GREENPEACE

THE CLEMENCEAU CASE
-
POTENTIAL HAZARDOUS MATERIALS ASSESSMENT

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Summary

This work has produced a likely inventory of potentially hazardous materials likely to be onboard the French decommissioned aircraft carrier Clemenceau.

The work includes assessments of reports and documents produced by TECHNOPURE, the company contracted by French authorities to remove directly friable asbestos.

For the purpose of producing a potentially hazardous materials Inventory, the IMO format as presented in Part 1 of Appendix 3 of the IMO Guideline on Ship recycling (A 23/Res.962 (2003) has been adopted. This includes material categories other than asbestos. These have been estimated from identified representative vessels from where comprehensive data are available and further from experience on hazardous materials survey inventories.

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Clemenceau

Asbestos

PCB

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TECHNICAL REPORT

1 EXECUTIVE SUMMARY

The Clemenceau has been subjected to asbestos removal limited to the removal of directly friable asbestos. The vessel has seemingly never been the subject of a hazardous materials inventory survey. Due to this, there is no reliable information on the vessel's material composition. The reasoning for the priority made by the SDIC (French authority) on limiting the hazardous materials removal process to only include the removal of friable asbestos may rest on the attention asbestos receives in general rather than on actual onboard substances and their potential individual and/ or joint effects on the environment as well as their effects on human health.

1.1 Developed inventory of potentially hazardous materials onboard

An Inventory of Potentially Hazardous Materials On Board has been developed based on reports and documents from TECHNOPURE and further from representative reference vessels and experience. Note that this estimate is based on a number of assumptions, necessary because an onboard survey has not been possible. However, the identified materials and their estimated presence are substantiated by cross-reference to other surveys undertaken for this purpose in the past. The presented figures, though necessarily being estimates, are therefore considered representative.
The assessments conclusion is as follows:

Inventory reference	**Material**	**Estimated Quantity**
1A	Asbestos (Asbestos Contaminated material (ACM)	760 tons
1B	Paints on vessels' structure – Additives Heavy metals with highest presence of zinc, lead and copper. May also contain residuals of chlorine compounds and phosphates of calcium and zinc.	Present
1C	Plastic materials	Present
1D	Materials containing PCBs, PCTs, PBBs at levels of 50 mg/ kg or more	165 (330)* tons
1E	Gases sealed in ship's equipment or machinery	Assumed removed or leaked
1F	Chemicals in ship's equipment or machinery	Assumed removed or leaked
1G	Other substances inherent in ships' machinery, equipment or fittings	Likely to be present

* 95% upper confidence limit

Note that this work assumes that all operationally generated wastes (part 2 of the IMO inventory format) and stores (part 3) have been removed.

1.2 Recommendations

There is no real doubt about the presence of the included substances as listed above. In order to secure the safe management of the disposal and any related processes, detailed inventories must be developed. It is recommended to undertake an in-depth and well prepared survey of the vessel including sampling and analysis in order to establish a quality inventory. This will enable whom it may concern to make substantiated and correct decisions as to the management of onboard potentially hazardous waste.

For this purpose, it is recommended to apply the IMO Guideline on Ship Recycling and to take into account all relevant recommendations presented by the guidelines of the Basel Convention as well as by ILO.

2 INTRODUCTION

2.1 Background

The decommissioning of the naval vessel Clemenceau has come under scrutiny with regards to the steps undertaken by French authorities with regards to efforts related to;

Identifying potential onboard hazardous materials;

- Ø Onboard location of these;
- Ø Quantification of any such materials.

2.2 Scope

The purpose of this report is to assess the composition of hazardous materials likely to be found integrated in the vessel's structure or in its components. The assessment will rest upon previous studies undertaken on this topic inclusive of merchant as well as naval vessels.

The assessment will discuss likely material composition in various ship systems based on the Ship Inventory Dossier Environment (SIDE) approach developed by Det Norske Veritas (DNV), ref.:/1/. This is a statement issued following a verification process (ENVER), also described in the referred document. The DNV procedure applied in the development of the *Green Passport* as referred to in the current IMO Guideline on Ship Recycling is that of the ENVER – resulting in the development of a SIDE statement which in turn is translated to the IMO defined *Green Passport* format inclusive of the *Inventory of potentially Hazardous Materials On Board*. It may be noted that IMO have seemingly in more recent work left the *Green Passport* term and instead adopted the term; Inventory of Potentially Hazardous Materials (ref.: /2/) or Inventory of Hazardous Materials (ref.:/3/).

2.3 Limitations

It should be noted that this work is based on data made available largely from third parties. The assessment and subsequently any recommendations and conclusions arriving from it rests upon data and information as referred to in the report. This study has not undertaken any onboard survey.

3 BACKGROUND

Since the public's attention was drawn to the conditions under which ships are beached, deconstructed and re-used/ recycled in the mid 1990's, a level of recognition that changes was in need, by both the industry itself as well as by intergovernmental authorities, was born. In the wake of this, we have seen the development of various mandatory instruments;

- IMO Guideline on Ship Recycling (IMO, 2003);
- Guidelines on Environmentally Sound Management for full and Partial Dismantling of Ships (UNDP, 2002);
- Guidelines on safety and health in shipbreaking (ILO, 2003),
- Industry code of practice on Ship Recycling (ICS 2001),

Practical application of these has suffered from inconsistencies and lack of coordination with respect to individual conditions set by these. This has now led to the initiative of developing a legally binding instrument purposely designed for regulating aspects related to the processes of permanently decommissioning obsolete tonnage. Recently an initiative has been made on the coordination of the three intergovernmental guidelines (ref.:/4/).

One such area is requirements associated to the recycling facility. Another is related to requirements to the condition of the ship and to the documentation to follow. This documentation includes references to inventories for the purpose of identification, localisation and quantification of hazardous substances. The different mandatory instruments have different approaches to the content of such inventories. Work is currently underway, initiated by IMO, to attempt to produce a standard format of potentially hazardous materials and criteria for the selection of the materials to be listed in such an inventory, ref.: /2/.

