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ENHANCEMENT OF ON-SITE EMERGENCY DIESEL GENERATOR RELIABILITY

Final Report

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TASK V - RECOMMENDATIONS

The recommendations discussed below bear on subjects or items which have been previously covered at least to some degree in the reports on Tasks I, II, III, or IV. All are based on the prime concept of improving the reliability of the emergency diesel generator (DG) units from the standpoint of changes in system or component design, operation, and/or maintenance. The classification and sequence of listing of the recommendations are based on the relative importance assigned to each item.

It must be emphasized that the intent of this program was one of arriving at specific recommendations aimed toward the solution of DG operational problems. Consequently, statistical analysis was limited to only that necessary to categorize and weight the severity of the various operational problems as identified in LER's. Since the implementation of the recommendations is subject to numerous and varied decisions, the impact upon the net improvement in the numerical reliability of the DG units has not been established.

The recommendations submitted are classified into three basic categories based upon the urgency of the suggested corrective action.

A. Most Significant Corrective Action
B. Significant Corrective Action
C. Additional Corrective Action

A. Most Significant Corrective Action

The most significant corrective actions are those actions which, if implemented, can have a very substantial effect upon the reliable operation of the emergency DG units. Consequently, the implementation of these actions should be considered of high priority. The majority of these actions require rather

significant hardware changes accompanied by the related economic considerations associated with equipment cost, installation cost, and the effects upon operating procedures.

1. Air Driers in Compressed Air Starting Systems

The current reliability survey of the emergency DG units indicates that engine starting failure is the most frequent malfunction. Water in the starting air either directly or indirectly is the "root cause" of most of the trouble. Relatively few instances are caused by electrical components such as contactors, solenoid valves, electrical faults, etc.

Water wetted surfaces in the presence of air promote rapid oxidation which is especially serious with steel pipe. This causes rust, pipe scale, dirt and the water itself to corrode, score, and jam the internal surfaces of the air starting motors and the sliding of the vanes of the air motors thus preventing rotation. Double sets of air motors, with alternate operation to reduce of failure to start, has been only partially effective. Sticking and/or jamming of control valves and pilot valves occur occasionally in all air starting systems from the same causes; also, damage is possible to cylinder walls in engines where starting air is admitted directly to the engine cylinders. Periodic draining of the water condensate from the air storage tanks and the use of air strainers and filters have also been only partially effective. The formation of the water condensate in the compressed air is an inherent and inescapable thermodynamic relationship. Water vapor is present in the atmosphere in all climates and the amount depends on the relative humidity, ambient temperature, and barometric pressure. Thus, the problem is general and varies only in degree among all the power plant locations.

The most effective methods of moisture removal from air are air driers of the dessicant type and the refrigerated type. Air driers have been used in science and industry for over a half century. The deliquescent type using dessicants perhaps of a crystalline nature are commonly used for pneumatic

controls and instrumentation, but are not suitable for handling large flows and quantities of air. Furthermore, oil carry over from the compressors tends to foul the dessicants. The refrigerated type using Freon 12 or 22 are used extensively in compressed air systems for air tools of various types using rotary air motors and air cylinders for linear motion, etc.

The refrigerated type air driers are standardized commercial products available with specified performance in as many as 22 closely spaced sizes of flow capacity ranging from 5 SCFM to 5000 SCFM (Standard Cubic Feet per Minute at 29.92 inch Hg and 60°F). These driers are available under about eight different brand names with national distribution although it is believed that most driers come from not more than four manufacturers.

A size of 250 SCFM or larger is recommended for several reasons. The flow capacity with respect to minimal practical restriction, pipe size, and match to the installed starting air compressor should be considered in detail. Also smaller flow capacity sizes tend to omit certain desirable components from the unit in the interest of cost and may thus compromise performance. Furthermore, the cost of about $4000 for such a unit does not decrease commensurately for smaller units.

Typical Information for Refrigerated Air Driers - 250 SCFM

Flow Capacity SCFM	Air Pressure Psi. Ga.	Pipe Size inches	Motor Hp.	Floor Space feet	Inlet Temp. Max°F	Dew Point °F	Appr. Cost
250[1]	150 max[2]	2"	2	3'x5'	100°F[3]	50°F[4]	$4000

[1] Not smaller, but larger to match total compressor capacity as installed.

[2] Higher pressure available at increased cost.

[3] After cooler must be supplied at compressor discharge. May be combined with the reheat air to air heat exchanger.

[4] Dew point of 35°F adds about 60 percent to cost. Use reheat instead. See the diagram in Appendix E. The reheat tends to eliminate any "carry over" of water droplets from the cooler which operates at saturation.

No power plant visited had a refrigerated air drier for starting air. Nevertheless, refrigerated starting air driers are strongly recommended, between the air compressors and the air storage tanks, and favored by at least two engine manufacturers. The relatively long shut down time for water to accumulate between operating periods and the extreme reliability requirements make a refrigerated air drier highly advisable. All present water drains, strainers, filters, and lubricators and their use should be continued. Any modification of the air driers with respect to substituting manual water drains in place of automatic drains, etc. is not considered advisable. The use of well developed commercial items, available with alternate and equivalent performance and with multisources of supply, does simplify the choice and installation of the equipment.

References:

Included in Appendix E is additional information including:

a. Selected pages of preengineered commercially available air driers are copied from two manufacturers' catalogs because the information was in a convenient form with the understanding that essentially equivalent equipment is available from other manufacturers.

b. The flow diagram reproduced is typical.

c. A partial list of such air driers by other manufacturers.

2. Air Quality in Diesel Generator Room

Malfunction or failure of the contactors and relays to function properly is second only to the starting problem. The root cause is usually dust, dirt, and grit between the electrical contact surfaces. In fact, a few of the failures to crank and start have been caused by this problem.