Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690 - 0767

February 15, 1989

Dr. Thomas E. Murley
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attn: Document Control Desk

Subject: Byron Station Units 1 and 2
Braidwood Station Units 1 and 2
ATWS Protection - 10 CFR 50.62
NRC Docket Nos. 50-454/455 & 50-456/457

References: (a) October 10, 1985 G.L. Alexander letter to H.R. Denton
(b) December 12, 1986 P.C. LeBlond letter to H.R. Denton
(c) January 30, 1987 P.C. LeBlond letter to H.R. Denton
(d) May 11, 1987 P.C. LeBlond letter to U.S. Nuclear Regulatory Commission
(e) March 8, 1988 K.A. Ainger Letter to T.E. Murley
(f) July 6, 1988 R. Chrzanowski Letter to T.E. Murley
(g) November 9, 1988 R. Chrzanowski Letter to T.E. Murley

Dear Dr. Murley:

Commonwealth Edison previously proposed the design and installation schedule for the ATWS Mitigation System (AMS) for the Byron and Braidwood Station in reference (a). The initial design and subsequent design changes were submitted in references (b), (c), (d), (e), (f), and (g) based on NRC requests for information and teleconferences.

Enclosed with this letter is Revision 6 to "ATWS Mitigation System Specific Design for Byron/Braidwood Stations". Revision 6 describes the changes made to hardware based on the selection of a new vendor to supply the system. (The software design remains the same.) These were discussed in a teleconference held on February 9, 1989 between Commonwealth Edison personnel and the NRC staff.

Attachment A to this letter provides a listing of the changes made from Revision 5 to Revision 6. Attachment B to this letter provides a copy of Revision 6 with the affected pages so marked. Attachment C to this letter provides the vendor manual that describes the Lambda Uninterruptable Power Supply as discussed during the teleconference.

Reference (a) previously outlined the methodology utilized by Commonwealth Edison to develop estimated implementation dates for the ATWS Mitigation System. The specific proposed dates contained in reference (b), (f), and (g) for the Byron and Braidwood Stations utilized this methodology and were predicated upon NRR pre-implementation final approval of the specific design.

A001
Encl.
ADD: Bob Pulsifer

Utilizing the methodology of reference (a) with the procurement schedule that is currently inprogress, the following 14-month delivery schedule will be required as follows:

1.	Obtain NRR Pre-Implementation Final Approval on Specific Design.	t=0
2.	Equipment Delivery	14 months
		total t+14 months

As previously discussed in reference (a), (b), (c), and (g), this modification is tied to the normally scheduled refueling outages for each unit. Thus incorporating the above information provides the current implementation dates listed below:

	Planned Refueling Outage	Proposed ATWS Implementation
Byron Unit 1	Fall 1988 Winter 1990	Winter 1990
Braidwood Unit 1	Fall 1989 Spring 1991	Spring 1991
Byron Unit 2	Winter 1989 Summer 1990	Summer 1990
Braidwood Unit 2	Spring 1990	Spring 1990

The information provided in this letter is being submitted for NRC review and acceptance. Please direct any further questions regarding these matters to this office.

Very truly yours,

A. C. Hansader

for S.C. Hynsader
Nuclear Licensing Administrator

/scl:0038V:

Att.

cc: Resident Inspector-Byron
Resident Inspector-Braidwood
J. Hinds-NRC Region III Office
L. Olshan-NRR
S. Sands-NRR

ATTACHMENT A

Specific Changes to Revision 6 of the

ATWS Mitigating System Specific Design

for Byron/Braidwood Stations

Commonwealth Edison Company

ATWS MITIGATION SYSTEM LICENSING SUBMITTAL CHANGES
BYRON/BRAIDWOOD - UNITS 1&2

REVISION 5 PAGE NO.	REVISION 5 SUBMITTAL	REVISION 6 PENDING SUBMITTAL	REASON FOR CHANGE
3-1& 3-2		Added statement about the SAIC equipment's 2-out-of-3 logic coincidence to trip.	New feature to SAIC equipment that enhances reliability.
3-4	Inoperable alarm includes loss of power, AMS in test, and automatic bypass (C-20 < 40%).	Added "module removed." Deleted "automatic bypass" (C-20 < 40%).	Feature unique to SAIC system. This deletion is based on the philosophy that this "Inoperable" alarm should warn operators of "unsafe" and "abnormal" conditions. This bypass situation is a normal, operational design condition (similar to R.G. 1.47 status windows).
4-1	...Rosemount master trip unit...	SAIC (Science Applications International Corporation) bistable...	New hardware purchased with logic system - see below.
4-1	...Rochester Solid State Logic System or approved equivalent.	SAIC Solid State Logic System	Rochester no longer supplied the original specified hardware; thus, new vendors were investigated, and SAIC was chosen.
4-2	Current-limiting voltage regulator from a new non-safety-related 24 Vdc battery with a dedicated battery charger...	Non-safety-related 24 Vdc uninterruptible power supply (UPS)...purchased from Lambda Electronics.	The battery and charger were combined into a UPS.
4-2	The voltage regulator...current limit of 32 amps.	The UPS...current limit of 5.7 amps.	The new SAIC equipment required much less current, thus the power limit is reduced.

REVISION 5 PAGE NO.	REVISION 5 SUBMITTAL	REVISION 6 PENDING SUBMITTAL	REASON FOR CHANGE
4-2		Normal power to the UPS is from non-safety, non-battery backed 120 Vac bus with a 15 amp breaker.	Power diverse and separate from RPS power.
4-2	None	The UPS 120 Vac input will be separated by distance and barriers such that the only credible power supply failures will be to the 24 Vdc and 5.7 amp UPS output power.	The smaller power supply will be incorporated into the AMS cabinet, but the 120 Vac will be separated from the rest of the panel.
4-3	New 24 Vdc battery system,...	New UPS, as...	New UPS
	The new battery shall...	The new UPS shall...	New UPS
	...powered from a dc source (i.e.,...)	...powered from an uninterruptible dc source (i.e., internal batteries and...). Power will be available for at least 1 hour after a loss of ac power.	New UPS Specified this design requirement.
	A new battery, with...	A new UPS, with...	New UPS
4-4	(test switch)	(main test/bypass switch)	Better description
	---use of Struthers Dunn relays or approved equivalent.	...use of Struthers Dunn relays.	Finalized on these relays.

REVISION 5 PAGE NO.	REVISION 5 SUBMITTAL	REVISION 6 PENDING SUBMITTAL	REASON FOR CHANGE
4-4	None	All activities involved in the construction, maintenance, and operation of the AMS will be in accordance with the 18 items of the Generic Letter 85-06, and other Commonwealth Edison Co. quality requirements.	Added statement to define QA requirements for activities beyond procurement. NRC requested clarification.
4-5	The automatic bypass of the AMS is alarmed as AMS inoperable.	The automatic bypass of the AMS is indicated in the control room via an AMS armed status light and a "C-20 power level permissive" status window.	(See Section 3-4)
	None	Described the "operating bypass" feature that allows calibration of 1 analog input without degrading system operation.	This is a new SAIC feature that allows online calibration.
4-7	...approximately 30 volts dc and 32 amps...	...approximately 30 volts dc and 10 amps...	Changed maximum current due to new loads and power supply down-sizing.
	...output of the battery/charger circuit.	...output of the UPS power supply circuit, and due to the distance and barrier isolation of the 120 Vac UPS input power.	New UPS 120 Vac input power is isolated from the rest of the AMS equipment by distance and barriers.
	Additional test...by vendor test data.	(deleted additional test) These tests envelope any credible voltage and current levels present in the AMS cabinet.	TEC isolators are tested to values that envelope this new maximum credible volts and current.

REVISION 5 PAGE NO.	REVISION 5 SUBMITTAL	REVISION 6 PENDING SUBMITTAL	REASON FOR CHANGE
4-8	IEEE 323-1974 and 324-	IEEE 323-1974 and 344	Typo
4-9	...exposed to is 32 amps.	...exposed to is 10 amps.	Maximum amps decreased due to new UPS.
	These output relays will be ...SER.	These output relays have been ...SER. Reference WCAP-8687, Appendix B, Supplement 2-E68A.	Purchase of S-D 219 relays from Westinghouse includes completed test as referenced.
4-12	...of the master trip units...	...of the bistable units...	Replaced MTUs with SAIC bistables.
	Housed in a single MTU chassis.	Housed in three dual bistable modules.	Describes new SAIC equipment.
4-12 & 4-13 & 4-14	(The detailed calibration of the Rosemount MTUs is described here.)	(The detailed calibration of the SAIC bistables is described here.)	Describes new SAIC bistable equipment.
4-14 & 4-15 & 4-16	(The detailed testing of the Rochester logic system is described here.)	(The detailed testing of the SAIC logic is described here.)	Describes new SAIC logic testing. The function of the "MTU test switch" and the new "logic test input switch" is similar. The testing of the 3 logic systems and the 2/3 coincidence is described here.

ATTACHMENT B

ATWS Mitigation System Specific Design

for Byron/Braidwood Stations

Commonwealth Edison Company, Revision 6

February 1989
Rev. 6

ATWS MITIGATION SYSTEM
SPECIFIC DESIGN
FOR
BYRON/BRAIDWOOD STATIONS
COMMONWEALTH EDISON COMPANY

Project Nos. 7725-52/53
7775-07/08

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this document is to provide a description of the specific ATWS Mitigation System design proposed for implementation at the Byron and Braidwood Stations. The description is intended for the use of the Nuclear Regulatory Commission in evaluating the specific design for compliance to the ATWS rule of 10CFR 50.62(c)(1).

2.0 ATWS MITIGATION SYSTEM DESIGN BASIS

The Byron/Braidwood Stations ATWS Mitigation System (AMS) design is based on the following requirements:

a. The ATWS Rule (Reference 1)

b. ATWS Quality Assurance Requirements (Reference 2)

c. Westinghouse AMSAC Generic Design Guidance (Reference 3)

The foregoing documents provide the basis for the specific AMS system design as described in Section 3.0. In addition to the details provided in Section 3.0, plant specific information, as requested by the NRC in their letter (Reference 4) stating acceptance of the Westinghouse AMSAC Generic Design, is included in Section 4.0.

3.0 ATWS MITIGATION SYSTEM FUNCTIONAL DESCRIPTION

This section will functionally describe the proposed ATWS Mitigation System (AMS) design for the Byron and Braidwood Stations. The operation of the proposed AMS is defined in Figure 3-1 and by the following descriptions.

3.1 System Overview

The required initiating actions of the AMS are as follows:

a. initiate the auxiliary feedwater system, and

b. trip the main turbine.

The plant variable that is monitored to determine loss of heat sink and provide for the actions described above is Steam Generator (SG) level. Each steam generator is monitored by four existing sets of level instrumentation. Any of the four level measurements indicating low level is an indication of loss of heat sink for that steam generator.

As shown in Figure 3-1, one AMS logic train with three logic subsystems is provided. Both the main turbine trip and auxiliary feedwater actuation signals are initiated by this logic train. For reliability, three redundant, identical logic subsystems are provided, and a two-out-of-three coincedence of these logic subsystems is required in initiate actuation.

Each AMS logic subsystem monitors the RPS Ch. 1 SG level transmitter from each steam generator for a total of four level inputs. A three-out-of-four coincident logic scheme is employed to interrogate these SG level signals, therefore requiring three of the steam generators to indicate a loss of heat sink in order to actuate each subsystem. The AMS level setpoint will be 3% of narrow range span below the RPS Steam Generator level setpoint.

Two-out-of-three coincedence of the logic subsystem trips will actuate the auxiliary feedwater system (i.e., motor driven and diesel driven auxiliary feedwater pumps and related equipment) and trip the main turbine (through the emergency trip). A time delay (approximately 25 seconds) is provided to ensure the reactor protection system will provide the first trip signal.

Arming of the AMS is automatic and is accomplished when both the C-20 power level ($\geq$40% of nominal full power) permissives are achieved (see figure 3-1). Upon a decrease in power below the C-20 power level the AMS will be automatically bypassed. The C-20 power level permissive is developed in the AMS system based on turbine impulse chamber pressure.

After an AMS initiation of the auxiliary feedwater system and tripping of the main turbine, the AMS will self reset. That is, after AMS initiation as power decreases and after a time delay (approximately 360 seconds), the C-20 interlock will inhibit the logic thus allowing shutdown of the auxiliary feedwater system

and reset of the main turbine trip. The time delay allows the AMS to remain armed long enough to perform its function in the event of a turbine trip.

The logic provides for one inhibiting signal which is manually implemented under administrative control and prevents the logic from initiating its intended functions (i.e., start the auxiliary feedwater system and trip the main turbine). This inhibiting signal results from the requirement that the AMS must have the capability for testing during power operation. When the operator selects the AMS test/bypass mode, the final AMS actuation output devices (relays) are inhibited from operating and inadvertently initiating the auxiliary feedwater system or tripping the main turbine during power operation.

Control of the auxiliary feedwater system and main turbine are provided for by existing controls and are not in the scope of the AMS design.

3.2 Main Control Room Interface

The control room interface between the AMS and the operator includes the following alarms and indications located at the main control boards:

a. Alarms - AMS Initiated

AMS Inoperable*

24VDC P/S Failure

b. Indications - AMS Initiated - Red Light

AMS Armed - Green Light

AMS In Test Mode - Amber Light

c. Bypass Permissive Light Box - ATWS Permissive C-20

*Inoperable alarm includes loss of power, module removed, and AMS in test/bypass.

3.3 Termination of Steam Generator Blowdown

Steam generator blowdown will not be automatically terminated by the AMS. Since the immediate effect of steam generator blowdown, in the event of an ATWS event, is to remove heat from the steam generator, automatic isolation is not necessary. Once AMS is initiated, steam generator inventory can be adequately satisfied with both trains of auxiliary feedwater operating. Auxiliary feedwater flow per steam generator will be approximately 320 gpm with maximum blowdown flow per steam generator of 90 gpm.