3.1 The Clemenceau

The Clemenceau (main specifications are listed in table 1) was decommissioned on October 1, 1997 and sold on for scrap in June 2003 after an appeal for tenders on April 14, 2003. Following evidence that part of the removal of asbestos would not proceed as stipulated by the sales contract, in the Spanish port of Gijon, the contract was rescinded and declared void in late October 2003.

Table 1: Clemenceau specification

Year of deployment	1963
Displacement (max. draft)	32760 t
Length	265.00 m
Beam	51.20 m
Draft	8.60 m
Propulsion machinery	Steam turbines, 2 shaft, 126000 shp.
Boilers	6
Capacities, crew	1920
Capacities, aircraft	40

3.2 Materials and their us in different vessel types

The materials to be found onboard vessels mirror the use for which they were originally designed, any retro-fittings and/ or rebuilding undertaken during its life, but first and foremost - the general shipbuilding practice at the time she was built.

Both onboard assessments of ageing vessels as well as on-site assessments of ship recycling sites or ship repair yards will provide input as to what type of materials one may expect to find.

Naval vessels in comparison to merchant vessels differ in design on a number of issues;

- Installed power and machinery configurations;
- Crew accommodation capacity;
- Ventilation systems;
- Electronic systems;

Additionally, most merchant vessels are designed to carry cargo. They will therefore have larger deadweight capacity and hence, displacement exceeding that of navy ships. Naval vessels again differ due to their specified capability often by complex weapons systems and associated arrangements.

Aircraft carriers are very different from any vessel type used for commercial purposes. They are literarily a floating airport and consequently equipped accordingly. Apart from the actual runway, this includes facility for storage of air-fuels, parking, landing and take-off and lifting arrangements for planes, workshop facilities, etc. These vessels are also characterised by their capability of keeping a high speed leading to the requirement of extraordinary large machinery capacities. Due to the large requirement associated to installed power and a general lack of space, these vessels are equipped with steam turbines. This incorporates the production of supersaturated steam and consequently complex boiler configurations and thereby required comprehensive thermal insulation. The concentration of materials associated to high temperature applications is found more frequent and in higher concentrations onboard vessels powered by steam turbines.

3.2.1 Identifying potentially hazardous materials onboard existing vessels

Even though various known hazardous materials now have restricted use or are even banned from general use and have been so for many years, they are frequently found onboard even younger vessels. Thus, age itself is no guarantee against the occurrence of certain substances onboard. Therefore, the leading experts on ships' hazardous inventories will claim that an onboard survey including sampling of areas, sections, systems, surfaces, etc., known from experience to be associated to certain substances is essential in order to establish a high quality inventory and consequently a decision support tool/ platform necessary for identifying sound environmental management of the forthcoming process.

Most such surveys now make use of the IMO guideline. Some institutions, e.g. DNV, have developed protocols based on this guideline in order to undertake surveys on existing vessels.

A survey protocol for this purpose will contain a pre-planning stage, where all available and relevant documentation is compiled and assessed. This assessment will define the areas of focus when undertaking the onboard survey. Both the pre-assessment and the survey itself should be performed by experienced personnel with knowledge on identification and quantification in particular of potentially hazardous materials.

Normally these surveys are done onboard while the vessel is in operation. Consequently, onboard ship generated waste and substances necessary for the running of the ship (e.g. chemicals, fuels, etc.) need to be addressed accordingly.

The onboard survey should include

- Interview with relevant personnel;
- Review of onboard activities;
- Visual inspection of all accessible areas,
- Sampling of components and/ or materials considered to be a potential source of potentially hazardous substances;
- Identification/ quantification and localisation of potentially hazardous materials;

The potential hazardous material sources may be divided in three categories;

1. Ships structures and components,
2. Operationally generated wastes;
3. Stores;

For the Clemenceau case, it seem reasonable to assume that categories 2 and 3 have been dealt with so that the vessel can be considered free from ship generated wastes, e.g.;

- Sewage - black/ grey water (and ballast);

- Garbage – plastics and food waste;
- Fuels – heavy fuel oils/ diesel oils/ any other HC-based fuel;
- Lubricating oils – in tanks/ barrels/ buckets/ cartridges/ in systems – components;
- Sludge – Chemicals/ fuels/ lubricating oils;
- Oily water – Bilge water tank/ drain tanks;

And also from stores;

- Refrigerants – R 12/ R22/ or similar/ etc.;
- Acetylene – bottles/ systems;
- Oxygen – bottles/ systems;
- Any other gases stored or stored in systems;
- Chemicals (for boiler, engines, turbines) - treatment chemicals/ degreaser/ cleaners/ thinners/ etc.;
- Medicines – various medicines/ ships hospital;
- Paint – paint stores;
- Other stores;

Assuming all these substances and any associated ship generated wastes or stores have been removed, the remaining sources of potentially hazardous wastes onboard are those in components and integrated with the ships structure.

3.3 Potentially hazardous materials in ships structures and components

Based on data from the pre-study, the survey protocol will contain procedures for identifying target substances. This will include the verification, quantification and localisation of the identified target substance. The protocol will also include procedures for components and materials that may contain such target substances and also similarly for components or materials of an uncertain origin/ type.

For the Clemenceau, an asbestos survey has been undertaken, (ref.:/7/). This is assessed later in this report (chapter 4).

3.3.1 PCB – target substance

There is also available documentation from similar vessels relevant for the Clemenceau covering the target substance PCB. This information is considered in chapter 4 and preliminary estimates on likely onboard concentrations of PCB based on the sources assessed by the available documentation is presented. This information may be prepared further and interpreted according to procedures for an onboard PCB survey as a part of a potentially hazardous materials inventory survey. Note that other potential sources of PCB should be considered, e.g. electrical components such as capacitors.

