



The 7 Most Endangered 2014

Programme run by **Europa Nostra**,
the Voice of Cultural Heritage in Europe,
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Carillons of the Mafra National Palace, Portugal

Report

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1. Summary

The project concerns the restoration of the carillons and associated bells and clocks in the two bell towers of the Basilica of the National Palace at Mafra, situated some 40 km north-west of Lisbon.

The National Palace, built between 1717 and 1730 by King João V, comprises a series of majestic buildings with a fine Basilica as its centre-piece. The Basilica has a strong musical tradition with its unique six organs which are played together, and its carillons and bells in the towers.

The carillons and bells no longer function and are in such a state of disrepair that they are currently blocked and supported by scaffolding to prevent danger to the public below. The equipment is on four floors, with on the first floor the clocks, the second floor the carillons, above that the large swinging bells and on top the clock bells. All these were installed in 1730 and were at the time state-of-the-art, the best Europe could produce. The north and south towers have the same equipment but provided by different suppliers and so are different in detail.

The project is to repair and secure the bells and bring as many as practical back into service. The clocks are in relatively good condition and can be restarted with the addition of a motorised winding system. The carillons will be restored so that the south tower carillon can be played but the north tower carillon will be kept as a museum piece (it is tuned differently, and so historically of interest). The large swinging bells will be repaired to ensure their safety but the cracked bells (ten out of eleven) will not be repaired, so only one bell will be able to ring. At level two, the timber structure supporting the carillons will need major repairs as the material has decayed mainly due to excess humidity and this is particularly so in the south tower. The swinging bells timber support may also need attention. The larger clock bells will be restored similarly to the swinging bells but here only one of the six bells is cracked. Some maintenance repairs to the towers will also be done.

The programme proposed, with some minor concerns, is appropriate and has been well studied by experienced engineers and musicologists. The Ministry of Cultural Heritage is responsible for the works and will administer the contracts through its technical department. The main concerns are how to undertake the repair works with these heavy bells at height, and optimising the pre-contract information to reduce subsequent contract risk.

The programme is estimated to cost about 1.9 M Euro for the works base cost with a total financial need of 2.5 M Euro. Works could start by end 2015 with completion in mid-2017.

Finance should be sought from European Union funds such as the grants for regional development (ERDF) and to be supplemented by national and municipal sources.

This is a very worthwhile initiative which builds on the already strong attraction of Mafra with its Palace, Museum, Library and Basilica and important musical heritage. It is a relatively modest investment which will allow the carillons to be restored and the clocks and some of the bells to operate. Some suggestions are made to improve the outcome, by adding minor works and carrying out a further study into the timber structure pre-contract.

Overall this is an excellent project and to be supported.



2. Purpose, location

To restore the carillons and associated bells and clocks in the bell towers of the Basilica of the Palácio Nacional at Mafra (PNM).

Mafra is situated some 40 km north-west of Lisbon.

3. Context

The National Palace complex comprises a series of majestic buildings mostly constructed between 1717 and 1730 at the initiative of King João V. The central building is a fine Basilica in the Baroque style with a dome and two towers which house the carillons, the bells and the clocks. The Palace itself encompasses the Basilica and provides a long impressive façade facing the town. Behind this façade the Monastery buildings provided space for some 300 monks including dormitories, a hospital and a large library with a fine collection of 15th and 16th century books. The whole provides a wonderfully coherent series of buildings, embellished with excellent sculptures of Carrera stone by Italian and Portuguese sculptors.

The Monastery buildings are now mainly occupied by the Army as a training college and the Palace section is equipped as a museum showing the King's and Queen's apartments and their paintings and furniture. The Library is of particular importance and active with its unique and large collection of treasures which are open to the public and researchers. It is hoped in the future to rationalise the space used by the Army to allow visitors to see more of the buildings and to facilitate the visitors' circuits.

The Basilica itself is exceptional with a fine balanced design. It has a great musical tradition as it has six organs installed around the transept and these can be played together. This is unique in the world. The organs have been renovated recently and are played regularly attracting a large audience.

The two towers of the Basilica are some 50 metres high and have four levels. The lowest level houses the carillon equipment and the clocks, the second level the carillon bells, the third level the liturgical "swinging" bells, and the top level the large clock or hour bells.

