

Chapter 3: Management of material and infrastructure

Audit Objective 2: Whether the supply of bio-tanks and other materials and infrastructure required for induction of bio-toilets was adequate?

3.1 Supply of bio-digester tanks for fitment/retrofitment of bio-toilets

3.1.1 Procurement of bio-digester tanks from private parties

On 18 November 2011, Railway Board approved the Action Plan for induction of bio-toilets for 2012-13. Initially, RCF was instructed to supply 100 tanks to Carriage Workshop, Bhopal in first phase. In August 2012, Railway Board advised RCF and ICF to procure bio-tanks (RCF: 1164, ICF: 1332) for the DMA coaches being supplied to Zonal Railways. To accelerate pace of fitment, Railway Board (October 2012) directed MLR Workshops viz., Bhopal and Parel to procure bio-tanks with associated material for 250 and 50 coaches respectively. In November 2012, five¹ Zonal Railways were also instructed for one time procurement of 200 bio-toilet material. During the same month, Railway Board also advised RCF and ICF to procure and supply bio-toilet material to Zonal Railways, for retrofitment of bio-toilets in in-service coaches as well as for fitment in coaches provided with DMA as per quantities assessed in August 2012.

In June 2014, Railway Board, authorized Zonal Railways to procure bio-toilets and material as per approved drawings of RDSO/ICF/RCF. Zonal Railways were also required to ensure quality of material procured. However, Zonal Railways found it difficult to procure bio-toilet material, only a few Purchase Orders were issued and many demands for procurement were pending. Given the target for induction of 17000 bio-toilets in 2015-16, Railway Board advised (July 2015) all Zonal Railways to expedite the procurement process and start installation of Bio-toilets. After the target of 30,000 bio-toilets was fixed and internal target of 60,000 bio-toilets was assigned to the Zonal Railways for the year 2016-17, Stores Directorate of Railway Board awarded a rate contract for procurement of bio-tanks for all Zonal Railways and planned for distribution of 80,000 bio-tanks among Zonal Railways (August 2016).

The position of supply of bio-tanks and related material in various Zonal Railways during the review period was checked and the following was observed:

¹ CR, ER, NFR, WR and SCR

3.1.1.1 Pending indents for bio-tanks and related material

It was observed that as on 30 September 2016, 27 indents pertaining to requirements of eight Zonal Railways in 2014-15 and 2015-16 for bio-toilets and related material were pending. In the absence of adequate material and accessories, fitment of bio-toilets was held up in workshops at Gorakhpur (NER), Tirupati (SCR), Kharagpur (SER), Bhavnagar (WR), New Bongaigaon (NFR) and Nishatpura (WCR). It was further observed that

- In CR, indent for 228 bio-tanks was placed on ICF in December 2012 by Matunga workshop. These were received from ICF between December 2013 and August 2014. The work of fitment of bio-toilets was completed in September 2016. A target for POH of 43 eligible coaches (i.e. coaches in which headstock of both sides are replaced during POH) was set by Railway Board in April 2015 for Matunga workshop. This work was proposed in two parts i.e. departmentally and through a contract at an estimated cost of ₹ 3.50 crore. Fixing of bio-tanks was proposed through contract and replacement of headstocks along with associated heavy corrosion repairs to coaches and furnishing of toilet area was proposed to be carried in-house. The contract was yet to be finalized in September 2016.
- In Bhopal Workshop, 11 indents for 834 bio-toilets were pending as non-stock demand as on 31 March 2017.
- In SER, three indents were placed on 28 September 2015 and 09 October 2015 for 532 sets of bio-tanks, of which 482 sets were yet to be supplied from Motibagh Workshop, SECR.
- Indents for 50,000 and 12,000 liters of inoculum for Workshops in Hubli and Mysore, though indented in April 2016 were pending.