3.3.2 Heavy metals – target substances

From experience, paint and coatings are a frequent source of heavy metals in addition to PCB. Even modern products may contain a number of different substances of concern to both human health as well as to the environment. The most frequent occurring metallic compounds found on painted/ coated surfaces are; arsenic (As), cadmium (Cd), chrome (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn) and mercury (Hg). In historic terms, metallic compounds in paints have not been subjected to restrictions associated to use. Even though a vessel will have been sandblasted and repainted during its life, large areas are likely to still have the original paintwork left in one form or another. Further, relatively new paints have been found to contain numerous metallic compounds. With few exceptions, there is little evidence to suggest that the levels are lesser in older paintwork.

It is likely that coated and painted surfaces of the Clemenceau will contain metallic compounds in addition to PCB. The concentration levels reported from samples taken from vessels built in the 1970s and operated throughout the 1990s suggest that the levels are modest with some exceptions. Table 2 lists the most frequent found components based on a sample of merchant vessels. Note that there may be some divergence in product properties for paints/ coatings used onboard naval vessels.

Table 2: Heavy metals in paintwork typically found in products applied to ships

Component	**Typical concentration levels (mg/ kg)**
As	2 – 3
Cd	1 – 4
Cr	10 - 1000
Cu	20 - 20000
Pb	100 – 8000
Ni	8 – 220
Zn	500 – 20000
Hg	0.01 - 0.1

Note that there may be traces and residues from paint products used in the past such as chlorinated rubber which was used as a binder for anti corrosion. This may have been used in both the primers as well as in the topcoats. This product is no longer in use due to potential health effects during coating application. Note also that the levels of lead may be higher than indicated in the table above. In the 1950s lead based primers where commonly in use. Due to the high density of lead, the mass concentration of this was high, maybe up to 30% or 40% by weight of the product. Lead based primers where phased out through replacement primarily with zinc-based products.

Again, it may be expected that a portion of the original paintwork has been removed.

Other compounds used more frequently during the era in question were calcium- and zinc phosphates. These are still in use in some anticorrosion products but not to the same extent as earlier.

The general concentration levels of these compounds (table 2) depend upon the application. The most used compounds are zinc, lead and copper (in this order). In order to enable an assessment of metallic compounds for the Clemenceau, a paint sample and analysis procedure should be developed and undertaken as part of the inventory survey.

TBT (tributyltin) has been addressed with particular interest by different parties. This is a metallic biocide used in antifouling with well understood environmental effects. The product is banned from use onboard certain vessels (size dependent). IMO have also developed a legal instrument that will ban the use of antifouling containing TBT when it enters into force. It may be noted that this instrument (convention) has retroactive mechanisms. This has led to the paint manufacturers launching alternative products. These products are now being specified as sailing vessels are dry-docked for their periodic surveys.

The Clemenceau will have an antifouling paint covering its submerged surfaces containing TBT. It may be noted that most antifouling containing TBT also contain a number of other biocides. TBT-based antifouling may contain from 10 – 200 mg/kg TBT. In order to address the quantity onboard the Clemenceau, sampling and analysis for submerged surfaces should be included in general paint sample and analysis procedure as proposed above.

Other sources of heavy metals (apart from oils, chemicals, etc) are listed in the table 3 below;

Table 3; Other sources of heavy metals

Location	**Compound**
Fluorescent light tubes	Mercury
Thermometers	Mercury
Level switches	Mercury
Navigational equipment (gyro)	Mercury
Onboard electronics	*
Battery rooms/ life boats/ emergency systems	Lead
Anodes (tanks/ ships hull)	Zinc

* Shipboard electronic equipment is usually replaced at intervals. This is also valid for naval vessels. The may contain a variety of heavy metals including cadmium, vanadium, etc.

The sources listed in table 3 are easy to identify. With the exception of fluorescent light tubes and to some extent level switches, the number of these components is highly manageable. They should be removed in a safe manner and disposed off in accordance to best practices/ appropriate regulations.

Florescent light tubes contain approximately 15 mg of mercury per unit. This is spread on the inside of the tube surface. If these are cracked, the mercury contaminated volume will dramatically increase. Care should be taken in removing these safely and avoiding cracking.
A conventional merchant vessel of a comparable size will typically contain between 600 and 800 fluorescent light points (if this product is used). Taking into account the fact that most of the volume of such a ship is cargo space, it is reasonable to assume that the number of such fittings on a naval vessel will be considerably higher. At say 10 times the concentration, the amount of mercury aggregated in these tubes is between 90 and 180 grams as each tube typically contain 15 mg of mercury. This is a very manageable volume.

3.3.3 Radioactive materials – target substances

Conventional use of radioactive substances onboard vessels include applications such as emergency signs and smoke (ionising) detectors. There is limited information available as to the use of radioactive materials onboard naval vessels for other applications. It is likely that the Clemenceau will have onboard both such signs as well as smoke detectors.

3.4 Other potentially harmful substances

It may be noted that a number of shipboard systems require oils, gas or chemicals of different specifications in order to function. This may be hydraulic oils for lifting and mooring equipment, halons or CO_2 in fire fighting systems. Taking into account the time that has passed since the Clemenceau was decommissioned from service, it has been assumed that all such systems also have been decommissioned, closed down and secured. This should to be checked and verified. If this is not the situation, all such system substances must be removed and catered for according to their individual characteristics.

For use in fire-exposed areas, flame retardants are commonly in use. There is at present a growing concern regarding the effects these may have on human health and the environment.

4 RELEVANT POTENTIAL HAZARDOUS MATERIALS AND LIKELY QUANTITIES

4.1 Hydrocarbons – residues

Hydrocarbons either as a consumable, a waste (oily water/ bilge water) or as a required component substance e.g. as a lubricant or stored onboard as supply (tanks, barrels, containers, etc.), are assumed to have been removed. The reasons supporting this assumption are;

- The time gone since the vessel was decommissioned in combination with;
  - risks associated to continuous onboard storing;
  - value
- Well established facilities for the reception of such substances.

4.1.1 Recommendation

The assumption should be verified by independent verification.

