FOR DESIGN BY DATE TIME		
DRAWN SHIPMAN	DATE 11/18/59			
CHECKED				
TITLE 200 Lines				
DESIGNER CN HARRISON	DATE			
PURPOSE	IMPORT NO.	CLASSIFICATION	NO. 2821FW	ITEM NO. 7000
DO-1590	20596	NONE	SK-2-3417	SHEET NO. -
DATE 11/18/59				

**DATE
FILMED**

10/27/94

END