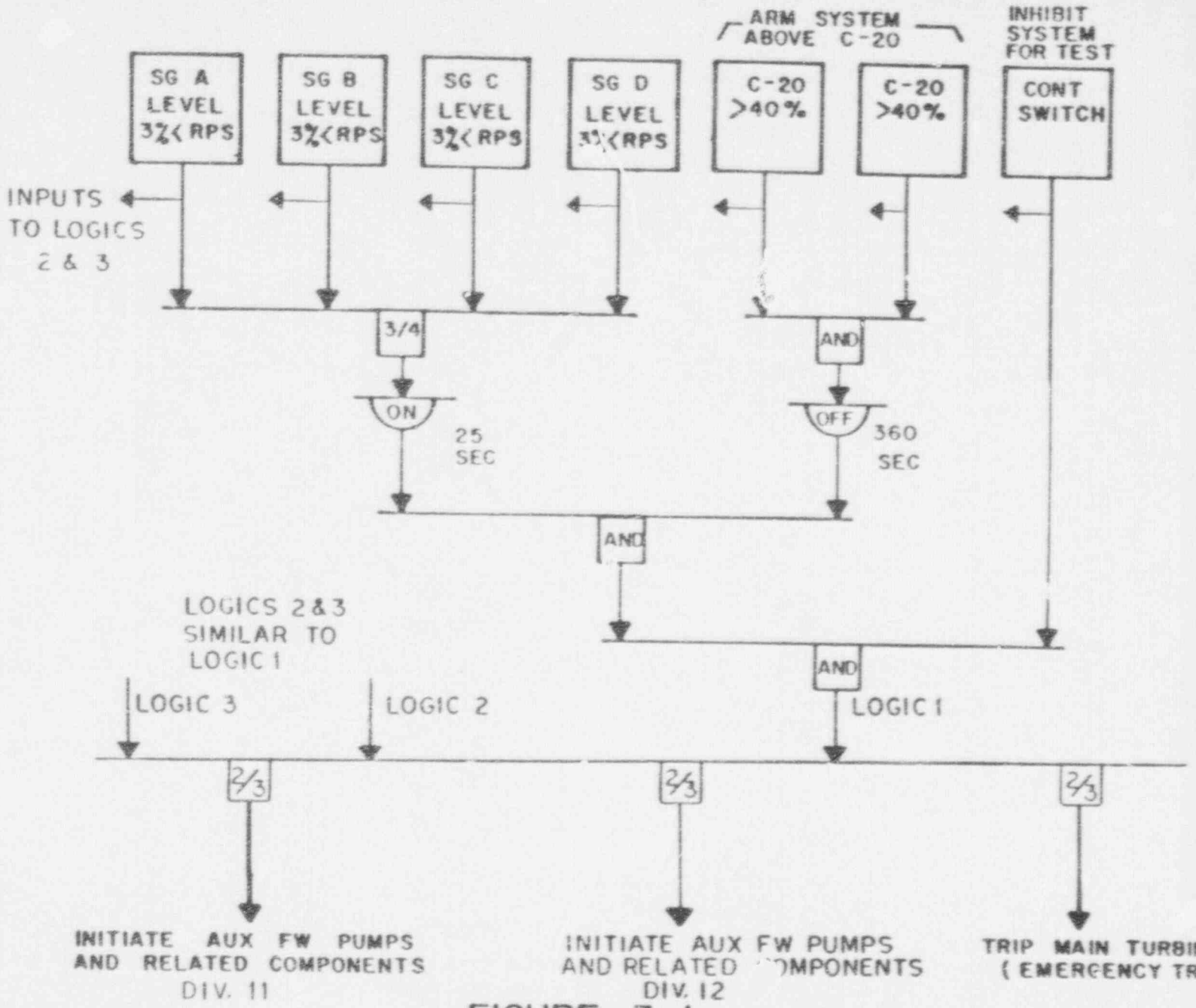


FIGURE 3-1

ATWS MITIGATION SYSTEM SIMPLIFIED LOGIC DIAGRAM

FEB 1989 | REV. 5

4.0 PLANT SPECIFIC DESIGN DETAILS

The following section provides the plant specific design details as requested by the NRC. Each topic is addressed in the order in which they are listed in Reference 4.

4.1 Diversity

The ATWS Mitigation System (AMS) design for the Byron and Braidwood Stations uses equipment which is largely diverse from that used in the Reactor Protection System (RPS). AMS inputs are derived from the existing SG level and C-20 instrumentation which is located in the RPS Westinghouse 7300 protection cabinets.

The AMS SG level and C-20 inputs are isolated from the existing instrumentation loop signals by Technology for Energy (TEC) Analog Signal Isolators. These isolators are classified as safety related. After isolation the signals are fed to SAIC (Science Applications International Corporation) bistable units which generate the SG low level and C-20 logic inputs to the SAIC Solid State Logic System. The Solid State Logic System provides implementation of the coincidence logic, permissives, test inhibits, time delays and other AMS functions. Outputs from the logic system are then used to trip the turbine and start auxiliary feedwater via a number of interposing relays. The interposing relays interlocking safety related circuits are classified as safety related. These relays will be Struthers Dunn relays.

Major components of the AMS are therefore provided by manufacturers who are diverse from those used in the Westinghouse 7300 protection cabinets and Westinghouse solid state logic cabinets.

4.2 Logic Power Supplies

The AMS logic will be powered through a non-safety related 24 VDC uninterruptable power supply (UPS) purchased from Lambda Electronics specifically to power the AMS cabinet. This UPS will have a current limit of 5.7 amps.

Normal power to this UPS will be from a 120 VAC, non-safety related, and non-battery backed bus. A 15 amp breaker in the distribution panel will limit the maximum current available at the AMS cabinet, UPS input. Inside of the AMS cabinet, the UPS power supply and its 120 VAC input power will be isolated by distance and barriers from the rest of the cabinet equipment. Thus the maximum credible fault of the power supply and its associated cables would be limited to its 5.7 amp at 24 vdc output.

The guidelines in 10CFR50.62 (ATWS Rule) state that:

> The AMS power supply is not required to be safety-related.
>
> The AMS must be capable of performing its safety-related function following a loss of offsite power.
>
> The AMS logic power must be independent from the power supply for the Reactor Trip System.

The AMS logic power must be independent from the power supply for the Reactor Trip System.

A new UPS, as the AMS power supply, complies with the guidelines in 10CFR50.62 as discussed below:

a. Safety Classification of AMS Power Supply

The new UPS shall be non-safety related.

b. Operation Following Loss of Offsite Power

Since the AMS cabinet is powered from an uninterruptable dc source (i.e., internal batteries and voltage regulator), the system is capable of performing its function following a loss of offsite power. Power will be available for at least one hour after a loss of all AC power.

c. Independence From Reactor Trip System Power Supply

Since the AMS Cabinet will be powered from a new UPS, with its own battery charger, the AMS logic power supply is totally independent from the Reactor Trip System power supply.

4.3 Safety-Related Interface

Two safety-related interfaces exist between the AMS and existing safety related circuits. The first is the interface between the AMS and the SG level and C-20 instrumentation circuits. As previously discussed in Subsection 4.1, analog signal isolation is provided by the use of Technology for Energy Corporation analog signal isolators. The second is the interface between the AMS and the auxiliary feedwater circuits. Isolation is provided by the use of Struthers Dunn relays. The existing criteria for physical separation between reactor protection, ESF, and non-safety system wiring will also be utilized.

4.4 Quality Assurance

Safety-related components which are part of the AMS will be procured with the appropriate quality assurance required for safety-related equipment. All other components in the AMS design will be procured using the quality assurance requirements stated in Generic Letter 85-06 (Reference 2).

All activities involved in the construction, maintenance and operation of the AMS will be in accordance with the eighteen items of the above referenced generic letter and other Commonwealth Edison Company quality control requirements.

4.5 Maintenance Bypasses

Maintenance at power can be accomplished by taking the AMS out of service administratively (main test/bypass switch) and removing electrical power. It is recommended that the main test/bypass switch located in the AMS cabinet, be placed in the test/bypass mode to ensure that maintenance activities do not result in spurious actuation of the AMS output relays. Loss of power to the AMS or placing the AMS in test mode will result in an AMS inoperable main control alarm. This alarm along with other AMS alarms and indicating lights will be grouped and located on the main control board utilizing human factors engineering practices.

4.6 Operating Bypasses

The AMS shall be automatically armed coincident with power above C-20 (40% of nominal full power) as a permissive. Bypass of the AMS shall be automatically initiated if the power is reduced below C-20. The C-20 power level is measured by two transmitters. The transmitters will measure first stage impulse chamber pressure at the high pressure turbine. The basis for the 40% of full power setpoint is provided in O/G-87-10 (Ref. 5). The automatic bypass of the AMS is indicated in the control room via an

"AMS armed" status light and a "C-20 power level permissive" status window at the Bypass Permissive Light Box.

4.7 Means for Bypassing

The main test/bypass switch as discussed in Sections 3.1 and 4.5 is a permanently installed toggle switch with two positions: normal and test/bypass. The main test/bypass switch is located in the AMS cabinet and is the only means provided for bypassing the entire system. An operating bypass switch is provided to allow bypassing of any one bistable during system operation. This allows on-line testing and calibration of the analog instrument loops without degrading system operation or reliability. Other means for bypassing as specifically excluded by the guidance are not used. The main test/bypass switch will be included in the overall human factors engineering review of the system.

4.8 Manual Initiation

Manual actuation of the AMS is not provided. Manual initiation of auxiliary feedwater and manual tripping of the turbine can be accomplished by the operator at existing controls provided on the main control boards.

4.9 Electrical Independence From Existing Reactor Protection System And Other Safety Related Circuits

The interface between the SG level and C-20 instrumentation loops and the AMS is made through Technology for Energy Corporation (TEC) Model 156 Nuclear Qualified Analog Isolators. These isolators, which are located in a mild environment, have been fully qualified by the vendor according to the guidelines set forth in the applicable IEEE Standards. The maximum credible voltage/current transient which the non-safety-related (output) side of the circuits would be exposed to is approximately 30 volts DC and 10 amps due to the current limiting voltage regulator installed on the output of the UPS power supply circuit and due to the distance and barrier isolation of the 120 vac UPS input power. Appendix A of AMSAC Generic SER criteria has been satisfied by the TEC Model 156 isolator as follows:

A) Attachment 1 of this document are diagrams which show how the maximum credible transients were applied during the TEC testing. These diagrams also include short, ground, and open testing.

B) The TEC Model 156 isolator has been tested to demonstrate that the isolator would provide isolation during maximum credible transient of 120VAC at 20 amps

and 2000VDC at 20 mA and during other transients such as shorts, opens, and grounds. This testing is documented in TEC Reports 156-TR-02 and 156-TR-03. These tests envelope any credible voltage and current levels present in the AMS cabinet.

C) See Item B above.

D) The pass/fail acceptance criteria for the TEC isolator will be that the isolation capability of the assembly is not degraded during or after the transient.

E) The TEC isolators were tested to IEEE 323-1974 and 344-1975 as documented in TEC Reports 156-TR-02 and 156-TR-03. This environmental and seismic testing envelopes the Byron/Braidwood station requirements for the installed location.

F) The TEC isolator has been successfully tested to determine susceptibility, at 10V/M from 20-50 MHZ and 15 V/M from 100-500 MHZ with a spot check from 500 to 1000 HZ. The stainless steel case will also be grounded which generally eliminates electromagnetic interferences.

The design of the isolators is based on an inherently fail-safe principle which ensures isolation, even if all power is removed from the device. It should be noted that the TEC isolators are protected by both in-line circuit fuses and internal fuses on the isolator outputs.

The AMS output interface to the safety related auxiliary feedwater circuits is provided at the output relays via coil to contact separation. The proposed output relays are Struthers Dunn auxiliary relay Type 219. These relays, which are located in a mild environment, will be certified to operate in the environment in which they are located. The results of the seismic testing, already performed, envelope the Byron/Braidwood Stations requirements. In addition, the relays have been functionally tested. The maximum credible voltage and current transient which the non-safety-related side of the circuits would be exposed to is approximately 30 volts dc at 10 amps (i.e., the AMS cabinets where the relays are located, are powered from a 24 volt DC System which is current limited to 5.7 amps). The relays will be purchased from Westinghouse who has provided generic qualification, via WCAP-8687, Appendix B,

Supplement 2-E68A, to the criteria stated in Appendix A of AMSAC Generic SER. The relays have been operationally tested to faults of 580 vac and 250 vdc. These test values envelope the maximum expected credible voltage and current levels present in the AMS cabinets.

The relays are rated 10 amps non-inductive and 3 amps inductive at 120VAC. The relays are rated 3 amps non-inductive and 1 amp inductive at 125VDC. The relays are inherently fail-safe because power is not required for the relays to function as isolation devices. Typically electromagnetic interference is not a problem with relays. More-detailed documentation addressing qualification and testing is available in the Westinghouse offices.

4.10 Physical Separation From Existing Reactor Protection System

The AMS hardware is located in its own cabinet which is separate from the existing reactor protection system cabinets. Actual isolation of the SG level, C-20, and aux-feedwater circuits will be done in the AMS cabinet. Isolators, safety related relays and wiring within the AMS cabinet will be physically separated to meet all existing

separation requirements. Likewise all existing criteria for physical separation of reactor protection, ESF, and non-safety system wiring external to the AMS cabinet will also be followed.

4.11 Environmental Qualification

The AMS cabinet is located in a mild environment. The environmental parameters for the location, Zone A1, are listed in the Byron/Braidwood FSAR Table 3.11-2.

The four existing SG level transmitters are located in a harsh environment. The environmental parameters for the location, Zone C6, are listed in the Byron/Braidwood FSAR Table 3.11-2.

The two existing C-20 transmitters are located in a mild environment. The environmental parameters for the locations, Zones T1 and T2, are listed in the Byron/Braidwood FSAR Table 3.11-2.

Both non-safety and safety-related components of the ATWS cabinet and the SG level and C-20 transmitters will be designed to meet the environmental conditions existing in the zones they are located.

Seismic qualification will be provided for the AMS cabinet and internal safety-related components which provide the input and output AMS interface to external safety related circuits. Isolation devices shall be provided with seismic qualification in accordance with the basis for plant licensing.

4.12 Testability at Power

The AMS is designed to allow testing of the bistable units, solid state and relay logic system, and final AMS output relays during power operation as well as below the C-20 power level permissive. AMS testing at power will be performed once every 6 months. AMS testing at power is subdivided into three areas which are described individually below.

a. Testing of bistable units - The logic train requires six bistables (one per steam generator plus two C-20's) which are housed in three dual bistable modules mounted in the logic subrack assembly.

An Operating Bypass selector switch on the test panel will allow the testing of any one bistable at a time. Selection of a bistable with this switch will introduce a selectable logic tripped or not tripped signal to the logic system regardless of bistable state. Thus, calibration or test of that bistable can be

accomplished without introducing a false trip signal into the logic system. The bypassing of this bistable will be alarmed in the control room and indicated locally. Test points on each bistable front panel allows monitoring of the process variable voltage, the setpoint voltage and the reference voltage.

b. Testing of system logic (solid state and relay) - Since the bistables are tested individually, it is not possible to force more than one bistable into a trip status simultaneously from the Operating Bypass switch. To artificially initiate the system logic for testing, external logic test input test switches are provided for each bistable output.

The six logic test input switches are only functional if the master test/bypass switch is in the test/bypass position. This position of the master test/bypass switch is alarmed via the AMS inoperable alarm in the control room, is indicated via status light in the control room, and is indicated locally.

