Department of Industrial Relations
STATE OF CALIFORNIA

Standardized Regulatory Impact Assessment: Title 8, Group V Elevator Safety Orders

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1 INTRODUCTION

This standardized regulatory impact assessment (SRIA) analyzes the economic impact of a Title 8 Group 5 elevator safety orders (ESOs) proposed by California's Department of Industrial Relations (DIR). The main purpose of the proposed Title 8 Group 5 ESOs is to assure, to the extent feasible, the safety of the public and of workers with respect to conveyances covered by Division 5, Part 3, Chapter 2 Elevators, Escalators, Platform and Stairway Chair Lifts, Dumbwaiters, Moving Walks, Automated People Movers, and Other Conveyances [7300-7324.2] of the California Labor Code. The proposed ESOs include provisions for the design, construction, installation, operation, testing, inspection, maintenance, alteration, repair, removal, and dismantling of all conveyances. The proposed ESOs do not require altering or retrofitting any of the State's approximately 130,000 existing conveyances.

In accordance with Labor Code §7323, the proposed ESOs must include provisions **at least as effective** as the referenced model consensus standards. One of the principle objectives of the proposed ESOs is to adopt **more effective** regulations when deemed necessary for the protection of the riding public and workers. As an example, the proposed ESOs include regulations that are intended to reduce the safety risks inherent in many machine room-less (MRL) elevator designs. Specifically, DIR's proposed ESOs would require modifications in elevator system design to reduce the risk of (i) incidents related to accessing elevator equipment in the hoistway for maintenance and inspection purposes and (ii) incidents involving exposed live parts that present a significant electrical hazard to workers and the public.

This SRIA report is intended to identify and estimate direct and indirect economic impacts of DIR's proposed ESOs. Such effects include changes in the direct costs to the elevator installation and maintenance sector, indirect impacts to other sectors resulting from these changing direct costs, and economic impacts of improvements in elevator safety for both workers and the public. The analysis also includes a qualitative description of other impacts of the proposed ESOs, as required for SRIAs. These impacts include the economic effects on small businesses in California, any incentives for innovation arising from the regulation, and any change in the competitive position of California businesses attributable to the regulation.

Results of this economic impact assessment suggest that DIR's proposed elevator safety orders would have a small but positive impact on the overall California economy. The proposed ESOs would result in $21.0 million and $30.3 million annually in direct costs and cost savings, respectively, which generates a small positive stimulus for California gross state product (GSP), with positive spillover effects across the economy. Results from a macroeconomic forecasting model suggest that cost savings generates a small positive impact on the state's real growth,

increasing household and enterprise incomes, employment, investment, and fiscal revenues.

1.1 Major Regulation Determination

The proposed ESOs are expected to result in annual direct costs and costs savings of $21.0 million and $30.3 million, respectively. In addition to the indirect economy-wide impacts and safety improvements, direct economic effects of the elevator safety standards will exceed the $50 million annual threshold requiring an SRIA.

1.2 Public Outreach and Input

Throughout the course of the last four years, representatives from DIR and the DOSH (Division of Occupational Safety and Health) Elevator Unit have conducted and participated in many formal and informal stakeholder meetings. Stakeholder input was solicited and received from NEII (the trade association for the world's largest elevator manufacturers), small business elevator companies, general contractors, architects, consultants, BOMA (building owners and managers), large business employers, firefighters, first responders, the IUEC (labor), and the public.

Many subcommittee meetings were convened with a focus group of affected stakeholders, including NEII representatives, elevator company engineers, elevator consultants, and IUEC labor representatives.

2 DIRECT COSTS AND BENEFITS

2.1 Methodology and Assumptions

Two primary direct economic impacts are likely to result from the proposed elevator safety orders. First, the standards are meant to improve worker safety by reducing the risk of major accidents arising from system installation and maintenance. Second, the industry will need to adapt to the proposed regulations by modifying the conveyance systems that are used. These modifications could result in either direct costs or direct benefits depending on the nature of the modification in the installation and maintenance of elevator systems. This second category of costs and benefits has been directly quantified for this SRIA and also serves as the primary inputs into the macroeconomic assessment.

These changes in direct costs fall into several specific categories related to the installation and maintenance of regulated conveyance systems, including inspections, new elevator installations, control space conversions, rentable space impacts, maintenance, firefighter testing, reduction in variances, and plans checks. A discussion of each of these cost categories is described in detail below.

- **Inspections**

  In order to be at least as effective as the ASME A17.1 model consensus standard, the proposed ESOs will require one-year and five-year periodic testing for the State's older (Group II) elevators and escalators.

  As is required by Labor Code 7311.1 and 7311.2, all testing must be conducted by Certified Competent Conveyance Mechanics (CCCMs) and supervised apprentices who are employed by Certified Qualified Conveyance Companies (CQCCs). The additional labor cost for the proposed periodic testing of Group II elevators and escalators will be directly offset by the ESO proposal to reduce the frequency of firefighters' emergency operation testing (see below). This is therefore considered to be a "transfer of duties" because CCCMs (and their supervised apprentices) are the only qualified labor source for conveyance testing in the State of California.

  A survey of Building Owners and Managers (BOMA) members indicated that a high percentage of existing maintenance contracts already include provisions for this periodic testing. For estimating purposed, this SRIA assumes that CQCCs will be successful in selling the required testing services to approximately 50% of all Group II conveyance building owners and managers. It is also assumed that the competitive sell rate for this labor will be three times the labor hour + full fringe benefit cost (i.e., a 300% markup is applied).

The additional costs of periodic testing are assumed to accrue to building owners. CQCCs, both large and small companies, and CCCMs (and apprentices) are expected to benefit from the higher demand for inspection services.

- **Installation of New Elevators**

For many years, the model consensus standard has contained a prescriptive set of requirements for access to elevator equipment located outside the hoistway. These provisions apply to both traction and hydraulic elevator equipment located within a machine room. The prescriptive requirements are well understood by manufacturers, designers, installers, and regulators.

Recent revisions to the consensus standard allow for the placement of this elevator equipment within the hoistway. This type of installation is considered a machine room-less (MRL) configuration (same equipment, but with no machine room). According to the model consensus standard, access to this equipment must be "safe and convenient." DIR staff have determined that this performance-based language is subject to interpretation and has been ineffective in producing acceptable installations. Therefore the proposed ESOs include a more effective prescriptive rule that clearly defines the requirements for access to MRL equipment located within the elevator hoistway.

It is anticipated that the proposed ESOs for access to MRL equipment will alter the current product mix, and thus installations, for three types of conveyances: machine room-less traction elevator installations, machine room traction elevator installations, and machine room hydraulic elevator installations. The specific product mix assumptions for future installations are discussed in Section 2.2.

For building developers that switch from machine room-less to machine room traction elevators, there will be an increase in installation costs. These costs will also be borne by global elevator manufacturers. However, for building developers switching from MRL to machine room hydraulic elevators, DIR estimate that there will be cost savings associated with the new installations. The new conveyance installations are also expected to benefit small California business CQCCs and California-based elevator component manufacturers, which will have greater market share under the proposed ESOs.

- **Control Space Conversions**

Current machine room-less (MRL) elevator installations require a control space for the elevator controller equipment. A control space is the space outside the hoistway, intended to be accessed without full body entry that contains the motor and motion controllers. This space could also contain electrical and/or

mechanical equipment used directly in connection with the elevator, but not the electric driving-machine.

DIR staff determined that control spaces, with doors that open directly into publicly accessible areas of the building, expose the public and elevator workers to potential shock and electrocution risks. The proposed ESO will require a control room for future MRL traction elevator installations. A control room, unlike a control space, is intended for full body entry, of sufficient size to provide the required electrical work space clearances about exposed live parts with the control room door in the closed and locked position.

The economic impact analysis includes the construction costs associated with increasing the size of the space from 17 sq. ft. (control space requirement) to 33 sq. ft. (control room requirement). This requirement only affects future installations and will be borne by building developers.

