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SABITA REPORT

Situation assessment report towards classification and delisting of penetration grade Bitumens

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REPORT



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Executive Summary

Golder Associates Africa (GAA) was appointed by SABITA to undertake a study with the overall objective of resolving the current constraints in respect of the classification and disposal of penetration grade bitumen. This Report presents phase 1 of this study and consists of a situation assessment to establish a clear understanding of the legal and classification aspects that needs to be addressed in order to find a solution for the disposal of penetration grade bitumen.

The situation assessment by Golder included the evaluation of a Report titled "Evaluation of the Classification and Disposal Options for Penetration Grade Bitumens" by Africon *et al*, of national and international approaches towards the classification of hazardous waste and of the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA).

Based on the situation assessment the following conclusions are presented:

- Since the TCLP extractable Lead (Pb) for two (A and D) out of the four samples (A,B,C and D collected from each of the four manufacturing plants in South Africa) is close to the detection limits of the analytical instrumentation that has been used by the laboratories that did the analysis for Africon *et al*, the following emerges:
 - The extent to which two analytical values of 0.12 and 0.11 mg/l of samples A and D respectively (i.e. 50% of the samples) exceeds the Acceptable Environmental Limit (AE) for Pb ($AE_{Pb} \leq 0.10$ mg/l) is of no significance due the closeness of these values to the analytical instrument's detection limit of 0.10 and other analytical uncertainties (e.g. appropriateness of the methodology used to determine the detection limit and general operating error). A false positive result may have occurred.
 - Due to increased uncertainty of results close to the detection limit, analysis of the four samples cannot with acceptable confidence detect increases of 0.01 and 0.02 mg/l.
 - Due to the insignificance of the two Pb analyte values of 0.11 and 0.12 mg/l in the context of instrumental detection limits and analytical variation, these two values could be accepted as close enough to the AE of 0.10 mg/l to be regarded as equal to the AE (especially since the other two samples B and C were reported as below the detection limit of the analytical instrument).
 - In terms of the South African hazardous waste classification system as based on the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF, 1998) and accepting that the Pb in the other two bitumen samples does not exceed the AE for Pb (for reasons presented above) it is submitted that the bitumen samples is not hazardous and that the bitumen waste under consideration can be disposed of at legally compliant waste disposal sites in South Africa, provided that all occupational health stipulations and the permit requirements for a specific site is met.
 - As an alternate to reasoning to the submission that 50% of the samples show a variation of insignificance in relation to the AE of Pb and hence that the Pb concentrations in these samples are equal to or less than the AE of Pb, is to representatively resample at the four bitumen manufacturing processes in South Africa and to reanalyse at laboratories using lower detection limits of 0.05 mg/l Pb.
- Based on the international approach towards the classification of bitumen not containing tar (Basel Convention, European Waste Catalogue US EPA Solid and Hazardous Waste Exclusions, Australia's Hazardous Waste (Regulation of Exports and Imports) bitumen is classified as non hazardous.
- When the TCLP extractable Pb is compared to the AE for Pb as detailed in the draft Third Edition Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF,



2005) (based on latest toxicological information) as well as the Regulatory Limit of the USEPA for Pb, all the bitumen samples are classified as non hazardous.

- The secondary environmental risk assessment done by Africon *et al* in the Report titled “Evaluation of the Classification and Disposal Options for Penetration Grade Bitumens”, also indicate that the Pb concentrations observed in the bitumen samples will not have a negative impact on the receiving environment should it be co-disposed on landfill in the General Disposal Site Class.
- It is therefore recommended as follows for consideration by SABITA:
- The Departments of Environmental Affairs and Tourism (DEAT) and of Water Affairs and Forestry(DWAF) are approached through formal submission with all supporting motivation to endorse the classification of non penetration grade bitumen as non-hazardous (GAA can prepare the required documentation for submission under a SABITA letterhead) .
- Re-sampling and reanalysing are considered especially should DEAT and DWAF insist on such route to be followed.
- SABITA’s documentation on “Health, Safety and Environmental Guidelines for Bitumen and Coal Tar Products”, 1998 is updated to appropriately encompass information collated in this study and relevant previous investigations, studies to the extent of reflecting the Duty of Care principle contained in South African Environmental legislation.



