ATTACHMENT C
IP3-88-004

Switch Setting Policies

Table 4 - Design Parameters for Ten IEB 85-03 MOV's

Table 5 - Comparison of Thermal Overload Relay Heater Sizes for Ten IEB 85-03 MOV's Based on General Limitorque Methodology Vs. Westinghouse MCC Specifications

Figure 2- Limitorque General Methodology for MOV Overload Relay Heater Sizing

New York Power Authority
Indian Point 3 Nuclear Power Plant
Docket No. 50-286
DPR-64

ATTACHMENT C

This attachment provides the results of the activities taken in response to Action Item (b) of IEB 85-03. The requirements of this action item can be summarized as follows:

> "Using the results from Item (a) above, establish the correct switch settings. This shall include a program to review and revise, as necessary, the methods for selecting and setting all switches (i.e., torque, torque bypass, position limit, overload) for each valve operation (opening and closing).
>
> "If the licensee determines that a valve is inoperable, the licensee shall also make an appropriate justification for continued operation in accordance with the applicable technical specification."

The general policies and justifications adopted by the Authority in establishing the correct switch settings are provided below in addition to the specific application of these policies and justifications to each of the ten IEB 85-03 MOV's.

As indicated in the initial 180-day response to the subject bulletin, the Authority was in the process of evaluating a number of commercially available MOV testing tools to determine the merits that such tools have in aiding the resolution of the IEB 85-03 concerns. However, the Authority's interest in such MOV testing tools was not precipitated by the issuance of IEB 85-03 and, in fact, IP3 was one of the first plants to voluntarily undertake a MOV pilot testing program utilizing the Motor Operated Valve Analysis and Test System (MOVATS) in 1983. In this regard, after a cautious evaluation of the various MOV testing tools available, the Authority contracted with MOVATS, Inc. to purchase the 2150 Series equipment.* The Authority selected MOVATS because of their advanced capabilities in the nuclear industry and has incorporated its use in addressing the concerns of IEB 85-03. In addition to the obvious testing and diagnostic benefits that use of the

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*Refer to Union Electric's safety-related MOV program for the Callaway plant (lead plant for IEB 85-03) for a detailed description of the MOVATS equipment and it's operation.

MOVATS equipment provides, the development of the MOVATS differential pressure valve data base could potentially provide additional benefits. However, for reasons elaborated upon below, such benefits are viewed by the Authority with cautious optimism. In any case, the Authority has incorporated certain of the generic MOVATS methodology in establishing proper switch settings for the MOV's within the scope of IEB 85-03, as detailed below.

The general approach used by the Authority in establishing each of the various switch settings can be summarized as follows:

I. Torque Switch Settings

For each of the MOV's within the scope of IEB 85-03, the torque switch is wired to stop valve travel in the closed direction and ensure that sufficient loads are delivered to the valve stem to provide leak tight closure of the valve.

For the open direction, the torque switch provides an element of protection in the event the open limit switch fails to operate properly. Typically, the open torque switch is set to actuate at a thrust value above the calculated unseating load (including maximum design differential pressure loads). During valve unseating, however, the initial load peak (cracking load) may be of a high enough level to cause the torque switch to trip. Because of this, the open torque switch is electrically bypassed during this phase of operation.

In addition, the torque switch is in both the opening and closing circuits to protect the valve and the motor operator from mechanical problems during valve cycling.

To establish the open and close torque switch setpoints, the thrust values for full differential pressure conditions must be accurately established. Such values were originally established by the valve manufacturer and/or Limitorque Corporation as part of the design process. These thrust values were then applied in the Limitorque selection procedure to size the MOV and are based on MOV operation at the design differential pressures given in the E-Specs. The Authority obtained and subsequently verified the original design data associated with each of the 10 IEB 85-03 MOVs in response to this action item. Table 4 summarizes the key design parameters (thrust/torque requirements for overcoming the E-Spec design differential pressures) for each of the subject MOV's.

As indicated previously, however, MOVATS has been in the process of developing a differential pressure valve data base that could potentially be used to confirm these thrust requirements. The original approach taken by MOVATS was to derive equations* that model the forces associated with MOV operation. Then, actual pressure testing data for a particular type of valve would be used to demonstrate the validity (i.e., conservatively predicted results) of the derived equations.