- **Rentable Space Impacts**

The proposed ESOs are expected to decrease the number of traction MRL installations. These elevators will be converted to machine room hydraulic elevators and machine room traction elevators. The proposed ESOs will affect the size and location of the rooms and spaces associated with each type of elevator installation.

- For traction MRLs converting to hydraulic machine room elevators, the control space requirement in a leasable portion of the building (17 sq. ft.) is eliminated and replaced by a machine room requirement in a leasable portion of the building (35 sq. ft.), thereby reducing the leasable area of the building by 18 sq. ft.
- Traction MRLs converting to machine room traction elevators would relocate the control space requirement in a leasable portion of the building (17 sq. ft.) to an overhead (roof-top) machine room in a non-leasable area of the building, thereby increasing the leasable area of the building by 17 sq. ft.
- The remaining MRLs would require converting the control space (17 sq. ft.) to a control room (33 sq. ft.), thereby reducing the leasable area of the building by 16 sq. ft.

Both the costs and cost savings are expected to accrue to building owners.

- **Maintenance Costs**

The projected decrease in the number of traction MRL installations is expected to create an increase in the number of machine room hydraulic elevators and machine room traction elevators. The monthly maintenance cost for a hydraulic

elevator is significantly less than the monthly maintenance cost for a traction MRL elevator. The monthly maintenance for a machine room traction elevator is equivalent to the monthly maintenance cost for a traction MRL elevator. Therefore the proposed ESOs are expected to result in an overall reduction in maintenance costs. These savings are expected to accrue to building owners. The lower maintenance costs could have a negative impact on large CQCCs as demand for their services declines.

- **Firefighter Testing**

The proposed ESOs will reduce the number of tests of firefighters' emergency operation from monthly testing to quarterly testing. The firefighters' emergency operation is a special mode of operation within the elevator's control logic that changes the way an elevator operates in an emergency. This reduction in the frequency of firefighters' emergency operation testing will affect approximately 121,500 existing conveyances.

This testing must be done by Certified Competent Conveyance Mechanics (CCCMs). The reduction in labor hours associated with this duty will be transferred to the newly required one-year and five-year periodic testing of Group II elevators (described above). The direct benefit associated with the reduction of this testing was calculated at labor + fringe cost (no markup).

- **Reduction in Variances**

Variances will no longer be required for alternate suspension and traction MRL installations since they will be covered under the proposed ESOs. This cost savings is expected to accrue to major elevator manufacturers and building owners. The Occupational Safety and Health Standards Board and Board staff, along with the Division of Occupational Safety and Health, Elevator Unit staff will also be positively affected by the reduction in variances.

- **Plan Checks**

The proposed ESOs will require plan checks in accordance with the Labor Code §7301.1. The fees for this additional direct cost have already been adopted and can be found in CCR Title 8 §344.30. These additional costs are expected to accrue to building developers and CQCCs.

The estimated changes in direct costs reflect deviations from an assumed baseline where the proposed safety orders are not adopted and the status quo regulations are maintained. It is assumed that the proposed safety orders go into effect in 2017 and take three years before full compliance is reached. From 2017 to 2020 it is assumed that compliance increases linearly and thus direct costs also change

linearly in the early years of implementation. From 2020 through 2030, it is assumed that the direct costs remain constant.

2.2 Direct Costs and Benefits to California Businesses

In support of the economic assessment, DIR staff produced detailed estimates of annual changes in direct costs of the proposed ESOs, assuming full compliance with the safety standard is reached in 2020.[1] These estimates are based on (i) labor wage rates and materials costs and (ii) the annual change in elevator installations. There are three types of elevators that are affected by the proposed ESOs: machine room traction elevators, machine room-less (MRL) traction elevators, and machine room hydraulic elevators. Table 1 shows the assumed annual change for each class of elevator during the phase-in and full implementation periods of the proposed ESOs. The ESOs would cause a large decline in machine room-less traction elevators in the first year of implementation (from 830 elevators to 80 elevators), after which new designs will allow MRL elevators to recapture some of the market. Machine room traction elevators are assumed to account for 70% of the necessary elevators installations resulting from the loss in MRL elevators, with 30% of the installations coming from hydraulic elevators.

Table 1: Elevator Installation Assumptions

	Group IV	Projections Subsequent to Adoption of Proposed Group V ESOs		
	2015	Year 1	Year 2	Year 3+
Machine Room Traction Elevators	260	790	730	680
Machine Room-Less (MRL) Traction Elevators	830	80	160	240
Machine Room Hydraulic Elevators	1050	1270	1250	1220

Source: DIR staff.

The shift between different types of elevators will likely result in both increased and decreased direct costs to elevator installation and maintenance professionals. These induced costs and cost savings for each category are shown in Table 2. Additional costs are presented as negative direct costs and reduced costs are presented as positive direct costs (cost savings). Using the cost and cost savings data, the proposed ESOs are expected to result in a benefit-cost ratio of approximate 1.48. This suggests

[1] Details on the calculation of direct costs and benefits are included in Appendix C.

that the proposed ESOs will reduce the net costs to elevator installation and maintenance businesses in California.

Table 2: Change in Direct Costs (million $ 2015)

	Additional Cost	Reduced Cost
Group II Inspections	TOD	TOD
Elevator Installations	-$14.730	$16.140
Control Space Conversions	-$1.200	$0.000
Rentable Space Impacts	-$2.899	$2.999
Maintenance Costs	$0.000	$0.970
Firefighter Testing	$0.000	TOD
Reduction in Variances	$0.000	$3.540
Reduced Testing Requirements	$0.000	$6.649
Plan Check	-$1.598	$0.000
Total (with TOD)	-$20.427	$30.296

Source: DIR staff. Numbers may not add up due to rounding.

Two of the sources of reduced cost, eliminating five-year load tests for Group II hydraulic elevators and a reduction in the frequency of firefighter testing, are considered to be a "transfer of labor duties" (TOD) for existing workers. Under this assumption the additional savings of $40.92 million ($13.91 million for Group II inspections + $27 million for firefighter testing) would partially offset the higher cost associated with Group II inspections. The reduction in labor costs from these two categories would therefore be $6.65 million ($40.92 million – $34.27 million for additional Group II inspections). The net reduced costs from this transfer of duties is shown in Table 2. This is the only instance in the present analysis where specific costs and savings are aggregated to represent a net cost.

2.2.1 Impact on Small Businesses in California

Small businesses in California that are qualified to install conveyance systems have been adversely affected by the high market penetration of machine room-less (MRL) traction elevators. This is due to market advantages for large manufacturers holding rights to patented hoist way configurations in MRL elevators. Machine room elevators, which will likely capture growing market share, do not have any patents preventing small businesses from bidding on contracts. Therefore, it is likely that small businesses will see their competiveness improve and can benefit from the proposed ESOs. DIR estimates that small businesses could potentially account for 10% of new machine room elevator installations. Small businesses would therefore

be expected to install approximately 42 of the 420 MRL elevators that would be converted to machine room traction elevators. The average installation costs approximately $200,000, which would generate $8.4 million in additional revenue to small businesses. Approximately 40% of this incremental revenue would go to labor. However, no new jobs are expected to be created since certified mechanics from the same labor pool would be expected to redirect their services from non-small businesses to small businesses.

Available data cannot identify whether the increase in revenue would create new small businesses. The additional 42 installations could perhaps create 1 or 2 additional businesses or it could induce existing small businesses that only compete for service contracts to also compete for installation contracts.

2.3 Direct Costs and Benefits to California Consumers

The proposed regulations are not currently expected to have direct impacts on California consumers. Indirect and induced economic impacts on California consumers are reported in Section 3.