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1.0 INTRODUCTION

The three companies, Africon, Environmental and Chemical Consultants and Infotox completed a report on the "Evaluation of the Classification and Disposal Options for Penetration Grade Bitumens" for the South African Bitumen Association (SABITA) in April 2003. The objective of this study was to classify penetration grade bitumen from the four manufacturing plants in South Africa in accordance with the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF, 1998) and to determine the class of landfill required for disposal.

It was concluded in the Africon *et al* Report that all the penetration grade bitumens delist which implies that penetration grade bitumen waste can be disposed of on authorised General waste landfills with an engineered leachate management system; provided that the loading rate, as has been used in the delisting calculation is not exceeded.

In response to these findings, Africon has applied and obtained delisting approval from DWAF on behalf of their client SABITA. However, despite dedicated further attempts by Africon to identify a sufficient number and spatially strategically located GB+ and GB- sites, and to obtain the required co-operation from the permit holders responsible for the selected sites, showed unsatisfactory progress due to constraints beyond Africon's and SABITA's control.

Golder Associates (GAA) were subsequently contracted to undertake a situation assessment and based here on, to determine the most appropriate course of action to resolve the current constraints in respect of the classification and disposal of penetration grade bitumen.

This document presents phase 1 of the Situation Assessment and presents recommendations for SABITA's consideration as based on a number of conclusions drawn from the assessment.

2.0 PROJECT OBJECTIVES

The overall objective of this project was to resolve the current constraints in respect of the classification and disposal of penetration grade bitumen, following a phased approach:

- ❖ Phase 1: A situation assessment to establish a clear understanding of the factors within the current and eminent legal framework, classification and delisting policy that need to be addressed to resolve the constraints regarding the classification and disposal of penetration grade bitumen; and
- ❖ Phase 2: Based on the situation assessment, develop an optimum course of action in consultation with SABITA. This will enable SABITA to contribute strategically in approaching the relevant Government Departments and/or Disposal Site Permit holders to apply for the required approvals / authorisation / permissions in relation to resolving the bitumen disposal problems.

3.0 SCOPE OF WORK

The scope of work for Phase I situation assessment entailed the following:

- ❖ Meeting with SABITA to discuss the proposed approach in more detail and to provide a clear focus for the project;
- ❖ Identifying the documentation that would need to be scrutinised and ensuring that gaps in information is appropriately resolved;



- Assessing and analysing the documentation; and
- Producing a Situation Assessment Report (this report) on the findings of the assessment.

4.0 CONTEXT

The conclusion and hence recommendations contained in this Report is based on information available to GAA which primarily includes the Report from Africon et al titled "Evaluation of the Classification and Disposal Options for Penetration Grade Bitumens" in April 2003.

In this Report the consultants (Africon *et al*) does not express itself on sample representivity or the analytical methods employed.

This Report therefore represents first statements on the available information for consideration by SABITA in order to select an appropriate course of action based on the recommendations presented herein.

5.0 HAZARD RATING BASED ON AFRICON REPORT, "EVALUATION OF THE CLASSIFICATION AND DISPOSAL OPTIONS FOR PENETRATION GRADE BITUMEN"

Bitumen is an end product of the refinery process of crude petroleum, other than tar which is derived from the pyrolysis of coal. Bitumens are complex mixtures containing a large number of chemical components of relatively high molecular weight, typically 82-85% combined carbon, 12-15% hydrogen, 2-8% sulphur, 0-3% nitrogen and 0-2% oxygen (Asphalt News, 2005).

Penetration grade bitumen is a viscous, non-volatile liquid, significantly distinct from other volatile substances like acetone, benzene, petrol, toluene, diesel and paraffin, with a flash point of > 230°C.

As a result of a SABTA's initiative, penetration grade bitumen compliant with SABS 307 has been re-classified for road transportation by Standards South Africa from UN 1999: TARS LIQUID; Class 3 and will now fall within the requirements of UN 3257: ELEVATED TEMPERATURE LIQUID, N.O.S.; Class 9.