Each logic test input switch is a three position toggle with each position accomplishing the following respective function:

Logic Test Input Switch Position	Function
Norm	Allows the bistable output to directly operate the logic system
Test-Trip	Disconnects the bistable output from the logic and forces a logic "1" creating an artificial "trip situation."
Test-Norm	Disconnects the bistable output from the logic and forces a logic "0" creating an artificial "non-trip or normal situation."

Each logic test input switch will be used to simulate bistable inputs to the three logic subsystems. When the proper combination of 3 out of 4 steam generator level trips and the 2 reactor power trips are simulated, then the three logic subsystems will trip and that will result in AMS SG level pretrip and AMS armed local indicating lights being lit. After the appropriate time delay an output tripped light will light.

An individual logic bypass switch is provided for each of the three logic subsystems. When the master test/bypass switch is in the test/bypass position, these individual logic bypass switches will force the associated logic subsystem output to the "untripped" state regardless of logic inputs. This feature allows testing of the 2 out of 3 logic functions.

c. Testing of final AMS output relays - The testing circuits used for the final AMS output relays and final actuated devices at power will be similar to the testing schemes used in the Byron/Braidwood Safeguards Test Cabinets. However, for the purpose of the AMS, testing of the final AMS output relays and final actuated devices will be limited to a continuity test only of the circuits and not full actuation of the final devices (control relay which operates the auxiliary feedwater pump, for example).

Continuity testing of the circuits will be used because,

the AMS is not safety-related,

any additional periodic cycling of safety related system components in the auxiliary feedwater system as a result of AMS testing should be limited in order to maximize the qualified life of those components, and

tripping of the turbine at power is obviously unacceptable.

A complete off-line end to end test will be performed once each refueling outage. This test will simulate inputs to transmitters and monitor proper actuation of output relays. A test procedure will be prepared once the system hardware is purchased.

4.13 Completion of Mitigative Action

Once initiated the AMS actuation signal will go to completion except as delayed by the 25 second time delay. The C-20 permissive is delayed from de-energizing for 360 seconds to ensure that the C-20 permissive is present so that AMS operates.

Seal-in of the AMS actuation signal is not necessary at the logic level, since the final actuated or tripped equipment control circuits (auxiliary feedwater and turbine trip) will remain in that condition until stopped or reset by the main control room operator.

4.14 Technical Specification

No specific technical specification is proposed at this time.

5.0 References

1. ATWS Final Rule - Code of Federal Regulations 10CFR50.62 and Supplementary Information Package, "Reduction of Risk from Anticipated Transients Without Scram (ATWS) Events for Light-Water-Cooled Nuclear Power Plants".

2. "Quality Assurance Guidance for ATWS Equipment That is Not Safety-Related", Generic Letter 85-06; April 16, 1985.

3. "AMSAC Generic Design Package", WCAP-10858 Rev. 1.

4. Rossi, C. E., "Acceptance for Referencing of Licensing Report", NRC Letter to L. D. Butterfield, Chairman of ATWS Subcommittee, Westinghouse Owner's Group, July 7, 1986.

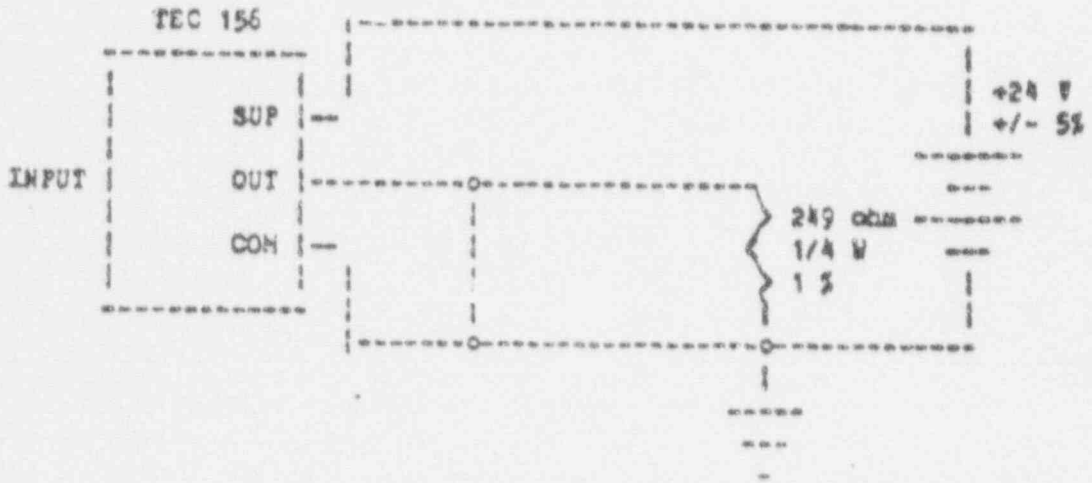
5. Westinghouse Owners Group Letter OG-87-10, dated February 26, 1987.

6.0 Attachments

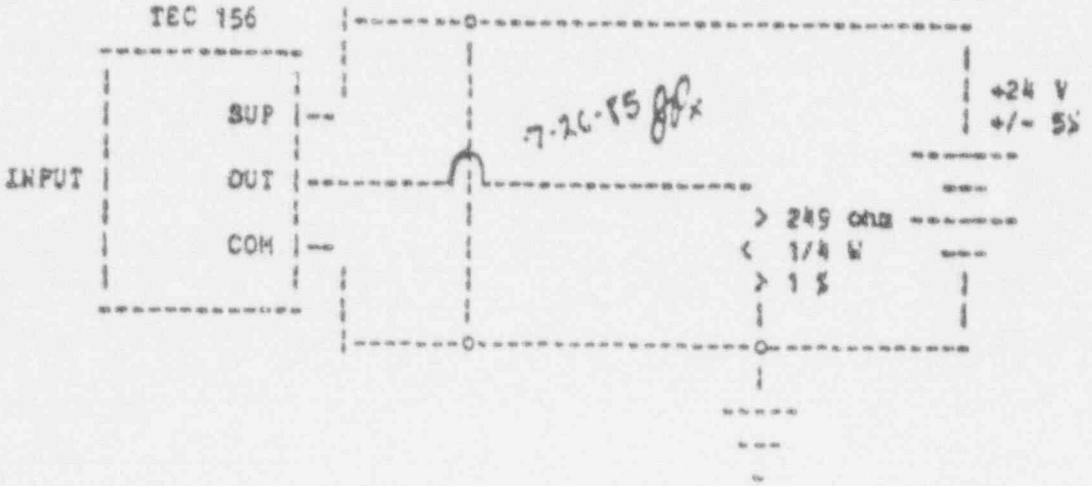
ATTACHMENT 1
(9 PAGES)

2.2.1. Output (non-1E) short-circuit fault conditions (continued)

OUTPUT TO COMMON SHORT

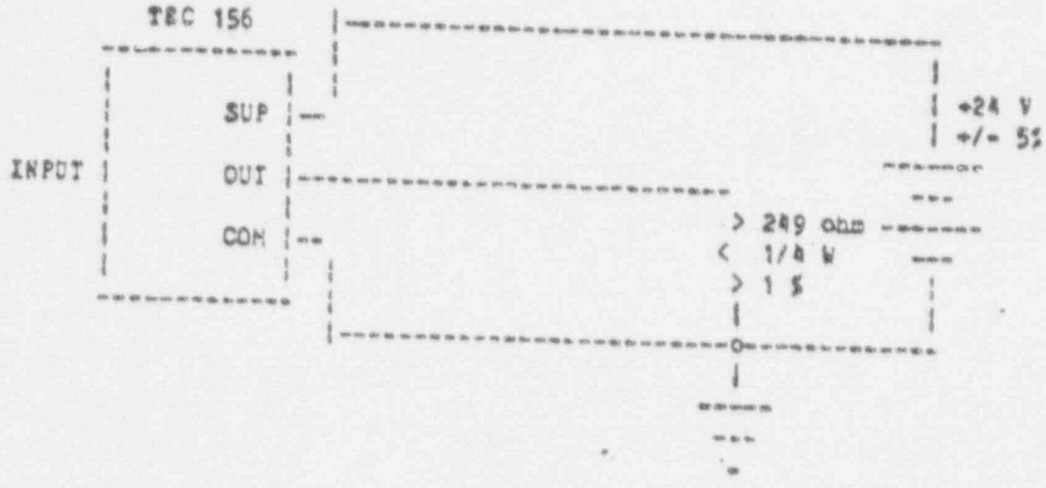


SUPPLY TO COMMON SHORT



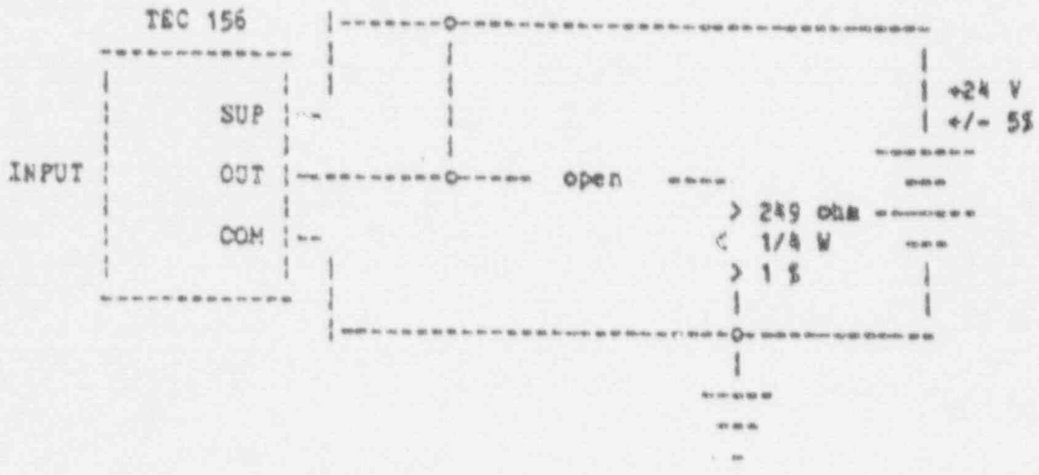
2.2.1. Output (non-IE) short-circuit fault conditions

NORMAL - NO FAULT

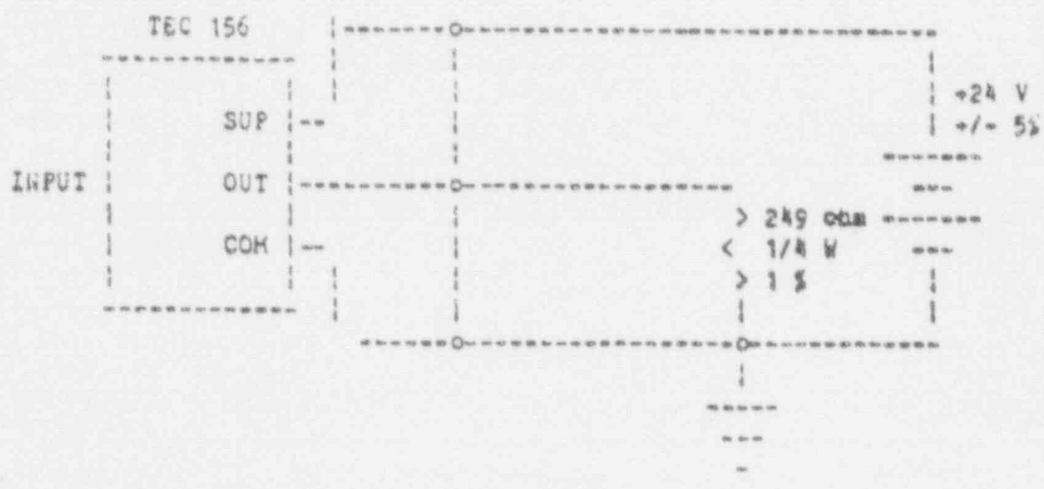


7.2.1. Output (non-IE) short-circuit fault conditions (continue

SUPPLY TO OUTPUT SHORT

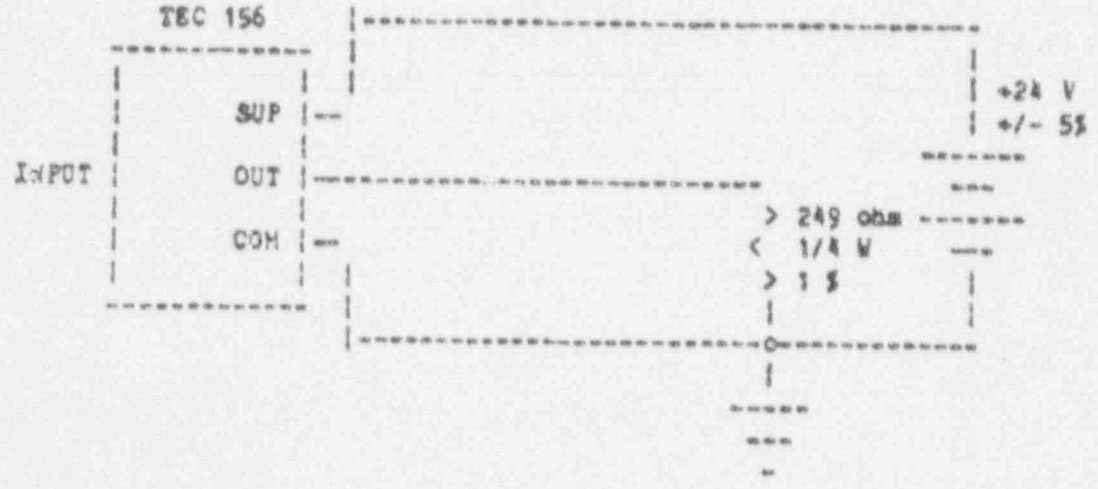


SUPPLY TO OUTPUT TO COMMON SHORT



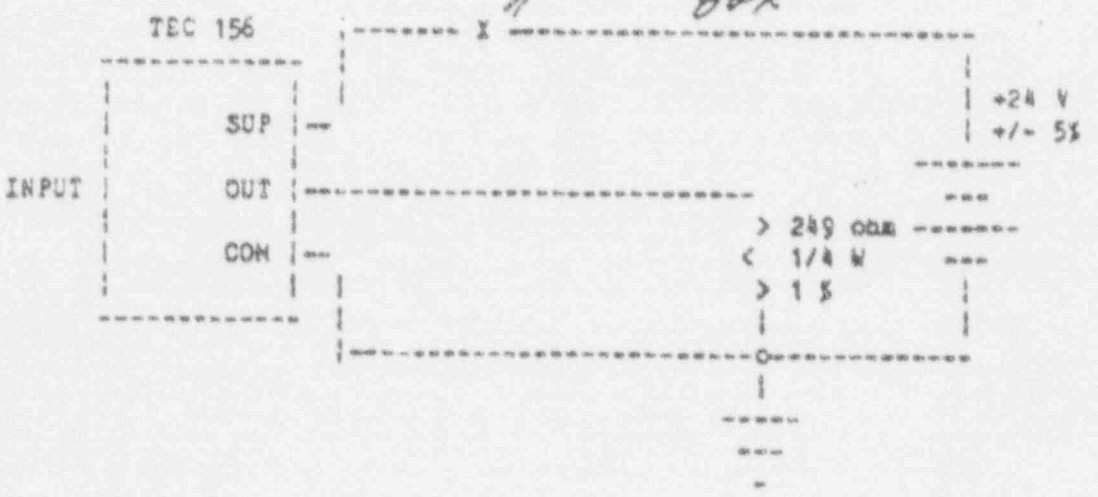
2.2.2. Output (non-1E) open-circuit fault conditions