3.1.1.2 Pending supply against Purchase Orders for bio-tanks and related material

In 11 Zonal Railways (CR, ER, ECoR, NR, NFR, NWR, SR, SCR, SER, WCR and WR), shortfall in achievement of targets for retrofitment was mainly due to non-supply/short supply /delay in procurement of bio-tanks and other related material during the review period. As per directions given by Railway Board in June 2014 meeting, complaints regarding failure and reluctance of vendors to attend warranty claims were to be registered on the web portal by CRSE of respective Zonal Railways. It was observed that there were several instances of short supply of bio-tanks by a number of firms against purchase orders issued for the years 2014-15 and 2015-16 in various Zonal Railways. However, Zonal Railways did not utilize the complaint mechanism to effectively address the problems of short supply, non-supply, defective supply, non-attending of

warranty claims etc. by the firms on which orders were placed. It was observed that

- The bio-tanks supplied by various firms have a warranty of 36 months from the date of supply or 24 months from the date of installation in the coaches. A review of records of RCF, Kapurthala showed that during 2014-15 to 2016-17, 158 complaints relating to 903 bio-tanks supplied by 15 firms for improper working under warranty were received. The main reasons for improper working were choking, ball valve jammed/leakage, non-working of pedal mechanism and failure of wire rope/clutch etc. Of these 58 complaints relating to 351 bio-toilets were pending as on 31 March 2017. Out of these, 55 complaints relating to 345 bio-toilets pertained to eight²firms.
- There were 50 warranty claims pending on CR (23), NWR (15) and SWR (12) as on 30 September 2016 in respect of defective material received in Carriage Workshops. Warranty claims were not registered on the web portal by CRSE/NWR in respect of 15 defective bio-tanks in Ajmer and Jodhpur Workshops. The mechanism was thus not being used for follow-up and replacement of defective material. No such registration was made in SR.
- In WR, a contract for 'Supply of 51 sets of bio-tanks was awarded to M/s Omax Autos Limited on 31 December 2015 and the material was received on 5 and 6 August 2016. During inspection of the material by the consignee i.e. Workshop at Lower Parel/WR, deficiencies such as change in the specification of items, non-receipt of few items etc. were noticed and reported to RITES on 3 September 2016 by Chief Workshop Manager, Lower Parel. Thereafter, the firm agreed to replace the material (pre-inspected by RITES) without any Joint Inspection. However, the defective material was replaced only in January 2017, resulting in delay in fitment of allotted bio-toilets in the coaches.
- In CR, several cases of warranty period failure of bio-toilets were also noticed. The response of vendors in attending to warranty claims was not



Fig 4: New bio-tanks received from supplier lying unutilized at Lower Parel Workshop, WR

² M/s Mohan Rail Components, M/s Rail Fab, M/s MK Precision Metal parts, M/s JSL Life Style Ltd., M/s Amit Engineers, M/s Omax Auto Ltd., M/s Rail Tech, M/s Oriental Veneer Products Limited

satisfactory. During the check of records of Divisional Mechanical departments of Mumbai and Solapur, it was noticed that there were 18 complaints pertaining to Solapur division for the period April 2015 to July 2015 and 148 complaints pertaining to Mumbai division for the period August 2014 to October 2016, regarding defects in bio-toilets under the warranty period. Online complaints were registered by Railway Administration on ICF/RCF portal. However, no action was taken by ICF, RDSO and concerned firms for rectification of defective bio-toilets. CR Administration in their reply stated that RCF and ICF were required to pursue the matter with vendors for attending the warranty issues and impose warranty claims, if defects were not attended in time. The defective coaches were not detached from the rake, but were allowed to run with temporary attention.

- In ER, one purchase order was placed on M/s Banka Biolo Pvt. Ltd, Hyderabad in January 2016 for supply of bio-tanks. No material was received from the firm till March 2017.

Due to inadequate progress of retrofitment of bio-toilets in passenger coaches by Zonal Railways for the year 2015-16 (33.52 *per cent* up to September 2015), Railway Board decided to place bulk order for supply, installation and commissioning of approximately 80,000 bio-toilets in in-service coaches. Member Mechanical directed (29 December 2015) to float the tender and finalize the same within three months, indicating zone-wise consignees. Mechanical Directorate requested (29 January 2016) Store Directorate to start the process. Stores Directorate sought (2 February 2016) details of description of the items, scope of work, consignee details with quantity breakup, quarter wise requirement for the next three years, sanctioned rolling stock programme, provision of funds, inspecting authority and whether the description, specification, drawing would be applicable uniformly to all Zonal Railways. Finally, the tender was floated in June 2016. Railway Board awarded the contract on 17 to 19 August 2016 with nine³ different firms for supply, installation and commissioning of 80,000 bio-tanks (20,000 coach sets) in various Zonal Railways.