5.1 Hazard rating of penetration grade bitumen

The hazard rating of penetration grade was addressed a Report on the "Evaluation of the Classification and Disposal Options for Penetration Grade Bitumens" in April 2003.

Samples of penetration grade bitumen from the four manufacturing plants in South Africa was analysed by an accredited laboratory on and the classification done in accordance with the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF, 1998) in order to determine the class of landfill required for disposal. Uncertainty exists whether all laboratories used were accredited since it appears that a subcontracting laboratory may have been used in one instance.

The sample analyses included TCLP extract with analyses of a wide range of inorganic and organic analytes.

The Minimum Requirements require a primary classification of the cold bitumen according to SABS Code 10228. Since the samples were not flammable (the flash point is >61°C), corrosive (the pH is >6 or <12) or reactive, the only possible hazardous characteristic is that of toxicity, which is determined by comparing the



concentrations of any inorganic or organic components leached with the acceptable environmental limit (AE) for any leached constituents.

The analytical results indicated the following:

- Toluene was the only organic constituent detected in the TCLP extract, but at concentrations close to the detection limit of 1 mg/l and well below the AE of 1.2 mg/l. It was thus concluded that no organic compounds leached from the samples that can have a significant impact on the environment; and
- Two of the penetration grade bitumen samples leached Pb at concentrations slightly exceeding the AE of 0.10 mg/l, resulting in HR2 hazard rating in terms of the Minimum Requirements.
- The other two samples formally classified as non-hazardous in terms of the Minimum Requirements.

Based on this information, the Africon study concluded that penetration grade bitumen can be delisted for disposal to medium or large general waste landfills that have a leachate management system, i.e. GMB+ or GLB+, provided the estimated environmental concentration (EEC) is less than the AE of Pb.

6.0 DISCUSSION

6.1 Representivity of samples

It appears that only one sample (excepting sample A) of penetration grade bitumen was collected from each of the manufacturers for analyses. The Africon *et al* report is silent on the method followed during sampling which makes it difficult to assess the sample representivity against the background of potential variability in bitumen quality over time due to process or feed change that may occur.

It is believed that sample representivity does not only have scientific relevance, but is of further importance due to the logistic, financial and other implications to SABITA members as a result of the ultimate of the ultimate classification of penetration grade bitumen. Blind duplicate samples would also have ensured enhanced accuracy of laboratory data at the time of analyses.

The difference in results obtained from the laboratory used for the study, especially the difference in detection limits, is also a source of concern, especially since the Pb concentration is close to the detection limit. Representative re-sampling and reanalyses using accredited laboratories which uses analytical methods with lower detection limits (which are verified using suitable methodology), could provide the required scientific certainty and could reveal and hence confirm that penetration grade bitumen can be classified as non hazardous.

6.2 Pb present in bitumen samples

According to the Minimum Requirements, Second Edition (DWAF, 1998) the AE for Pb is 0.1 mg/l, derived from a LC50 of 1 mg/l, while the acceptable exposure (AE) in the Third Edition of the Minimum Requirements is 0.12 mg/l. Although the Minimum Requirements Third Edition was not published for use, the toxicological and human health data detailed in the document is considered to be the most up to date information. Based on this information, all the bitumen samples could be classified as non hazardous.

The USEPA classification of hazardous waste (as defined in 40 CFR Part 261), based on TCLP extracts, has a regulatory level for Pb of 5 mg/l, much higher than the AE used in SA. Only if the TCLP extractable Pb in the waste exceeds this level, a waste is classified as hazardous.



Based on this assessment, penetration grade bitumen can be classified as non hazardous due to low leachable Pb and other Chemicals of Concern (COC) concentrations in the TCLP extract.

7.0 CLASSIFICATION OF PENETRATION GRADE BITUMENS BASED ON INTERNATIONAL CLASSIFICATION SYSTEMS

A brief research of international classification systems in respect of bitumens revealed the following:

7.1 Basel Convention

In terms of the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal waste from the production or processing of petroleum coke and bitumen are classified as hazardous waste (List A3: Wastes containing principally organic constituents, which may contain metals and inorganic materials, number A3010).