NORMAL - NO FAULT



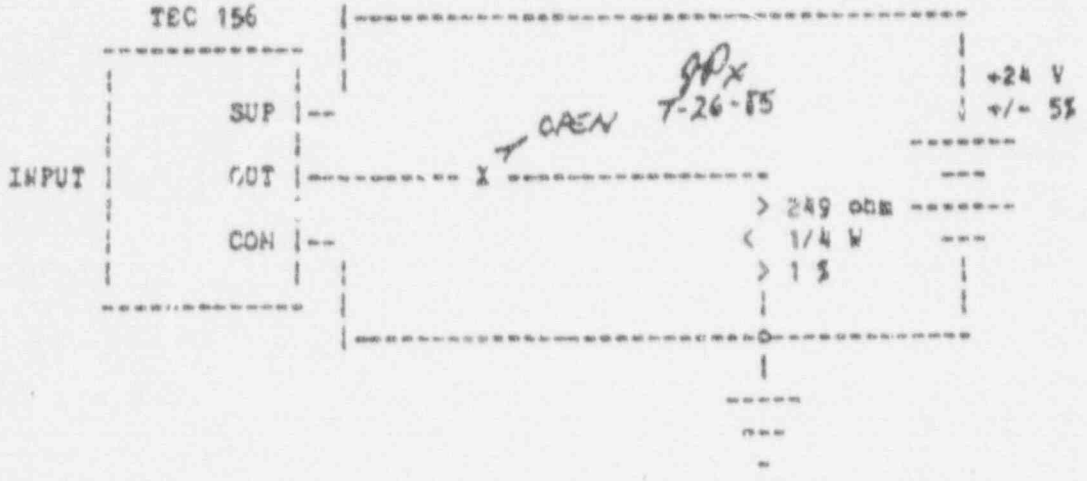
SUPPLY CONNECTION OPEN-CIRCUITED

OPEN

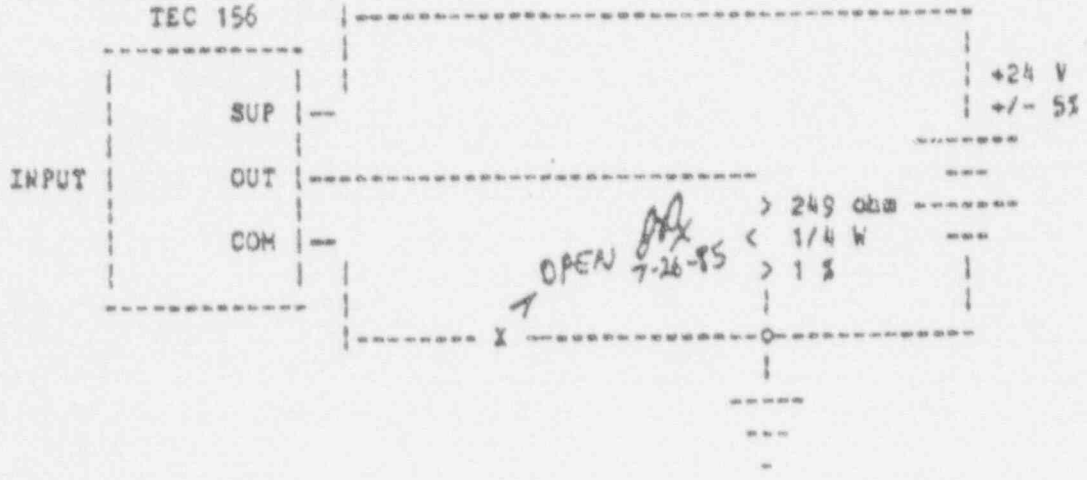


2.2.2. Output (non-1E) open-circuit fault conditions (continued)

OUTPUT CONNECTION OPEN-CIRCUITED

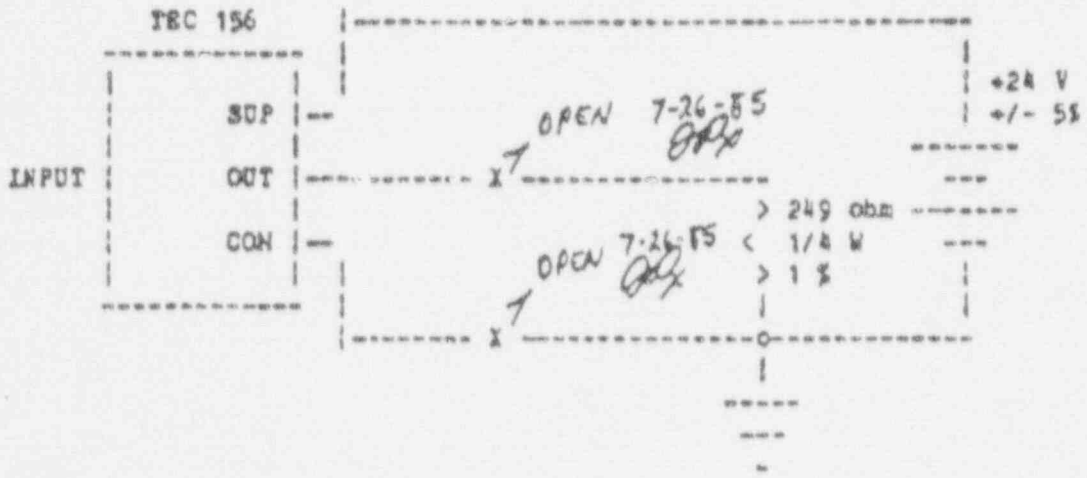


COMMON CONNECTION OPEN-CIRCUITED

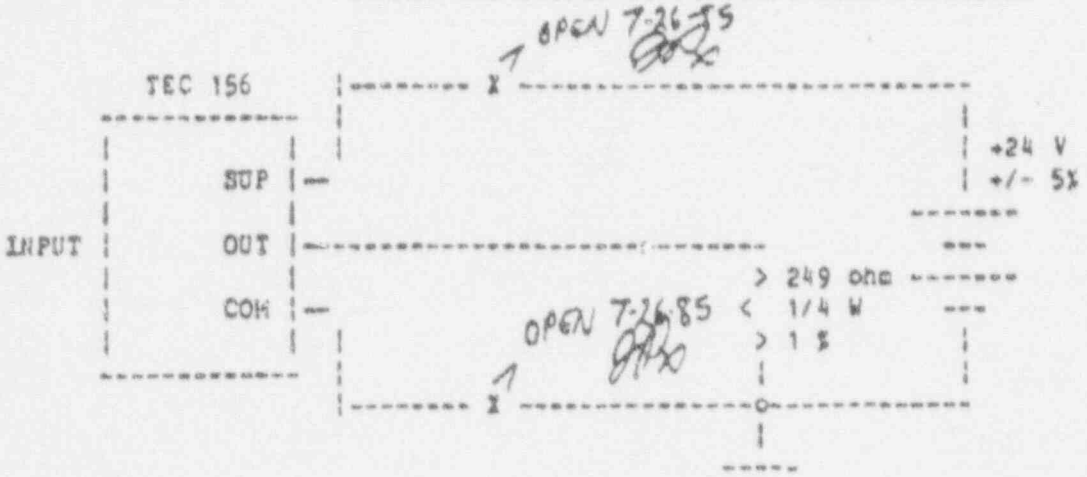


2.2.2. Outputs (non-1E) open-circuit fault conditions (continued)

COMMON AND OUTPUT CONNECTIONS OPEN-CIRCUITED

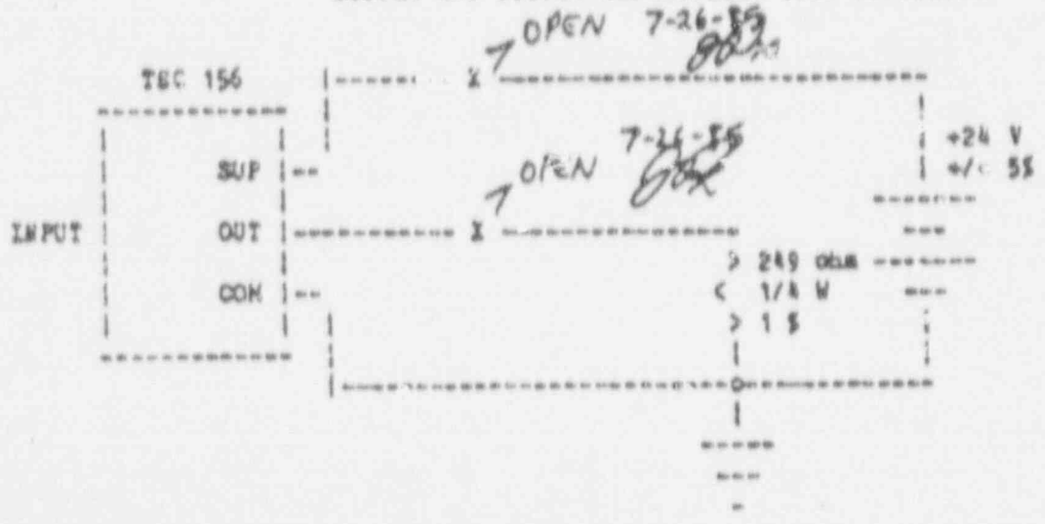


COMMON AND SUPPLY CONNECTIONS OPEN-CIRCUITED

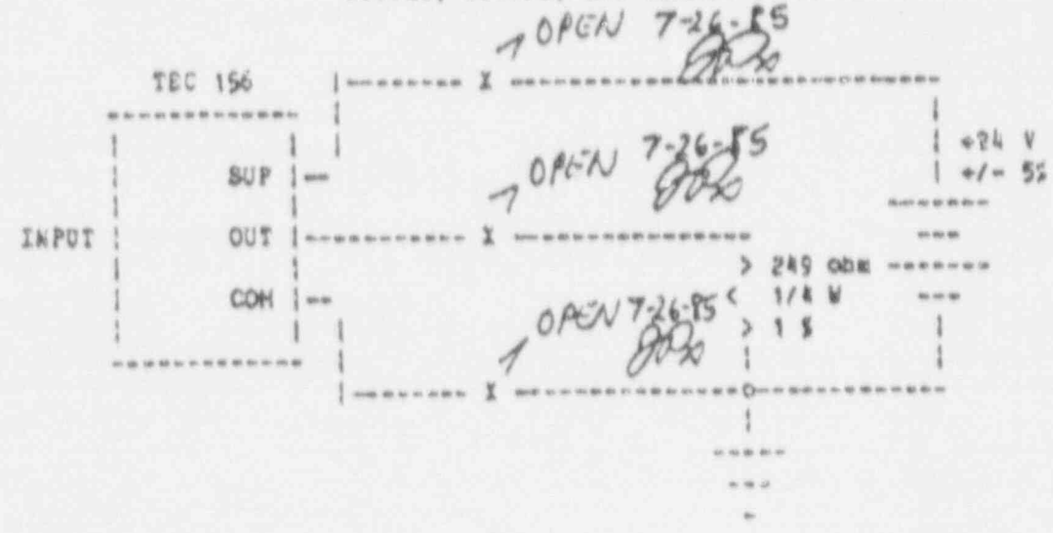


2.2.2. Output (non-1E) open-circuit fault conditions (continued)

SUPPLY AND OUTPUT CONNECTIONS OPEN-CIRCUITED



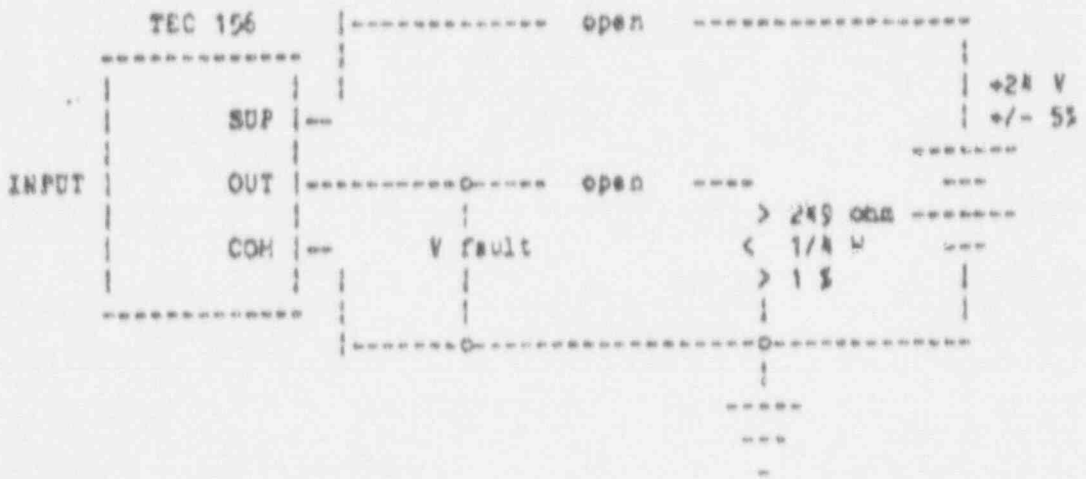
SUPPLY, OUTPUT, AND COMMON CONNECTIONS OPEN-CIRCUITED



