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INTER-OFFICE MEMO

DATE: January 7, 1990 M-304-91

SUBJECT: Supplement to Y E S offer - Epoxy Coating of End Sheets

FROM: R. G. KOZAK - 361A

TO: District / Zone Service Managers (M25)
Area Service Managers (M25C)
Customer Service Representatives (M25B)
Service Assistants (M28A)

Recently Tom Bowers, our district service manager in Cincinnati, received an excellent procedural specification for an alternative coating product called Belzona. Perhaps many of you have either heard of or have used it. In order to give you the benefit of this alternative, I am attaching this information. File it in the overview section of Y E S Offer # 9, "Epoxy Coating of End Sheets."

If you need to contact a Belzona representative directly, a central contact number has been listed in the material.

Whether you choose to use the Belzona products or not, the information contained will be useful in performing Epoxy Coating work. I encourage you to read it.

Epoxy Coating projects have been used successfully as a specialty S & R offering by many districts. If you have not proposed this offer to a prospect recently, it might be time to dust off your Y E S material on this subject. This is another good way to recreate our customers.

Thank you Tom Bowers for this information.

Best regards,

Bob Kozak

HEAT EXCHANGER REPAIR USING BELZONA MOLECULAR COATINGS

APPLICATIONS

Tube sheet coatings can be used to rebuild and resurface metal surfaces that are subject to erosion-corrosion, accelerated by impingement, entrainment, cavitation, or bi-metallic corrosion, as a result of water or aqueous solutions flowing under turbulent conditions at temperatures below 140 F (60 C). Equipment that can be treated includes centrifugal and turbine pumps, butterfly and gate valves, elbows and T-pieces, propellers and bow thrusters.

Tube sheet coatings can also be used to rebuild or protect tube sheets or water boxes on heat exchange equipment. The Belzona material used in this application is wear-resistant and durable.

Tests have shown that a tube sheet repaired or protectively coated with Belzona Molecular Ceramic Metal will not lose its integrity when normal repairs, including rerolling or replacement of tubes, are later performed on it. In the case of a complete retubing job, however, small amounts of the coating material may chip off. Remaining material will nevertheless remain firmly bonded to the tube sheet, and an additional coating can be applied, without removing the original coating, to restore the protective ability of the material.

Customers often ask how much of the original tube sheet thickness could erode before coatings could no longer provide a satisfactory repair. Coatings cannot substitute for metal strength. The tube sheet must maintain its structural integrity in the repair process to work properly.

SELECTION

Belzona technical representatives, located throughout the United States, will provide technical support upon request. Contact Belzona at the following address for the name of the nearest Belzona representative:

Belzona America, Inc.
2000 N.W. 88 Court
America's Gateway Park
Miami, FL 33172
305-594-4994

PROCEDURES

Before applying coatings to tube sheets or water boxes, check that tubes are in good condition. If condition of equipment is questionable, tubes should be replaced and rolled in before coating is applied. Any standing water in the tubes should be blown out using an air line. Proceed to completely dry inside of tubes by blowing from a large fan through them. It works best to run it 12 to 18 hours. It is most important that tubes are completely dry on the inside.

Surface Preparation is necessary to ensure effective molecular adhesion to metal surfaces subject to erosion-corrosion attack.

On the surface to be treated, use grit blasting equipment and 1240 Black Beauty Grit to remove any weld or cutting scale or any surface laminations (tears or shelling). Grind all edges or irregular protrusions to a smooth contour with a radius of not less than 0.1 in. (2.5 mm).

Chiller heads that are 26" dia. or larger should be worked one end at a time. Perform all procedures on one end (to completion) before setting up and finishing the other end. It works best to do one end one day, and the other end the next day on large units.