It was observed that out of the nine firms on which orders were placed by Railway Board for supply of 20,000 coach sets, seven firms viz. M/s JSL Life Style Limited, M/s Omax Auto Limited, M/s Mohan Rail Components Private Limited, M/s Rail Fab, M/s Amit Engineers, M/s Hindustan Fibre Glass Works and M/s Rail Tech, had complaints pending against them regarding quantity and quality of

³ M/s Victora Auto Private Limited, Faridabad, M/s JSL Lifestyle Limited, Bahadurgarh, M/s Hindustan Fibre Glass Works, Vadodara, M/s Mohan Rail Components Private Limited, Kapurthala, M/s Rail Fab, Kapurthala, M/s Omax Autos Limited, Gurgaon, M/s Amit Engineers, Mohali, M/s Oasis Fabrications, Jagadhari, M/s Rail Tech, Kapurthala

material supplied against Purchase Orders placed by the Zonal Railways during 2015-16 and 2016-17. It was seen that

- In NWR, M/s JSL Lifestyle short supplied 360 bio-tanks, which were to be delivered by April 2016 and a risk & cost PO had been issued by NWR.
- In NCR, M/s Hindustan Fibre Glass, M/s Mohan Rail Components Private Limited and M/s Omax Auto Limited had not supplied any quantity as against 510 bio-tanks up to 31 March 2017.
- In WR, M/s Omax Auto Limited replaced 51 sets of bio-tanks in WR after a gap of five months.
- In RCF, 58 complaints relating to 351 bio-toilets due to ball valve Jammed, clutch wire rusted, choking, leakages etc. were pending mainly against M/s JSL Life Style Limited, M/s Omax Auto Limited, M/s Mohan Rail Components Private Limited, M/s Rail Fab, M/s Rail Tech, M/S Oriental Veneer Products Limited, M/s M.K.P Metal Parts and M/s Amit Engineers as on 31 March 2017.

Status of supplies against the Railway Board order was reviewed and it was observed that,

- As of March 2017, 33,783 bio-toilets were to be supplied to 16 Zonal Railways but only 14,274 bio-toilets were supplied by the firms. Out of these, only 12,016 bio-toilets were fitted in coaches up to March 2017.
- In WR, M/s Rail Tech, supplied 600 bio-toilets to be fitted in 150 coaches, of which 168 were found to be defective (having welding cracks) during inspection by RITES and the whole lot was rejected. Similarly 44 bio-tanks supplied to Lower Parel Workshop for fitment in 11 coaches by M/s Hindustan Fibre Glass Works, Vadodara were also having welding defects and were rejected by the consignee. Further, 124 defective bio-tanks fitted in 31coaches were also dismantled from various coaches.
- Out of 712 bio-toilets and 800 bio-toilets to be supplied by M/s Mohan Rail Components to ER and SCR respectively, no supply has been made by the firm till 31 March 2017.
- Similarly, out of 1,000 bio-toilets to be supplied to ECoR by five firms i.e. M/s JSL Life Style Limited, M/s Rail Fab, M/s Rail Tech, M/s Cercon Casting Limited and M/s PD Steels, not a single bio-toilet has been supplied till 31 March 2017.
- Of the 444 and 300 bio-toilets supplied by M/s Rail Fab, 68 and 24 bio-toilets were rejected by NR and NWR respectively, due to defects.

As such, as on 31 March 2017, 304 bio-toilets supplied by various firms were found defective and thus rejected/could not be installed. Delay in supply and

defective material supplied by the suppliers has adversely affected retrofit activity of bio-toilets.

As regards the slow progress of retrofit of bio-toilets by the vendors in Zonal Railways against rate contract awarded by Railway Board, Ministry during Exit Conference stated (July 2017) that out of nine, three defaulting firms viz. M/s Rail Tech, M/s Rail Fab and M/s Hindustan Fibre have been de-listed. Further, performance of one more contractor (M/s Mohan Rail) is extremely poor and the Rate Contract has been proposed for cancellation. They further stated that the existing supply was being managed through the remaining five firms, for the current tender. They added that 24 vendors have been identified for supply of bio-toilets to the Zonal Railways for future requirement.