Bituminous material (asphalt waste) from road construction and maintenance, containing tar (A3200) is also classified as hazardous while bituminous material (asphalt waste) from road construction and maintenance, not containing tar is classified as non hazardous (B2130).

7.2 European Communities

In the European Waste Catalogue (Commission Decision 2000/532/EC) bituminous materials (section 05 01 17) and bituminous mixtures, other than those containing coal tar (section 17 03 02) are classified as non hazardous.

7.3 US EPA

The US EPA Solid and Hazardous Waste Exclusions (40 CFR Section 261.4) only considers bitumen produced from the refinery of coal tar as Coke by-product wastes (Section 261.4(a)(10)) and not bitumen derived from crude petroleum.

EPA based its decision to exclude coke by-product wastes on the fact that recycling these wastes did not have a significant effect on the chemical composition of the products. Further, coke by-product residues are often managed as raw materials rather than wastes, thereby reducing the risk posed to human health and the environment because the material has an intrinsic value that promotes its safe management.

7.4 Australia

In Australia's Hazardous Waste (Regulation of Exports and Imports) Act 1989, Act No. 6 of 1990, waste from the production or processing of petroleum coke and bitumen are classified as hazardous waste (wastes containing principally organic constituents, which may contain metals and inorganic materials). However,



bituminous material (asphalt waste) from road construction and maintenance, not containing tar is classified as non hazardous.

7.5 Globally Harmonised System of classifying and labelling chemicals (GHS)

This system is considered in this report since the indications are that the South African Hazardous Waste Classification System, which is currently under revision, may be aligned with the GHS system.

Many countries have participated in the last 10 years to develop a “Globally Harmonised System of classifying and labelling chemicals (GHS)”, to “promote common consistent criteria for classifying chemicals, and developing compatible labelling and safety data sheets. The goal of GHS is to identify the hazards of chemicals and to convey information, statements, symbols and safety data sheets and criteria in a harmonised integrated hazard communication system.

Unfortunately and based on the information available to date, GAA was unable to find any evidence of the GHS system that has been amended to provide for the disposal of hazardous waste, excepting for New Zealand where such an amended GHS has been developed and adopted.

8.0 SOUTH AFRICAN LEGAL APPROACH FOR HAZARDOUS WASTE CLASSIFICATION

8.1 Definitions

The South African Government’s strategic and visionary approach towards waste management is the definition of waste in the National Environmental Management: Waste Act, 2008 (Act 59 of 2008):

“Waste” means any substance, whether or not that substance can be reduced, reused, recycled and recovered, that –

- i) is surplus, unwanted, rejected, discarded, abandoned or disposed of;
- ii) the generator has no further use of – for the purposes of production, reprocessing or consumption;
- iii) that must be treated or disposed of; or
- iv) is identified as a waste by the Minister.

“hazardous waste” means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment.

This definition implies that in the case of the penetration grade Bitumens, proving that the impact on health and the environment is not detrimental, is determinant in demonstrating that Bitumens in terms of NEM:WA is non hazardous. In this respect AE as well as the secondary environmental risk assessment provides for the appropriate procedural mechanisms to demonstrate environmental acceptability. Both these approaches are addressed in this Report.



8.2 Waste classification

Bitumen waste per se is not specifically classified as hazardous waste in South Africa. However, the Minimum Requirements require a primary classification of the cold bitumen according to SABS Code 0228.

Since penetration grade bitumen is not flammable, corrosive or reactive, the only possible hazardous characteristic is that of toxicity.

The Minimum Requirements outline a comprehensive approach to the classification of the toxic characteristic of a potentially hazardous waste. In this context the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste applies a classification system developed on similar criteria such as the 9 classes of SANS 10228, and takes into account the toxicity (LD50), ecotoxicity (LC50), carcinogenicity, mutagenicity, teratogenicity, persistence, environmental fate and Estimated Environmental Concentration (EEC) of the waste.