4.2 Asbestos

Asbestos is a soft and flexible fibrous mineral with properties that make it attractive for a number of applications. It is fire resistant, resistant to chemical degradation, has high tensile strength, good thermal and electrical insulating properties, has good frictional properties, and is relatively easy to manipulate, modify, apply and use.

Asbestos materials are found in most all vessels from the period of relevance with respect to the Clemenceau. Even relatively new vessels may have some asbestos components integrated in their structure or systems. Even today, asbestos containing spare parts can be purchased.

The most common asbestos applications are related to its use as thermal insulator. In ships producing vast amounts of heat for propulsion, which is the case in particular with respect to steam turbine configurations, incorporating multiple boiler-systems, one would expect to find asbestos in considerable volumes;

- Inside the boilers themselves as;
  - Heat resistant component in bricked areas;
  - Insulating liner as a sandwich material between bricked area and steel plating;
- Steam-lines
- Exhaust systems including connectors and manifold

Asbestos material was also commonly used for thermal insulation of piping in general, e.g. hot water lines, fuel oil lines, etc.

Asbestos is however not only found in engine room compartments. Other typical areas of application include wall and ceiling panels as well as doors. This implies that asbestos may also be widely used in accommodation areas. For this reason, it is not unusual to include also air sampling in addition to material sampling when undertaking an asbestos survey.

Other areas of application include floor insulation (often as a cover on steel decking under a layer of concrete). Some floor surfaces in certain areas are also made from materials containing asbestos. Asbestos in floors may be found randomly onboard. However, there is a trend to see this applied in refrigerating compartments, galley, etc.

Asbestos may also be found in electrical cabling, brake linings, in gaskets and as a component in sealing materials. Also some paint systems have been reported to contain asbestos (e.g. bitumen based products).

4.3 Asbestos applications and survey

Due to the vast range of applications, an asbestos survey needs to be equally comprehensive.

Recently, protocols have been developed tailored for shipboard asbestos surveys as an integral part of the “Green Passport” development (ref.:/12/) also for existing ships. Besides providing best-practice guidance for the actual survey, these protocols also include recommendations

associated to the preparation of the survey as well as in relation to sample management and analysis. The initial stage in such a survey always includes a thorough assessment of all available documentation of relevance (technical specifications, system delivery documentation, operational history/ modifications and refitting history, etc.). These protocols will also provide a listing of requirements, e.g. surveyor qualification, sampling equipment, measures against cross contamination, requirements to the sealing/ securing of the sample area as well as to the sample, analysing laboratory accreditation, etc.
Asbestos may appear friable, e.g. accessible without interference to the material or surrounding areas. It may also be visible and/ or indirectly accessible. Then again, it may be present as a component of another material, e.g. mixed in concrete, or used as an additive to another thermal insulator. There has been a general consensus among asbestos experts that directly friable material may be removed. In some cases, it is also recommended to remove indirectly friable asbestos material. Further, any asbestos removal that may free asbestos fibres allowing them to escape into the surrounding atmosphere (space) should be avoided. It should be noted that this practice arrives from decontamination processes rather than from disposal processes.

In the case of recycling a ship in an environmental sound manner, the asbestos will be released at some stage. It is therefore essential that measures are in place so that proper asbestos identification, securing and eventually removal are ensured. From a technical perspective, this may take place during a decommissioning process prior to actual dismantling. However, it is likely that the removal procedure will require some dismantling and e.g. can be considered as an activity integrated in the actual ship dismantling process, still under the same strict safety precautions.

4.3.1 The Clemenceau asbestos documentation

Since the vessel has not undergone any potentially hazardous materials inventory survey, there is no asbestos survey available either. Consequently, there is no accurate or verifiable documentation in relation to onboard asbestos or to any other material of concern.

A compiled report on the asbestos removal procedure carried out on the Clemenceau by TECHNOPURE (ref.:/11/) has been considered.
TECHNOPURE carried out the removal under contract with the SDIC. The contractual scope seems to be limited to include directly friable asbestos only. The documentation in the report makes account for the removal of 69910 kg.

The report refers to 10 defined zones where removal work has been undertaken. The work is verified by photographic references as well as by air sample results. There are also references to removal "scenes" (location identity) and identifiable big bags used in the removal process. There is not sufficient information in the report to connect the big bag identity (number and zone) and the scene from where it was taken to the asbestos removal inventory presented on page marked R98 BSDA. There may be some references related to the actual asbestos samples, however, the printing quality of these are of a quality making parts of them difficult to read.

Table 4 and 5 refer to the defined zones, verification procedures, air sampling and removal procedures and reported removed quantity. As may be seen, there are inconsistencies in the reported removed quantity and the documentation compiled in the report. The documentation provides visual presentation of installations and structures of various types but typical for areas where one would expect asbestos to be present. The impression is that a thorough visual inspection has been undertaken. However, there is no justification in the report regarding the removal priorities made.

Based on the visual assessment, areas, structure or components suspected to contain asbestos have been identified. In conjunction with this, air samples have been undertaken. It may be noted that sampling has been undertaken over a period of time. It is assumed this is the case regarding actual removal as well.

Air sampling for asbestos fibres is usually applied either to substantiate a suspicion of asbestos in use in an area or to monitor the spreading of such fibres during and/ or after removal. It is not totally clear as to the when the air sampling was undertaken with respect to the removal processes.

Some of the air sampling results give high concentrations suggesting that it was undertaken during or after removal (e.g. zone 1: analysis 83.342/s04.1220/11 (22.12.2004), zone 2: analysis 83.342/s04.1220/34 (26.01.2005)). Some of the samples have revealed the asbestos type applied.

The asbestos samples account for all asbestos reported removed.

The project has been provided with a listing of removed asbestos referring to three sample references not included in the report from TECHNOPURE; R98021; 01 and 02. There are also some minor inconsistencies with respect to some of the verified samples submitted in the TECHNOPURE reference. The document referred to is dated January 10, 2006 and marked; Marine Nationals. This latter document exceeds the corrected removed quantity as provided by TECHNOPURE by some 36 t.