3.1.1.3 Supply of bio-tanks for coaches where provision of DMA was made

During the review period, PUs were required to supply bio-tanks to the Carriage Workshops for retrofit of bio-toilets in coaches where provision of DMA had been made. It was noticed that bio-tanks and material required for Dual Mounting were not supplied by PUs to the Carriage Workshops at Liluah and Kanchrapara (ER), Harnaut (ECR), Mancheswar (ECoR), Jagadhri (NR), Izzatnagar (NER), New Bongaigaon (NFR), Ajmer and Jodhpur (NWR). It was observed that

- In ECoR, no material was supplied by PUs for DMA. For Direct mounting of bio-toilets, Railway Board set a target of 255 numbers for Mancheswar Workshop, however, material for the same were yet to be received (March 2017).
- In ER, in Liluah Workshop, during POH, DMA were provided in 58 coaches but no bio-toilets were fitted in these coaches.
- In SCR, there were 219 coaches with DMA in August 2014. However, bio-toilets were fitted only in 116 coaches, till March 2017.
- In SER, no passenger coaches were fitted with bolted design bio-toilets directly mounted during POH. Eight coaches were fitted with dual mounting arrangement at the time of replacement of head stock during POH, but bio-toilets were not fitted. There were 56 passenger coaches having dual mounting arrangement but not fitted with bio-toilets.
- In Bhavnagar Workshop (WR), instances came to notice wherein due to mismatch between 'J' brackets and 'C' channels, stock of 'J' brackets remained unused and on other hand coaches received with DMA of 'C' channels were turned out unattended. As against the target of 195 coaches, WR was able to fit bio-toilets only in 29 coaches in 2015-16, due to delay in procurement of bio-tanks.

Thus, supply of adequate numbers bio-toilets for retrofitment in Workshops and Zonal Railways against the orders placed by the Railway Board needs to be ensured to achieve the ambitious targets of fitment of bio-toilets in the next few years.

3.1.1.4 In-house manufacturing of bio-digester tanks in Motibagh Workshop, Nagpur

A proposal for creation of facilities for manufacture of bio-tanks at Motibagh Workshop, Nagpur of SECR was initiated during 2011-12⁴ at an estimated cost of ₹ 14.63 crore. Railway Board further directed (August 2014) SECR to start in-house manufacturing of bio-digester tanks at Motibagh Workshop, Nagpur by procuring sub-assemblies in knocked-down condition. The plant and machineries were received and commissioned in February 2015 at a cost of ₹15.86 crore. However, production of bio-tanks commenced only in November 2015. Delay in commencement of production was attributed to delay in procurement of material for bio-tanks.

Table 10 - Production vis-à-vis installed capacity for manufacture of bio-tanks in Motibagh Workshop			
<i>Year</i>	<i>Installed capacity</i>	<i>Actual production</i>	<i>Quantity supplied to ZRs/PUs</i>
<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
2014-15	2500	Nil	Nil
2015-16	2500	610	602
2016-17	2500	2550	1289
Total		3160	1891

In Motibagh Workshop, SECR, bio-tanks are being manufactured under Rolling Stock Programme (RSP) and subsequently Zone wise allotment is made by Railway Board. It was seen that

- Motibagh Workshop was not able to manufacture bio-tanks as per installed capacity in 2014-15 and 2015-16. However, they manufactured more bio-tanks than their installed capacity in 2016-17.
- Despite acute demand of bio-digester tanks from various Zonal Railways, eight bio-tanks manufactured in 2015-16 and 1261 bio-tanks manufactured in 2016-17 were yet to be supplied (March 2017) to Zonal Railways. As regards reasons for non-supply of bio-tanks Railway Administration stated that the allotted Zonal Railways are responsible for collection of bio-tanks from Motibagh Workshop.
- As on December 2016, demand from various Zonal Railways for 770⁵bio-

⁴ Pink Book item No. 320 of 2011-12

⁵ CR-60, ECoR-42, ECR-67, ER-41, NCR-10, NER-41, NFR-39, NR-79, NWR-46, SCR-76, SECR-06, SER-50, SR-116, SWR-42, WCR-15, WR-40

tanks for DSLR coaches, 88⁶bio-tanks for Guard Vans and 775⁷ bio-tanks for passenger coaches (Total 1633 bio-tanks) was pending with Motibagh Workshop.

- Quality control checks in respect of bio-tanks manufactured in Motibagh Workshop were yet to be prescribed.