At the Authority's request, MOVATS provided the open and close thrust requirements predicted by their equations to cycle each of ten IEB 85-03 MOV's against the maximum expected differential pressures provided in Attachment B. In most cases, the MOVATS-predicted values were significantly less than the design values specified in Table 4. (This result was not particularly surprising since in many cases the maximum expected differential pressures, on which the MOVATS-predicted thrust values are based were found to be significantly less than the E-Spec design differential pressures, on which the design thrust values are based). However, since it was apparent that the MOVATS differential pressure valve data base had not undergone a rigorous validation and approval process, the MOVATS-predicted thrust requirements were not taken credit for.

The Authority's approach in establishing correct torque switch settings has been to assure that the original design requirements are achieved. Rather than simply specify a number setting on the torque switch to establish the proper setpoint, the Authority has elected to determine the actual thrust being delivered to the valve stem by MOVATS testing each of the ten IEB 85-03 MOV's. This approach has two benefits as viewed by the Authority: (1) assurance is provided that the torque switch settings established are capable of producing the original design thrusts (this is especially important for those MOVs that have unbalanced torque switches), and (2) suitable justification is provided to gain relief from testing under maximum expected differential pressure conditions. (Refer to Attachment D for a more detailed discussion of this latter benefit).

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* According to MOVATS, the subject equations were derived from the general calculational methodologies employed throughout the industry (e.g., valve manufacturers, Limitorque, etc.) and were intended to establish conservative bounding thrust estimates for cycling a particular type of valve (e.g. flex wedge gate, double disc gate, globe, etc.)

Based on the above, a torque switch will be deemed to be set correctly if, as a minimum, the thrust values provided in Table 4 are capable of being achieved and, as a maximum, these thrusts are within the capabilities of the valve and the motor operator.

Since the target thrusts provided in Table 4 are based on the E-Spec design differential pressures rather than maximum expected differential pressures, conservative torque switch settings will, in general, result. From Attachment B, it is noted that the maximum expected differential pressures for eight of the ten IEB 85-03 MOV's are significantly less than the corresponding E-Spec design differential pressures for these MOV'S. For the two remaining MOV's (SI-MOV-887A and 887B), the maximum expected differential pressures have been conservatively judged to be equivalent to the E-Spec design differential pressures. This implied lack of margin for these two latter valves is not judged to be of concern for the following reasons: (1) the approach outlined above for assuring correct torque switch settings provides for setting the torque switch to achieve, as a minimum, the target thrusts provided in Table 4, (2) the scenarios postulated for SI-MOV-887A and B operation at the E-Spec design differential pressure are extremely unlikely, (3) the MOV design process has inherent conservatisms associated with it (e.g., high coefficient of friction assumed for converting torque to thrust, etc.), and (4) the measured running thrusts for SI-MOV-887A and B have been shown to be significantly less than the design limits.

As detailed in Attachment D, the Authority MOVATS tested each of the ten IEB 85-03 MOV's during the recent 10-year ISI and Cycle 5/6 Refueling Outage to assure that the actual torque switch settings were capable of producing the design thrusts provided in Table 4. Subsequent to these activities, the Authority learned that MOVATS modified their approach in developing their differential pressure valve data base. As indicated above, the original approach was aimed at deriving equations that model the forces associated with operation of an MOV and then demonstrating that such equations predict conservative results when compared to actual pressure testing data. The current approach utilized by MOVATS no longer attempts to model MOV cycling forces but rather is based on a statistical evaluation of full and partial pressure testing data for various types and sizes of MOV's. This new approach was apparently pursued based on observed non-conservatisms in the thrust requirements predicted by the original MOVATS force-modeled equations.

In light of these new developments, the Authority intends to keep abreast of the work being done by MOVATS to develop a differential pressure valve data base. When and if this data base and the statistical methodology utilized is validated and approved by an appropriate regulatory body for use in establishing MOV thrust requirements, the Authority will give due consideration to the need for re-adjusting torque switch setpoints.

