DEC 07 2000 *Sta. 15* (20) ENGINEERING DATA TRANSMITTAL

1. EDT 629455

2. To: (Receiving Organization) SNF Storage Projects	3. From: (Originating Organization) MCO Project	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: *HFFXC061* W-442 MCO Project *105532/AA30*	6. Design Authority/Design Agent/Cog. Engr.: Louis H. Goldmann *LHG*	7. Purchase Order No.: N/A
8. Originator Remarks: For filing of attached letter report and approval and release of the letter report. *** Per L. H. Goldmann, 12/7/00 - J. Aardal / Sta. 15*		9. Equip./Component No.: Seals 10. System/Bldg./Facility: W-442 MCO Project 12. Major Assm. Dwg. No.: H-2-828040
11. Receiver Remarks: CSB-00-1301 CVD-00-1980 K-00-1281	11A. Design Baseline Document? (●) Yes ( ) No	13. Permit/Permit Application No.: N/A 14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-6468		0	C.E. Graves 4/19/00 Letter Report, "Evaluation of Tin Plating for MCO Seals"	~~ESQ~~ *** 12/7 N/A*	1	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D OR N/A (See WHC-CM-3-5, Sec. 12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
1	1	Design Authority L.H. Goldmann *LHG*	*[signature]*	*6/1/2000*	*R3-86*						
1	1	*Author* ~~Design Agent~~ C.E. Graves	*LHG for*	*6/1/2000*	*G3-15*						
1	1	Cog. Eng. D.R. Lucas	*[signature]*	*6/5/00*							
1	1	Cog. Mgr. K.E. Smith	*KE Smith*	*6/1/00*							
1	1	QA C.R. Hoover	*CR Hoover*	*6/1/00*							
1	1	Safety B.D. Lorenz	*BD Lorenz*	*12/5/00*							
		Env.									

18.	19.	20.	21. DOE APPROVAL (if required)
[signature] L.H. Goldmann *6/1/2000* Signature of EDT Originator / Date	*KE Smith 6/1/00* K.E. Smith Authorized Representative for Receiving Organization / Date	*[signature]* *12/6/2000* L.H. Goldmann Design Authority/ Cognizant Manager / Date	Ctrl No. N/A ( ) Approved ( ) Approved w/comments ( ) Disapproved w/comments

DISTRIBUTION SHEET

To	From	Page 1 of 2
Distribution	SNF Storage Subprojects	Date 05/31/00
Project Title/Work Order		EDT No. 629455
Project W-442 MCO Subproject, C. E. Graves 4/19/00 Letter Report, "Evaluation of Tin Plating for MCO Seals" HNF-6468		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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DISTRIBUTION SHEET

To	From	Page 2 of 2
Distribution	L. H. Goldmann	Date 05/31/00
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		ECN No.

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S

HNF-6468
Revision 0

Evaluation of Tin Plating for Multi-Canister Overpack Seals

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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C. E. Graves
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Assistant Secretary for Environmental Management

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FLUOR GLOBAL SERVICES

April 19, 2000

Mr. Kimball E. Smith
BABSR Construction/L6-58
Richland, WA 99352

Dear Mr. Smith:

EVALUATION OF TIN PLATING FOR MULTI-CANISTER OVERPACK SEALS

In response to your request, the attached letter report evaluates the use of tin plating on the Multi-Canister Overpack (MCO) seals used with the port cover plates, process valves, and test plugs. Topics examined included corrosion resistance, radiation resistance, and elevated temperature behavior of the tin plating in the expected MCO environments.

If you have any questions, please contact me at 376-5545.

Sincerely,

C. E. Graves
Design Engineer

c: L. H. Goldmann R3-86 FDH
R. E. Russell RER E6-15 FFS

EVALUATION OF TIN FOR USE IN MCO

1.0 INTRODUCTION

The Multi-Canister Overpack (MCO) incorporates plated seals for use with (1) the port cover plates, (2) process valves of the shield plug, and (3) test plug of the cover cap. These seals are required to maintain leakage rates as low as 10^{-7} scc/atm-sec. in the cover cap to test plug seal. The seals are manufactured by EG&G division of Perkin Elmer. Currently, the MCO design calls for use of silver or gold plated seals in these locations. The seal plating materials are deposited on Inconel 718 or X-750 substrates. Some of these seals are reused several times in service on the MCO.

The MCO manufacturer has built several MCOs and is in the leak testing stage and has had great difficulty obtaining acceptable leakage rates at their plant in Camden, New Jersey. The seal manufacturer was called in to evaluate the situation and now the seal manufacturer recommends tin plated seals. This evaluation examines the corrosion resistance and thermal stability of tin plating on the seals.

2.0 SUMMARY

The use of tin plating on MCO seals was evaluated for corrosion resistance and thermal stability. The corrosion resistance of tin in the expected MCO environments is acceptable. The effect of radiation hardening will offset creep deformation results. However, a low melting point indicates unsuitability at significantly elevated temperatures.

3.0 MCO ENVIRONMENT CONDITIONS

A summary of the external environmental conditions expected by the MCO is listed in Table 1. Internal service environments will be discussed in the corrosion section.

Table 1. MCO Environmental Conditions (Goldmann 2000)

Parameter	*Condition*
Atmosphere	-33° – 46°C (-27° – 115°F) 5 to 100% humidity
K-Basin Storage Pool	6° – 38°C (43° - 100°F) 5.5 – 7.5 pH <1 ppm of Cl, NO_3, SO_4, PO_4, F, Na, Ca, & Fe
Cold Vacuum Drying Facility	10° – 75°C (50° – 167°F)
Transportation	0° – 75°C (32° – 167°F)
Canister Storage Building	10° – 132°C (50° – 270°F)
Expected Service Pressure	593 kPa (86 psia) maximum
Internal Design Pressure	3310 kPa (450 psi)

In addition to the conditions listed above, the suitability of the tin plating at temperatures up to 375°C (707°F) is also examined. This temperature maximum was suggested in optional/alternate processing scenarios.