Thus, there is a need to ensure that bio-tanks manufactured in Motibagh Workshop are dispatched to consignee Zonal Railways on time. Quality control checks for bio-tanks manufactured by Motibagh Workshop also needs to be laid down.

Regarding in-house production of bio-tanks at Motibagh Workshop/Nagpur, Ministry during Exit Conference stated (July 2017) that the same was now commissioned. Special type of bio-tank used in Guard van etc. were being manufactured by Motibagh workshop.

3.2 Bacteria generation facilities

Bio-toilets work on the principle of biological degradation of human waste by bacterial inoculum. Anaerobic bacteria inoculums used in the bio-toilets digest human waste converting it into water and gases (Methane and Carbon dioxide). Presence of bacteria in sufficient numbers in the bio-digester tanks is crucial for efficient functioning of the bio-toilets. Keeping this in mind and to ensure uninterrupted supply, Railway Board in its Action Plan (November 2011) directed ICF and RCF to create bacteria generation facilities for bio-toilets within power of GMs. Further, in a Review Meeting (February 2012), DRDO was requested to assist in supply of bacterial culture till the facilities were established.

Railway Board directed (November 2011) that bacteria generation plants may be set up at RCF, Kapurthala and ICF, Perambur within the powers of General Manager. However, these were not setup till date. In fact, JWG in its 8th meeting (December 2012) suggested that for the time being RCF and ICF may not pursue with in-house bacteria generation plant for the time being and continue procurement from private firms.

In this regard, action was initiated to set up bacterial generation facilities in Motibagh Workshop of SECR and facility was created in March 2014 with installed capacity of 30,000 liters per month. The major raw material for generation of bacteria is water and cow dung. During the period of review, Motibagh Workshop has been able to produce bacteria as per its installed capacity. Bacteria are supplied to Zonal Railways as per their demand. Audit

⁶ ECoR-25, ECR-40, NFR-23

⁷ Against target of 850 bio-toilets, 75 have been despatched so far

noticed that sample of bacteria was occasionally⁸ sent to DRDE/Gwalior to check the specified parameters. No adverse reports came from the DRDE/Gwalior.

Keeping in view increased demand for bacteria from Zonal Railways, a proposal for installation of two more plants of 100 cum capacity (Total capacity of 2.3 lakh liters per month) at a cost of ₹ 0.66 crore was sanctioned by General Manager/SECR in October 2016. Though the work was proposed to be completed by March 2017, detailed estimate was yet to be sanctioned (March 2017).

Another proposal for construction of 100 cum capacity RCC inoculum generation plant at Rajendra Nagar Coaching Depot (ECR) was approved by General Manager/ECR during 2015-16 on out of turn basis. However, the same could not be executed due to the exhaustion of limits for sanctioning of such works by the General Manager. Setting up of bacteria generation plant at Coaching Depot/Rajendra Nagar was under process as on 31 May 2017.

JWG in their 21st meeting (September 2016) expressed concern over inadequate supply/quality of supply of bacteria inoculum and stated that there is a need to expedite installation/augmentation of bacteria generation facility in SECR, ECoR and ECR.

The proposal for creation of facility for bacteria inoculums was mooted in February 2016 and sanctioned by GM/ECoR at a cost of ₹69.55 lakh with a capacity of 100 cum. The LOA for construction of Bacteria inoculums plant was issued (June 2016) and contract awarded to M/s Super flow Engineering Corporation, Gwalior with instructions to complete the work by 26 June 2017. The plant was commissioned on 23 February 2017.

In view of the ambitious target for induction (fitment as well as retrofitment) of bio-toilets in the next few years, bacteria generation facilities needed to be installed/ augmented early.

Ministry during Exit Conference stated (July 2017) that at present DRDO approved suppliers of bacteria (inoculums) were available, who were supplying to the Railways. They further stated that bacteria generation plants on the two identified locations were in progress and would be installed to cater the need of Southern and Eastern regions of Railways.