Four samples of penetration grade bitumen from the major manufacturing companies and South Africa have been analysed to determine its hazardous characteristics. Based on these results, 2 samples tested non hazardous while the other 2 samples had a HR2 rating based on slightly elevated Pb concentrations in the TCLP extract (0.11 and 0.12 mg/l respectively) exceeding the AE of 0.1 mg/l which is also the analytical detection limit for Pb as presented in the report. If the AE for Pb detailed in the Third Edition Minimum Requirements are used, all the samples classify as non hazardous. Since the toxicological data in the Third Edition is the most up to date, it is recommended that this data be used to classify the bitumen.

8.3 Demonstrating that the environmental impact of leachate from Bitumens does not detrimentally affect the environment

In order to determine the amount of the hazardous substance(s) (in this case Pb) that may leach and migrate from the disposal site, over indefinite time, this concentration of hazardous substances is expressed as EEC and determined by site specific or fixed-scenario risk assessment or both.

In the fixed scenario risk assessment, which is a simplified risk based approach, it is assumed that the total mass of a hazardous substance disposed of on one hectare of a disposal site will leach into one hectare groundwater with a depth of 15cm underlying the disposal site. This amount is expressed as the EEC. This approach is derived from techniques used by the USEPA for determining an aquatic EEC. This definitive body of water is an assumption and forms part of the precautionary approach and presents a worst case scenario. Of importance, however, is that the acceptable exposure level may not be exceeded in this body of water.

In the case of a site specific risk based approach to determine the EEC, account are taken of all site specific attenuation factors, such as waste treatment, mode of site operation, climatic conditions and engineering attributes in the form of covers, liners and leachate interception. This approach is very expensive and time consuming and being site specific does not present a feasible option for the SABITA study.

According to the Minimum Requirements, waste may delist if the EEC is equal to or less than one tenth of the LC50 for that specific substance, based on the fixed scenario approach. The EEC of the substance in the waste is calculated in grams disposed of per hectare per month multiplied by a factor of 0.66. Therefore, $EEC (ppb) = g/ha/month \times 0.66$.

Delisting is when a hazardous compound in a waste moves from a specific risk group to a lower risk or 'non-risk' group. It does not become a non-hazardous compound, but the associated risk declines to a risk, which is smaller or even acceptable. Delisting is regulated by the most hazardous contaminant in a waste stream.



The EEC of such a most hazardous contaminant must be compared to the AE to determine whether such a waste stream will delist or not. Delisting criteria is as follows:

- $>0.1 \times \text{LC50}$ = Risk - Remain in Hazard Rating class
- $<0.1 \times \text{LC50}$ = Risk - HR1 remains in H:H landfill site
- = No Risk - HR2, HR3 & HR4 can delist to G:B+ landfill site
- $<0.01 \times \text{LC50}$ = No Risk - All Hazard Ratings can delist to G:B+ landfill site

Note that Hazard Rating 2, 3 and 4 compounds delist when EEC is $<$ AE, but due to the presence of carcinogens and teratogens in Hazard Rating 1, compounds in this group will only delist when the EEC is less than $0,1 \times \text{AE}$.

Treatment of a contaminant may change its properties, for example mobility, which will affect leachability into the environment. Tests used to prove this would include the "Toxicity Characteristic Leaching Procedure" or the "Acid Rain" test.

Assuming that samples B and D do not contain Pb at concentrations exceeding the AE value of 0.10 mg/l (as debated earlier in this document) it could be stated that no element in these samples will leach above its acceptable environmental value which will render samples B and D not hazardous. The validity of this statement is based on the intrinsic toxicological characteristics of Pb

Similarly the total load as based on the estimated environmental concentration and calculated in the Africon *et al* Report would serve as an upper limit not to be exceeded in terms of the total load of Bitumens disposed of per hectare of a disposal site in order to ensure that the effect of the leachable portion of Pb from Bitumens does not detrimentally affect the environment. Following this approach penetration grade bitumens could be regarded as non hazardous based on the definition of hazardous waste as reflected in NEM:WA.