Table 4: Zone references used by TECHNOPURE

Zone	Type	Zone	Type
1	Forward boiler room	6	Forward catapult
2	Forward engine room	7	Side catapult
3	Anchor compartment	8	Funnel (no removal)
4	Aft boiler room	9	Fore-ship (all compartments/ bridges)
5	Aft engine room	10	Stern (all compartments/ bridges)

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Table 5: Summary of the content report by TECHNOPURE

Zone	Visual Inspection and results	Air sampling and analysis/ comments	Removal	Quantities*
1	Photographic documentation	83.342/s04.1220/14 83.342/s04.1220/12 (24.12.04) 83.342/s04.1220/12 (23.12.04) 83.342/s04.1220/11 83.342/s04.1220/10 83.342/s04.1220/9 83.342/s04.1220/8 78.189/P04.3576/5 83.342/s04.1220/13	Big bags 1 – 40 Reference (N° scelle) provided in the report but no reference to where/ what)	
2	Photographic documentation	83.342/s04.1220/21 83.342/s04.1220/34 78.189/P04.3576/6 Amosite	Big bags 1 – 138 Reference (N° scelle) provided in the report (ref../11/)	
3	Photographic documentation	83.342/s04.1220/49 78.189/P04.3576/8 83.342/s04.1220/20 83.342/s04.1220/18 83.342/s04.1220/23 83.342/s04.1220/38 83.342/s04.1220/20	Receipts: R98010 (4 t) R98011 (4.5 t) R98012 (5 t) R98013 (5 t) 78.189/P04.3576/	Removed quantity: 18.5 t.
4	Photographic documentation	83.342/s04.1220/50 78.189/P04.3576/4	Big bags 1 – 59 Reference (N° scelle) provided in the report (ref../11/) Receipts: R98014 (7 t) R98015 (5 t) R98016 (4 t) R98017 (6 t)	Removed quantity: 22 t.
5	Photographic documentation	83.342/s04.1220/59 83.342/s04.1220/58 78.189/P04.3576/3 83.342/s04.1220/44	Big bags 1 – 79 Reference (N° scelle) provided in the report (ref../11/)	
6	Photographic documentation	ITO40407-1648 ITO40407-1652	Big bags 1 – 54	

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		ITO40407-1649 ITO40407-1595 ITO40407-1592 ITO40407-1597 ITO40407-1598 83.342/s04.1220/6 83.342/s04.1220/4 83.342/s04.1220/5	Reference (N^o scelle) provided in the report (ref../11/)	
7	Photographic documentation	ITO40407-1648 ITO40407-1652 ITO40407-1649 ITO40407-1595 ITO40407-1592 ITO40407-1597 ITO40407-1598 83.342/s04.1220/1 78.189/P04.3576/1 83.342/s04.1220/3 83.342/s04.1220/2	Big bags 1 – 40 Reference (N^o scelle) provided in the report (ref../11/)	
8	No photographic documentation	83.342/s04.1220/33 83.342/s04.1220/32 Amosite		
9/ 10	Photographic documentation	83.342/s04.1220/57 83.342/s04.1220/53 83.342/s04.1220/48 83.342/s04.1220/36 83.342/s04.1220/31 83.342/s04.1220/37 Amosite/ Chrysotile 83.342/s04.1220/36 83.342/s04.1220/35 Chrysotile 83.342/s04.1220/45 83.342/s04.1220/7 83.342/s04.1220/46 83.342/s04.1220/52 83.342/s04.1220/47 83.342/s04.1220/46 83.342/s04.1220/30 83.342/s04.1220/29 83.342/s04.1220/28 83.342/s04.1220/24 83.342/s04.1220/16 78.189/P04.3576/7 78.189/P04.3576/2 83.342/s04.1220/43 83.342/s04.1220/41	Big bags 1 –155 Reference (N^o scelle) provided in the report (ref../11/)	

* Note that certified analysis of samples are provided for the entire removed volume but not referred to in a consistent referenced manner.

4.3.1.1 Limitations in the asbestos removal work undertaken

The removal of asbestos material from the defined zones includes only directly friable asbestos.

Remaining asbestos is either indirectly friable or incorporated into ships structure and/ or components/ systems. Asbestos of this nature will cause contamination of surrounding material, e.g. Asbestos Contaminated Material (ACM). All ACM should be considered as equally harmful as the directly friable asbestos.

From the volume removed as well as from experience, it is evident that substantial ACM remain onboard the vessel. The quantities of this can only be established accurately by a well planned thorough asbestos survey. However, some considerations may be undertaken resting on the description of vessel systems and past experience. This approach has been applied by TECHNOPURE following the removal (ref.:13).

Funnels and casings, asbestos in boilers and connecting systems:	70 t
Asbestos woven electrical cabling:	300 t
Bridge deck insulation:	100 t
DVAC flooring	125 t

The internal memo concludes with an estimate of remaining ACM in the region of 500 to 1000 t of asbestos.

Recent work undertaken on a combined container/ bulk vessel with conventional slow speed two stroke combustion engines as main propulsion of size: 30,000 dwt revealed a total amount of onboard asbestos of 115 m^3. Taken into account the density of asbestos and assuming the materials to which it is mixed have a density of approximately 2 t/ m^3, the total quantity lies in the region of 230 t (plus).

This reference vessel is powered with less than 10% of the power in comparison with the Clemenceau. Further, it has conventional machinery and does not require thermal insulation to the extent in which is the case for a steam turbine power-plant as is the case with the Clemenceau. Neither does it carry a crew by size anywhere near that of the Clemenceau. Therefore, one would expect the Clemenceau to contain considerably larger amounts of ACM, in particular related to the machinery space as well as to the accommodation areas.

Experience regarding the use of asbestos in electrical cabling insulation is inconsistent as some studies consequently refer to this while others do not. However, it is likely that the cable insulation will contain significant amounts of other hazardous materials (PCB, see item 4.4) – thus, all onboard electrical cabling should ideally be analysed. If this is not feasible, all cable insulation should be considered a hazardous waste.