2.2.3. Output (non-IS) applied voltage/current fault conditions

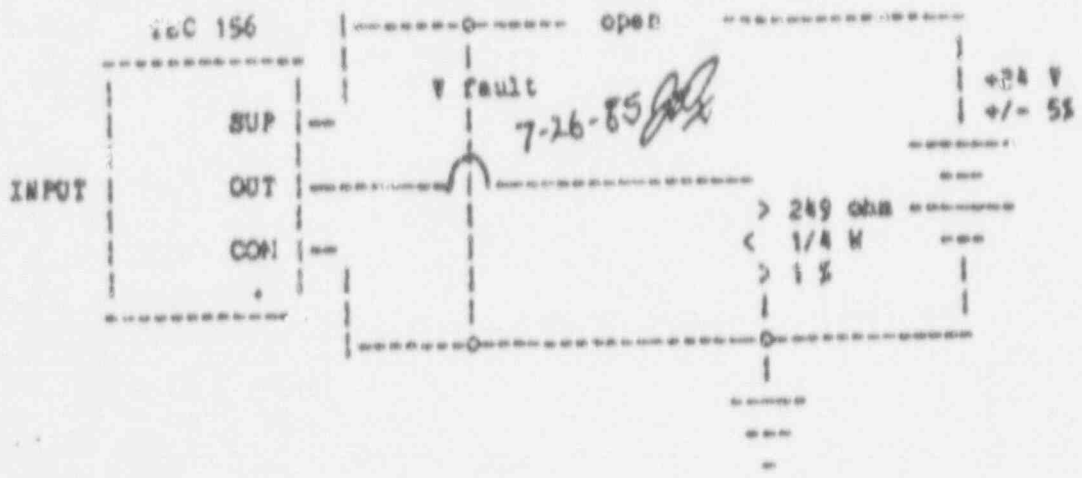
NORMAL - NO FAULT

COMMON TO OUTPUT APPLIED VOLTAGE/CURRENT FAULT

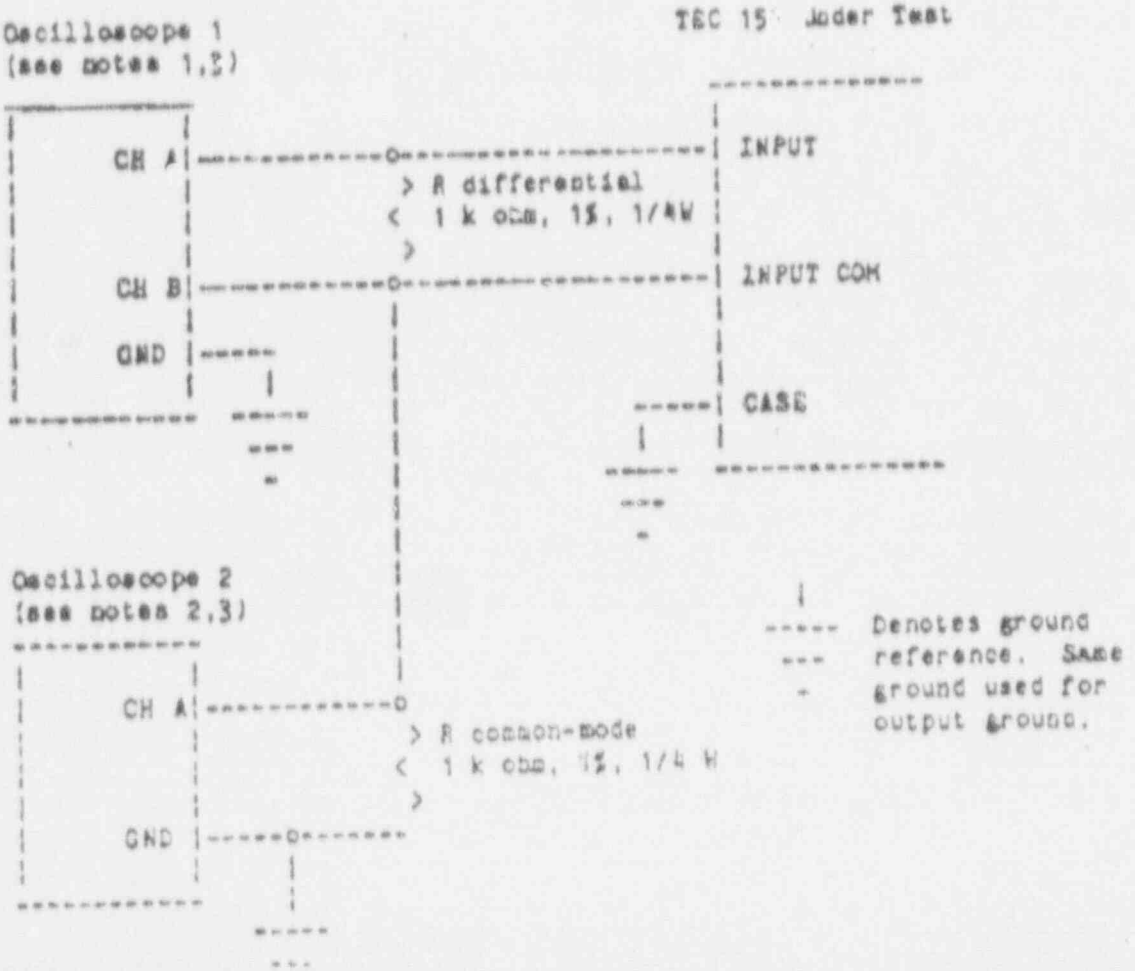


2.2.3. Output (non-1E) applied voltage/current fault conditions (continued)

COMMON TO SUPPLY APPLIED FAULT VOLTAGE/CURRENT



CIRCUITRY FOR MEASURING 1E-INPUT SIGNAL DEGRADATION CAUSED BY NON-1E (OUTPUT) FAULTS IN THE T&C 156 ISOLATOR



ATTACHMENT C

Lambda Uninterruptable Power Supply Description

LAMBDA ELECTRONICS

YOUR INQUIRY NUMBER	
Discussion with Al Hill	
OUR QUOTE NUMBER	DATE
97031	1/23/89

Lambda Assembly 23704 consists of the following power supplies and accessories:

1 LRA-17-CS	Rack Adapter W/Slides
1 LFS-42-24-41698	Power Supply
1 LFS-V-40	UPS Module
3 FRL-24-005	5 AH Batteries
1 MBW-1205-22	AC Line Filter

The AC input tot his Assembly is 105 to 132 VAC, 47-63 HZ.

The UPS Module, Batteries, and power supply are mounted in the rack adapter. The AC control panel is mounted to the rack adapter, and wired tot he UPS Moduel, Batterioes, and power supply. The AC input and DC output for the entire assembly is through barrier strips moutned at the rear of the rack adapter.

The front panel contains a double pole series trip circuit breaker for AC input and UPS Module control, an AC pilot light, and three battery line fuses.

This Assembly can provide an outpt of 24VDC at 5.7 Amps for up to one hour after an Ac Line failure. After one hour of battery operation, the batteries will need approximately 6 hours to recharge. NOTE: Upon starting up the system the batteries should be allowed approximately 1-2 hours to charge up. (AC input must be present).

Terminals are available at the rear for access to the UPS Moduule interface signals (AC Line rail, battery low, charger fail). These signals are available as optically isolated open collectors with a 5mA sinking capability. Under a fail condition, the opto-transistors turn-off.

The AC input is provided with a Line Filter.

LAMBDA ELECTRONICS

YOUR INQUIRY NUMBER	
Discussion with Al Hill	
OUR QUOTE NUMBER	DATE
97031	1/23/89

Lambda Model LFS-42-24-41698 has all catalog specs. applicable to Model #LFS-42-24 with the following deviations:

The unit is modified to allow UPS operation with this Power Supply, while utilizing a 105 to 132 VAC input band, two (2) terminals are added which are used to wire Lambda LPS-V-40 UPS Module to the unit.

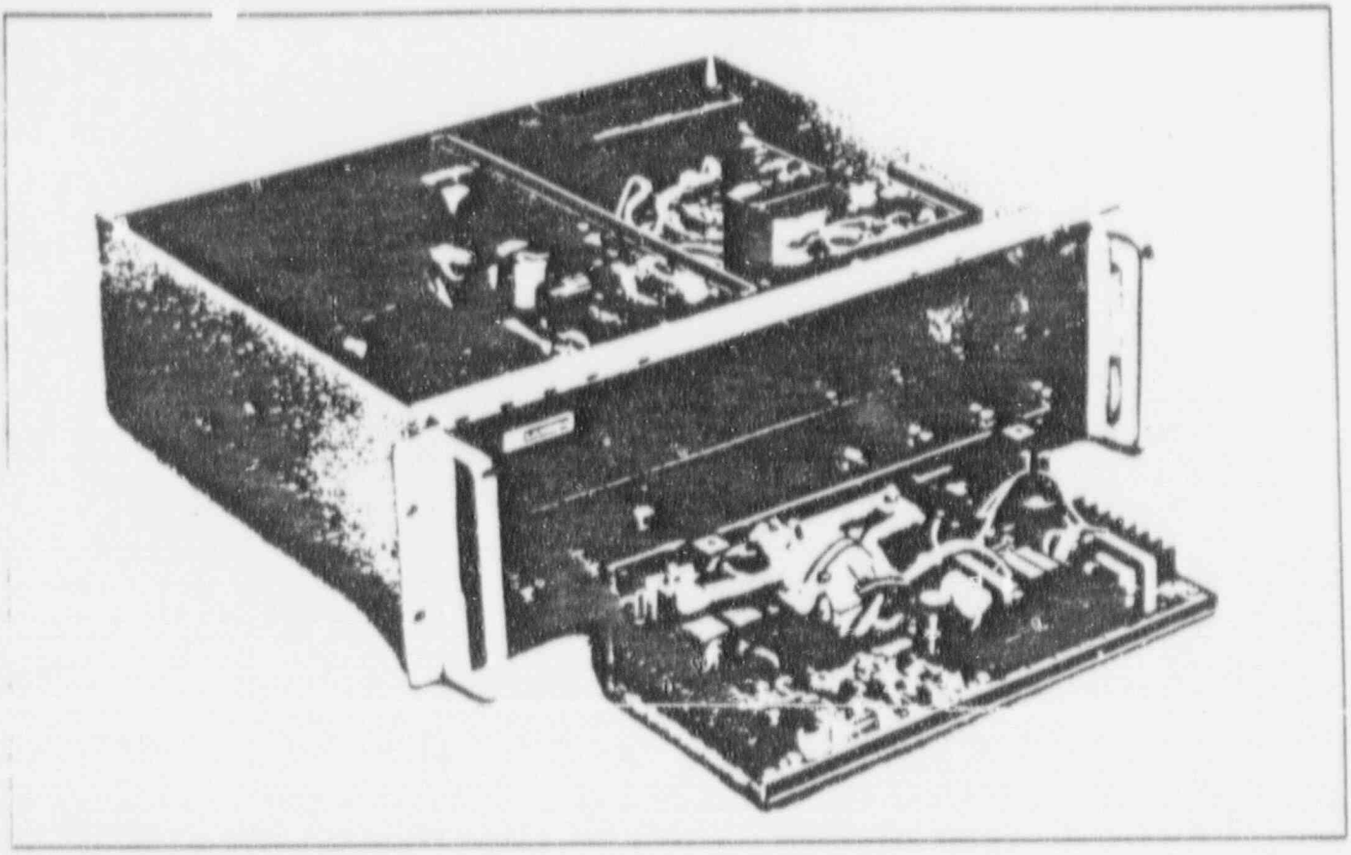
For operation at 105 to 132 VAC input, the UPS Module is wired tot he added terminals, and the AC input is wired to the AC input of this power supply. No AC is applied to the UPS Module.

For operation utilizing 185 to 265 VAC input, the AC input is applied to the UPS Modules while the same wiring as above is maintained (except for AC input). No AC input is applied to the Power Supply.

Caution should be used as the added terminals will have high DC voltage present. (Approximately 240 to 375 Volts).

PART VI—CUSTOM POWER SYSTEMS

LAMBDA HIGH EFFICIENCY UPS MODULAR SYSTEM



COMES COMPLETELY ASSEMBLED AND READY TO USE

- ❑ includes 416W modules
- ❑ Five minute minimum battery backup at 400 watts of DC power
- ❑ A double pole, single throw, system On/Off switch; AC input fuse; and DC battery fuse are all located on the front panel
- ❑ Front panel LED's indicate AC line fail, charger fail, and battery-low
- ❑ DC output voltage adjust potentiometers and test points provided on front panel
- ❑ AC line fail, charger fail, and battery-low interface signals available as normally open relay contacts via a rear plate terminal strip
- ❑ Convection cooled. No fans or blowers needed
- ❑ 85% minimum efficiency on battery operation, 98% minimum on standby operation.
- ❑ Rear plate input and output terminations
- ❑ Truly uninterruptible, glitch-free operation
- ❑ 6-8 week delivery using Lambda standard off-the-shelf modules

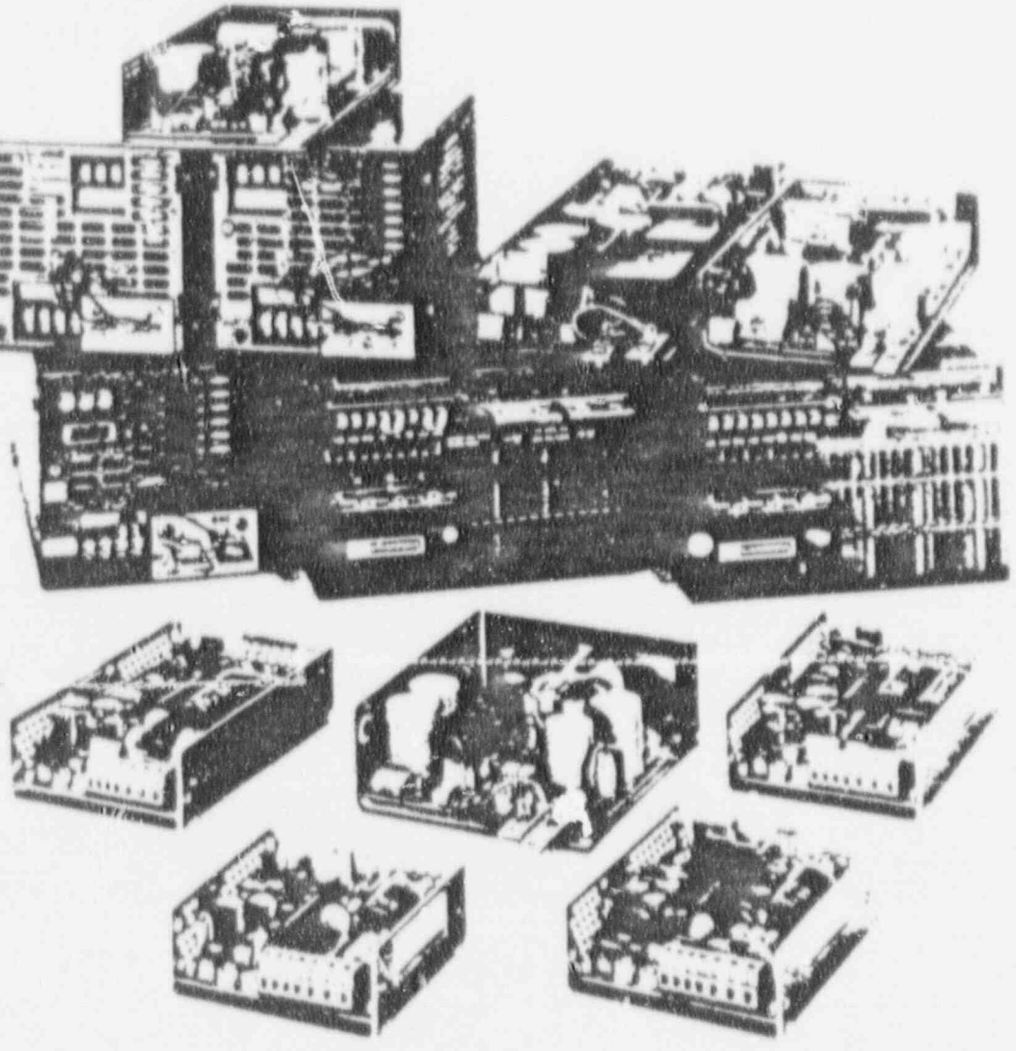
RAPID RESPONSE UPS

Lambda's LPS Series is now available as a complete UPS System, mounted in an LRA-15 or LRA-17 Rack Adapter for standard 19-inch rack mount configurations. Configuration U4 (pictured above) provides a completely assembled, ready to use, UPS power system.