II. Limit Switch Settings

Each of the ten MOV's within the scope of IEB 85-03 employs a two-rotor geared limit switch in its design. The closed rotor controls the circuits for the open torque switch bypass and the "open" light indication. The open rotor controls the circuits for the closed torque switch bypass, the "closed" light indication and the open coil. As such, the limit switch is wired to stop valve travel in the open direction. (As indicated in Section I above, the torque switch is wired to stop valve travel in the closed direction.) The general approach and considerations that have been taken in establishing the correct settings for the closed and open rotors are summarized below.

Closed Rotor

The major concern for the closed rotor setting is to assure that the entire unseating process that occurs during valve opening is sufficiently bypassed. Historically, it was believed that a closed rotor setting of 5-10% of full stroke (based on stem movement) would be sufficient to encompass the initial valve unseating. After the valve began to pass fluid, the high loading conditions would decrease rapidly. MOVATS has shown that with the typical bypass switch setting of 5-10% of full stroke, the open torque switch may not be bypassed for the full unseating process. Based on this finding, a conservative disc bypass margin* of 20-25% is recommended to insure that the entire unseating process is bypassed. (Refer to Union Electric's safety-related MOV program for the Callaway plant** for further details.)

The Authority has adopted this recommendation in establishing the proper closed rotor settings for the ten MOV's within the scope of IEB 85-03. However, for two-rotor limit switches, such settings could potentially pose a problem with respect to position "light" indication. Specifically, a 20-25% disc bypass margin would cause the following position indication anomalies: For the close cycle, initial valve closed indication will occur when the valve is actually 20-25% open (i.e., the "open" light will be prematurely de-energized). Similarly, for the open cycle, valve intermediate position indication will not occur until the valve is actually 20-25% open (i.e., energization of the "open" light will be delayed). In addition, such settings could impact permissive signals if such signals are employed in the control circuitry (See 856 C,E,H,J below).

Each of the ten MOV's within the scope of IEB 85-03 employ a "seal-in" feature in their control circuitry design. As such, a 20-25% disc bypass margin does not subject these valves to the problems outlined in IE Information Notice 86-29: "Effects of Changing Valve Motor-Operator Switch Settings," dated April 25, 1986 for "throttle" or jog type valves (i.e., the concerns associated with the recommended disc bypass margin are limited to position indication and the potential impact on any "permissive" signals since all of the subject valves close on the torque switch rather than the limit switch). Based on the above, the acceptability of setting the closed rotor of the ten IEB 85-03 MOV's to achieve a disc bypass margin of between 20-25% must be determined based on valve-specific evaluations of the impact of such settings on both position indication and any "permissive" signals. These evaluations are provided below:

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* Disc Bypass Margin is defined as the time from beginning of unseating (point at which actuator starts to develop thrust to move the valve disc) to bypass switch drop-out divided by stroke time.

** Callaway Plant: Lead plant for IEB 85-03.

SI-MOV-856C,E,H AND J

For these MOV's, the duration of the position indication anomalies that will result from a disc bypass margin of 20-25% are on the order of two to three seconds. However, the lack of true closed position indication for these MOV's is not a problem as these MOV's are not required to change position for the injection phase since they are already in their safe open position.

SI-MOV-856C&E and 856H&J are interlocked with their associated hot leg injection valves (SI-MOV-856G and B, respectively) to preclude runout of the SI pumps. This interlock provides for the associated cold leg valves to be closed prior to opening of the associated hot leg valve when establishing hot leg recirculation (reference Emergency Operating Procedure EOP ES-1.4: "Transfer to Hot Leg Recirculation"). This interlock is derived from the motor operator limit switch. Due to the brief window that this interlock could be affected (i.e., on the order of two to three seconds), no significant operational concern exists. However, an appropriate caution statement has been added to the referenced procedure to preclude the possiblility of a disc bypass margin of 20-25% from impacting this interlock.

SI-MOV-887A and B

For these MOV's, the duration of the position indication anomalies that will result from a disc bypass margin of 20-25% are on the order of five and ten seconds, respectively. However, the lack of true closed position indication for these MOV's is not a problem as these MOV's are not required to change position for the injection phase since they are already in their safe open position. For conditions requiring these MOV's to be closed, true valve position indication between 0 and 20-25% is not critical since these MOV's are in series and only one needs to close in order to provide for proper line-up.