2.4 Direct Safety Benefits

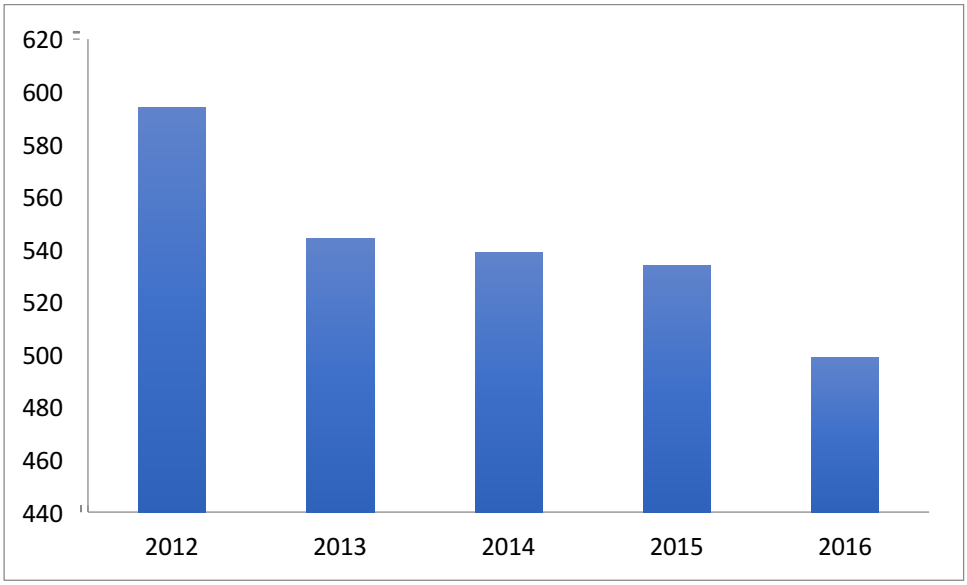
The primary objective of the proposed elevator safety orders is to reduce the likelihood of work-related injuries for elevator workers and decrease risks to the general public. These incidents impose economic costs on both the worker and the industry. According to data from the US Department of Labor's Bureau of Labor Statistics' Census on Fatal Occupational Injuries, elevator workers have a fatality rate that is nearly 50% higher than the fatality rate for all construction trade workers.[2] A national report on elevator-related deaths and injuries indicates that nearly 28 individuals are killed annually in accidents involving elevators.[3] Approximately 10,200 serious elevator-related injuries are also reported each year on average. These statistics include worker-related deaths and injuries, as well as incidents involving the public.

Estimates from DIR's Division of Occupational Safety and Health Elevator Unit fatality investigations found that between 2010 and 2016 there were 11 reported elevator-related fatalities. There were four certified competent conveyance mechanics (CCCM)

[2] The average fatality rate for elevator workers is 24.1 deaths/100,000 workers. The average for construction trade workers is 16.3 deaths/100,000 workers. Fatality rates were calculated based on an average of 2012-2015 reported deaths and occupational employment estimates.
[3] McCann, M (2013), "Deaths and Injuries Involving Elevators and Escalators," Center for Construction Research and Training.

fatalities and seven general industry or general public fatalities. California data on non-fatal incidents related to elevator safety was gathered from the Workers' Compensation Information System (WCIS).[4] This database only included reported worker-related incidents involving injuries and may therefore underestimate the total number of incidents. The total number of incidents would also include incidents involving the public and unreported worker-related incidents, which are not included in the WCIS database. Between 2012 and 2016 an average of 542 work-related injuries per year were reported, although the number of incidents has declined over the past five years. Figure 1 shows the number of worker-related elevator incidents reported to DIR between 2012 and 2016.

Figure 1: Work-Related Elevator Injuries in California



Data explicitly quantifying the reduced likelihood of injury or death due to the proposed ESOs was not available for this SRIA. This lack of data makes it difficult to directly monetize the benefits of improved safety to workers and the public as a result of the proposed ESO. However, the areas for reducing risk are outlined below with a discussion on how DIR's proposed ESOs are meant to alleviate such risks. It might be useful to incorporate actuarial values and estimate the loss aversion benefits of safety and public health regulations, but we have not incorporated these in the present assessment.

[4] https://www.dir.ca.gov/dwc/WCIS.htm.

The proposed ESOs are expected to reduce the likelihood of both fatal and non-fatal injuries by:

- **Improving access to equipment**: The proposed ESOs include prescriptive design requirements for MRL elevators. The new MRL design requirements, together with the expected increase in machine room elevators will reduce the risks associated with accessing equipment at the top of the elevator hoistway.
- **Reducing electrical hazards**: The proposed ESOs would require better control of the location, accessibility, and exposure of live parts.
- **Mitigating exposure to shearing and crushing hazards in the hoistway**: The proposed ESOs provide clearance and/or guarding requirements between fixed obstructions in the hoistway and the car top railings.
- **Eliminating confined space work that is associated with some machine room-less (MRL) elevator designs:** The proposed ESOs include prescriptive design provisions for machine room-less (MRL) elevators that make critical components requiring maintenance and inspection accessible to elevator workers and inspectors when the car top is level with the top landing hoistway door.
- **Ensuring equivalence to the Title 8 General Industry Safety Orders:** In order to protect elevator workers, the proposed ESOs amended provisions of the model consensus standard that were deemed less protective than the minimum level of safety prescribed by the Title 8 General Industry Safety Orders which are applicable to all places of employment.

2.5 Energy Consumption

The proposed ESOs are not expected to have any discernable effect on energy consumption. The energy consumption of a modern traction elevator is determined by the mechanical requirements of the rated car capacity, the degree of counterweight overbalancing, and the elevator's rated speed. The calculated power requirements are then divided by a series of major component efficiencies (motor, gearbox, roping arrangement, electronic drive power converter, transformers and/or other filters used in the power path of electricity from utility lines to the elevator). The combined efficiency ratings of these components ultimately determine the minimum feeder wire size to operate the equipment. To determine the actual energy consumed, other elevator and building design traits must be estimated and made part of the calculations. Most current low-rise and mid-rise traction elevator designs utilize a 2:1 roped or belted gearless a.c. permanent magnet driving-machine. The same 2:1 rope or belted driving-machine can be utilized in both the machine room and machine room-less configurations. The physical location of the elevator's driving-

machine (in the machine room or in the hoistway) does not affect the unit's energy consumption.

3 ECONOMIC IMPACTS

3.1 Methodology for Determining Economic Impact

The economy-wide results of the proposed regulations are assessed using the Berkeley Energy and Resources (BEAR) model. The BEAR model is a dynamic economic model for evaluating long-term growth prospects for California. The model is an advanced policy simulation tool that models demand, supply, and resource allocation across the California economy, estimating economic outcomes annually over the period 2016–2030. This kind of computable general equilibrium (CGE) model is a state-of-the-art economic forecasting tool, using a system of equations and detailed economic data that simulate price-directed interactions between firms and households in commodity and factor markets. The role of government, capital markets, and other trading partners are also included, with varying degrees of detail, to close the model and account for economy-wide resource allocation, production, & income determination.

BEAR is calibrated to 2013 economic activity data for the California economy and includes highly disaggregated representation of firm, household, employment, government, and trade behavior (see Figure B.2 in Appendix B). For this SRIA, the model is aggregated to 60 sectors that are of particular relevance to the economic activities most likely impacted by the proposed regulation (see Table B.2 in Appendix B). The model's 2016-2030 baseline is calibrated to California Department of Finance economic and demographic projections.[5]

3.2 Scenarios

This economic impact analysis considers the proposed safety standard (*proposal*) and two regulatory alternatives. The two regulatory alternatives include a less stringent safety standard (*less stringent*) and a more stringent safety standard (*more stringent*). The more stringent safety standard is based on the Navy and Army Corps of Engineers (NAVAC) design guide.[6] This standard prohibits the use of machine room-less elevators and controllers in the hoistway and thus imposes a higher compliance cost on the industry. In exchange for higher compliance and monitoring costs, it is plausible that this standard would result in greater safety benefits, but we do not monetize these benefits in this study. The less stringent standard assumes the adoption of the American Society of Mechanical Engineers (ASME) 17.1 safety code

[5] A baseline comparison of BEAR and DOF forecasts for key economic variables is available upon request.

[6] The NAVAC design guide is available at https://www.wbdg.org/ccb/NAVFAC/INTCRIT/fy13_01.pdf.

for elevators. This standard would not provide the same improvements of safety benefits as the proposed ESOs, but it also would not require the same number of installation and maintenance modifications, resulting in lower compliance costs. The changes in direct costs for the regulatory alternatives were calculated by DIR staff and are reported in Appendix A.