The clocks are different with the north one having a "Roman" face with 6 hours and the south one the normal 12 hour face, both with an hour hand only. Both clock mechanisms were state-of-the-art when they were installed and have charming bronze statues embellishing the works. The clocks are activated by weights which need to be manually hoisted. The clocks operate the hour bells and also activate the carillon bells with a variety of chimes with several tracks stored on two cylinders in each tower. As well as the automatic system described above, the carillons can be played through a manually operated keyboard.

The condition of the clocks and the base mechanism for the carillons are relatively good, but all have suffered from neglect and lack of maintenance. The north tower carillon was extensively damaged during the revolution in 1910 and has not been played since.

The carillon bells are housed on the second floor above the operating mechanisms.



The south tower houses the carillon, made and installed by the famous Antwerp bell maker Guillaume Witlockx in 1730 and is the most complete Witlockx carillon in existence. It initially comprised 47 bells, the heaviest weighing 9.6 tonnes. It had a major overhaul and was retuned in 1986 by the Dutch firm Eijsbouts when 6 new bells were added. One small bell is cracked but otherwise the bells themselves are in good condition.

The north tower's carillon was made and installed by Nicolau Levache of Liege also in 1730. Originally it had 46 bells with the heaviest being 9.6 tonnes. It is virtually in its original state as constructed with only one bell missing, which was later replaced but is now cracked. Four bells were added later, doubling the existing bells thus retaining and not extending the musical range of the carillon. These bells have been little used and are generally in good condition but with some elements (e.g. hammers, clappers) missing. The carillon system associated with the bells is badly damaged and unusable as noted above.

The swinging bells operate on the third floor of both towers. There are 11 in all, with four in the south tower and seven in the north. Again the heaviest bell weighs 9.6 tonnes and all were installed in 1730, six being by Nicolau Levache. The heaviest bell was recast in 1830 and is the only one that is not cracked. These cracked bells would need to be replaced or recast before tuneful use.

The clock bells are placed on the top floor and ring the hour and the quarters. The hour bells, one in each tower, weigh 12 tonnes and are the largest bells in Portugal. Five of the six bells were cast and installed by Levache. The bells are in good condition but as the clocks do not work, neither can they.

The towers are built of masonry with an additional timber support structure for the bells. The masonry structure is sound, robustly built at the time as was the remainder of the Palace, which is also in good general condition. The structure has not been damaged by any of the serious earthquakes (e.g. in 1755) and is generally considered to be adequately designed to resist future seismic events. The towers have lightning conductors installed in about 1780 and so were pioneers in this field; the towers have been struck in the past and so the system has operated effectively, although it is now in need of some repair.

The timber structure has suffered despite being built of Brazilian hardwood. The tops of the towers are exposed to the elements and being not far from the coast are in a relatively aggressive maritime environment. Timber sections have rotted and some have broken and moved and the situation is precarious and unsafe in some places. The situation is particularly severe in the south tower, partly because of its extra exposure to the elements but also due to inappropriate repairs. The timber has been treated with an epoxy based sealant which trapped moisture in the wood, thereby encouraging deterioration. The risk of partial collapse has obliged the authorities to support the main bells with scaffolding and to provide safety nets to catch any falling debris, both from the timber frame and from the corroded bells and their clappers and hammers. It is noted that the cost of providing the scaffolding is significant at some 35 000 € per annum.

The case for action to stabilise, repair and renovate the bells has been well recognised by all concerned at local, regional and national level.



4. Description

The programme of works comprises restoring to the extent practicable the equipment housed in the towers of the Basilica such as the clocks, the carillons, the swinging and clock bells and other associated works. In more detail, which may still need refining:

Restoring the Clocks:

The clock mechanisms in both towers to be brought back into operation with repairs as necessary and the connections to the hour bells to be restored.

Restoring the Carillon bells:

The 103 Carillon bells in both towers to be inspected and renovated. Most will be lowered to the ground and stored or moved to the repair shop but some may be able to be treated *in situ*. The works to include all elements of the suspension and percussion of each bell such as the crowns, bolts, hammers and the wooden headstocks.

Two small bells, which are cracked, to be recast and then replaced.

The connections of the bells to the playing systems to be replaced in both towers.

The north tower bells (Levache) will not be retuned but the south tower bells (Witlockx) may be retuned (an option to be decided later).