4.0 SEAL DESCRIPTION

For a complete description (including drawings) of the seal configuration, the reader is referred to Appendix 14 of the MCO Design Report (Goldmann 2000) and drawing H-2-828048 (DESH 1999). The tin used for the seal plating is high-purity commercial tin recognized as Grade A per ASTM B339 (ASTM 1995). Average mechanical properties for this material are given in Table 2. The tin plating is expected to be 51 - 102 μm (2 - 4 mils) thick.

Table 2. Pure Tin Material Properties (Hampshire 1990)

Property	*Value(s)*
Hardness (HB)	3.9 at 20°C (68°F) 2.3 at 100°C (212°F)
Yield Strength at 23°C (73°F)	11.0 MPa (1.60 ksi)
Percent Elongation	57%
Melting Point	232°C (450°F)

Like lead, tin is subject to tensile creep deformation and rupture even at room temperature and at stresses below the yield strength. For example, with an initial stress of 1083 kPa (157 psi) an extension of 3.5% was recorded in 551 days. At 2256 kPa (327 psi), an extension of 101% and specimen failure occurred after only 173 days (Hampshire 1990). Data for elevated temperature compressive creep (i.e., during storage) was not found during the literature search or vendor discussions. Given the relative thinness of the plating (lack of bulk material), significant damage to the seal from compressive creep is not expected.

5.0 TIN CORROSION IN THE MCO

5.1 DURING STORAGE PRIOR TO USE

MCO components will need to be stored prior to actual fuel loading, most likely in a dry (warehouse) condition. At ordinary atmosphere temperatures, the protective surface oxide film on tin is very thin and exhibits a very slow rate of growth. In rural atmospheres, similar to that of the Hanford site, a corrosion rate of 0.48 μm/yr (0.019 mil/yr) was measured (Maykuth 1987, Table 1).

5.2 MCO CONTAINING LIQUID WATER

Unalloyed tin is well recognized for handling distilled water, like that of the K basins, as the only reaction is a slow growth of an oxide film, with a negligible amount of tin entering solution (Maykuth 1987). The ion levels in the water are low enough that they would not contribute to corrosion acceleration.

The main dissimilar metal contact scenario (galvanic corrosion) for the seal is contact between the tin plating and the austenitic stainless steel cover plates, process valves and test plugs. Even with a large area ratio of austenitic stainless steel to tin, seawater corrosion tests showed only a slight increase in the corrosion rate of the tin (Maykuth 1987, Table 6).

Galvanic corrosion due to contact with the Inconel seal substrate must also be considered. As with the stainless steel, only a slight increase in the corrosion rate of tin is expected (Maykuth 1987, Table 6).

The time period during which the MCO is immersed in or filled with liquid water is less than 2 days. This is insufficient time for significant galvanic corrosion of the tin-plated seals to occur.

5.3 MCO DURING REMOVAL OF LIQUID WATER

During cold vacuum drying, less than 48 hours is needed to remove liquid water from the MCO and establish a low water vapor pressure inside. This period is too short to cause significant corrosion of the tin, as there is no significant buildup of aggressive species. Once liquid water is removed and condensation is precluded, galvanic corrosion ceases.

5.4 MCO AFTER REMOVAL OF LIQUID WATER

During storage in the Canister Storage Building, there is the potential for four gases to exist within the MCO in addition to inert gases (e.g., helium):

1. *Hydrogen gas* – tin does not react with hydrogen gas below its melting point (Maykuth 1987).
2. *Chlorine/Iodine gas* – tin is readily attacked by chlorine and iodine gas at room temperature (Maykuth 1987). Data for elevated temperature attack was not available. As chloride and PCBs levels in the sludge are low, they are not expected to be present within the MCO in measurable levels.
3. *Oxygen gas* – at temperatures up to 130°C (265°F), tin oxidation follows a logarithmic rate law that tends to become parabolic at higher temperatures.

Cleaning of the fuel prior to loading, coupled with inert gas purges during drying, reduces the possibility of gaseous corrosion problems.

Contact between the tin-plated seal and the stainless steel cover plates/shield plug could cause liquid metal embrittlement of the stainless steel. A lower fatigue limit and lifetime at stresses below the fatigue limit for 18-8 stainless steel have been noted when tested in tin at 300°C (570°F) (Kamdar 1987). Tin contact with the austenitic UNS21800 [Nitronic 60] plug valve would produce similar results. As the contact areas with the tin-plated seal are small, significant damage of either stainless steel is not expected.

A literature search yielded no specific information regarding the radiation resistance of tin (possibly due to the relatively low melting point). In general, weak metals (metals of high purity), increases of the yield strength up to factors of ten are not unusual (Berggren 1965). The lower the initial yield strength, the greater will be the potential increase in strength due to radiation exposure.

6.0 CONCLUSIONS

From a corrosion perspective, tin is suitable for the MCO environment in each processing stage. The melting point of tin is 100°C (180°F) above the expected storage temperature maximum. Yet, the tin plating will be molten at the alternate temperature maximum of 375°C (707°F) and functionally useless as a sealant. Damage to the stainless steel MCO by liquid metal embrittlement by the tin is not expected. Damage to the tin plating from creep deformation during the long-term MCO storage is probable, but the counteractive effects of irradiation hardening would minimize or eliminate this deformation.

7.0 REFERENCES

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