Several sensitivity scenarios are included in the economic assessment. The first sensitivities (*S1*-*S3*) test the robustness of the direct cost allocation strategy in the macroeconomic model. This sensitivity was considered for the proposal (*S1*) and both regulatory alternatives (*S2*-*S3*). A justification for this sensitivity is described in the following section. A fourth sensitivity (*S4*) considers a conservative case where only the direct costs identified in Table 2 are assumed to be realized. In this scenario, none of the cost savings estimated by DIR are assumed to be realized. This sensitivity is unlikely but provides a bookend for a "worst-case" scenario.

3.3 Inputs into the Assessment

The changes in direct costs outlined in Table 2 are the primary inputs into the economy-wide assessment of the proposed regulation. Direct costs and cost savings for each category are mapped individually to the appropriate macroeconomic sector.[7] For this SRIA, the direct cost categories are all part of the BEAR model's non-residential building construction and maintenance sector. This aggregated sector includes both commercial buildings and apartment buildings. Elevators in single-family housing units, which comprise a very small fraction of the State's installed elevators, were not included in the macroeconomic analysis. A distinction between business sizes (i.e., small businesses) was not made in the macroeconomic analysis due to limitations of the model—no California macro model currently distinguishes between enterprise types within a specific sector.

All categories except rentable space impacts correspond with the non-residential construction sector. It is also arguable that the direct impacts associated with changes in rental space are actually part of the real estate sector. To test this possibility, we include a sensitivity case that allocates the rentable space impacts to the real estate sector rather than the non-residential construction sector.

3.4 Assumptions and Limitations of the Model

The following assumptions were made for the macroeconomic assessment.

[7] As a technical point, it should be noted that input data on costs and benefits cannot be assessed as separate impact scenarios because the results of the model would not be additive. When we implement the full regulation, however, output cost and benefit impacts are reported separately.

- The baseline economy grows at the long-term real GSP growth rate projected by the California Department of Finance. The labor force is also projected to change according to the Department of Finance's demographic forecast.
- Elevator growth trajectories are assumed to remain constant over the analysis period. It is plausible that cyclical variation in economic activity could cause these projections to increase or decrease relative to the values assumed in this analysis.
- Compliance costs and cost savings in the elevator sector (the non-residential sector in the macroeconomic model) are assumed to pass through fully to consumers, which are likely to be other businesses occupying these non-commercial buildings.
- Full compliance, starting in 2020, assumes that buildings are 100% compliant with the proposed ESOs. This assumption is reasonable given the frequent nature of elevator inspections.

3.5 Results of the Assessment

The required SRIA macroeconomic reporting variables are presented in the tables below and include GSP, employment, real enterprise output, real investment, and household income. Qualitative interpretation is provided regarding other economic impacts that could not be directly estimated with the model.

3.5.1 Impacts on Gross State Product

The impact of the proposed safety orders on real GSP is shown in Table 3. The proposal is expected to have a modest but positive overall impact on aggregate economic activity in the State. Even when fully implemented, the impact on GSP is small, ranging from $11.8 million annually in 2020 to $23.1 million in 2030. The impact on GSP in later years is greater than program implementation years, even though the structure of the direct costs and benefits remains unchanged after 2020. This is attributable to the cumulative growth dividends, or multiplier effects, of net program savings.

Our estimates also suggest that both of the regulatory alternatives also have the potential to increase GSP. As expected, the impacts increase with the magnitude of the net cost savings of the proposed ESO described in the Section 2.2. The sensitivity scenarios do not have a significantly different impact on GSP than do the three core scenarios. This suggests that the core results are generally robust to the direct cost allocation method. The high cost scenario shows that if none of the cost savings projected by DIR are realized, the proposed ESO could have a modest negative impact on GSP relative to the baseline, ranging from -$26.4 million in 2020 to -$51.7 million

in 2030. As with the other scenarios, this reduction from baseline GDP is very small relative to the overall size of the California economy.

Table 3: Change in Gross State Product from Baseline (2013 $ million)

	2018	2020	2025	2030
Proposal	3.550	11.793	17.383	23.073
Less Stringent	2.310	7.672	11.308	15.010
More Stringent	6.270	20.829	30.700	40.750
Sensitivity Analysis				
S1—Proposal	4.538	14.839	20.896	26.981
S2—Less Stringent	2.310	7.672	11.307	15.009
S3—More Stringent	4.464	15.956	28.226	41.110
S4—High Cost	-7.963	-26.449	-38.984	-51.746

Source: BEAR model.

3.5.2 California Employment Impacts

Model results suggest that the proposed standard will have very modest beneficial impacts on state employment. As shown in Table 4, employment (measured as full-time equivalents) would increase above the baseline by approximately 83 FTE professional jobs. There are two opposing economic forces driving the employment impacts. First, employment in the non-residential construction sector is expected to decrease by a very modest amount (~26 FTE jobs by 2030) since the proposed regulations would slightly decrease demand in this sector. The lower elevator installation and maintenance net cost accrues to sectors that utilize elevator industry services, such as professional service sectors that use office space, hotels, and medical facilities. These sectors see modest gains in employment, with the net economy-wide employment effect being the 71 additional jobs in 2030.

The two regulatory alternatives also show a modest positive impact on economy-wide employment levels. The economic forces are identical to those outlined for the proposed regulation since the regulatory alternatives simply differ in the magnitude of the direct effects. For example, the more stringent alternative has a larger negative impact on the non-residential construction sector but also a larger positive impact on the sectors that utilize elevator services. The net effect for the more stringent alternative is an economy-wide increase of 126 FTE jobs in 2030.

The sensitivity analysis that explores the cost allocation methodology shows no significant difference than the primary modeling approach. The high cost sensitivity (*S4*) shows a modest negative employment impact relative to the baseline (~160 FTE

jobs).[8] These adverse impacts are absorbed primarily by the professional service sectors that utilize elevator services since additional costs are assumed to be passed through by elevator manufacturing and installation companies.

Table 4: Change in Employment from Baseline (FTE jobs)

	2018	2020	2025	2030
Proposal	7	25	50	71
Less Stringent	4	16	33	46
More Stringent	12	44	89	126
Sensitivity Analysis				
S1—Proposal	12	41	67	88
S2—Less Stringent	4	16	33	46
S3—More Stringent	-8	-10	52	105
S4—High Cost	-15	-56	-113	-160

Source: BEAR model.

3.5.3 California Business Impacts

The economy-wide impact of the proposed safety orders and the regulatory alternatives on real enterprise output is shown in Table 5. Not surprisingly, the direction and magnitude of these aggregate business effects follow the GSP and employment effects discussed in the previous sections. The proposed regulation and the regulatory alternatives would, on net, act as a very modest economic stimulus that benefits California's businesses.

The distributional impacts on individual business sectors are similar to the distribution of employment impacts discussed in the previous section. Because of improved reliability, the elevator installations and maintenance sector, which is represented in the model's non-residential construction sector, experiences a small decline in demand due to lower resource needs under the proposed safety orders. These savings are passed along to consumers, primarily sectors that purchase or rent non-residential buildings for their business activities. For the proposed regulation, these distributional impacts are very modest in percentage terms for any individual sector (< $10 million in 2030).

Table 5: Change in Real Enterprise Output from Baseline (2013 $ million)

	2018	2020	2025	2030
Proposal	0.430	3.004	11.454	20.132

[8] The negative employment impact should not be interpreted as a loss of jobs relative to the current workforce. Rather, the negative employment impact implies that job *growth* will be slightly below the baseline projection.

Less Stringent	0.279	1.954	7.452	13.097
More Stringent	0.759	5.305	20.230	35.556
Sensitivity Analysis				
S1—Proposal	1.109	5.181	14.375	23.692
S2—Less Stringent	0.279	1.954	7.451	13.096
S3—More Stringent	-2.158	-2.695	15.678	35.147
S4—High Cost	-0.964	-6.737	-25.689	-45.151

Source: BEAR model.