The end result will be that the south tower carillon will be fully operational and that the north tower carillon will be restored to be usable but not for regular use, more as a museum piece.

Restoring the Musical instruments:

The restoration of the manual playing system for both instruments, with upgraded keyboards and associated study keyboards. The Levache instrument will be partly restored while the Witlockx will be fully restored.

The restoration of the automatic playing systems, with preventive anti-corrosion measures on the iron work. The Levache instrument restoration will be limited to allow the playing of the clock bells while the Witlockx instrument will be fully restored.

Renovation of the original gravity winding system in both towers, with the addition of electric motors to replace the manual rewinding.

Restoration of the south tower carillon cabin, with improved insulation and new electrical systems for heating and lighting. The north tower carillon cabin will not be restored.

Restoration of the historical keyboards, stored in the mezzanine for museum display.

Restoring the Swinging and Clock Bells

The eleven Swinging bells and six Clock bells will be inspected and then properly secured and stabilised. They will not necessarily need to be removed, but might be for construction convenience.

The work to include all elements of the suspension and percussion of each bell such as the crowns, bolts, hammers and also the wooden headstocks. Only one large Swinging bell and five of the Clock bells are fit to play and this situation will be maintained.

Additional measures

Reinforce and strengthen the wooden structural frames supporting the Carillons and Swinging bells in both towers. The work is much more extensive in the south tower.

(Provide a drainage system in the south tower at level three to reduce humidity).

Renovate and restore the exterior of the stone structure of the towers with repointing.

New electrical systems for lighting in both towers with heating added in the south tower.



5. Technical aspects

The main causes of the deterioration of the towers and their contents have been a lack of regular maintenance and inappropriate restoration in the past, coupled with a relatively aggressive maritime environment. Severe corrosion of parts of the bell systems, notably the hammers, clappers and supports, has created the danger of falling objects. Decay of structural timber supporting the main bells has also created a danger which has been resolved by propping and scaffolding as a temporary solution.

The need now is to recognise these causes to avoid any recurrence in the future after reconstruction and repairs have been undertaken. Thus proper drainage at level 3 in the south tower may help reduce the dampness around the structural timber. The timber should be properly treated and seasoned to ensure its longevity (not with an epoxy based paint as previously). Regular maintenance inspections and actions are essential to anticipate any future problems.

Another technical problem is how to carry out the works in the zones where the heavy bells are being propped and where repairs are required to the bell fastenings and the structural timber frame. These working methods are primarily the responsibility of the works contractor but need to be overviewed and assisted by the promoter to reduce contract risk and the impact on costs, either at bid or completion stage. Further work pre-contract on investigating the scope of the problem relating to the structural timber would seem worthwhile to clarify matters thus reducing the risk for the bidders to the benefit of the client.

Other potential external risks merit mention. The seismic risk is ever present in Portugal. Old buildings are quite difficult to assess rationally for seismic forces. These towers have been sturdily built and being nearly 300 years old have already been submitted to major earthquakes in the past (e.g. that in Lisbon in 1755) without much noticeable effect. Lightning strikes are another risk which is being addressed in the project with the existing conductors being renovated. The current proposals seem sensible and adequate.

The bells and the carillons are musical instruments. They have been closely studied by experts, with each bell being inspected and tested. The recommendations of these experts are that the south tower carillon bells would benefit from retuning while the north tower carillon bells are tuned to original historical sounds which should be retained as such. The experts suggest adding 2-3 bells in the south tower to complete the full set (the missing bells are small ones). All the swinging bells are cracked except one and clearly it would be ideal to replace these but this is not really feasible in the current financial climate (and is not proposed in the project). It might be worth investigating what is actually required to repair these bells and whether a less onerous option than replacement might be possible. One of the clock bells, not an hour bell, is cracked and likewise this will not be repaired or recast or even used.

6. Implementation

The National Palace of Mafra (PNM) is “owned” by the state and administered by the Ministry of Cultural Heritage (Património Cultural). The upkeep and maintenance and major upgrades are the responsibility of the Directorate General of Cultural Heritage (DGPC) which has its own technical department of studies, projects, and works (DEPOF). PNM has its own staff and director responsible for



its activities but all are under the aegis of the Ministry. The Ministry of Finance has the key role in financial matters. The decisions on scope and timing are taken in agreement between the DEPOF, the director of PNM and the general director of DGPC.

