Improving Supply of Spare Parts for Priority Medical Equipment in Kenya

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The work described within the report was carried out as part of the Strengthening Oxygen Utilization and Respiratory Care Ecosystems (SOURCE) project and the Scaling Access to Lifesaving Equipment (SCALE) project. SOURCE is an initiative led by PATH to improve equitable access to high-quality respiratory care services at all levels of the health care system and ultimately, reduce maternal, child, and overall mortality from hypoxemia-related causes. The SCALE project seeks to strengthen the policy, data, procurement, and maintenance systems that support access to broader medical devices. Both initiatives support governments and partners in focus geographies to push forward efforts to reinforce oxygen and medical device systems as necessary components of national health care systems, pandemic preparedness, and global health architecture.

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Abbreviations

bCPAP	bubble continuous positive airway pressure
CAPEX	capital expenditure
KES	Kenyan shilling
MOH	Ministry of Health
PPD	Public Procurement and Disposal
PSA	pressure swing adsorption
SCALE	Scaling Access to Lifesaving Equipment [project]
SOURCE	Strengthening Oxygen Utilization and Respiratory Care Ecosystems [project]
USD	United States dollar

Executive summary

Spare parts for medical devices are crucial to maintaining uninterrupted service delivery in health care facilities. However, the public procurement of spare parts for medical devices is constrained by reactive and ad hoc purchasing decisions, often due to a lack of system-wide historical data on what spare parts are needed, in what quantities, and when. Without a data-driven, coordinated procurement strategy, purchasing decisions remain fragmented and inconsistent, limiting the ability to achieve economies of scale, ensure quality, or maintain timely availability of spare parts across the health system.

To address this challenge, PATH developed a spare parts quantification and costing tool by engaging biomedical engineers in Kenya to build consensus around a standardized list of essential spare parts and the estimated annual frequency of use. The tool equips budget managers at health facilities and within county governments and the national Ministry of Health with more accurate system-wide estimates of annual spare parts demand and costs.

Developing this system-wide view of spare parts demand and cost is an important first step towards broader strategic procurement and management of medical devices, including: (1) market transparency and coordinated purchasing to improve economies of scale for spare parts; (2) streamlining of brands for medical devices to simplify management, and (3) strengthened procurement and donation policies to promote use of limited but high-performing device brands.

Additionally, the quantification and costing of spare parts is critical to establishing a business case for investing in medical device maintenance. Comparing the cost maintenance to the revenues generated from well-serviced devices can be a useful analysis to determine optimal levels of budgetary allocation for device maintenance. This tool enables health facility and government leaders in Kenya to make a more data-informed decision around device maintenance.

Introduction

Medical devices constitute an integral part of health care systems, playing a pivotal role in the prevention, diagnosis, treatment, and rehabilitation of various medical conditions.[1] Their significance in ensuring efficient health care service delivery cannot be overstated. However, Kenya faces shortfalls in the availability and functionality of medical devices, and most health facilities in the country do not have the minimum quantity of required devices. Additionally, several studies have shown that 35 percent or more of the devices at public health facilities may be broken, miscalibrated, or otherwise not functioning properly, with these breakdowns most often attributed to a lack of available spare parts[2]. Managing spare part requirements for medical devices is a challenge in Kenya. PATH, through its Strengthening Oxygen Utilization and Respiratory Care Ecosystems (SOURCE) and Scaling Access to Lifesaving Equipment (SCALE) projects, identified several market factors that impact the availability of spare parts.

On the demand side, public-sector consumers, such as the Ministry of Health (MOH), county governments, and health facilities, are constrained by predominantly reactive and ad hoc procurement practices for medical devices. The absence of a national strategic procurement framework has led to uncoordinated purchasing decisions that are often inefficient and unable to leverage economies of scale. These practices are rooted in systemic challenges driven largely by a fragmented administrative structure. The devolved governance structure and recent enactment of the Facilities Improvement Financing Act (2023) have further enabled counties and health facilities to operate independently, limiting the potential for pooled device procurement absent a dedicated framework or mechanism. The result is a highly fragmented demand environment where purchases are made in isolation, which reduces efficiency and undermines opportunities for cost savings. Additionally, inadequate planning and forecasting capacities and limited access to market intelligence have adversely impacted the spare part market. Neither the MOH nor county procurement units currently possess the tools or systems necessary to accurately forecast medical device needs. This is compounded by the lack of essential operational data, such as device pricing, supplier reliability, or brand performance.