A Typical Lambda UPS Rack System Provides:

1	~~LRS-55-5 (5V @ 60A)~~ LFS-42-24 (24V @ 5.7A)	
1	LRA-17 Rack Adapter CS (with slides)	
1	~~LPS-40~~ UPS Module LFS-V-40	
3	FRL-24-005 (Gates Battery)	
	Configuration U4, with above features, completely wired and tested	
	LMBW-1205-22 (AC line Filter)	TOTAL PRICE

LAMBDA LFS SERIES



INDUSTRIAL GRADE SWITCHING FOR WORLDWIDE APPLICATIONS

- ☐ Power density exceeds 5.0W/in³.
- ☐ Priced from 38¢/W.
- ☐ 117 models in 13 package sizes, from 2V through 48V, up to 400A.
- ☐ 1500W and 2000W packages incorporate parallel current sharing circuit with automatic temperature compensation.
- ☐ Capability for remote sense, remote programming and remote turn-on/turn-off capability.
- ☐ Protection from short circuit, overvoltage and fan failure conditions.
- ☐ Meets UL478, CSA 22.2, 143 and 154; VDE0806, 60 and IEC380.
- ☐ International input of 115/230 user selectab (85-265VAC on 19W, 30W and 60W packag 170-265VAC, single or three phase on 1500 2000W packages).
- ☐ Isolation Ratings: 3750VRMS input to outpu (8mm spacing). 1500VRMS input to ground 500VRMS output to ground.
- ☐ In-rush current limiting.
- ☐ Operation from −10°C to +60°C.
- ☐ Class H insulated magnetics; high grade electrolytic capacitors; CC4 printed circuit boards.

PART III—INDUSTRIAL POWER SUPPLIES AND CONVERTERS

LAMBDA LFS SERIES

DC OUTPUT
Voltage range shown in tables

REGULATED VOLTAGE
regulation, line ..... 0.1% from 95 to 132VAC or 187 to 265VAC on LFS-43, 44, 45, 45A, 46, 47, 48. 85 to 265VAC on LFS-38, 39, 40. 85 to 132VAC or 170 to 265VAC on LFS-41, 42. 170 to 265VAC or 3 phase on LFS-49, 50.
regulation, load ..... 0.1% from 0 to full load.
ripple and noise ..... 15mV RMS, 75mV pk-pk for 2V, 5V and 6V models
20mV RMS, 150mV pk-pk for 12V through 28V models
35mV RMS, 200mV pk-pk for 48V models
temperature coefficient ..... 0.03%/°C.
remote programming resistance ..... 1000Ω/V nominal.
remote programming voltage ..... volt per volt.

AC INPUT
line ..... 95 to 132VAC / 187 to 265VAC, 47-440Hz
85 to 132VAC / 170 to 265VAC, 47-440Hz on LFS-41, 42 (user selectable). 85 to 265 VAC, 47-440Hz on LFS-38, 39, 40 (wide range input, no tap change). 170 to 265VAC, 47-440Hz single phase or three phase on LFS-49 and LFS-50.

power ..... LFS-38, 31.5 watts maximum.
LFS-39, 45 watts maximum.
LFS-40, 89.5 watts maximum.
LFS-41, 120 watts maximum.
LFS-42, 186 watts maximum.
LFS-43, 326 watts maximum.
LFS-44, 440 watts maximum.
LFS-45, 45A, 682 watts maximum.
LFS-46, 932 watts maximum.
LFS-47, 1103 watts maximum.
LFS-48, 1470 watts maximum.
LFS-49, 2457 watts maximum.
LFS-50, 3220 watts maximum.

RMS current ..... 0.4A RMS maximum on LFS-38.
0.75A RMS maximum on LFS-39.
1.5A RMS maximum on LFS-40.
2.0A RMS maximum on LFS-41.
3.7A RMS maximum on LFS-42.
5.7A RMS maximum on LFS-43.
7.5A RMS maximum on LFS-44.
12.0A RMS maximum on LFS-45, 45A.
15.0A RMS maximum on LFS-46.
18.0A RMS maximum on LFS-47.
25.0A RMS maximum on LFS-48.
22.0A RMS maximum (single phase), 16.0A RMS maximum (three phase) on LFS-49.
30.0A RMS maximum (single phase), 20.0A RMS maximum (three phase) on LFS-50.

EFFICIENCY
40% minimum on 2V model of LFS-38. 45% minimum on 2V models of LFS-39, 40, 41. 55% minimum on all other 2V models. 60% minimum on 5V and 6V models of LFS-38. 67% minimum on 5V and 6V models of LFS-39, 40. 68% minimum on 12V through 20V models of LFS-38. 70% minimum on 12V through 20V models of LFS-39. 71% minimum on 24V through 48V models of LFS-39. 72% minimum on 5V through 15V models of LFS-42. 73% minimum on 12V through 20V models of LFS-40. 74% minimum on 24V through 48V models of LFS-38, 40. 75% minimum on 5V through 15V models of LFS-41, 42, 43, 44, 45, 45A, 46, 47, 48, 49, 50. 78% minimum on 20V through 48V models of LFS-41. 80% minimum on all 20V through 48V models of LFS-42, 43, 44, 45, 45A, 46, 47, 48, 49, 50.

DC INPUT
110 to 370VDC on LFS-38, 39, 40. 230 to 370VDC on LFS-41. 260 to 370VDC on LFS-42, 43, 44, 45, 45A, 46, 47, 48 (unit must be wired for 220V configuration). 240 to 370VDC on LFS-49, 50.

OVERSHOOT
No overshoot at turn-on, turn-off or power failure.

OPERATING TEMPERATURE RANGE
Continuous duty 0° to 60°C with suitable derating above 40°C. Guaranteed turn-on at −10°C with reduced specifications.

OVERLOAD PROTECTION
ELECTRICAL
Internal overload protection. Automatic electronic current limiting circuit limits the output current to a preset value, thereby providing protection for the load as well as the power supply.

HOLD UP TIME
2V, 5V and 6V models will remain within regulation limits for at least 16.7 msec after loss of AC power when operating at full load. Will maintain 105VAC input at 60Hz. 100 msec hold up when operating at maximum output power and 210VAC input at 50Hz on LFS-38, 39, 40 and 41. (When configured at 220V input, 20 msec holdup when operating at maximum output power and 210VAC input at 50Hz.)

IN-RUSH CURRENT LIMITING
All models are provided with in-rush current limiting to limit the current to a preset value.

OVERVOLTAGE PROTECTION
Non-crowbar, inverter shutdown type OV protection is standard on all models.

COOLING
LFS-38, 39, 40, 41, 42, 43, 44, 45 are convection cooled. LFS-45A, 46, 47, 48, 49, 50 are fan cooled.

DC OUTPUT CONTROLS
Simple screwdriver adjustment over the entire voltage range.

INPUT AND OUTPUT CONNECTIONS
All input, sensing and remote on/off connections are made via PC board mounted terminal block. DC output connections are made via heavy duty bus bars (LFS-38, 39, 40, 41 are PC board mounted terminals). Ground connections are made via chassis stud.

MOUNTING
One mounting surface and one mounting position on LFS-38, 39, 40, 41, 42, 43, 44, 45. One mounting surface, multiple mounting positions on LFS-45A, 46, 47, 48, 49, 50.

REMOTE TURN-ON / TURN-OFF
TTL compatible signal enables remote turn-on/turn-off of the power supply. A voltage of 2.8V to 5.0V applied to remote on/off terminals will initiate turn-off. Open circuit or short circuit condition, or a zero to 2.8V signal will cause turn-on.

REMOTE SENSING
Provision is made for remote sensing to eliminate the effects of power output lead resistance on DC regulation.

ISOLATION RATING
3750V RMS input to output (8mm spacing). 1500V RMS input to ground. 500V RMS output to ground.

CURRENT SHARING
The LFS-49 and LFS-50 have internal circuitry that allows units operated in parallel to share load current. Effects of different supply ambient temperatures are compensated for. For example, the hottest unit will automatically supply less load current. A single additional connection must be run between the supplies. This connection is available on the terminal block.

PHYSICAL DATA

Package Model	Lbs. Net	Lbs. Ship	Size Inches
LFS-38	0.58	1.58	1.38 × 3.82 × 3.54
LFS-39	0.74	1.74	1.38 × 3.82 × 4.53
LFS-40	1.03	2.03	1.46 × 3.82 × 6.02
LFS-41	1.25	2.25	1.78 × 3.82 × 6.30
LFS-42	1.30	2.30	1.9 × 4.75 × 5.687
LFS-43	3.00	4.00	1.9 × 4.75 × 9.125
LFS-44	3.50	4.50	1.9 × 4.75 × 11.75
LFS-45	6.00	7.00	1.9 × 4.75 × 16
LFS-45A	6.00	7.00	4 × 4 × 9
LFS-46	8.75	11.75	5 × 4.875 × 7.25
LFS-47	9.19	12.19	5 × 4.875 × 8.875
LFS-48	12.31	15.31	5 × 4.875 × 11
LFS-49	16.00	19.00	7.375 × 4.875 × 11.50
LFS-50	18.00	21.00	7.375 × 4.875 × 12.875

FINISH
Gray, Fed Std 595, No. 26081.

ACCESSORIES
For rack adapters and other accessories, see Part VII of this catalog.

GUARANTEED FOR 3 YEARS
Three year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of three years.

UL / CSA / TUV / IEC
Most units have received formal agency approval or have passed all tests and are waiting for formal notification.