External consultants have been closely involved in defining and preparing the project. These experts have covered the musical side for the bells sets and carillons, the timber structure and the overall structure. It would be very desirable that these same consultants should follow the works to completion and with an extra input pre-contract on the timber structure as noted elsewhere.

The programme of works depends on the availability of funding but an outline could be as follows:

Carry out further pre-contract surveys	up to	March 2015.
Finalise tender documents		May 2015
Launch pre-selection		March 2015
Launch tender		June 2015
Award contract		December 2015
Construction period (18 months)	completion	June 2017

This would allow the works to be completed in time for the 300th anniversary of the start of construction of the Palace in 1717, an occasion to celebrate.

7. Procurement

It is intended to package the works into one contract under a main contractor who will be responsible for the whole. Specialist contractors notably on the bells and carillons will be included in the contractors group; as this specialisation is a key factor a pre-selection process is proposed to ensure properly competent and experienced firms are only accepted for the second bidding phase. This is a sensible arrangement. The first phase is to ensure competence and the second more to test costs and programme proposals. It should be noted that any quality judgement is rather subjective and so the second phase should be mainly decided on costs.

The procedures should comply with the EU directives on procurement.

8. Environment, sustainability, social

The works as such do not present great risks to the environment being renovation works on existing established buildings. In effect by securing the bells, a danger to life and limb will be reduced.

Sustainability requires that the works remain valid and thus require that proper monitoring and maintenance is carried out in future to protect the investment and avoid a repetition of the past problems. Looking at ways of completing the works and even extending them in the future in an optimal manner are also related to sustainability and are relevant.

The National Palace and the Basilica and its bells are a cultural heritage of national importance for their historical, architectural, musical and even industrial interest. They provide a significant tourist attraction, with a positive impact on local employment. All this is well understood by the authorities who



are supporting the development of the PNM in other ways also so as to enhance its relevance and this is very positive.

9. Operation, use, demand

The Palace and its operation, including the bells and any musical events, are under the responsibility of the PNM, carried out with the agreement of the Church authorities as appropriate.

It is envisaged that carillon concerts will take place as was the case up to the 1970s. This will complement the other musical attractions of the Basilica such as concerts for the six organs which attract specialists and enthusiasts from afar. Other attractions are the Museum and the renowned Library. In addition the restoration project will allow specialists to visit the towers and their unique campanology, with the original Wicklockx and Lavache bell sets.

On a very practical level the operation of the clocks and the carillons will be greatly facilitated by the project, for example by installing motorised winding for the clocks replacing manual winding, which historically occupied some 25 persons for the towers' clock and bell systems.

Current visitors to the Palace complex exceed 250 000 per annum and this should increase post project. It is planned longer term to improve access to parts of PNM by agreement with the Portuguese Army who currently use much of the building. It is envisaged to move the Museum of Music from Lisbon thus making Mafra the principal musical centre of the country. A more aggressive tariff policy might then be introduced.

All this is part of a coherent plan to enhance the National Palace, its heritage value and relevance, so as to encourage local and international tourists. The project forms a part of this vision.

10. Investment cost

The project's scope is fairly well known but some aspects still depend on further information being obtained, either pre-contract as is recommended, or after the contract is let when the contractor discovers the exact state of decay. Consultations have taken place with specialist firms to give an indication of costs and these form the basis of the cost estimate.

North tower carillon restoration	650 000	Euro (2014 value)
South tower carillon restoration	950 000	
Stonework restoration	20 000	
Musical instruments	120 000	
Tower clocks restoration	100 000	
Lightning strike protection, weathercocks	55 000	
Total works	1 895 000	
Consultants (pre-contract, during contract) 3%	57 000	
Supervision (contract & project management) 8%	152 000	
Contingencies (10% base cost)	189 500	
Grand Total (+VAT)	2 293 500	
(Rounded)	2 500 000)	



Note that the financial needs should include VAT (presumably at 6%), and this need to be added. It is advisable to aim for the rounded amount for funding to provide some margin of error in view of the imprecision of some aspects of the work and its specialised nature – which often means a lack of strong competition on prices.

The main funds for the works would be required in 2016 and 2017 but some allocation will be required in 2015 for consultants and project preparation, most of which may well be done by departments inside the Ministry.