On the supply side, local distributors lack visibility on the device brands currently in use at the facilities. A 2021 study by PATH revealed significant market fragmentation in the medical device sector across seven counties in Kenya.3 For instance, across the 100 health facilities observed in the study, the inventory reported the presence of 35 unique brands of neonatal resuscitators, 32 unique x-ray brands, and 18 unique ultrasound brands.[3] Local distributors are, however, not privy to the brand distribution across the counties. This lack of awareness of demand quantities and preferences, including brand and model, complicates the process for suppliers to maintain local bulk stock of spare parts. As a result, suppliers are often compelled to source parts from manufacturers ad hoc to fulfill orders rather than stocking parts in a local warehouse for more cost-effective distribution.

[1] This document uses the terms ‘devices’ and ‘equipment’ interchangeably.

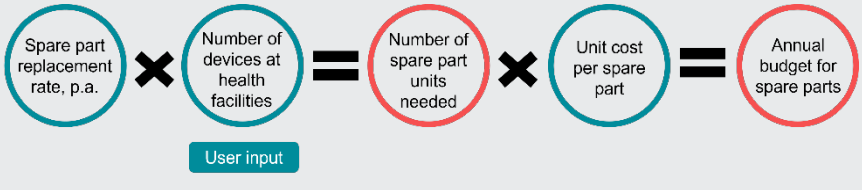
[2] Recent PATH-led device inventories, which typically involve only surface-level functionality checks like asking a clinician or checking if the device turns on, have found 10 to 20 percent of devices in health facilities to be obviously broken and nonfunctional. Deeper-dive studies, such as Bakare et al 2020, Perry and Malkin 2011, and WHO 2010, which subject devices to examination by trained biomedical engineers, have found higher nonfunctionality rates of 35 to 85 percent of observed devices.

[3] PATH. *Improving Access to MNCH Medical Devices. Summary of Research and Recommendations from the Market Dynamics for Medical Devices Project*. PATH; 2023. https://www.path.org/our-impact/resources/improving-access-to-mnch-medical-devices-summary-of-research-and-recommendations-from-the-market-dynamics-for-medical-devices-project/

An ideal scenario would involve data-sharing platforms where suppliers can access real-time information about the medical device models present in the market and when a need arises, while purchasers can easily identify reliable suppliers who can meet their needs within existing resource constraints. However, the absence of a common understanding of the essential spare parts for the devices that need to be in stock, along with a lack of transparent market pricing and budgeting tools, have perpetuated inefficiencies in procurement and spare part management. Health facilities and the MOH struggle to plan effectively for spare part needs, often facing unpredictable costs and limited access to critical components. This analysis explores efforts to address these gaps by (1) gaining consensus on an essential list of spare parts, (2) researching market prices and brand availability in Kenya, and (3) developing a budgeting tool to support accurate and efficient financial planning for medical devices and their spare parts.

The approach

From September 2024 to May 2025, PATH supported the MOH and county governments of Nairobi, Nyeri, and Meru in a systematic approach to improving spare parts quantification, as outlined below.

Identified critical devices	PATH engaged a group of key decision-makers from the MOH to identify 12 essential devices available in health facilities that would constitute the sample for this analysis. The 12 devices identified were: **anesthesia machine; bubble continuous positive airway pressure (bCPAP) machine; mechanical ventilator; nebulizer; oxygen analyzer; oxygen concentrator; patient monitor; pressure swing adsorption (PSA) plant; pulse oximeter; suction machine; ultrasound machine; and x-ray machine.**
Developed a standard list of spare parts	PATH engaged a group of biomedical engineering professionals to reach a consensus on a standard spare part list for those 12 devices. This resulted in a list of 188 spare parts, classified by their criticality and maintenance use and whether they were for corrective or preventive maintenance.
Conducted supplier and pricing landscape	PATH conducted a supplier landscape assessment and developed a directory of locally available suppliers for medical devices. Contact information on existing suppliers was obtained through PATH's existing list of suppliers. Additional suppliers were identified through desk research and consultations with counties to determine their primary medical device providers. Thereafter, follow-up communication was conducted with the suppliers who specialized in any of the 12 critical devices of interest. The exercise collected data on spare part availability, prices, lead times, and available brands.
Estimated rate of part breakdown	PATH used a modified Delphi process to determine consensus on the rate of breakdown for the selected devices and their essential spare parts. The consulting biomedical engineers met and sequentially deployed 12 online surveys—one for each device and its associated parts—to capture the observed frequency of device and spare part breakdown. This session formalized consensus on the rate of breakdown and, by extension, maximized the response accuracy in this matter where organized data were lacking. See Annex for more details of this process.
Built a quantification and costing tool	PATH then developed a comprehensive spare part quantification tool. The Microsoft Excel tool was designed to accommodate various scenarios—allowing users to customize inputs based on their specific needs—to ensure flexibility and relevance to diverse contexts. Users can adjust breakdown rates (higher rates for poor maintenance or lower rates for consistent, effective maintenance); cost scenarios (a high-cost scenario for premium brands or a low- to median-cost scenario for generic brands); and device functionality (functional only, nonfunctional and awaiting repair, or both). PATH applied the formula below to estimate the total spare part budget for these devices: 