3.5.4 California Investment Impacts

The impacts on economy-wide real investment of the proposed safety orders and/or regulatory alternatives are shown in Table 6. The proposed regulation has modest positive effect on statewide investment (~$5.6 million in 2030). The regulatory alternatives also have a modest positive impact, differ slightly and only in magnitude due to magnitude of the initial stimulus being modeled. It is worth noting that investment is more directly connected to the size of the stimulus and does not increase over time as a result of the multiplier effects. This is the reason that post-2020 investment levels do not grow as much as real enterprise output or GSP results. We note a weak increase over time, driven by savings from increased income, but this is secondary to the policy-induced investments.

Table 6: Change in Real Investment from Baseline (2013 $ million)

	2018	**2020**	**2025**	**2030**
Proposal	1.508	4.666	5.217	5.557
Less Stringent	0.981	3.035	3.394	3.615
More Stringent	2.663	8.240	9.214	9.814
Sensitivity Analysis				
S1—Proposal	1.691	5.207	5.759	6.075
S2—Less Stringent	0.981	3.035	3.394	3.615
S3—More Stringent	3.039	9.515	10.941	11.940
S4—High Cost	-3.381	-10.463	-11.700	-12.462

Source: BEAR model.

3.5.5 Impacts on California Households

The net cost savings generated by the proposed elevator safety orders induces modest but positive impact on real incomes for California households. Table 7 shows the impact of the proposed orders and regulatory alternatives on incomes over the assessment interval (2016-2030). In the early years of implementation, as the new standards are enforced, the proposed orders would raise household incomes $1.7 million, while low stringency would yield a dividend of $1.1 million, and higher

stringency yields $3.0 million. These are very modest aggregate changes relative to the baseline, to be expected given the magnitude of the direct costs and benefits, and the primary beneficiaries would be those directly employed in compliance. Household income continues to increase, relative to the baseline, through 2030 as the spending multipliers sustain long-term income effects. The sensitivity results show very similar impacts to the main results, suggesting again that the strategy for modeling rentable space impacts does not have a strong influence on household income. In other words, for the aggregate economy, the magnitude of compliance investments is more important than the target sectors of direct compliance spending. The high cost sensitivity shows the opposite income effect for households. The higher net costs are passed along, which reduces incomes, particularly in sectors affected by compliance.

Table 7: Change in Real Household Income from Baseline (2013 $ million)

	2018	2020	2025	2030
Proposal	1.678	5.781	9.386	13.037
Less Stringent	1.091	3.761	6.106	8.482
More Stringent	2.963	10.210	16.577	23.026
Sensitivity Analysis				
S1—Proposal	2.346	7.838	11.739	15.634
S2—Less Stringent	1.091	3.760	6.106	8.481
S3—More Stringent	1.138	5.098	13.042	21.356
S4—High Cost	-3.764	-12.965	-21.050	-29.240

Source: BEAR model.

Table 8 shows the distributional impacts of the proposed safety orders and regulatory alternatives on household income by decile in 2030. Results suggest that indirect income benefits accrue primarily to middle- and upper-income households. In the high cost sensitivity, higher net costs are also absorbed by middle- and upper-income households.

Table 8: Change in Household Relative Real Income by Decile in 2030 (2013 $ million difference from baseline)

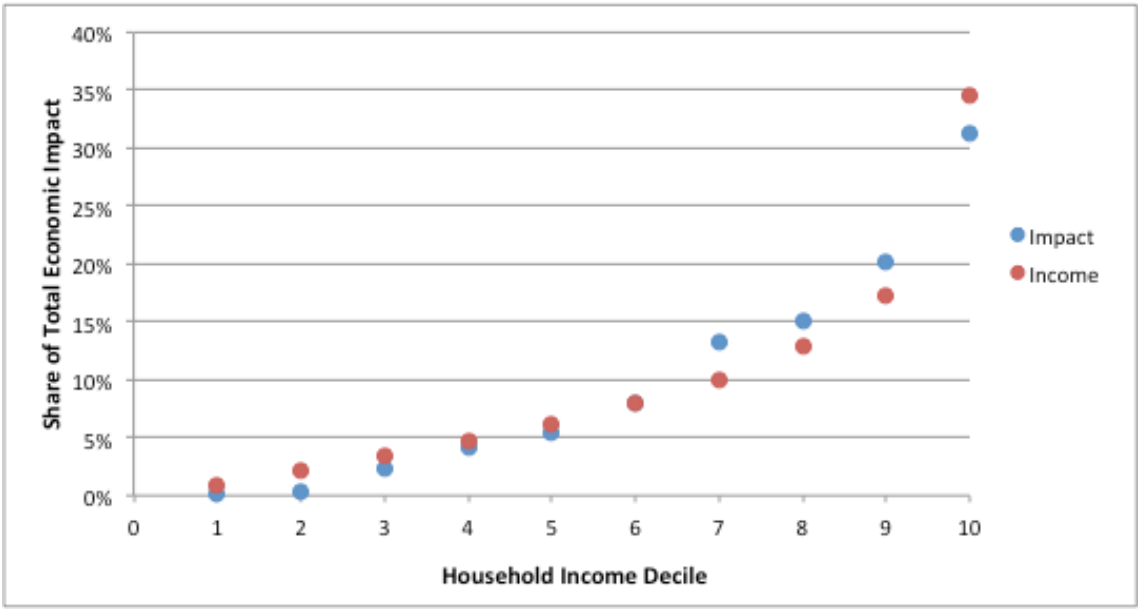
	Proposal	Less Stringent	More Stringent	S1—Proposal	S2—Less Stringency	S3—More Stringent	S4—High Cost
HH1	0.02	0.01	0.03	0.02	0.01	0.02	-0.04
HH2	0.03	0.02	0.06	0.05	0.02	0.03	-0.08
HH3	0.29	0.19	0.52	0.36	0.19	0.42	-0.66
HH4	0.53	0.34	0.94	0.65	0.34	0.78	-1.19
HH5	0.71	0.46	1.26	0.91	0.46	0.90	-1.59
HH6	1.04	0.68	1.84	1.28	0.68	1.56	-2.34
HH7	1.73	1.12	3.05	2.05	1.12	2.92	-3.87
HH8	1.97	1.28	3.48	2.38	1.28	3.11	-4.41
HH9	2.63	1.71	4.64	3.12	1.71	4.47	-5.89
HH10	4.09	2.66	7.22	4.81	2.66	7.14	-9.17
Total	13.04	8.48	23.03	15.63	8.48	21.36	-29.24

Source: BEAR model. HH1 = lowest income decile.

Figure 2 illustrates these distributional effects for the Proposal scenario. The vertical axis measures percent income going to each household decile. The red series represents the share of total state household income of each decile (about 1.5% for the lowest and about 35% for the highest). The blue series shows corresponding shares of the aggregate regulatory benefit going to each decile. As we can see, upper-middle-income households (Deciles 7-9) capture a bigger share of the benefit than their base income share, while the highest and lower deciles all capture less than their income share.

The reason for these disproportionate impacts is that the cost savings from the safety orders are passed on to users of elevator services, and these are primarily professional service sectors that employ highly skilled workers with higher incomes. It should be noted that these income benefits, are very small considering that they will be spread across such a large workforce.

Figure 2: Distributional Effects on California Households by Income Decile



Source: BEAR model.

3.5.6 Incentives for Innovation

The scenarios considered here do not assume that new investment leads to endogenous technology improvements beyond the compliance standards. These productivity gains are quite common to modern competitive technology adoption, however, suggesting that we might be underestimating benefits that would accrue from compliance.

Further consideration of such induced innovation might be justified for more thorough accounting for regulatory compliance, which in the first instance is generally dominated by adoption cost considerations. In addition to a variety of renewal and incubation benefits like the ones mentioned above, standards often create strategic competitive dynamics that promote innovation, productivity, and growth. For example, the new elevator standards will change the composition of elevator types. Machine room-less (MRL) elevators will lose market share as a result of compliance, and this will create an incentive for innovation in order to bring MRL elevators up to code. This process was graphically illustrated by California's adoption of appliance efficiency standards in the 1970s. In this case, driven by cost and market share considerations, manufacturers moved relatively quickly to comply with across their entire US inventory, making California the de facto national efficiency standard.