Based on experience and reference input, the following remaining levels of ACM have been estimated;

Type	Remaining ACM
Funnels and casings, asbestos in boilers and connecting systems:	70 t
Asbestos woven electrical cabling	300 t (corresponding to approx 50% of installed cabling)
Bridge deck insulation	100 t
DVAC flooring	125 t

This corresponds to a remaining 595 t of ACM. Including the already removed quantity, the total ACM equals 665 t. Compared to the reference vessel above, this number still seems low.

Taken into account spaces and systems not accounted for such as internal doors, ceiling plates, wall plating, provision stores and refrigerated compartments, deck fittings and equipment, etc. the estimated total remaining ACM in the region of 500 – 1000 t is considered a moderate and not unlikely estimate.

4.4 Polychlorinated biphenyls (PCB)

PCBs are;

- found in a variety of equipment and materials including paints/ coatings, cable/ electrical insulation, thermal insulation material, transformers, capacitors, oils plastics, rubber materials, etc.
- toxic and persistent in the environment. Exposure may lead to adverse health affects.

Chemical reactions following heating of PCBs (e.g. potentially released when burning off PCB-contaminated insulation from cables) may cause the generation of polychlorinated dibenzofurans and polychlorinated dibenzo-p-dioxins. There is an increasing awareness associated to this as these compounds are believed to be more toxic than PCB itself (ref.:/5/).

PCB products are synthetic organic chemicals designed by a manufacturer to impart certain desired properties. These products may come in a solid form or as a liquid. The concentration of chlorine will determine its level of viscosity (high level of chlorine – liquid/ low level of chlorine – solid). This flexibility has allowed PCB to be used broadly in industrial applications.

According to the Basel Convention (ref.:/9/), the threshold value for classifying PCB containing materials as hazardous waste is 50 ppm (corresponding to 50 mg/ kg or 0.005% by weight).

4.4.1 PCB products in ships systems

There are references to PCB sampling analysis surveys undertaken in both the merchant as well as in the naval sector. According to information received, the Clemenceau has not been subject to such sampling.

The US Program Executive Office (Ships) – Navy Inactive Ships Programme (PMS 333) set up in 2002, have recently undertaken the first PCB sampling and analysis programme for an aircraft carrier. Following a US Navy application for exemption from the US EPA Toxic Substance Control Act (TSCA) for using the vessel as an artificial reef, the Navy was requested to undertake an onboard survey including sampling. The TSCA prohibits disposal of PCB of concentrations above 50 ppm.

The vessel, the ex USS Oriskany, was surveyed in 2004 and a report was issued (ref.:/6/).

The ex USS Oriskany has the following specifications (table6);

Table 6: ex. USS Oriskany specification

Year of deployment	1950
Displacement light	27100 t
Displacement (max draft)	40600 t
Length	275.00 m
Beam	40.00 m
Draft	
Propulsion machinery	Steam turbines, 4 shafts, 150000 hp
Boilers	
Capacities, crew	3460
Capacities, aircraft	

In relation to ship type and size, the Clemenceau and the ex. USS Oriskany are compatible. The Oriskany is built somewhat earlier than the Clemenceau. However, there is no evidence suggesting that there should be any major divergences between the two with respect to building practice. Both vessels have steam turbine propulsion systems and approximately the same number of years in operation. Typically for naval vessels, both have been exposed to relatively comprehensive refitting and modifications and assumingly been exposed to a comparable level of upgrading.

Based on the above assumptions, an extrapolation from the results of the ex. USS Oriskany PCB survey may be applied to provide an estimate for PCB concentrations onboard the Clemenceau.

The Oriskany report concludes as follows;

"*The estimate shows that the PCB source term related to electrical cable accounts for 95% of the total PCB loading of Oriskany. The next largest contributor, bulkhead insulation, only* *accounts for 3% of the total PCB load. Moreover, if paint, rubber products, and ventilation gaskets where addressed in terms of a bulk product disposal, they would be unregulated based on their mean concentration, and rubber would only be above regulatory limits at the very conservative 95% UCL of the mean concentration.*"

The report from the PCB assessment of the ex. USS Oriskany is primarily based on PCB concentration data from samples collected onboard. Where data was not directly available for the ex. USS Oriskany, data from surrogate vessels were used to approximate conditions found on the ex. USS Oriskany as closely as possible. These surrogate vessels where selected using a set of predefined criteria to ensure comparability.

Results from the ex. USS Oriskany PCB assessment is summarised in table 7.

Table 7; PCB results following an assessment onboard the ex USS Oriskany

	Mean PCB ppm	95% UCL	Weight (t)*	PCB (kg) $_{mean}$	PCB (kg) $_{UCL}$
Bulkhead insulation	215.1	587.7	52.5	11.3	30.85
Rubber products	*37.3*	*50.9*	*5.4*	*0.2*	*0.3*
Paints	*11.6*	*19.7*	*135.6*	*1.6*	*2.7*
Electrical cabling	1493.9	2766	183.1	273.5	506.5
Ventilation gaskets	*20.3*	*33.5*	*1.2*	*0.025*	*0.04*
Lubricants	60.3	106.8	94.4	5.7	10.1
Sum			472.2	292.3	550.5

*: Category material quantity

UCL. Upper confidence limit

Italic: Unregulated in terms of bulk product disposal as their mean concentration is below 50 ppm.

It may be noted that data from PCB studies in the merchant fleet reports frequently capacitors in light fittings to be the most frequent source of PCB. This source does not seem to have been included in the ex. USS Oriskany assessment. Note further that it is rare to see PCB concentration values above 50 ppm in cable insulation onboard merchant vessels. There may be several reasons for this, one being the age of the merchant vessels assessed compared to the ex. USS Oriskany and the Clemenceau. Another is of course the very different specifications to which the vessels are built.