Key findings

Differences in annual spare part costs by county

The annual budget for spare parts for the current sampled medical devices, shown below in Table 1, is KES 51.4 million (US$395,333) for Meru; KES 54.5 million ($419,580) for Nairobi; and KES 83.9 million ($645,458) for Nyeri. This budget would cater for both preventive and corrective maintenance activities for all the functional and nonfunctional medical devices in the sampled list.

Table 1: Estimated annual spare part budget in Meru, Nairobi, and Nyeri counties for sampled devices, in Kenyan shilling (KES) and United States dollar (USD).

	Meru	Nairobi	Nyeri
Total annual spare part budget for functional devices	KES 32.1 million ($247,296)	KES 46.1 million ($354,433)	KES 63.2 million ($486,265)
Total annual spare part budget for nonfunctional devices	KES 19.2 million ($148,038)	KES 8.5 million ($65,147)	KES 20.7 million ($159,193)
Total annual budget for spare parts	KES 51.4 million ($395,333)	KES 54.5 million ($419,580)	KES 83.9 million ($645,458)

Source: PATH, 2025.

Influence of supplier type and sourcing methods on spare part prices

Seventeen distributors were targeted for interviews, but data collection only occurred with eight of them.[4] This represents a 47 percent response rate. The low response rate from distributors may be attributed to the fact that a majority of them did not stock spare parts locally, instead relying on just-in-time ordering directly from manufacturers. This made it difficult for them to estimate spare part prices, as their prices would fluctuate based on exchange rates, level of order quantities, or other market determinants at the time of ordering.

Among the eight respondents (hereby referred to as suppliers), five (62 percent) sourced parts directly from the manufacturer, two (25 percent) were third-party suppliers, and one (13 percent) was an authorized distributor.[5] The type of supplier appeared to influence prices, whereby those sourcing directly from manufacturers reported higher prices compared to the other supplier categories. This may be explained by the primary brands the manufacturers work with or the smaller, ad hoc order quantities.

[4] At least eight suppliers based in Nairobi, Kenya can provide spare parts for 10 of the 12 critical devices and equipment in this study, but spare parts for oxygen analyzers and PSA plants were not commonly available among the sample pool of suppliers interviewed. As a result, the analysis did not include oxygen analyzers or PSA plants due to the lack of unit cost information from sampled distributors. This situation may be due in part to PSA plants having service agreements with authorized distributors who are tasked with maintenance. As such, there was no business case for distributors to stock parts for this equipment.

[5] "Authorized distributors" are given authority by manufacturers to sell their devices and parts, usually focusing on a single brand. Distributors sourcing directly from manufacturers (mainly from China) often deal in multiple brands. "Third-party suppliers" refers to entities that procure items either from authorized distributors or from distributors who obtain products directly from manufacturers and subsequently distribute those items within the local market.

Because each spare part had a high variation in unit cost, the analysis used a uniform median price derived from all sampled suppliers.

Decision between repairing or replacing the device

An observation made during data collection was the preference to replace a device rather than purchase spare parts. The analysis sought to compare the cost of purchasing a year's worth of spare parts for the same device with the annual replacement cost of a device (which was calculated as the device capital expenditure [CAPEX], annualized over its expected lifespan and adjusted for expected failure rate). Table 2 summarizes the comparison between the annual budget for spare parts and the annual capital cost for each device.