11. Financing possibilities

Heritage projects normally require a grant form of financing as the financial benefits are often slight. The situation is more favourable here as there is a link, albeit indirect, to tourism and a wider interest for the city to continue to develop the Palace and its evident potential in encouraging visitors with the advantages that that entails. However every effort should be made to procure grants if possible.

The principal source of grants is from the European Union (EU). Grants can be allocated to heritage projects but there needs to be a clear link to a positive economic impact and preferably to employment. In addition the project should fit into a coherent regional strategy. These criteria seem to be largely respected by this project.

The EU regional fund, the ERDF, encourages small scale initiatives related to tourism and can support projects with positive environmental impacts through protecting, promoting and developing cultural heritage.

While the overall EU grant envelopes are approved by Brussels, they are based on proposals made by the national authorities; these national and regional authorities later decide on approving the (small) grant amounts within the agreed envelopes. It is thus important that the national authorities work together with the local municipalities and others to prepare a convincing dossier for grant support, if this project is considered as a priority. The grant component cannot cover the full cost of a project (probably about 50%) and so some other funding is required. In addition the funds are not immediately available, may require some bureaucratic effort to obtain and administer and may also have conditions imposed.

In view of this, additional funding will be required to complete the finance plan and also to have some readily available funds to finance further studies and the project preparation phases. It is understood that the Mafra Municipality might be able to pre-finance some of these activities.

Efforts to tap private funds, or institutions such as the Calouste Gulbenkian Foundation, should be explored as the heritage and musical/historical context might be attractive to potential benefactors. Finally the European Investment Bank might be a potential source of loan funding.

A separate paper may be presented by the EIB Institute on funding of heritage projects, thus updating the 2013 version.



12. Conclusions: Proposed action programme and recommendations

This is a relatively compact intervention which could have a real impact on enhancing interest in the National Palace complex as a cultural heritage destination particularly in re-establishing its campanological credentials. It will bring the bells back into use and properly secure them allowing their potential to be realised. It is thus considered to be a very worthwhile and needed initiative.

The project has been well studied and the proposals are sensible, providing significant benefits without excessive costs. The full restoration of all the large bells for example would have been considerably more expensive. This possibility should however be retained for the longer term or at least it should not be excluded by current actions.

The conclusion is that the project as proposed merits strong support and should proceed.

The recommendations made here are in the form of suggested actions to optimise and to reduce the project risk rather than be fundamental conditions.

It is suggested that:

- An update of the previous study on the structural timber work should be undertaken to assess more accurately what is actually required to be done to reinforce, repair and replace the damaged components and also how to do it. The computerised model used to analyse the timber structure (which I understand exists) should be updated if practical and then made available to the contractors with the updated report on the state of the structure and the associated recommended actions. The objective is to provide the bidders with accurate recent information to help them prepare valid bids, thus reducing risks. The contractors would still remain responsible for their proposals however.
- The scope of the work required on the bells should be clearly defined so as again to reduce risk. Some items, such as retuning the south tower carillon, may only be known or decided later and provision for such changes should be made in the contract. Such changes should be under the ultimate control of the project manager, but using the expertise and judgement of the specialist contractors as necessary.
- It would be interesting to add the 2-3 bells in the south tower carillon to complete the musical set, as recommended by the musicologists.
- It would be useful to add a drainage feature at level three of the south tower to reduce humidity, as noted by the structural engineer.
- It would be sensible to continue to use independent experts to advise on the structural and musicology aspects and to support the project/contract management team throughout.
- It would be sensible to include in the costs the professional services associated with such a project and with a reasonable contingency allowance. It is recommended that these margins as given in the report are included for prudence when seeking funding.
- Some provision might be included to ensure that further work, say on the eventual replacement or repair of some large bells, is not excluded in the future.

And a stronger recommendation:

- Efforts should be made to set up a regular monitoring programme and a maintenance schedule to ensure that the bells are kept in good condition henceforth.



Appendix 1

References, Mission details

References:

Nomination form for the Carillons of the Palácio Nacional de Mafra. October 2013.
EIB Institute Pre Mission questionnaire. May 2014
PNM response to Pre Mission questionnaire. July 2014
Further correspondence between PNM and Peter Bond. October/November 2014
Presentation “Welcome to the bells site”

Mission details:

28 & 29 October 2014	Mafra technical visits and meetings.
30 October 2014	Lisbon meeting with Ministries.