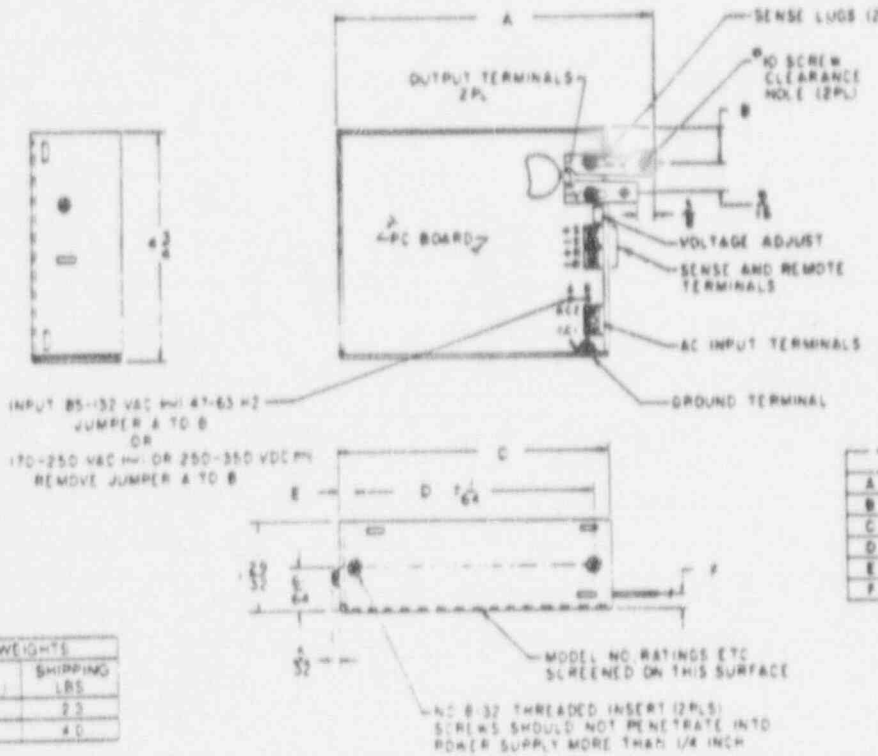
LAMBDA LFS SERIES

Switching Power Supplies

	MAX CURRENT AT AMBIENT OF (A) 40°C	50°C	60°C	DIMENSIONS (inches)	COMPLETE MECH. SPEC. PG.	PRICE QTY. 1	QTY. 10	QTY. 100	QTY. 250	QTY. 1000	MODEL
15V ±5% ADJ. (cont'd.)	32.5	24.5	16.0	1.9 × 4.75 × 16	171	$ 504	$ 480	$ 392	$ 371	$ 342	LFS-45-15
	32.5	24.5	16.0	4.0 × 4.0 × 9.0	172	504	480	392	371	342	LFS-45A-5
	42.0	39.0	33.0	5 × 4.875 × 7.25	171	609	580	450	428	403	LFS-46-15
	52.5	50.0	44.5	5 × 4.875 × 8.875	171	714	680	560	478	450	LFS-47-15
	70.0	64.5	55.0	5 × 4.875 × 11	171	840	800	680	600	560	LFS-48-15
	115.0	108.0	100.0	4.875 × 7.375 × 11.50	171	1145	1090	900	780	760	LFS-49-15
	153.0	143.0	133.0	4.875 × 7.375 × 12.875	171	1365	1300	1100	940	920	LFS-50-15
20V ±5% ADJ.	0.95	0.65	0.45	1.38 × 3.82 × 3.54	169	76	72	63	55	51	LFS-38-20
	1.5	1.05	0.75	1.38 × 3.82 × 4.53	169	103	98	80	70	65	LFS-39-20
	3.0	2.1	1.5	1.46 × 3.82 × 6.02	169	147	140	115	99	92	LFS-40-20
	4.5	3.1	2.2	1.78 × 3.82 × 6.30	169	195	185	148	130	120	LFS-41-20
	6.7	6.1	5.1	1.9 × 4.75 × 5.687	170	247	235	170	155	140	LFS-42-20
	11.8	9.2	6.8	1.9 × 4.75 × 9.125	170	294	280	228	207	189	LFS-43-20
	16.0	11.5	8.5	1.9 × 4.75 × 11.75	172	378	360	297	270	252	LFS-44-20
	25.0	19.0	12.5	1.9 × 4.75 × 16	172	504	480	392	371	342	LFS-45-20
	25.0	19.0	12.5	4.0 × 4.0 × 9.0	172	504	480	392	371	342	LFS-45A-20
	32.0	30.0	25.0	5 × 4.875 × 7.25	171	609	580	450	428	403	LFS-46-20
	40.0	38.0	34.0	5 × 4.875 × 8.875	171	714	680	560	478	450	LFS-47-20
	53.0	49.0	41.5	5 × 4.875 × 11	171	840	800	680	600	560	LFS-48-20
	85.0	80.0	72.0	4.875 × 7.375 × 11.50	171	1145	1090	900	780	760	LFS-49-20
	111.0	104.0	97.0	4.875 × 7.375 × 12.875	171	1365	1300	1100	940	920	LFS-50-20
24V ±5% ADJ.	0.8	0.55	0.4	1.38 × 3.82 × 3.54	169	76	72	63	55	51	LFS-38-24
	1.3	0.9	0.65	1.38 × 3.82 × 4.53	169	103	98	80	70	65	LFS-39-24
	2.5	1.75	1.25	1.46 × 3.82 × 6.02	169	147	140	115	99	92	LFS-40-24
	3.8	2.6	1.9	1.78 × 3.82 × 6.30	169	195	185	148	130	120	LFS-41-24
	5.7	5.1	4.3	1.9 × 4.75 × 5.687	170	247	235	170	155	140	LFS-42-24
	10.0	7.8	5.7	1.9 × 4.75 × 9.125	170	294	280	228	207	189	LFS-43-24
	13.0	10.0	7.5	1.9 × 4.75 × 11.75	172	378	360	297	270	252	LFS-44-24
	20.0	15.0	10.0	1.9 × 4.75 × 16	172	504	480	392	371	342	LFS-45-24
	20.0	15.0	10.0	4.0 × 4.0 × 9.0	172	504	480	392	371	342	LFS-45A-24
	27.0	25.0	21.0	5 × 4.875 × 7.25	171	609	580	450	428	403	LFS-46-24
	33.5	32.0	28.5	5 × 4.875 × 8.875	171	714	680	560	478	450	LFS-47-24
	44.5	40.5	35.0	5 × 4.875 × 11	171	840	800	680	600	560	LFS-48-24
	72.0	68.0	63.0	4.875 × 7.375 × 11.50	171	1145	1090	900	780	760	LFS-49-24
	97.0	90.0	84.0	4.875 × 7.375 × 12.75	171	1365	1300	1100	940	920	LFS-50-24
28V ±5% ADJ.	0.7	0.5	0.35	1.38 × 3.82 × 3.54	169	76	72	63	55	51	LFS-38-28
	1.1	0.77	0.55	1.38 × 3.82 × 4.53	169	103	98	80	70	65	LFS-39-28
	2.2	1.5	1.1	1.46 × 3.82 × 6.02	169	147	140	115	99	92	LFS-40-28
	3.3	2.3	1.6	1.78 × 3.82 × 6.30	169	195	185	148	130	120	LFS-41-28
	5.0	4.4	3.7	1.9 × 4.75 × 5.687	170	247	235	170	155	140	LFS-42-28
	8.6	6.8	5.0	1.9 × 4.75 × 9.125	170	294	280	228	207	189	LFS-43-28
	11.5	8.5	6.3	1.9 × 4.75 × 11.75	172	378	360	297	270	252	LFS-44-28
	17.5	13.0	8.5	1.9 × 4.75 × 16	172	504	480	392	371	342	LFS-45-28
	17.5	13.0	8.5	4.0 × 4.0 × 9.0	172	504	480	392	371	342	LFS-45A-28
	23.0	21.5	18.0	5 × 4.875 × 7.25	171	609	580	450	428	403	LFS-46-28
	29.0	27.5	24.5	5 × 4.875 × 8.875	171	714	680	560	478	450	LFS-47-28
	38.5	35.0	30.0	5 × 4.875 × 11	171	840	800	680	600	560	LFS-48-28
	64.0	61.0	56.0	4.875 × 7.375 × 11.50	171	1145	1090	900	780	760	LFS-49-28
	86.0	80.0	75.0	4.875 × 7.375 × 12.875	171	1365	1300	1100	940	920	LFS-50-28
48V ±5% ADJ.	0.4	0.28	0.2	1.38 × 3.82 × 3.54	169	76	72	63	55	51	LFS-38-48
	0.65	0.45	0.32	1.38 × 3.82 × 4.53	169	103	98	80	70	65	LFS-39-48
	1.25	0.87	0.62	1.46 × 3.82 × 6.02	169	147	140	115	99	92	LFS-40-48
	1.9	1.3	0.9	1.78 × 3.82 × 6.30	169	195	185	148	130	120	LFS-41-48
	2.8	2.6	2.1	1.9 × 4.75 × 5.687	170	247	235	170	155	140	LFS-42-48
	5.0	4.0	3.0	1.9 × 4.75 × 9.125	170	294	280	228	207	189	LFS-43-48
	6.5	5.0	3.8	1.9 × 4.75 × 11.75	172	375	360	297	270	252	LFS-44-48
	10.0	7.5	5.0	1.9 × 4.75 × 16	172	504	480	392	371	342	LFS-45-48
	10.0	7.5	5.0	4.0 × 4.0 × 9.0	172	504	480	392	371	342	LFS-45A-48
	13.5	12.5	10.5	5 × 4.875 × 7.25	171	609	580	450	428	403	LFS-46-48
	17.0	16.0	14.5	5 × 4.875 × 8.875	171	714	680	560	478	450	LFS-47-48
	22.5	20.5	17.5	5 × 4.875 × 11	171	840	800	680	600	560	LFS-48-48
	37.0	34.0	31.0	4.875 × 7.375 × 11.50	171	1145	1090	900	780	760	LFS-49-48
	48.0	45.0	42.0	4.875 × 7.375 × 12.875	171	1365	1300	1100	940	920	LFS-50-48

LFS-42, LFS-43, LFS-45A

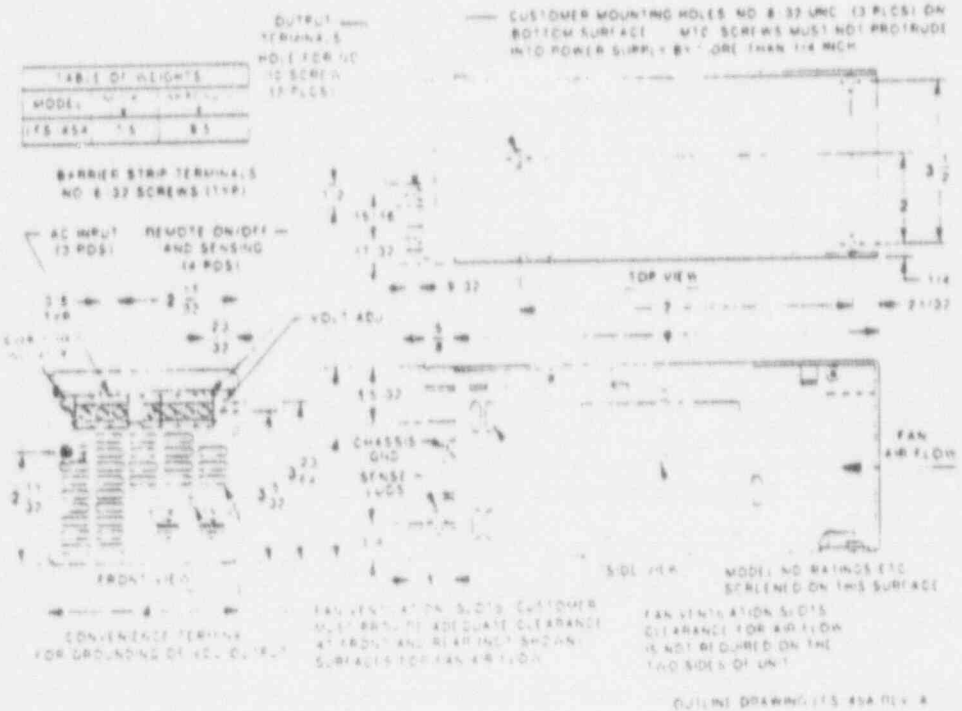
LFS-42
LFS-43



	LFS-42	LFS-43
A	6	10
B	4	8
C	5	9
D	5	9
E		
F		

TABLE OF WEIGHTS		
MODEL	NET LBS.	SHIPPING LBS
LFS-42	13	23
LFS-43	20	40

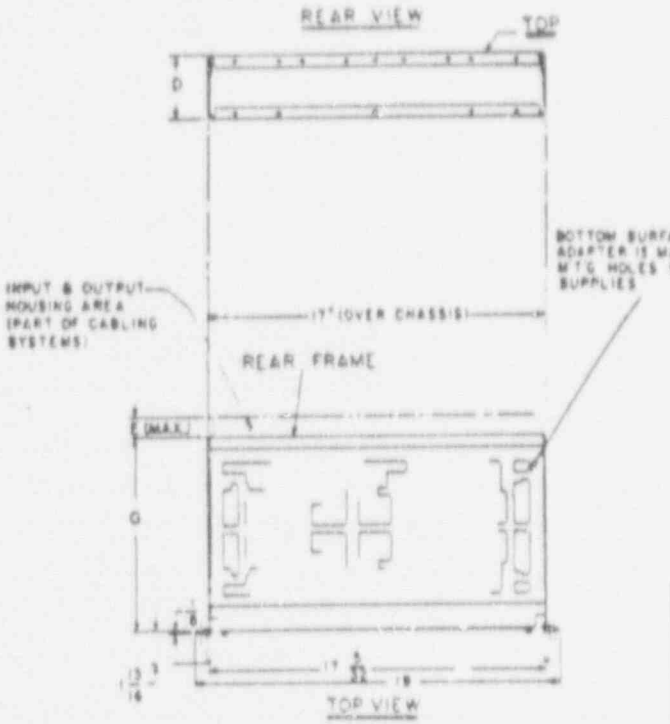
LFS-45A



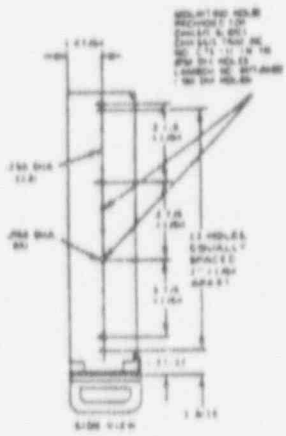
OUTLINE DRAWING LFS 45A REV A

RACK ADAPTERS

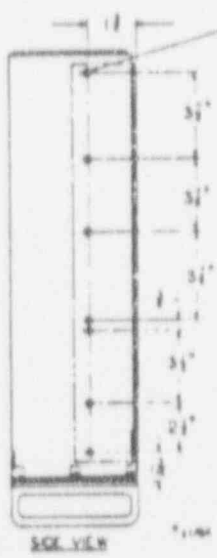
LRA-14 Rack Adapter
LRA-15 Rack Adapter
LRA-17 Rack Adapter
LRA-18 Rack Adapter



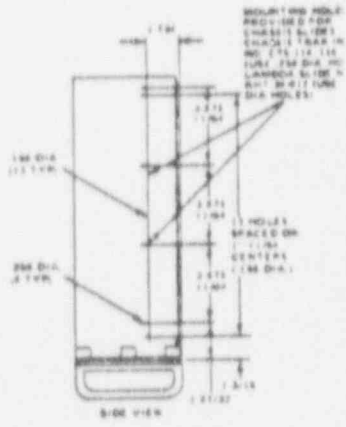
LRA-18



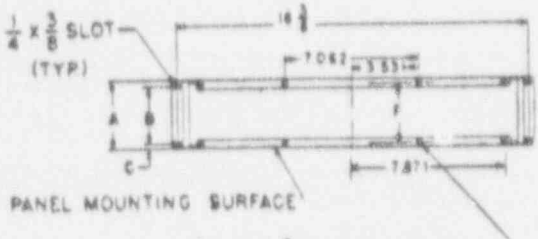
LRA-14



LRA-17



LRA-15



#6-32 X 3/8 LG SCREW & SPLIT LOCKWASHER (2D SUPPLIED LOOSE)

FRONT VIEW

TABLE OF WEIGHTS		
MODEL	NET (LBS)	SHIPPING (LBS)
LRA-14	8 1/2	12
LRA-15	10	13
LRA-17	13 3/4	17
LRA-18	15 1/2	18 3/4

LRA-14, LRA-15: MOUNTING HOLES PROVIDED FOR CHASSIS SLIDES LAMBDA SPECIAL SLIDE NO KHT-44-012 CHASSIS TRAK INC NO CTS-114, 118, 118

LRA-17: MOUNTING HOLES PROVIDED FOR CHASSIS SLIDES LAMBDA SPECIAL SLIDE NO KHT-44-013 CHASSIS TRAK INC NO CTS-122

LRA-18: MOUNTING HOLES PROVIDED FOR CHASSIS SLIDES LAMBDA SPECIAL SLIDE NO KHT-20-015

MODEL	A	B	C	D	E	F	G
LRA-14	3 15/32	3	15/64	3 21/64	1 1/4	3	1/4
LRA-15	5 7/32	2 1/4	31/64	5 5/64	1 1/4	4 3/4	1/4
LRA-17	5 7/32	2 1/4	31/64	5 1/16	1 1/4	4 3/4	2 1/8
LRA-18	5 7/32	2 1/4	31/64	5 5/64	3/4	4 3/4	2 1/8

LAMBDA RACK ADAPTERS

Chassis Slides

MODEL	FOR USE WITH RACK ADAPTER OR FULL RACK POWER INSTRUMENT	ADD TO PRICE QTY. 1	QTY. 10
KHT-34-012	LK-350-352 Series, LE Series, LRA-1, LT-820 Series, LT-860/870 Series, LRA-14, LRA-15	$172	$162
KHT-44-013	LRA-17	172	162
KHT-2*-016	LGS-FA	172	162
KHT-20-015	LRA-18	172	162

NOTE: To order rack adapters or full rack power supplies with chassis slides, add suffix "CS" to model number (Example: LRA-17-CS, LGS-FA-28-DV-R-CS) and add price of chassis slides.

KHT-34-012

KHT-44-013

Blank Front Panels

MODEL	DIMENSIONS	PRICE QTY. 1	QTY. 10
LBP-11**	¼ rack size, 5¼" height	$30	$28
SB-22***	¼ rack size, 5¼" height	30	28
LBP-20*	½ rack size, 5¼" height	66	63
LBP-21**	½ rack size, 5¼" height	51	48
SB-30	Full rack size, 3½" height	53	50
SB-40***	½ rack size, 5¼" height	51	48
SB-50	Full rack size, 5¼" height	51	48

Panel finish:
*Brushed aluminum clear anodized panels with grey inlay
**Tan in color to match tan plastic front panels now used in certain ½ and full rack supplies
***Dark brown to match LES-EE and LD models

LBP-21 SB-22 SB-40

SB-50 SB-30

*LBP-11, 20, 21 not shown

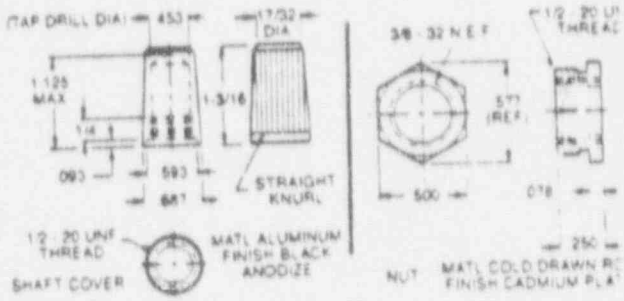
Pot Covers

MODEL	PRICE QTY. 1	QTY. 10
PC-1 Pot Cover	$13	$12

Tamper-proof potentiometer spindle cover designed for use with Lambda power supplies, but may be used with most instruments.