There appears to be no significant trends in factors like device CAPEX and how economical it is to repair or replace. The results in Table 2 indicate that in many cases repairing a device will be more economical than replacing it, regardless of the device CAPEX level. While higher CAPEX devices are generally more economical to repair than replace, the x-ray machine stands out as an extreme outlier. It has the highest CAPEX and annualized cost, yet a relatively low repair-to-replacement ratio (25 percent), making repairs still cost-effective. On the opposite end, the pulse oximeter, despite being a low-cost device, also favors repair due to its very low spare part cost and manageable failure rate, demonstrating that not all inexpensive devices are better replaced. This defies the observed preference to replace instead of to repair the device.

Table 2. Ratio of annual spare part budget to the annualized capital expenditure (CAPEX) per device, in USD.

	Annual spare part costs per device [a]	CAPEX per device [b]	Device lifespan (years) [c]	Annual device failure rate [d]	Weighted annual CAPEX [e]	Spare parts p.a. versus CAPEX p.a. [f]
Nebulizer	$16.89	$161.54	4.9	2.3x	$75.82	22%
X-ray machine	$21,302.75	$240,532.00	11.3	4.0x	$85,395.98	25%
Patient monitor	$579.34	$5,692.31	8.7	3.5x	$2,298.82	25%
Ultrasound machine	$757.08	$29,000.00	10.5	1.0x	$2,761.90	27%
Pulse oximeter	$21.75	$319.23	4.7	1.0x	$68.41	32%
Anesthesia machine	$423.41	$17,661.54	10.0	0.6x	$1,056.17	40%
Oxygen concentrator	$586.71	$2,307.69	8.3	4.0x	$1,112.14	53%
bCPAP machine	$237.67	$3,076.92	7.7	1.0x	$399.60	59%
Ventilator	$2,404.46	$27,692.31	9.3	1.0x	$2,977.67	81%
Suction machine	$335.47	$523.08	7.5	5.0x	$347.17	97%

[a] **Annual spare part cost per device** is the annual budget for the reported essential spare parts of one device. Some essential parts were not included in the costing because the distributor did not stock them or could not source them. The average figures here are therefore of the parts the distributor could source. The figures in the column are an average based on needs from three sampled counties.

[b] **CAPEX per device** is the average price per device as reported by the sampled distributors. Pressure swing adsorption (PSA) plants and oxygen analyzers are not considered in the table, as the sampled distributors did not provide pricing information on them.

[c] **Device lifespan (years)** is the average useful life of devices as reported by the biomedical engineers from the three sampled counties.

[d] **Annual device failure rate** is how many times a device is expected to break down each year. It is based on the median failure rate across all brands and models reported, not any specific one. The assumption is that if no spare parts are bought, each breakdown would require replacing the whole device—costing the same as its annualized CAPEX.

[e] **Weighted annualized CAPEX** is the ratio between CAPEX per device and its lifespan in years multiplied by the annual device failure rate.

[f] **Spare parts p.a. versus CAPEX p.a.** compares the annual spare part budget per device to its weighted annualized CAPEX.

NOTE: Spare part and device CAPEX figures reflect capital/purchase costs only; they exclude associate expenses such as labor and travel for device procurement, installation, and/or maintenance. Quantifying such costs was beyond the scope of this analysis, but we hypothesize that in general, they are likely to be of similar magnitude for both the device replacement scenario and the device repair scenario, and therefore would not have a strong directional impact on the ratios in Column F.

Recommendations for policy makers and implementers

Although lower than the annualized capital cost of medical devices in the above analysis, annual spare parts costs still represent a major potential expense for counties. To improve affordability, it is essential to implement strategies that promote bulk procurement, enhance transparency in procurement processes, and promote efficient maintenance practices that minimize spare part demand.

Lower spare part costs through market transparency and strategic procurement

From this work, it is evident that spare part costs are high. For some of the devices, the cost to buy essential parts for a device is nearly equal to the annualized capital cost. Meaning, the decision to repair or replace may be benign. However, this relatively high spare part cost is because of the expensive ad hoc procurement that is characteristic of the market. An ideal solution would entail pooling spare part demand at county or national level, leveraging economies of scale that come with bulk procurement.