3.5.7 Competitive Advantage or Disadvantage

Because, this is a very narrowly targeted regulation, we do not envision that the proposed ESOs would put California business, generally, at a competitive advantage or disadvantage. Elevators are a very localized service product, competitively provided across a spatially vast market. They may also be expensive, but are usually a small fraction of overall real estate capital and O&M costs. For these reasons, the relative costs of elevators have only the most negligible impact on interstate competition by their consumers. Imagine hotels in New York, Miami, and San Francisco, for example. One could pay two to five times as much for elevators without significantly undermining their competitiveness.

3.6 Summary and Interpretation of Results

The Department of Industrial Relation's proposed elevator safety orders are expected to have modest positive impacts on the California economy, measured in terms of GSP, unemployment, household income, and other macroeconomic variables reported in this SRIA. These economy-wide impacts are the result of net reduction in installation and maintenance costs that are passed on to users of non-residential buildings that utilize conveyance systems.

The proposed safety orders are also expected to reduce the risk to the public and elevator installation and maintenance workers of fatal and non-fatal accident. Although this benefit is not directly monetized in this SRIA due to a lack of detailed data, the fatality rates in the elevator sector are much higher than the broader construction trade sector, suggesting that there is considerable room for reducing risks of injury. The actuarial value of these benefits could be included in this and other safety- and health-related SRIAs but we have not yet done so.

3.6.1 Summary and Interpretation of Regulatory Alternatives

The analysis considered two regulatory alternatives. The low stringency regulatory alternative had few direct economic impacts but also is expected to provide less improvement in the overall safety of elevator workers. The macroeconomic impacts of the low stringency alternative are even more muted than the proposed ESOs. This alternative would essentially have no impact on macroeconomic indicators in the State. This alternative is rejected by DIR because it is less protective than the ESOs that are currently in place. It contains provisions that do not adequately protect workers from the shearing and crushing hazards associated with the recent addition of car top railings and machine room-less (MRL) elevator designs. It contains insufficient prescriptive language for safe access to critical components located at the

top of the elevator hoistway. Lack of safe access can lead to risky behavior by elevator workers and inspectors. Lack of safe access can also lead to poor maintenance and inspection of critical components which could ultimately compromise the public's safety.

The high stringency alternative, based on the Army and Navy regulatory standards, would yield both increased direct costs and increased cost savings to the elevator industry. The net direct costs actually generate greater aggregate savings for the elevator industry, based on DIR staff assumptions. These extra cost savings, relative to the proposed ESOs, would result in an approximately 50% higher GSP and employment than the proposed standard. However, these GSP and employment estimates are so small relative to the baseline that even small changes between the proposed ESOs and regulatory alternatives appear as large percentage changes. DIR is rejecting this higher stringency standard because it is intended to serve the needs of a very specific entity, the US military. The elevators installed in accordance with this alternative are designed to meet the long-term ownership needs of the end user. Although this alternative appears to provide the safest, most sustainable, least expensive long-term solution for elevator installations, it may not be appropriate for every private sector building planner, developer, and owner.

4 FISCAL IMPACTS

Based on information from the Public Safety State Inspection Management System (PSSIMS) database, approximately 10.8% of the existing conveyance systems in California are installed in public buildings. DIR staff project that going forward, approximately 10% of new elevator systems, covered under the proposed ESOs, would be in public buildings. Based on this assumption, it is reasonable to assume that 10% of the direct costs and cost savings detailed in Table 2 will accrue to public institutions that own and/or manage these buildings. The fiscal impact for the State government as purchasers and users of elevators would therefore be $2.095 million in additional direct costs and $3.030 million in direct cost savings. These costs and savings also assume that the pattern of substitution of elevators in commercial buildings is the same for all public sector buildings. Data to estimate any impact on local government as purchasers and users of elevators was not available.

Under the proposed ESOs, it is expected that DIR will collect the new plan check fees of approximately $1.598 million per year as new elevators are installed. The proceeds from the plan check fees will be used to offset DIR DOSH Elevator Unit salaries, benefits, and expenses related to the plan check function. The entire safety program is administered at the State level and nothing in the proposed ESOs will have a direct impact on local government revenues.

The very modest macroeconomic stimulus arising from the proposed ESOs can also be expected to have an induced impact on fiscal revenue. However, this impact is expected to be correspondingly positive but negligible.

5 Appendix A: Direct Cost Estimates for Regulatory Alternatives

Tables A.1 and A.2 show DIR staff estimates for the change in direct costs from the two regulatory alternatives considered in this SRIA.

Table A.1: Direct Cost Estimates for Less Stringent Regulatory Alternative (2015 $ million)

	Additional Cost	Reduced Cost	Net Direct Economic Impact
Group II Inspections	-$34.27	$13.91	-$20.36
Firefighter Testing	$0.00	$33.01	$33.01
Reduction in Variances	$0.00	$3.54	$3.54
Plan Check	-$2.13	$0.00	-$2.13
Confined Space	-$7.99	$0.00	-$7.99
Transfer of Duties	0	$4.66	$4.66
Total (without TOD)	**-$44.39**	**$50.46**	**$6.08**
Total (with TOD)	**-$2.13**	**8.2**	**$6.08**

Source: DIR staff.

Table A.2: Direct Cost Estimates for More Stringent Regulatory Alternative (2015 $ million)

	Additional Cost	Reduced Cost	Net Direct Economic Impact
Group II Inspections	-$34.27	$13.91	-$20.36
Elevator Installations	-$15.35	$22.50	$7.15
Rentable Space Impacts	-$12.41	$4.14	-$8.26
Maintenance Costs	$0.00	$1.43	$1.43
Firefighter Testing	$0.00	$33.01	$33.01
Reduction in Variances	$0.00	$3.54	$3.54
Transfer of Duties	$0.00	$12.65	$12.65
Total (without TOD)	**-$62.03**	**$78.53**	**$16.50**
Total (with TOD)	**-$27.76**	**$44.26**	**$16.50**

Source: DIR staff.

6 Appendix B: Technical Summary of the BEAR Model

The Berkeley Energy and Resources (BEAR) model is a constellation of research tools designed to elucidate linkages across the California economy. The schematics in Figures B.1 and B.2 describe the four generic components of the modeling facility and their interactions. This section provides a brief summary of the formal structure of the BEAR model. For the purposes of this report, the 2013 California Social Accounting Matrix (SAM) was aggregated along certain dimensions. The current version of the model includes 195 activity sectors, 22 occupations, and ten households aggregated from the original California SAM. The equations of the model are completely documented elsewhere (Roland-Holst 2008), and for the present analysis we only review its salient structural components.

6.1 Structure of the CGE Model

Technically, a CGE model is a system of simultaneous equations that simulate price-directed interactions between firms and households in commodity and factor markets. The role of government, capital markets, and other trading partners are also specified, with varying degrees of detail and passivity, to close the model and account for economy-wide resource allocation, production, and income determination.

The role of markets is to mediate exchange, usually with a flexible system of prices, the most important endogenous variables in a typical CGE model. As in a real market economy, commodity and factor price changes induce changes in the level and composition of supply and demand, production and income, and the remaining endogenous variables in the system. In CGE models, an equation system is solved for prices that correspond to equilibrium in markets and satisfy the accounting identities governing economic behavior. If such a system is precisely specified, equilibrium always exists and such a consistent model can be calibrated to a base period data set. The resulting calibrated general equilibrium model is then used to simulate the economy-wide (and regional) effects of alternative policies or external events.

The distinguishing feature of a general equilibrium model, applied or theoretical, is its closed-form specification of all activities in the economic system under study. This can be contrasted with more traditional partial equilibrium analysis, where linkages to other domestic markets and agents are deliberately excluded from consideration. A large and growing body of evidence suggests that indirect effects (e.g., upstream and downstream production linkages) arising from policy changes are not only substantial, but may in some cases even outweigh direct effects. Only a model that consistently specifies economy-wide interactions can fully assess the implications of economic policies or business strategies. In a multi-regional model like the one used

in this study, indirect effects include the trade linkages between countries and regions which themselves can have policy implications.