Build dust-proof "house" on end to be blasted. Use some type of vacuum system with exhaust to outside or an inline dust filter. Blasting dust getting into a powerhouse or machine room will cause considerable damage to electric motors that are running. The end not being blasted must be sealed off so dust and grit does not escape into the room. Good light should be provided for blasting. The most critical areas to be cleaned are the deep bi-metalic corrosion that occurs where the copper tubes and steel sheet come together. It must be cleaned to a white/copper finish. With normal care in blasting, no damage is done to copper tubes. Tubes are not corked during blasting.

BLAST-CLEANING - All surfaces to be treated with Belzona Ceramic Metal must be blast cleaned. The air supply used in this blasting must be oil-and-water-free. The substrate must be blast-cleaned to the following standard:

AMERICAN STANDARD NEAR WHITE FINISH
SSPC-SC-10-63T

"One from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint, or other foreign matter have been completely removed from the surface. At least 95% of each square inch or surface area shall be free of visible residues and the remainder shall be limited to the light discoloration mentioned

above. Photographic or other visual standards of surface preparation may be used as provided in the Appendix to modify or further define the surface if specified in the contract."

Abrasives for grit-blasting should be chosen to provide the specified level of cleanliness while ensuring a minimum profile depth of 3 mils (75 microns). Abrasives may be either metallic or non-metallic. Because abrasives must be angular, glass beads and other spherical materials cannot be used.

After blasting to the proper finish, remove the "end covering" that was put over the unblasted end of the machine. Use air nozzle and at least 90 psi air pressure to blow grit and dust out of each and every tube. Blowing it back into the "tent house" while dust vacuum is still on. Clean up blast media and residue from blast cleaned end of the machine. Vacuum chiller head and water box. At this point be prepared to move from one operation to the next very quickly. In some damp atmosphere's you will have from 2 to 3 hours after blasting that the near-white blasted steel will start to "bloom" or rust.

Where items of equipment have been immersed for long periods of corrosive solutions such as sea water, all areas involved should be blasted to the standards quoted above and then left for a minimum of 24 hours. At the end of this period, the entire area must be given a brush blast to remove all salts which may have sweated to the surface during that period. If necessary, this procedure must be repeated until all ingrained salts have been removed.

The Belzona Molecular Technical Services Department may be consulted for additional information.

Operators should also take care not to touch the prepared surfaces or allow any contaminants to contact the surfaces before the Belzona material is applied. If oxidation does occur, the surface must be blasted again before the coating is applied.

CORKS

Cork size should be determined and corks purchased prior to starting the job. The corks purchased for the job should physically be checked on the machine to insure proper fit.

To prevent material from entering the tubes during treatment, corks of a maximum diameter slightly greater than the internal diameter of the tube should be obtained (Table 1). One cork should be pushed into each tube. When all tubes are plugged, a flat piece of wood should be used to level all the corks with the tube ends.

TABLE 1 - CORK SIZES

CORK SIZE NO.	2	3	4	5	6	7	8	9
Top Diam (in.)	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16
Bottom Diam (in.)	3/8	27/64	15/32	17/32	37/64	5/8	43/64	47/64

CLEANING - Using a 2" or 2-1/2" bristle paint brush with 1/2 the length of the bristles cut off, scrub the entire blasted surface with Belzona N.F. Cleaner Degreaser. Start at the top and wash downward over the intire surface. Apply a final once-over with fresh solvent to ensure total cleanliness.

CAUTION Solvent vapors must be vented from the work site at all times during cleaning operation.

Blow clean air over corks to insure total solvent evaporation before coatings are applied.

APPLICATION OF CERAMIC R-METAL

MIXING - Belzona Ceramic Metal is packed in plastic containers. To activate the material for use, the Ceramic R-Metal Solidifier must be added to the Ceramic R-Metal Base, and the 2 components mixed thoroughly. To achieve this, the contents of a complete unit of Ceramic R-Metal should be transferred to a Belzona Mixing Board which is free of grease and other contaminants. The entire contents of the Solidifier container should then be added to the Ceramic R-Metal Base.

The molecular reaction begins when the 2 components are mixed. To obtain the full molecular advantages of Ceramic R-Metal, and to prevent streakiness, the components must be mixed to a homogenous consistency.