A current market problem is information asymmetry. Suppliers do not know the brands and models of devices used in health facilities. Similarly, facilities do not know when they need to make a purchase order, from whom they will purchase, the price charged, and which other facility is in similar need.

A short-term solution could involve MOH publishing an annual report on the total device count per brand/model and the forecasted parts demand for that year. This information would help suppliers know what parts they can procure in bulk in anticipation of the demand. Another solution could be a catalogue of suppliers published every year, following the prequalification exercise tasked to the counties through the Public Procurement and Disposal (PPD) Act. Beyond the contact information of the suppliers, there should be data on their stocked brands, their capacity to supply the listed essential spare parts, each part's unit price, and the expected lead time. Such data sharing will stimulate price negotiation and ultimately lower the device maintenance budget in health facilities.

Streamline medical device brands to improve economies of scale

Centralizing purchases and leveraging bulk ordering at the county and health facility levels can lead to more favorable pricing. MOH may need to actively consolidate the market around a limited number of preferred brands and suppliers to make bulk procurement more feasible. Achieving this may require the introduction of policies to regulate the brands of medical devices entering the market, including those received through donations.

PATH recommends that policy makers and implementers should work toward controlling the number of brands and suppliers allowed to participate in the medical device market. These efforts will translate into limiting brand proliferation and hence make bulk procurement of spare parts more economical.

Strengthen procurement and donation policies for streamlined access

The MOH has an opportunity to make strategic procurement decisions particularly on the models and brands they allow into the market. Selection of superior brands may cost more in the beginning, but the return on investment is observably higher over the course of its useful life. Although there is a PPD Act that endeavors to support this end, the extent of its implementation is unknown. A short-term solution may be the enforcement of performance contracts for medical device brands. If the device does not perform as it claimed, the supplier and their associates should be removed from the prequalified list of suppliers. The market should wean slowly from the use of that brand.

Procured items are subject to the PPD Act and regulations, but there is an existing policy gap on items received as donations. Kenya, like many other developing countries, receives a sizeable amount of donations, both as development aid and during emergencies. These donations—solicited and unsolicited—complement MOH efforts of ensuring access and avoiding interrupted service delivery, especially in times of health emergencies. However, donations bypass the PPD Act and regulations on prioritization of quality requirements. Health facilities tend to accept most, if not all, donated items, which can lead to issues. Some donations arrive without details on the manufacturer or where to obtain spare parts, and others have maintenance manuals in languages not understood by local engineers or lack them altogether. This results in a pileup of nonfunctional devices awaiting repair or worse—an equipment graveyard. PATH recommends the development of a medical device donation policy that spells out the criteria to be used before accepting medical equipment. This will help ensure that all devices and equipment received at the facility serve the purpose and population they are intended to.

With limited brands in the market, it would be relatively easy for MOH to design a standard training curriculum. A current issue is that high brand proliferation complicates training, particularly for complex devices like x-ray and ultrasound machines. However, limiting the players and hence the brands in the market will address the issue and enable MOH to build local capacities for users and maintenance staff.

Reduce equipment downtime through investment in biomedical maintenance shops

The findings from this analysis emphasize that regular preventive maintenance practices would avert occurrences of device failure. This would reduce the need for and purchase of spare parts, making the annual budget for maintenance much lower compared to the annualized capital cost of the device. Well-trained medical engineering professionals are crucial to achieving these savings. However, as established by PATH through the SOURCE project, challenges extend beyond the availability of trained professionals to include the necessary tools for them to perform their duties effectively.[6]

To address these challenges, a well-equipped engineering shop is essential—perhaps involving the refurbishment of an underutilized room within the health facility and equipping it with the necessary tools. PATH estimates that each toolbox would cost approximately KES 150,000 ($1,153).[7] The required number of toolboxes varies by facility level: Level 2 needs one toolbox, Level 3 needs three, Level 4 needs five, and Level 5 needs ten. Overall, a budget of approximately KES 1.4 billion ($11 million) would be sufficient to equip facilities with the minimum tools needed for regular preventive maintenance.7

PATH recommends that MOH, county governments, and other interested stakeholders drive resources toward this end of establishing and equipping engineering shops. Health facilities should also prioritize resource allocation toward refurbishing existing yet idle rooms to support this endeavor. Further, they should continuously allocate resources toward equipping the shop with other tools and kits beyond the generalized toolbox.