Front panel control knob with the Lambda PC-1 control knob cover, which fits standard potentiometer shaft threads. Useful in those applications which require permanent or semi-permanent laboratory or systems settings with no possibility of disturbing those critical settings.

The Pot Cover may be used with any pot using a ¼" mounting shaft. There are two parts to the Pot Cover – a lock nut and a black anodized ... buried knob. The device screws onto the threads of the potentio... ter shaft and is tightened. (Note that the opening in the front panel must be of large enough diameter to accommodate the ¼" diameter thread nut.) See dimensional drawing.



DESIGN GUIDELINES FOR LAMBDA'S UPS SYSTEM

1. Determine **actual** load requirements.

   For Example:
   1) ~~5 Volts @ 20.0A~~
   2) 24 Volts @ 2.0A 24V @ 4.17a
   3) ~~48 Volts @ 1.0A~~

2. Select a Lambda Switching Power Supply that fits your load requirement.

   For Example:
   1) ~~LUS-11-5~~ — ~~Rated At: 5 Volts @ 20.0A~~ LFS-42-2 /
   2) ~~LUS-10A-24~~ — ~~Rated At: 24 Volts @ 2.1A~~
   3) ~~LUS-10A-48~~ — ~~Rated At: 48 Volts @ 1.1A~~

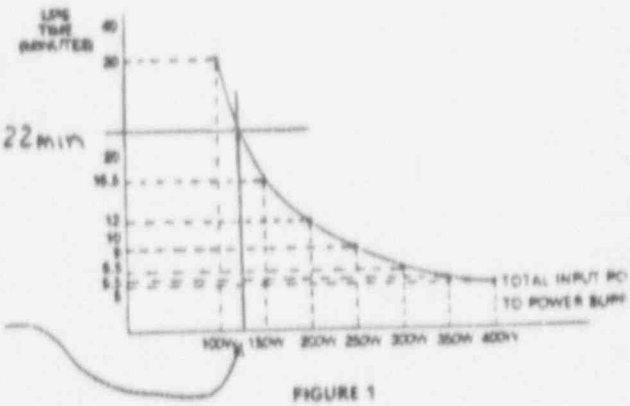
3. Determine the efficiency of each power supply using the chart in item 5 below, and calculate the input power using the following formula:

   For Example:

   $$\text{Input Power} = \frac{24 \times 4.17}{\text{~~Efficiency of Power Supply~~ } 80\%} = 125\text{w}$$

MODEL	EFFICIENCY	INPUT POWER
LUS-11-5	70%	142.86 Watts
LUS-10A-24	80%	60.00 Watts
LUS-10A-48	80%	60.00 Watts
	Total Input Power =	262.86 Watts

FOR USE WITH (1) FRL-24-005 BATTERY



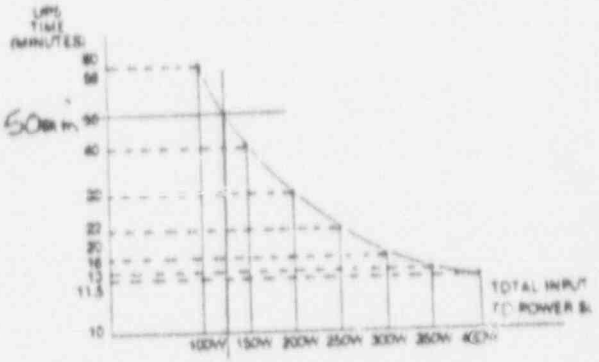
1 batt ≈ 22 min

FIGURE 1

4. a) When using (1) FRL-24-005 Battery, look at Figure 1 to determine the maximum amount of UPS time for the calculated total input power.
   In the above example, 262.86 watts corresponds to a maximum of approximately 8.0 minutes.

   b) For a longer UPS time use (2) FRL-24-005 Batteries in parallel and refer to Figure 2.
   For the same system 262.86 watts corresponds to a maximum of approximately 20 minutes.
   (For longer operation times, consult factory for a recommended battery.)

FOR USE WITH (2) FRL-24-005 BATTERIES CONNECTED IN PARALLEL



2 batt ≈ 50 min

125 W

FIGURE 2

∴ 1 batt + 2 batt = 22 min + 50 min = 1 hr 12

NOTE: These diagrams are approximations. Contact factory for precise UPS ti

5. Use the following guidelines for efficiencies whenever using a Lambda switching power supply.

OUTPUT VOLTAGE	EFFICIENCY
5V	70%
12V-15V	75%
24V-48V	80%
Dual Output Power Supplies	Refer to respective pages in Lambda Catalog
Triple Output Power Supplies	Refer to respective pages in Lambda Catalog

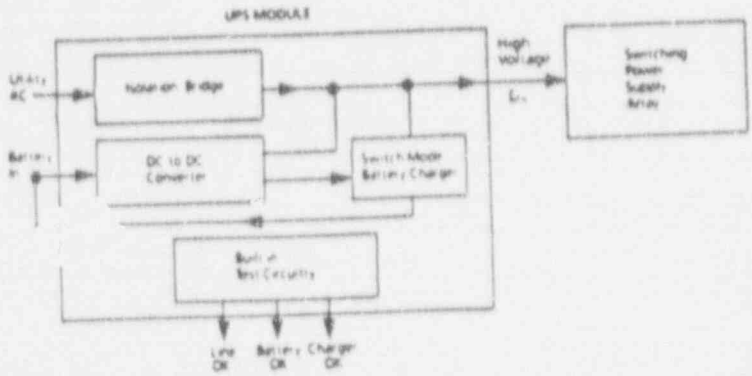


FIGURE 3

PART VI—CUSTOM POWER SYSTEMS

LAMBDA LPS SERIES

MODEL	MAXIMUM CURRENT OUTPUT OF UPS MODULE (A) 40°C	50°C	60°C	71°C	PRICE/QTY. 1	10	25	100
LPS-40	3.2	2.8	2.45	2.15	$606	$577	$544	$500
LPS-41	3.2	2.8	2.45	2.15	520	495	466	425
LPS-V-40	1.75	1.52	1.32	1.16	606	577	544	500
LPS-V-41	1.75	1.52	1.32	1.16	520	495	466	425

NOTE: AC input power for LPS-40 and LPS-41 is 105-132VAC. AC input power for LPS-V-40 and LPS-V-41 is 187-265VAC.
Both master and slave modules are rated at 416W. Any number of modules can be connected in parallel for increased output power.

Specifications

DC OUTPUT
The DC output voltage is proportional to the AC input voltage for as long as the AC line is above the minimum tolerance. Output will be maintained at 130V minimum (240V minimum for V models) when the AC input voltage drops below its minimum tolerance. These voltages will keep any Lambda Switching Power Supply operating within its published specifications.

PARALLEL OPERATION
Modules can be paralleled for increased system power. The stress on modules is equalized by adjusting the maximum output power of each module.

AC INPUT POWER
105-132VAC, 47-440Hz on LPS-40 and LPS-41. 187-265VAC, 47-440Hz on LPS-V-40 and LPS-V-41.

OUTPUT POWER
416 watts max.

Efficiency
Line operation ..... 98% minimum
Battery Operation ..... 85% minimum

BATTERY VOLTAGE
20 to 32VDC.

TRANSFER
Lambda's LPS Series allows transfer from line to battery operation and vice versa without involving sensing circuitry/active switching. No transients will be generated on the outputs of power supplies connected to the LPS System under brown-out or black-out conditions.

OPERATING TEMPERATURE RANGE
0 to 71°C.

STORAGE TEMPERATURE RANGE
-25°C to +85°C.

CHARGER SECTION RECHARGE CAPACITY
2 A minimum, 2.3 A maximum battery charging current.

CHARGER DERATING
No derating up to 71°C.

CHARGER OUTPUT VOLTAGE
28.2V ± .25 C. The temperature coefficient of the output voltage matches the characteristics of lead acid batteries in order to avoid overcharge.

PROTECTION
Both the charger and inverter are electronically protected against overload/short circuit. The charger output is fuse- against a battery discharge back into the unit in case of an internal component failure. An internal thermostat protects the unit against damage from excessive ambient temperature.

INTERFACE SIGNALS
AC Line Fail, Charger Fail, Battery Low. The battery-low signal is user adjustable and can be set to trip when the battery reserve time drops below a specified value. The signals are available as an open collector (optically isolated, 5mA sinking capability).

COOLING
Free convection cooling.

CONTROLS
The output voltage, battery-low threshold, and battery charger output voltage are screwdriver adjustable over the entire voltage range. Additional controls are available for special applications.

ISOLATION
Battery: Non-isolated (battery negative or positive terminal grounded).
Output to ground: 1,500V RMS, for one minute.
Battery to output: 1,500V RMS, for one minute.

MOUNTING
Two mounting surfaces, two mounting positions.

FUNGUS PROOFING
Available on request.

PHYSICAL DATA

Package Model	Lbs. Net	Lbs. Ship	Size Inches
LPS-40, V-40	3½	4½	3 × 4¹⁵/₁₆ × 12
LPS-41, V-41	3½	4½	3 × 4¹⁵/₁₆ × 12

FINISH
Gray, Fed. Std. 595, No. 26081.

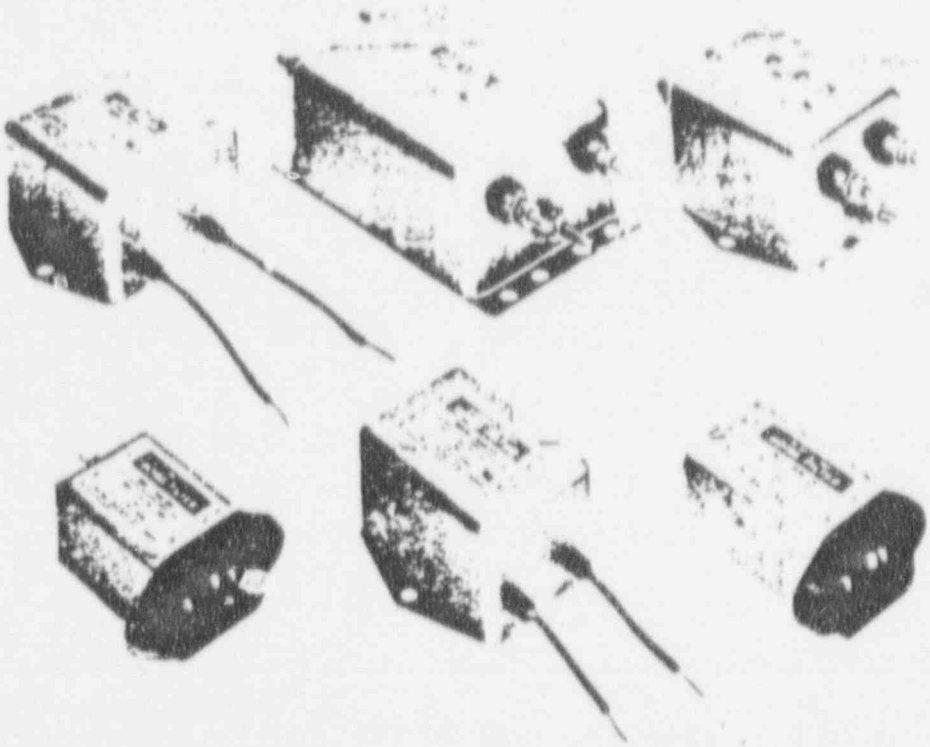
UPS POWER SYSTEM
Lambda will package your power system (LPS, battery, power supplies) in a standard Lambda rack adapter, and built to your specifications. Consult factory for price.

ACCESSORIES
Five-minute batteries by Gates, available for 400W systems. (Gates product number 0809-0026. Lambda product number PRL-24-005.) Contact factory for battery selection tables for longer battery operation times. Cover available. Consult factory for price and derating if necessary. Rack adapters available (see catalog).

UL/CSA
Under evaluation.

GUARANTEED FOR ONE YEAR
One-year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of one year.

LAMBDA MBW, MBS AND MIF SERIES LINE FILTERS



FEATURES—MBW, MBS and MIF SERIES FILTERS

Lambda's compact, lightweight MBW, MBS and MIF Series filters are designed to achieve optimal attenuation with switching power supplies. Built in accordance with VDE safety regulations they have been pretested with Lambda power supplies to meet FCC Docket 20780 Class A. All of Lambda's filters are UL recognized and CSA certified. They are stocked for production of quantities and are available for one day delivery from stock.

Prices:

	RATING	1	10	100	250
MBW-1203-22	3 Amps	$13.00	$17.00	$11.00	$ 9.25
MBW-1205-22	5 Amps	19.00	18.00	12.00	10.50
MBS-1210-22	10 Amps	26.00	24.00	16.50	16.00
MBS-1220-22	20 Amps	32.00	30.00	25.25	22.00
MIF-1203-22	3 Amps	18.00	17.00	11.00	9.25
MIF-1206-22	6 Amps	19.00	18.00	12.00	10.50

Specifications:

SPECIFICATION	UNIT OF MEASURE	MODEL MBW 1203-22	MBW 1205-22	MBS 1210-22	MBS 1220-22	MIF 1203-22	MIF 1206-22
Rated Voltage (max)	Volts	250	250	250	250	250	250
Rated Current (max)	Amps	3*	5*	10*	20*	3*	6*
Breakdown Voltage (min)	Volts	2500	2500	2500	2500	2500	2500
Insulation Resistance (min)	MΩ	100	100	100	100	100	100
Leakage Current (max)	mA	0.5	0.5	0.5	0.5	0.5	0.5
DC Resistance (max)	Ω	0.3	0.2	0.05	0.02	0.13	0.04
Operating Temperature Range*	°C	-20~+85	-20~+85	-20~+85	-20~+85	-20~+85	-20~+85

*No derating up to 55°C

NOTES: (1) The rated current is for operation up to 55°C. For temperatures between 55°C and 85°C derate according to curve A on p. 152
(2) The rated current is for operation up to 50°C. For temperatures between 50°C and 85°C derate according to curve B on p. 152