Optimum mixing occurs when the ambient temperature exceeds 50 F (10 C). At lower temperatures, the modules containing the components should be warmed in an oven, or by partial immersion in warm water, until their contents reach the maximum temperature of 77 F (25 C). During partial immersion, container lids must be secure to prevent contact of water and components.

Unless otherwise indicated, measuring and mixing must be carried out using the plastic spatula provided.

NOTE: Under no circumstances should a mixing utensil used with one component contact the other component without having been 100% effectively cleaned first.

Temperature and surface area determine the usable life of Ceramic R-Metal once it has been mixed. A large "ball" of the material

will have a shorter usable life than the same mass of material spread over a large surface. The usable life of a 2-kg mix of Ceramic R-Metal is given in Table 2. Ceramic R-Metal not applied within the specified time limits should be treated as waste.

TABLE 2 - USABLE LIFE OF 2 KG OF CERAMIC R-METAL

Temperature (F/C)	Usable life after mixing (Minutes)
41/ 5	35
50/10	30
59/15	25
68/20	20
77/25	15
86/30	10

APPLICATION - Belzona Molecular Ceramic R-Metal should be applied when both the air and substrate temperatures are between 41 F (5 C) and 86 F (30 C). Below this temperature range, the material will be too stiff for easy application, while above this temperature range, the material will be too "fluid" to enable the required thickness to be maintained on vertical surfaces.

The integrity of the division bar seal is extremely important for the proper operation of a multipass heat exchanger and must therefore be carefully rebuilt before exposed tubes are coated. The seal area should be reconstructed using a "square" steel section or angle iron former of a suitable length with a width equal to the width of the seal area to be rebuilt. This former should be degreased and coated with Release Agent. After Release Agent has dried, Ceramic R-Metal should be applied to both the former and the surface of the tube sheet to prevent air entrapment.

The former should then be carefully placed in the proper location across the tube sheet and clamped in place. Once the Belzona Molecular Ceramic Metal has solidified, the steel section should be removed and any needed dressing down can be implemented.

As soon as former is removed, Ceramic R-Metal repair can begin on exposed tubes.

Ceramic R-Metal should be applied directly onto the prepared surface using a gloved hand or the plastic applicator provided. The material should be pressed down firmly to remove entrapped air and to ensure maximum contact with the surface. Air pockets at crevices or section changes cannot be tolerated and must always be removed. The edge of the plastic applicator is particularly effective in forcing Ceramic R-Metal to the bottom of any irregularities.

Belzona Molecular Ceramic Metal should be applied to the plate of the heat exchanger and built up around each tube end. Striking off level the Ceramic R-Metal with the tube ends. At this stage do not add heat to the Ceramic R-Metal. This will cause it to "kick over" and solidify too quickly.

SOLIDIFICATION - Minimum solidification has occurred when areas rebuilt with Ceramic R-Metal are firm enough to accept the resurfacing layer of Ceramic S-Metal. This time will vary according to the thickness of material applied and air temperature.

While the Ceramic R-Metal is setting firm enough to accept the first coat of Ceramic S-Metal, construct a 10 foot to 12 foot long Visqueen or Canvas tube. Visqueen should be two layers thick. One end will be wrapped around and taped to the head of the chiller you are working on. The other end will be taped closed. Do not attach to machine at this time. Please keep in mind, the application should be moving along as quickly as possible.

RESURFACING WITH CERAMIC S-METAL - After all pitted and heavily eroded areas have been rebuilt with Belzona Molecular Ceramic R-Metal, the entire area should be resurfaced with Ceramic S-Metal. Application of the resurfacing layer of Ceramic S-Metal should be carried out within 15 to 30 minutes of final application of Ceramic R-Metal.