8.4 Secondary environmental risk assessment

In the report on the "Evaluation of the Classification and Disposal Options for Penetration Grade Bitumens" (April 2003) a site specific risk assessment was also conducted. Since Pb was the only constituent of concern in the TCLP extracts of the bitumen samples, it was the only constituent considered in the risk assessment.

Lead is a widespread pollutant in South Africa and in other countries, largely because of the use of lead alkyl compounds in petrol. Elevated concentrations of lead have been observed in soils alongside roads and in dust and dirt accumulated in car parks and other heavy traffic areas. Lead in soil is relatively immobile; therefore soils represent a major environmental sink for lead and its compounds. The immobilisation in soil is promoted by complexation with organic matter, carbonates, sulphates and phosphates.

In a landfill environment, particularly in a co-disposal landfill, significant amounts of organic matter are present, which together with large amounts of sulphate, carbonate and to some extent phosphate, tend to immobilise lead. According to the Minimum Requirements, general waste must be covered on a daily basis in order to minimise odours and vermin. Normally the cover material of choice is soil: the quantities of soil tend to be about 25% to 33% of the total material landfilled. Thus, there are large amounts of soil in a landfill that can absorb lead and render it immobile.

The TCLP tends to favour the dissolution of Pb, when present in a waste, because of the high concentration of acetate and acetic acid at the leach solution pH of 4.93 ± 0.05 , whereas in landfill the higher pH values of the leachate and the other factors discussed above would limit the mobility of the element. When bitumen wastes are disposed to landfills, the amount of lead that could leach is small, particularly when compared to



other lead containing wastes and, therefore, the environmental risk posed by such a disposal route is extremely low.

From this assessment it can be concluded that penetration grade bitumen can be disposed on general landfill.

9.0 CONCLUSION

The Minimum Requirements approach toward hazard rating showed that the leachable Pb concentration are only just above the AE (DWAF, 1998), which is very close to the assumed detection limit for Pb (0.1 mg/l). When the TCLP extractable Pb is compared to the AE for Pb detailed in the Third Edition of the Minimum Requirements (based on latest toxicological information) and the Regulatory Limit of the USEPA, all the bitumen samples are classified non hazardous.

The secondary environmental risk assessment also indicate that the Pb concentrations observed in the bitumen samples will not have a negative impact on the receiving environment should it be co-disposed on landfill.

The international community also classify bitumen derived from crude petroleum and bituminous materials (asphalt waste) as non hazardous.

In summary: an assessment of the analyte concentrations for the COC's i.e. Pb as contained in the Africon *et al* Report shows that due to the potential for analytical error all four Bitumens sample could be regarded as non hazardous. It is however submitted that this statement could only be conclusively verified by statically resampling and reanalysing at appropriate accredited laboratories.

In the wider context of considering aspects such as international classification systems, the Third Edition for Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF, 2005) and the secondary environmental risk assessment, the exceedance of the AE value of Pb in sample B and D by 0.01 and 0.02 respectively becomes of diminished importance in classifying bitumens.

On the weight of evidence it is submitted that enough information exists to approach DWAF and DEAT for their support to classify penetration grade bitumens as non hazardous.

10.0 PROPOSED WAY FORWARD

It is recommended that SABITA and GAA, SABITA approach the Departments of Environmental Affairs and Tourism (DEAT) and of Water Affairs and Forestry to conclude on the classification of penetration grade Bitumens.

The following is therefore submitted as part of the way forward for consideration by SABITA:

- The Departments of Environmental Affairs and Tourism (DEAT) and of Water Affairs and Forestry(DWAF) are approached through formal submission with all supporting motivation to endorse the classification of non penetration grade bitumen as non-hazardous (GAA can prepare the required documentation for submission under a SABITA letterhead) .
- Resampling is only considered should DEAT and DWAF insist on such route to be followed.
- SABITA's documentation on "Health, Safety and Environmental Guidelines for Bitumen and Coal Tar Products", 1998 is updated to appropriately encompass information collated in this and relevant



previous studies to the extent of reflecting the Duty of Care principle contained in South African Environmental legislation.

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APPENDIX A

Document Limitations



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