[6] MOH Kenya, *Kenya Medical Oxygen Roadmap 2025-2030*. MOH Kenya; 2025. Available at: https://stoppneumonia.org/wp-content/uploads/2025/05/Kenya-Medical-Oxygen-Roadmap-FApproved-Copy.pdf.

[7] Estimates from consultation with the Ministry of Health.

Looking forward

Spare part quantification and costing is a first step toward more strategic and cost-effective procurement. From here, several steps should be taken to improve spare part availability and affordability:

- Engaging local distributors to share expected demand and make a case for increased local supply/stocking of critical spare parts.
- Support health facilities to improve their procurement and budgeting practices using the above quantification and costing tool.
- Assess the broader business case for maintenance of medical devices, particularly *how much health facility revenue can be generated for every additional KES 100 invested in device maintenance,* to identify particular devices and parts with untapped potential to improve facility finances and patient health outcomes.

Through the demonstration of financial and operational benefits of device maintenance, PATH hopes to drive policy action and encourage increased investment in sustaining medical devices in Kenya—ultimately improving health care delivery across the country.

Annex. The modified Delphi process used to estimate spare part replacement rate

Spare parts are either required for regular preventive maintenance or ad hoc corrective maintenance (repairs). Depending on the type or use of the spare part, its rate of part breakdown may be challenging to predict.

Parts required for regular preventive maintenance can be forecasted by leveraging the manufacturer's recommendations on how frequently the part ought to be replaced. That recommended replacement rate provides a starting assumption. However, due to resource constraints (financial and human) on device maintenance, this work assumed that health facilities would tend to replace parts less frequently than recommended. The extent to which this occurs would vary per device and per health facility.

Parts required for corrective maintenance are difficult to forecast because their replacement rate depends on a variety of subjective factors including the comprehension of user training, the frequency of the preceding preventive maintenance activities, or the workload at the health facility. Standard techniques for forecasting spare parts depend largely on the availability of historical demand data or presence of maintenance policies in place.[8] Experience with Kenya's public health facilities demonstrates that procurement of spare parts is limited and occurs on an ad hoc basis. Further, maintenance policies are scarce, except in the context of highly complex medical equipment that had service agreements in place. These barriers meant that the analysis did not have sufficient historical data to implement typical forecasting techniques.

To address this challenge, PATH used a modified Delphi process—a systematic approach used to gain consensus from a panel of experts on a particular topic—to estimate a rate of breakdown for the selected devices and their essential spare parts. The consulted experts were biomedical engineers from Nairobi, Nyeri, and Meru counties. These engineers were gathered in a single room where they completed 12 sequential online surveys—one for each device and its associated parts. In each survey, respondents were asked to report the frequency of breakdowns they had observed for the device or its spare parts over a specified period.

For instance, in the case of a simple device such as a pulse oximeter that is known to break down frequently, the question was phrased as follows: *over the last 6 months, how many times did you observe the pulse oximeter (or an associated part, e.g., probe) at your facility break down?* For a complex device such as an x-ray machine, the question was phrased as follows: *over the last 2 years, how many times have you observed the x-ray machine (or an associated part, e.g., circuit breaker) break down?* To standardize comparison across devices, the reported frequencies were later converted to an annual breakdown rate. Any anomalies identified were discussed in plenary sessions following the completion of the surveys.

The data analysis made several key assumptions:

- Each part failure was considered an independent event.
- Multiple parts did not fail at the same time.
- The failure rate only accounted for parts marked for corrective maintenance.
- If a part broke down, the device also broke down and was rendered nonfunctional.

[8] S. Van der Auweraer, R. Boute, Forecasting spare part demand using service maintenance information, *International Journal of Production Economics*, Vol 213, 2019, pp 138-149, https://doi.org/10.1016/j.ijpe.2019.03.015

Based on these assumptions, the total breakdown rate for parts requiring corrective maintenance should not exceed the device's overall failure rate. If the sum did exceed the device failure rate, it was proportionally calibrated to match the device’s actual rate. For parts under preventive maintenance, it was assumed they were replaced at the same rate as they failed. These failures were considered independent of the device’s overall failure rate.

Overall, this plenary session formalized consensus on the rate of breakdown and, by extension, maximized the response accuracy in this matter where historical data were lacking.