The data presented in table 7 reflect the standard onboard the vessel at the time it was assessed. The estimate suggests that there were some 472.2 tons of PCB-contaminated material onboard if also addressing the quantity where the PCB concentration (mean) are lower than the 50 ppm threshold limit, There are three sources identified based on the ex. USS Oriskany that should be considered further;

PCB used in;

- Bulkhead insulation;
- Electrical cabling;
- Lubricants;

4.4.2 PCB estimates for Clemenceau based on findings from ex. USS Oriskany

Assuming that the vessels are comparable with respect to building practice, choice of building materials and application, it may be concluded that it is likely that the level of PCB in structure and components are equally comparable.

Vessel size and installed power are determining for structural and systems sizing. It is therefore likely that extrapolation taking into account the two vessels differences in size and power will provide a reasonable indicative figure for the likely amounts of PCB contained in the assessed systems/ structures.

$$^{\text{Displacement C x Power C}}/_{\text{Displacement O x Power O}} = {}^{\text{PCB C}}/_{\text{PCB O}}$$

C: Clemenceau

O: Oriskany

The ship specific data are taken from table 2 and 3.

The estimated volumes of PCB from the assessed sources are presented in table 8.

Table 8: PCB estimates for the Clemenceau based on the ex. USS Oriskany assessment

	Ex. USS Oriskany		**Clemenceau**	
	PCB (kg) $_{\text{mean}}$	PCB (kg) $_{\text{95\% UCL}}$	PCB (kg) $_{\text{mean}}$	PCB (kg) $_{\text{95\% UCL}}$
Bulkhead insulation	11.3	30.85	7.6	20.9
Rubber products	*0.2*	*0.3*	*0.15*	*0.2*
Paints	*1.6*	*2.7*	*1.1*	*1.8*
Electrical cabling	273.5	506.5	184.7	342.7
Ventilation gaskets	*0.025*	*0.04*	*0.02*	*0.03*
Lubricants	5.7	10.1	3.9	6.8
Sum	292.3	550.5	197.5	372.4

UCL. Upper confidence limit

Italic: Unregulated in terms of bulk product disposal as their mean concentration is below 50 ppm.

The estimated aggregated volumes of PCB contaminated materials from the assessed sources are presented in table 9.

Table 9; PCB contaminated material estimates for the Clemenceau based on the ex. USS Oriskany assessment

	Ex. USS Oriskany	**Clemenceau**
	Weight (t)*	Weight (t)*
Bulkhead insulation	52.5	35.5
Rubber products	*5.4*	*3.7*
Paints	*135.6*	*91.7*
Electrical cabling	183.1	123.9
Ventilation gaskets	*1.2*	*0.8*
Lubricants	94.4	63.9
Sum	472.2	319.5

: Category material quantity (contaminated quantity)

4.4.3 Other sources of PCB not considered by the ex. USS Oriskany survey

Fluorescent light tubes fitted before 1980 use PCB-containing capacitors. The content in these are typically 30 mg. They are often marked as PCB containing by the manufacturer and sometimes the quantity is also provided. There is one such capacitor of this type for each light fitting (ref.:/8/).

A merchant vessel of similar length and beam ratios as that of the Clemenceau have typically 600 – 800 such light fittings. Taking into account that a large part of the space onboard such a vessel is dedicated cargo and hence – probably - not particularly well equipped with lighting, it is reasonable to assume that there will be a considerable higher amount of these onboard the Clemenceau (if fitted with fluorescent light tubes). Assuming the concentration is as high as 10 times that of a conventional cargo-carrying vessel of the same type, the amount of PCB arriving from this source is approximately 180 – 240 grams. Capacitors are easily removable without causing any spreading or contamination to surrounding materials.

5 POTENTIALLY HAZARDOUS MATERIALS IN THE SHIPS’ STRUCTURE AND EQUIPMENT

In the following, the estimates produced in chapter 4 are applied in order to provide a likely inventory of Potentially Hazardous Materials in the Ships’ Structure and Equipment. The IMO format (ref.:/12/, Appendix 3; “Inventory of Potentially Hazardous Materials On Board”) has been used. The guiding text to this format reads;

This model inventory is a part of the ship's Green Passport (see section 5) and provides information with regard to materials known to be potentially hazardous and utilised in the construction of the ship, its equipment and systems. It may be supplemented, as appropriate, with technical information in respect of certain categories of potentially hazardous materials listed in this document, particularly with regard to their proper removal and handling."

5.1 1A – Asbestos

Asbestos surveys should always be undertaken by qualified, experienced and well trained surveyors used to working with ships asbestos inventories. All visual findings should be verified by sampling. Table 5-1 presents results based on the assessments undertaken in chapter 4.3 of this report.

Table 5-1: 1A - Asbestos

Type of asbestos materials	Location	Approximate quantity/ volume
Woven mats and underlying insulation material on pipes, (i.e. steam, fuel, oil, hot water, pipes, etc.). There may be a mix of asbestos positive and negative materials. All should be considered ACM. Exhaust pipe lagging, ventilation ducts including fittings, thermal and fireproof fittings. Boilers, boiler drums and casings, heaters, tanks, etc. Asbestos in brick wall and inner insulation lining. Pump rooms – boiler rooms, walls/ ceilings/ floors/ doors.	Engine rooms and machinery rooms; Include zones; 1, 2, 4, 5, 8	70 t – removed asbestos 70 t – ACM remaining in exhaust systems, funnel, etc. An added 15% should be included to account for internal use of asbestos in boiler configuration; Assumed total quantity: Approximately 160 t
Ceiling plates (contain typically 25 – 35% asbestos), wall plates (approx 35% asbestos typically), doors to cabins, dayrooms, offices, etc. in the accommodation. Deck covering, deck insulating material, etc.	Accommodation – these areas include zone 9 and 10	Asbestos in floorings was estimated at 225 t (top surface including deck insulating material). It is assumed that this is located primarily in the accommodation area. An added 20% should be included to account for doors, floors, walls, etc. Assumed total quantity: Approximately 270 t
Steam supply piping including electrical systems, pipings outside machinery spaces, tank cleaning systems (limited), etc. Brake linings, etc.	Deck – these areas include zones 3, 6 and 7 Machinery components	Asbestos in electrical cabling is estimated at 300 t. This figure may be uncertain due to inconsistency in experiences from asbestos used in cables. However, there is strong evidence that all cabling from this area contain hazardous materials and should be treated likewise. An additional 10 % should be

		included to account for piping systems, asbestos in deck machinery, etc. Assumed total quantity: Approximately 330 t

Total quantity of asbestos or ACM that may be onboard has been assessed and found to be in the order of: 760 t.