MIXING THE CERAMIC S-METAL FOR THE FIRST (BLUE) RESURFACING LAYER - Belzona Molecular Ceramic S-Metal is packed in a plastic container. To activate the material, the entire contents of the Ceramic S-Metal Solidifier (Blue) container should be added to the Ceramic S-Metal Base component, and the 2 components mixed thoroughly until a homogenous mixture free from streaks is obtained.

Mixing is easier when the ambient temperature exceeds 50 F (10 C). At lower temperatures, components must be warmed in an oven or by partial immersion in warm water, until they reach the maximum temperature of 77 F (25 C). During partial immersion, container lids must be secure to prevent contact of water and components.

Temperature determines the usable life of Ceramic S-Metal once it has been mixed. The usable life of a one-kg. mix of Ceramic S-Metal is given in Table 3. Ceramic S-Metal not applied within the specified time limits will not provide maximum molecular bonding and should therefore be treated as waste.

TABLE 3 - USABLE LIFE OF ONE KG OF CERAMIC S-METAL

Temperature (F/C)	Usable Life (Minutes)
41/ 5	60
50/10	50
59/15	40
68/20	30
77/25	20
86/30	10

APPLICATION - Belzona Molecular Ceramic S-Metal should be applied when both the air and substrate temperatures are between 41 F (5 C) and 86 F (30 C). Below this temperature range, the material will be too stiff for easy application, while above this temperature range, the material will be too "fluid" to enable the required thickness to be maintained on vertical surfaces.

Ceramic S-Metal should be applied with a brush whose bristles have been cut to half their original length. All bolt heads, crevices, protuberances, and other sharp edges should be double-coated to provide an adequate film thickness.

The recommended resurfacing thickness of Ceramic S-Metal is 10 to 15 mils (250-375 microns) per layer. This equates to a practical coverage rate of 1.0 kg Ceramic S-Metal per 11 sq ft per layer.

SOLIDIFICATION - Minimum solidification has occurred when the first resurfacing layer of Belzona Molecular Ceramic S-Metal is firm enough to accept the final resurfacing layer of Ceramic S-Metal. The time will vary according to the thickness of the material applied and the air temperature and humidity. Under normal conditions, the second layer of Ceramic S-Metal can be applied within 30-45 minutes of application of the first layer.

MIXING AND APPLYING THE SECOND (GRAY) LAYER OF CERAMIC S-METAL - Procedures are the same as outlined for the creation and application of the first (Blue) resurfacing layer, but Ceramic S-Metal Solidifier (Gray) should be used to activate the Ceramic S-Metal Base. Application instructions and time limits are the same as outlined above.

As soon as you finish the second coat application, attach the Visqueen or Canvas tube, that we previously discussed, to the finished end of the machine. This will act as a back stop and basket to catch the corks. Immediately go to the opposite end of the machine where your air nozzle with a tapered rubber end cap has been readied to blow out the corks. Minimum 100 psi. Place nozzle into each tube so it will seal any leakage. Pressurize each tube until the cork blows into the Visqueen tube at the other end.

Quickly move to the next tube and proceed until all corks that will blow out, have.

The reason you have been instructed to move quickly through the last several steps is that the Ceramic R-Metal has started to solidify. Some of these corks may be stubborn in coming out. If some of the corks do not come out, wati until the coating has cured "tack free." Remove them with the following procedure:

Place the ball of a medium size ball peen hammer in the center of the cork. Hit the hammer with a plastic or rubber mallet driving the cork back into the tube. Keep tapping the ball peen until all burrs or rings are removed from the inside of the copper tube. Remove the cork with air or a cork screw.

Inspect and touch-up any void or open areas around the tubes with Ceramic S-Metal. Set up and perform all the same procedures to unfinished end of the machine.

FINAL SOLIDIFICATION TIMES AND TEMPERATURES - After application of the final resurfacing layer of Belzona Molecular Ceramic S-Metal, complete and final solidification must be achieved before the coated part is immersed in any liquid. The final solidification time will depend on the temperature the whole system experiences after completion. Table 4 specifies minimum solidification times at given temperatures. Premature immersion of the system will retard solidification of the coating and could affect subsequent performance.