SI-MOV-1835A&B; 1852A&B

For these MOV's, the duration of the position indication anomalies that will result from a disc bypass margin of 20-25% are on the order of two to three seconds. As indicated in Attachment B, these MOV's receive an SI signal to open which requires these valves to change position. The proposed closed rotor settings will not significantly impact these valves during the injection phase since they are traveling to the full open position.

SI-MOV-1835A&B are taken credit for as containment isolation valves. These MOV's are arranged in parallel with each having a double disc gate configuration. Nitrogen gas from the Isolation Valve Seal Water System (IVSWS) is applied between the disc's of each valve by manually opening of the associated IVSWS valves. Since these valves close on the torque switch and not the limit switch, no significant operational concern exists. However, should either valve fail to fully seat when between 0 and 20-25% (i.e., valve not fully closed but "closed" light indication received in control room), the nitrogen gas applied from the IVSWS assures non-leakage from containment.

Depletion of the gas supply (i.e., measurable drop in nitrogen bottle bank pressure) would key the operators to suspect that one of these valves may potentially have not fully seated.

Both SI-MOV-1835A&B are part of the ASME Section XI program and are tested on a refueling basis to verify full stroking and timing of the valves. No failures have ever been experienced with these valves and in fact they have consistently met containment isolation valve leak rate acceptance criteria for Type C tests which verifies that the valves have fully closed.

SI-MOV-1852A&B are not given credit as being containment isolation valves and hence the closure of these MOV's is of no significant consequence. For passive failures during recirculation modes downstream of these MOV's but upstream of SI-MOV-1835A&B, full seating of SI-MOV-1852A&B for break isolation is desirable but not absolutely essential in light of the alternate flowpaths available.

As a final note, it is pointed out that setting the closed rotor to achieve a disc bypass margin of between 20-25% provides additional assurance that the valve will perform its intended function, even with an improperly set open torque switch. This additional benefit notwithstanding, it is recognized that anomalies in permissive signals and control room position light indication even for short durations are not desirable. As such, the Authority is considering modifying the control circuitry for each of the ten IEB 85-03 MOV's to preclude such impacts. (Refer to Attachment E for details).

Open Rotor

The major concern for the open rotor setting is to prevent backseating of the valve. The setting must account for post limit switch trip stem travel that could result from inertia of the MOV assembly, valve design, and delay in motor contactor dropout. As such, a general open limit switch setpoint cannot be established. Rather, the proper setting must be determined on a valve-specific basis to account for the particular operating characteristics of the MOV.

As indicated above, the open rotor setting must assure that the open coil is de-energized early enough during the final portion of the opening cycle to prevent backseating of the valve. However, for a two-rotor limit switch design, this same setting will also determine the extent of close torque switch bypass as well as the point which the "closed" light is de-energized (for valve full open indication) or energized (for valve intermediate indication). The extent of close torque switch bypass is typically of no operational concern since large hammerblow loading conditions do not occur during the initial phase of the closing cycle (provided the valve is not backseated). Similarly, no significant operational concern exists with respect to the "closed" light indication, since the intention is to establish the open rotor setting with the valve as far open as is possible, while at the same time insuring that the valve does not backseat due to any post limit switch trip stem travel.

III. Thermal Overload Settings

Each of the ten MOV's within the scope of IEB 85-03 is protected from electrical overload by devices which function at pre-determined values of overcurrent to de-energize the holding coils of the reversing contactor, thus opening the power contacts to de-energize the electric motor. These thermal overload devices are of the manual reset type and employ overload heaters on two phases of the power leads. The thermal overload devices are an integral part of the defense-in-depth protection afforded to the motor for various abnormal conditions (e.g., frozen bearing, tight packing, mid-travel obstruction, torque switch failure, limit switch failure, degraded voltage supply, etc.)

In general, the selection of the overload relay heater size to use with a Limitorque motor operator requires calculation. The general calculational procedure that Limitorque recommends is intended to establish a suitable overload relay heater size to protect the motor operator. The calculated size does not necessarily represent the only heater size that could be used for the particular application. In fact, Limitorque acknowledges that the heater sizing process involves "occasional compromise." Figure 2 provides the general methodology recommended by Limitorque for sizing overload relay heaters.

It is important to note that Limitorque did not size the overload heaters for use with the Limitorque motor operators existing at IP3. Rather, this was performed by the Westinghouse Electric Corporation as part of the design requirements and considerations for the motor control centers.