5.2 1B – Paint on vessel's structure

Paint samples from the superstructure, decks, topsides, holds, inner structures, etc. should be taken and analysed with focus on PCB and heavy metals. In addition, the antifouling paint should be analysed for the presence of TBT.

Table 5-2: Paint on vessels structure – Additives

Additives (lead, tin, cadmium, oreganotins, (TBT), arsenic, zinc, chromium, strontium, others.	**Location**
Likely components in the ships coatings and paint systems will to some extent represent the products used through history from the 1950s. In addition to the above mentioned components, one would expect to find residues of chlorine compounds and phosphates of calcium and zinc. As primers tended to be that of lead-based at the time, one would expect larger quantities of lead. Copper will also be present TBT will be present together with other biocides in all wetted surfaces.	All shipboard surfaces will have been coated. Surfaces with strong colouring will typically contain larger concentrations of copper and zinc. Chromium will not have been used in areas subjected to water. Some paints may contain PCB with concentration values above the 50 ppm threshold limit. Paints used in the 1970s and later only rarely have traces of this. Practice from the 1950s is uncertain. .

5.3 1C – Plastic materials

Due to insufficient data, an estimate on plastics have not been undertaken. One would however assume a large quantity of such materials to remain onboard even though one may also assume that a number of plastic material sources have been removed. Remaining sources may be seals, gaskets, flooring (vinyl), life saving equipment, etc.

5.4 1D – Materials containing PCB, PCTs, PBB at levels of 50 mg/ kg or more

According to the Basel Convention (ref.:/9/), the threshold value for classifying PCB containing materials as hazardous is set at 50 mg/ kg. The presented estimate has been produced by extrapolation using detailed data arriving from a representative vessel of similar characteristics built in the same era taking into account variations related to size and power installation. The results are presented in table 5-4.

Table 5-5: Materials containing PCB at levels of 50 mg/ kg or more

Material	Location	Approximate quantity/ volume

Bulkhead insulation	Throughout the vessel	35.5 t (97.6 t)
Electrical cabling	Throughout the vessel	123.9 (229.2 t)
Lubricants	Machinery areas including boiler rooms	63.9 (127.8 t)

Based on this assessment, the total amount of PCB-containing material above the threshold limit (50 ppm) is found to be in the region of 225 t. It may be assumed that lubricants have been removed, leaving the estimated remaining quantity at approximately 165 t.

Note that the approximate quantities have arrived from data samples treated statistically. Mean values have been applied. The numbers presented in brackets represents the 95% upper confidence limit. By applying this approach, the estimate increases by a magnitude of approximately 2. A more likely estimate lies somewhere between the two.

5.5 1E – Gases sealed in ships' equipment or machinery

Gases sealed in ships systems are often related to refrigerating systems, stores, etc. This vessel was decommissioned in 1997. It has therefore been assumed that any gas will have been removed. Refrigerating systems onboard ships will leak. In the case that these gases have not been removed, it is still likely that most have leaked out. However, a proper inventory survey should be undertaken to verify the amounts of gas onboard if any. See also chapter 3.2.1 above.

5.6 1F – Chemicals in ships' equipment or machinery

The same comments as for 1E applies.

5.7 1G – Other substances inherent in ships' machinery, equipment or fittings

This vessel was built in an era since when shipbuilding practices have been radically changed. One may note that the instrument referred to in this chapter and used to present likely onboard substances and quantities, was developed for the disposal procedures as found relevant for the merchant fleet. Most merchant vessels built in the 1950s have already been disposed of and hence, some considerations should be made as to the feasibility of using this instrument.

Due to its particular operations, there may be some systems that should be considered more comprehensively. However, the need for this can only be considered during an on board survey.

6 REFERENCES

/1/ Decommissioning of Ships – Environmental Standards; Third Party Environmental Verification Ship Decommissioning (ENVER), DNV Report no.: 2000-3157

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/3/ Proposal for a new legally-binding instrument on recycling of ships. (Submission to IMO MEPC 54 by Norway, MEPC 54/3

/4/ Comparison of Key Issues in the ILO, IMO and BC Ship Scrapping Guidelines) (ILO, IMO, BC 2005)

/5/ Technological and Economic Feasibility Study of Ship Scrapping in Europe, DNV report no.: 200-3527 (Commission of the European Communities, 2001).

/6/ Polychlorinated biphenyls (PCB) Source Terms Estimates for ex-Oriskany (CVA34), by CACI International Inc. (www.caci.com) on behalf of the Program Executive Office (Ships) Navy Inactive Ships Program (PMS 333) (December 2004)

/7/ Asbestos survey report by TECHNOPURE marked: PA04/00423-00)

/8/ Decommissioning of Ships – Environmental Standards. Ship breaking practices / on site assessment – Bangladesh – Chittagong, DNV report no. 2000-3158 (MARMIL – Norwegian Research Council/ Norwegian Shipowners Association)

/9/ Basel convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel, 1989)

/10/ Post asbestos survey report, Oriskany

/11/ Report from TECHNOPURE; Document reference: PA 04/00423-00, dated January 13, 2004

/12/ IMO Guidelines on Ship Recycling (IMO, 2003)

/13/ Internal memo from Eric Baudron to Jean Claude Giannino of TECHNOPURE dated march 7, 2005

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