Main persons involved:

Europa Nostra:	Pedro Ponce de León, Scientific Council member
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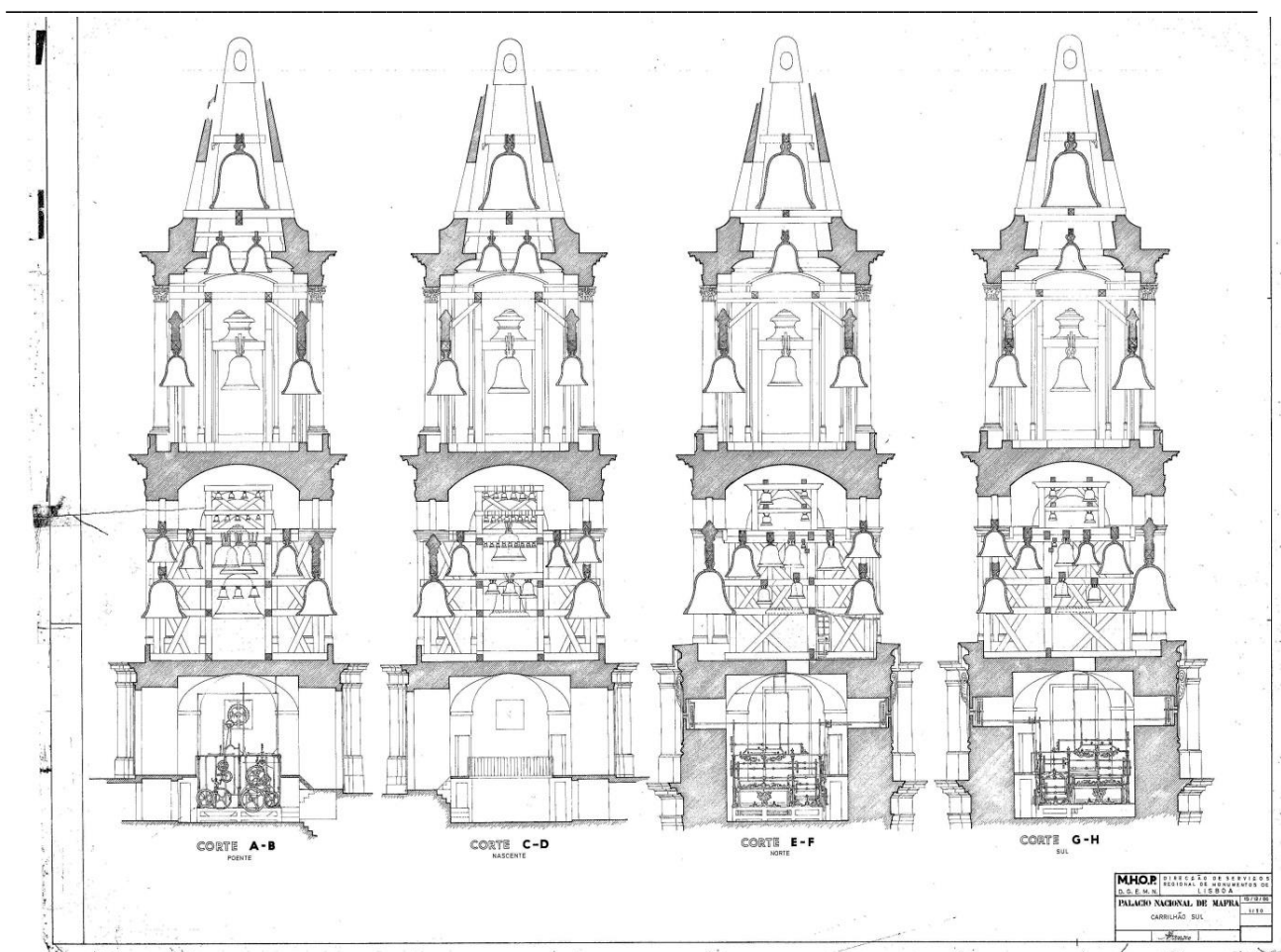
Appendix 2/1



The Palácio Nacional de Mafra, overall view and the bell towers



Appendix 2/2



Cross sections of the South Tower