The model we use for this work has been constructed according to generally accepted specification standards, implemented in the GAMS programming language, and calibrated to the new California SAM estimated for 2013. The result is a single economy model calibrated over the thirty-five-year time path from 2015 to 2050. Using the very detailed accounts of the California SAM, we include the following assumptions in the present model.

6.2 Production

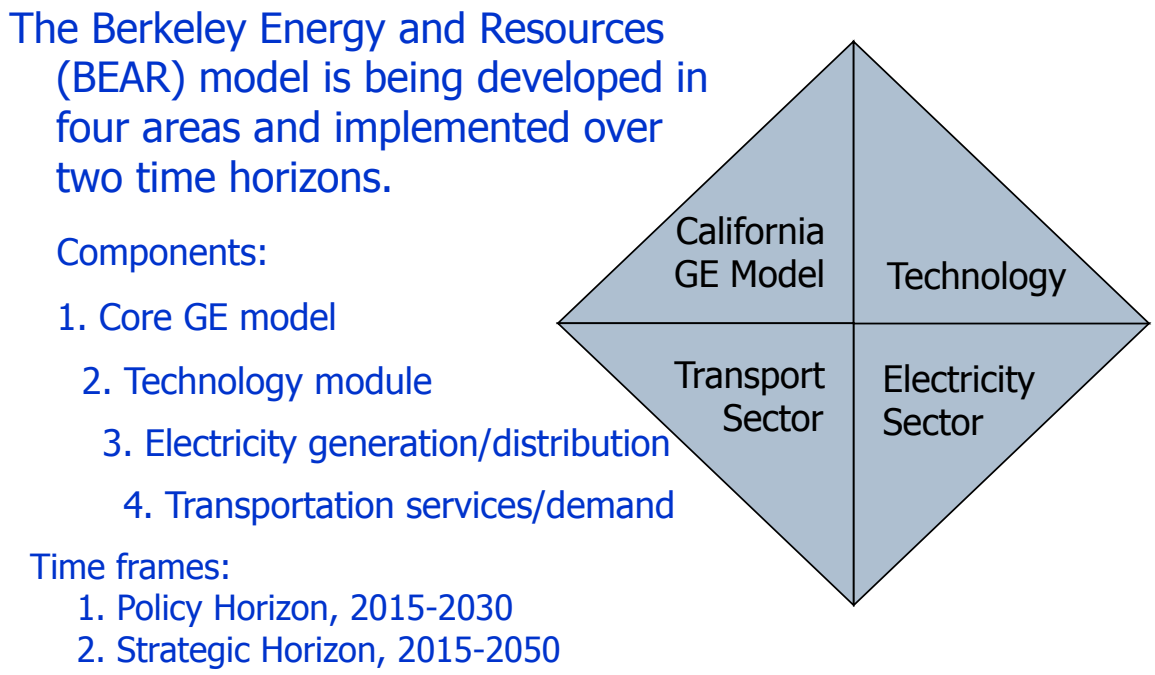
All sectors are assumed to operate under constant returns to scale and cost optimization. Production technology is modeled by a nested constant-elasticity-of-substitution (CES) function.

In each period, the supply of primary factors—capital, land, and labor—is usually predetermined.[9] The model includes adjustment rigidities. An important feature is the distinction between old and new capital goods. In addition, capital is assumed to be partially mobile, reflecting differences in the marketability of capital goods across sectors.[10] Once the optimal combination of inputs is determined, sectoral output prices are calculated assuming competitive supply conditions in all markets.

[9] Capital supply is to some extent influenced by the current period's level of investment.

[10] For simplicity, it is assumed that old capital goods supplied in second-hand markets and new capital goods are homogeneous. This formulation makes it possible to introduce downward rigidities in the adjustment of capital without increasing excessively the number of equilibrium prices to be determined by the model.

Figure B.1: Component Structure of the Modeling Facility



6.3 Consumption and Closure Rule

All income generated by economic activity is assumed to be distributed to consumers. Each representative consumer allocates optimally his/her disposable income among the different commodities and saving. The consumption/saving decision is completely static: saving is treated as a "good" and its amount is determined simultaneously with the demand for the other commodities, the price of saving being set arbitrarily equal to the average price of consumer goods.

The government collects income taxes and indirect taxes on intermediate inputs, outputs, and consumer expenditures. The default closure of the model assumes that the government deficit/saving is exogenously specified.[11] The indirect tax schedule will shift to accommodate any changes in the balance between government revenues and government expenditures.

The current account surplus (deficit) is fixed in nominal terms. The counterpart of this imbalance is a net outflow (inflow) of capital, which is subtracted (added to) the domestic flow of saving. In each period, the model equates gross investment to net saving (equal to the sum of saving by households, the net budget position of the

[11] In the reference simulation, the real government fiscal balance converges (linearly) towards 0 by the final period of the simulation.

government and foreign capital inflows). This particular closure rule implies that investment is driven by saving.

6.4 Trade

Goods are assumed to be differentiated by region of origin. In other words, goods classified in the same sector are different according to whether they are produced domestically or imported. This assumption is frequently known as the *Armington* assumption. The degree of substitutability, as well as the import penetration shares are allowed to vary across commodities. The model assumes a single Armington agent. This strong assumption implies that the propensity to import and the degree of substitutability between domestic and imported goods is uniform across economic agents. This assumption reduces tremendously the dimensionality of the model. In many cases this assumption is imposed by the data. A symmetric assumption is made on the export side where domestic producers are assumed to differentiate the domestic market and the export market. This is modeled using a *Constant-Elasticity-of-Transformation* (CET) function.

6.5 Dynamic Features and Calibration

The current version of the model has a simple recursive dynamic structure as agents are assumed to be myopic and to base their decisions on static expectations about prices and quantities. Dynamics in the model originate in three sources: (i) accumulation of productive capital and labor growth; (ii) shifts in production technology; and (iii) the putty/semi-putty specification of technology.

6.6 Capital Accumulation

In the aggregate, the basic capital accumulation function equates the current capital stock to the depreciated stock inherited from the previous period plus gross investment. However, at the sectoral level, the specific accumulation functions may differ because the demand for (old and new) capital can be less than the depreciated stock of old capital. In this case, the sector contracts over time by releasing old capital goods. Consequently, in each period, the new capital vintage available to expanding industries is equal to the sum of disinvested capital in contracting industries plus total saving generated by the economy, consistent with the closure rule of the model.

6.7 The Putty/Semi-Putty Specification

The substitution possibilities among production factors are assumed to be higher with the new than the old capital vintages—technology has a putty/semi-putty

specification. Hence, when a shock to relative prices occurs (e.g., the imposition of an emissions fee), the demands for production factors adjust gradually to the long-run optimum because the substitution effects are delayed over time. The adjustment path depends on the values of the short-run elasticities of substitution and the replacement rate of capital. As the latter determines the pace at which new vintages are installed, the larger is the volume of new investment, the greater the possibility to achieve the long-run total amount of substitution among production factors.

6.8 Profits, Adjustment Costs, and Expectations

Firms' output and investment decisions are modeled in accordance with the innovative approach of Goulder and co-authors (for technical details, see Goulder, Hafstead, and Dworsky 2010).[12] In particular, we allow for the possibility that firms reap windfall profits from events, such as free permit distribution. Absent more detailed information on ownership patterns, we assume that these profits accrue to US and foreign residents in proportion to equity shares of publicly traded US corporations (16% in 2006).[13] Comparing California and other US residents, the shares are assumed to be proportional to GSP in the US gross domestic product (GDP) (11% in 2009).

6.9 Dynamic Calibration

The model is calibrated on exogenous growth rates of population, labor force, and GDP. In the baseline scenario, the dynamics are calibrated in each region by imposing the assumption of a balanced growth path. This implies that the ratio between labor and capital (in efficiency units) is held constant over time.[14] When alternative scenarios around the baseline are simulated, the technical efficiency parameter is held constant, and the growth of capital is endogenously determined by the saving/investment relation.