TABLE 4 - MINIMUM SOLIDIFICATION TIMES BEFORE IMMERSION

Temperature (F/C)	Minimum Solidification Time Before Immersion (Days)
41/ 5	5
50/10	4
59/15	3
68/20	2
77/25	1-1/2
86/30	1

TECHNIQUES

Hammer all corks flush with the tube ends, since protruding corks prevent application of the coating between tube webbing where most damage occurs. See Table 1 for cork sizes.

Although it is cheaper to use corks than rubber stoppers for this purpose, they can only be used one time because they are usually damaged during removal from the tubes.

GRIT - To ensure that you achieve the necessary level of surface profile and cleanliness before applying the coating material, you may want to use a 1240 medium grade of grit. This grade is available as Black Beauty from the H.B. Reed Co., or as SAF-T-BLAST from Mineral Aggregates Co.

RAGS - All rags used for cleaning purposes must be completely free of waxes or oil residue.

LIGHTING - Adequate lighting facilities must be installed to facilitate all stages of preparation, application, and inspection.

WORKING SCHEDULE - You should develop a pattern of preparation and application so that each area is blast-cleaned to the correct standard, then receives the first coating within the specified time, and that the surface is completely free from dust or spent abrasive. You must apply the first coat before steel surfaces have a chance to rust to prevent contamination of the coating.

STORAGE - All Belzona Molecular materials should be stored in a cool place under cover in their containers until ready for application.

CONDITIONS OF APPLICATION - Belzona Molecular materials should only be applied on those surfaces that have been prepared and cleaned according to the foregoing recommendations. For best results, materials <u>should not</u> be applied under the following conditions:

1. When the temperature falls below 41 F (5 C) or the relative humidity exceeds 90%.

2. During rain, snow, mist or fog.

3. When there is moisture on the equipment surface, or moisture is likely to condense during the application period.

Belzona Molecular coatings should be applied only by skilled and experienced operators in the manner outlined in this manual.

SET-UP - The Belzona Material used in the protective coating will begin to harden soon after it has been prepared, so you will need to work quickly once the job is begun.

DIVISION PLATES - Pay particular attention to the method you use for recreating the seal at the division plates. The division plates will probably have to be modified to compensate for any increase in thickness when the coating is applied to the tube sheet or water box cover. We recommend coating the entire surface of the water box during tube sheet repairs.

NOTE: Coat gasketed surfaces with a thin film of Ceramic S-Metal.

HANDLING - Avoid contact of any Belzona Molecular product with skin or eyes. If contact is unavoidable, affected areas should be washed thoroughly with soap and water or with a resin-removing cream. Flush eyes immediately. If irritation continues, seek medical assistance.

INHALATION - The Belzona Molecular Ceramic Metal components do not contain any volatile solvents and inhalation is therefore unlikely to cause difficulty. If the normal odor of the uncured material is found to be unpleasant, then adequate ventilation should be provided.

Belzona Molecular N.F. Cleaner Degreaser is based on non-flammable solvents of low toxicity, but could cause nausea or dizziness if inhaled in excessive amounts for long periods. If ventilation is inadequate, workers should wear breathing apparatus, and should not exceed 30 minutes contact or work alone.

INGESTION - If Belzona Molecular products are swallowed, medical assistance should be sought at once.

SPILLS AND DISPOSAL - If spills occur, clean area with Belzona Molecular N.F. Cleaner Degreaser. Dispose of unused contents in a safe and approved manner.

FIRES - If Belzona Molecular products should become ignited, extinguish fire with dry powder, foam, or carbon dioxide fire extinguishers.

BIBLIOGRAPHY

Publications available from Belzona include the following:

1. B601 Working Recommendations
2. IMKAL Report Number 8017
3. Application Leaflets:
   No. 118 - R (Repair) Metal*
   No. 119 - Ceramic S Metal*

*These leaflets or their equivalents will be included in the package when ordered.