3.3 Availability of infrastructure in Carriage Workshops/MLR Workshops

Coaches received in Carriage Workshops for POH/MLR are required to be fitted with bio-toilets. Once fitted, these coaches come back to designated Carriage Workshops for POH after completion of prescribed time period and their POH becomes due. Adequate storage space for bio-tanks and bacteria inoculum and

⁸ March 2014, April 2014, July 2014, July 2015, December 2015, February 2016 and October 2016

other infrastructure facilities such as hydraulic/fork lifts, ramps for loading/unloading of bio-tanks etc. were required for ensuring that work of retrofitment of bio-toilets. Low lift hydraulic/fork lift jacks are required for lifting and moving bio-tanks in Workshops. These were to be made available as per Compendium issued by CAMTECH (April 2013). Railway Board directed (05 November 2014) Zonal Railways to procure evacuation machine for removal of non-biodegradable waste from the bio-tanks. Further, JWG in their 16th quarterly meeting (03 July 2015), decided that evacuation machines as per CAMTECH specifications were required to be procured for removal of non-biodegradable waste at Coaching Depot.

It was observed that

- In the 32 Coaching Depots test checked, evacuation system had not been procured by any of the Zonal Railways for removal of non-biodegradable waste from bio-tanks. In WR, bio-toilets were bypassed and continued to run in this condition for several trips, because non-bio-degradable waste could not be removed in the absence of evacuation machines.
- In MLR Workshop, Bhopal and Jhansi though low lift hydraulic jacks & evacuation systems were not available, the work was carried out with the available 'fork lift'. However, proper storage space for storing inoculums was not available in the workshops. There was no separate ramp for loading and unloading of bio-tanks and apron for retrofitment. Separate shed for storing bio-tanks was also a constraint in retrofitment of bio-toilets in the workshop. There were no problems and constraints in direct mounting of bio-toilets during MLR.
- Low lift hydraulic jacks were not available in Alambagh Workshop of NR, Izzatnagar and Gorakhpur Workshops of NER, Ajmer Workshop of NWR, Golden Rock & CW & LW/Perambur Workshops of SR, Hubballi Workshop of SWR, Bhavnagar Workshop of WR, Nishatpura Workshop of WCR. Dibrugarh Workshop of NFR had two Low Lift Hydraulic Jacks, but both were under repair.
- In WR, it was noticed that a contract for dismantling, cleaning, repairing and re-fitment of 236 bio-digester tanks during POH of coaches at Lower Parel Workshop at a cost of ₹ 6,13,600 was awarded vide Letter of Acceptance (LOA) dated 16 April 2016 to M/s Metro Engineering, Mumbai with a completion period of 12 months. Though the contractor requested (13 July 2016) Railway Administration to make available coaches for carrying out the above work, the same were not made available due to absence of infrastructure such as cleaning area, drainage area with requisite facilities, tank storage etc. which was to be arranged by the Engineering Department.

Lack of co-ordination between two Engineering and Mechanical Departments of the Railways thus led to non-commencement of work. Further, scheduled maintenance of bio-toilets was not carried out during POH for want of specific consent along with necessary guidelines and sanctions from Maharashtra Pollution Control Board.

- Storage facility for inoculums (anaerobic bacteria) was not available in workshops at Kanchrapara/ER, Harnaut/ECR, Alambagh/NR, Izzatnagar/NER, New Bongaigaon /NFR, Tirupathi/ SCR, Bhavnagar/WR, Nishatpura/WCR. Dedicated space for dismantling and storage of used/unused bio-toilets had not been provided in Workshops at Kanchrapara/ER and Nishatpura/WCR, while separate infrastructure for carrying out retrofitment of bio-toilets was not available in Jodhpur Workshop of NWR. Though covered place for storing of bio-toilets was available, a large number of bio-toilets were kept in the open in Kharagpur workshop of SER.
- In SR, adequate covered storage facilities for storing inoculums were available in all the three Workshops. However, the Workshops have no separate covered space for storing bio-toilets.
- There were no separate ramps for loading and unloading of bio-tanks for retrofitment in two selected workshops of CR and NFR, all the three Workshops of SR and Tirupati Workshop of SCR.
- Bio-toilet apron required to be provided as per minutes of JWG meeting (03 July 2015) had also not been provided in any of the selected carriage workshops.

The above deficiencies in infrastructure affected proper fitment of bio-toilets in Workshops and needed to be addressed urgently.

Ministry during Exit Conference stated (July 2017) that specification of Evacuation systems has been finalized recently. Budget provision had been made in the current year and Zonal Railways were in the process for procurement of Evacuation systems.