During the NRC's recent Safety System Outage Modification Inspection (SSOMI) of IP3, a concern was raised about inadequate electrical protection of MOV's at IP3. The Authority's response to the NRC inspection report was provided by letter dated November 13, 1987 and indicated that MOV overload protection is currently being reviewed for all safety related MOV's at IP3. It is the Authority's position that the specific function of the valve (i.e., its operation) is of primary concern and motor protection is considered secondary.

In order to be responsive to IEB 85-03, preliminary evaluations of thermal overload heater sizing for the ten IEB 85-03 MOV's have been performed. Table 5 provides a comparison of the thermal overload heater sizes that result from application of the Limitorque general sizing procedure and the heater sizes provided in the Westinghouse MCC Specifications for each of the ten IEB 85-03 MOV's. It should be noted that in each case, the Westinghouse specified heater sizes are larger than those resulting from application of the Limitorque methodology. This is not surprising since Limitorque's methodology is intended to assure motor protection. Actual heater sizes for each of the ten IEB 85-03 MOV's were field verified to the Westinghouse MCC Specifications (see Attachment D for results).

As indicated previously, however, the Authority may consider revision of existing overload protection if such revision is warranted based on the ongoing re-evaluations being conducted in response to the SSOMI finding. In any case, the Authority will advise the NRC of the ultimate disposition of this matter, as it relates to the concerns of IEB 85-03.

IV. General

Each of the settings described above (torque switch, limit switch, and thermal overload) were field-verified during the 10 year ISI and Cycle 5/6 Refueling Outage and adjusted if necessary in accordance with Action Item (c) of IEB 85-03. (Refer to Attachment D for results.)

TABLE 4

Design Parameters for Ten IEB 85-03 MOV's

MOV	E-Spec Design Differential Pressure (psi)	Thrust/Torque Required to Overcome E-Spec Design Differential Pressure (Lbs/Ft-Lbs)
*856C	2500	11,000/139
*856E	2500	11,000/139
*856H	2500	11,000/139
856J	2500	10,110,128
887A	150	2770/44
887B	150	2770/44
1835A	2500	8750/151
1835B	2500	8750/151
1852A	2500	8750/151
1852B	2500	8750/151

* The design thrust/torque requirements indicated are actually based on a differential pressure of 2750 psi rather than the E-Spec differential pressure of 2500 psi.

TABLE 5

Comparison of Thermal Overload Relay Heater Sizes for Ten IEB 85-03 MOV's Based on General Limitorque Methodology vs. Westinghouse MCC Specifications

MOV	Limitorque-Recommended Heater Size	Westinghouse-Specified Heater Size
856C,E&H	FH-25	H-30
856J	FH-26(1)	H-30
887A&B	FH-10	H-16
1835A&B 1852A&B	FH-25	H-30

(1) SI-MOV-856J locked rotor amps are slightly different than sister valves (SI-MOV-856C, E & H) and hence results in slightly different Limitorque-recommended heater size.

HOW TO SIZE OVERLOAD RELAY HEATERS TO PROTECT LIMITORQUE MOTORS

It should be kept in mind that Limitorque Operators and their motors are primarily protected by the operator torque switch, which may be mechanically set to deenergize the motor reversing starter control circuit at predetermined torques. The reversing starter overload relay should be considered as "back-up" protection in the event a torque switch contact does not open.

In general, overload relays are manufactured to be used with continuous duty motors whose locked rotor current to full load current ratio, locked rotor torque, ratio, and allowable locked rotor time, been agreed upon by members of the National Electrical Manufacturers Association (NEMA). However, Limitorque Motors produce locked rotor torques (starting torques) whose ratio to full load torque is much greater than general purpose motors. Because its frame size is smaller than a general purpose motor with the same running torque rating, its rotor may not be locked for as long a time as a general purpose motor.

Therefore, the use of "general purpose" overload relay with a Limitorque Motor requires calculation, and occasional compromise, to assign the most suitable overload relay heater. We suggest the following procedure:

<u>Sizing Overloads for use with Limitorque Motors</u>:

a. The majority of Limitorque Motors supplied are rated 15 minute duty. If the motor rotor is locked, the motor should be deenergized within 10 seconds. If the rotor is locked for 10 to 15 seconds, the possibility of motor damage exists. If the rotor is locked more than 15 seconds, it is probable that the motor will be damaged. Excessive locked rotor time can cause softening and eventual liquifying of the magnesium-aluminum rotor bars and end rings. This can occur even if the stator windings have not reached their total temperature limitation.

The average "general purpose" overload relay thermal element will carry 115% of its "rated" current continuously. Also it must be overloaded approximately 700% if it is to open the overload relay contact in 10 seconds. Since Limitorque Motors, according to their torque rating, can draw anywhere from 450% to 850% of full load current when the rotor is locked, we suggest the following procedure:

Refer to the certified full load and locked rotor currents on the certification stamp, on the submitted Limitorque drawings.

Refer to overload relay manufacturers curve. Determine percent of full load current required to open overload relay contact in 10 seconds. Determine percent full load current to open relay contact in 30 minutes. (This is usually 120% of heater "rating"). Multiply motor full load current by 0.87.

Determine overload heater rating just below the product of the above multiplication. Multiply this rating by the overload percent which will allow the motor to run for 30 minutes. If the product of this multiplication is more than the actual motor full load current, this heater rating may be considered for use. If the product is lower than the motor full load current, pick the next higher heater rating and try again.

Divide the motor locked rotor current by the heater rating. Multiply the result by 100%. If the product is higher than the overload relay vendor's % overload required to open the relay contact in 10 seconds, the correct overload relay heater rating has been picked.

If the locked rotor percentage product is less than the overload relay manufacturers % to trip in 10 seconds, go to the relay rating below the one being considered.

Divide motor full load current by this new rating, and multiply by 100%. Check the curve for tripping time. If it is over 15 minutes, or if it is over the minimum time the motor must run consider this heater rating as you did the higher rating.

If necessary, this can be repeated until you arrive at a heater rating which will not allow a motor to run for the minimum time. At this point you must either accept locked rotor current for more than 10, but less than 15 seconds, or you must obtain an overload relay of the "quick trip" type, such as manufactured by the Rowan Controller Company.

Here is an example of how an overload relay heater might be picked:

<u>EXAMPLE</u>

Reliance 10 ft. lb. starting torque motor full load current 4.2 amp @ 230VAC locked rotor current 23.8 amp @ 230VAC overload relay: Allen Bradley Bulletin 816
% overload to "trip" relay in 10 seconds: 700%
% overload to allow 30 minutes run: less than 120%

<u>CALCULATIONS</u>

1) 4.2 amp x 0.87 = 3.65 amp
2) closest heater rating below 3.65 = 3.59 amp
3) 3.59 amp x120% = 4.31 amp. This heater may be considered.
4) 23.8 amp ÷ 3.59 amp x 100% = 663%. This is below the 700% required for 10 second "trip".
5) closest heater rating below 3.59 amp is 3.26 amp
6) 4.2 amp ÷ 3.26 amp x 100% = 129%
7) curve shows 129% overload will "trip" relay in 15 minutes. This heater may be considered.
8) 23.8 amp ÷ 3.26 amp x 100 % = 731%. This heater may be used.

Limitorque Corporation, when sizing overload relays must be certain that the motor will stay energized for at least its duty rating. We had decided that the heater we put in our integral reversing starters must keep the motor energized for at least 30 minutes at full load current if it was rated "15 minute duty". This was to avoid nuisance tripping of the overload relay, even if the motor was slightly overloaded.

If the motor is rated "5 minute duty" we use an overload relay heater that will allow full load motor current for 7 minutes.

If the motor is rated "30 minute duty" we use an overload relay with rating closest to the motor full load current.

b) Motors rated "30 minute" and "continuous duty" can withstand locked rotor currents for longer times than "15 minute duty" and "5 minute duty" motors. They can be kept in locked condition at least 15 seconds.

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No.	DESCRIPTION	DATE
REVISIONS		

DRAWN DWF	LIMITORQUE CORPORATION	
CHECKED 2-27-73	TITLE OVERLOAD RELAY HEATER SIZING	
APPROVED 2-27-73	————	DWG NO. 19-495-0006-3
	DATE 2-28-73	

ORIGINAL DWG NO 19-495-0006-3

FIGURE 2