[12] Goulder L, Hafstead M, & Dworsky M (2010), "Impacts of alternative emissions allowance allocation methods under a federal cap-and-trade program," *Journal of Environmental Economics and Management* 60(3): 161-181.

[13] Lane, P R, & Milesi-Ferretti, G M (2007), "The External Wealth of Nations Mark II: Revised and extended estimates of foreign assets and liabilities, 1970–2004," *Journal of International Economics* 73(2): 223-250.

[14] This involves computing in each period a measure of Harrod-neutral technical progress in the capital-labor bundle as a residual. This is a standard calibration procedure in dynamic CGE modeling.

Table B.1: California SAM for 2013, Structural Characteristics

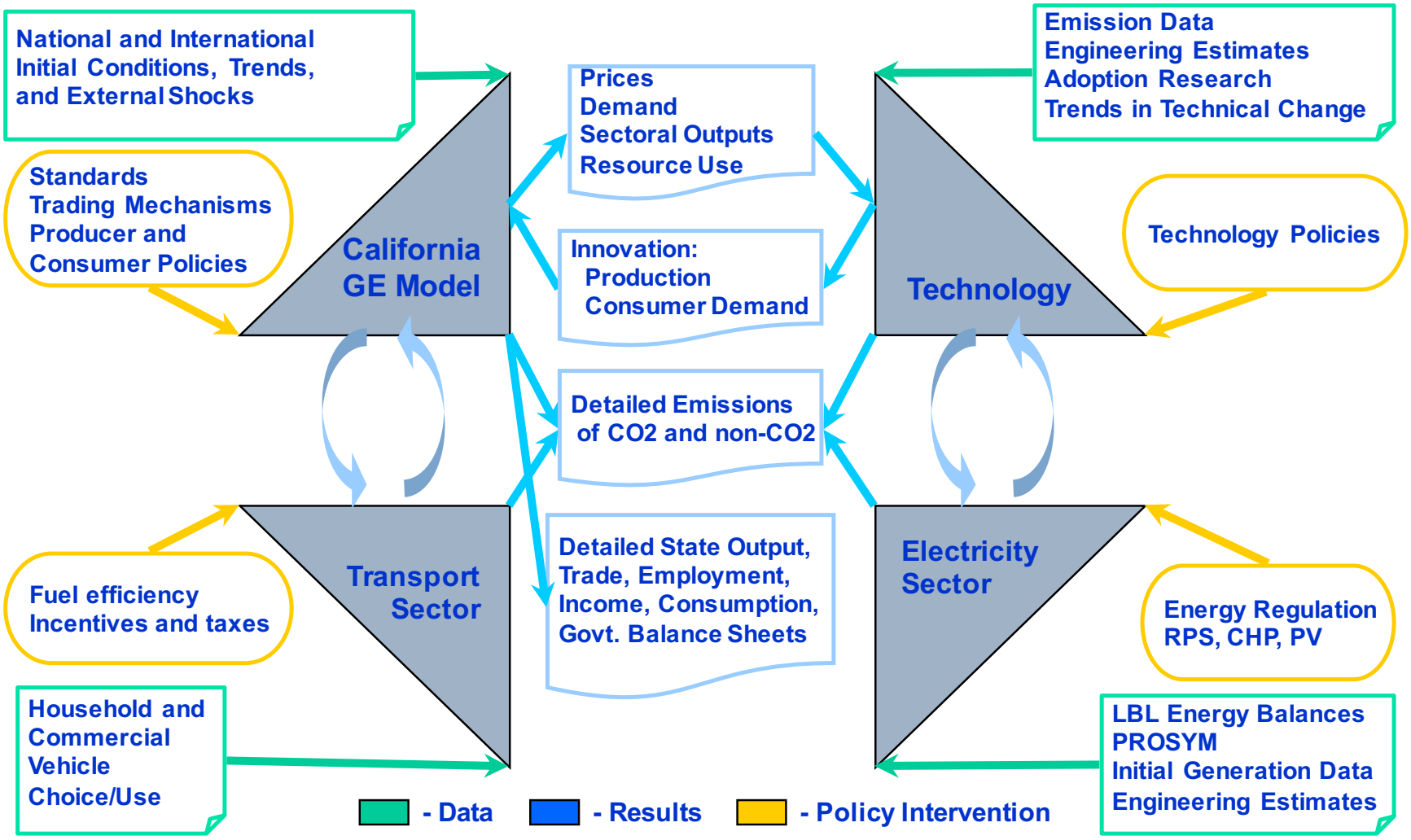
SAM Category
195 commodities (includes trade and transport margins)
24 factors of production
22 labor categories
Capital
Land
10 Household types, defined by income tax bracket
Enterprises
Federal Government (7 fiscal accounts)
State Government (27 fiscal accounts)
Local Government (11 fiscal accounts)
Consolidated capital account
External Trade Account

The 60 production sectors and commodity groups used in this analysis are shown in Table B.2. This aggregates based on the original 195 sectors in the BEAR model.

Table B.2: Aggregate Accounts for DIR California CGE Model

Label	Description	Label	Description
A01Agric	Agriculture	A31Aluminm	Aluminum
A02Cattle	Cattle and Feedlots	A32Machnry	General Machinery
A03Dairy	Dairy Cattle and Milk Production	A33MfgMon	Monitor and Displays Manufacturing
A04Forest	Forestry, Fishery, Mining, Quarrying	A34MfgComp	Computer Manufacturing
A05OilGas	Oil and Gas Extraction	A35SemiCon	Semi-Conductor Manufacturing
A06OthPrim	Other Primary Products	A36ElecApp	Electrical Appliances
A07EleHyd	Electricity Generation- Hydro	A37Autos	Automobiles and Light Trucks
A08EleFF	Electricity Generation-Fossil Fuels	A38OthVeh	Other Vehicle Manufacturing
A09EleNuc	Electricity Generation-Nuclear	A39AeroMfg	Aeroplane and Aerospace Manufacturing
A10EleSol	Electricity Generation-Solar	A40OthInd	Other Industry
A11EleWind	Electricity Generation-Wind	A41WhlTrad	Wholesale Trade
A12EleGeo	Electricity Generation-Geothermal	A42RetVeh	Retail Vehicle Sales and Service
A13EleBio	Electricity Generation- Biomass	A43AirTrns	Air Transport Services
A14EleOth	Electricity Generation-Other	A44GndTrns	Ground Transport Services
A15DistElec	Electricity Distribution	A45WatTrns	Water Transport Services
A16DistGas	Natural Gas Distribution	A46TrkTrns	Truck Transport Services
A17DistOth	Water, Sewage, Steam	A47PubTrns	Public Transport Services
A18ConRes	Residential Construction	A48RetAppl	Retail - Electronics and Appliances
A19ConNRes	Non-Residential Construction	A49RetGen	Retail- General Merchandise
A20ConPow	Power Sector Construction	A50InfCom	Information and Comm. Services
A21ConRd	Other Infrastructure Construction	A51FinServ	Financial Services
A22FoodPrc	Food Processing	A52OthProf	Other Professional Services
A23TxtAprl	Textiles and Apparel	A53BusServ	Business Services
A24WoodPlp	Wood, Pulp, and Paper	A54WstServ	Landfill Services
A25PapPrnt	Printing and Publishing	A55Educatn	Educational Services
A26OilRef	Oil Refining	A56Medicin	Medical Services
A27Chemicl	Chemicals	A57Recratn	Recreation Services
A28Pharma	Pharmaceutical Manufacturing	A58HotRest	Hotel and Restaurant Services
A29Cement	Cement	A59OthPrSv	Other Private Services
A30Metal	Metal Manufacture and Fabrication	A60GovtSv	Government Services

Figure B.2: Schematic Linkage Between Model Components



7 Appendix C: Direct Cost Calculations

This appendix explains the detailed microeconomic calculations for technology-related costs and cost savings associated with proposed ESOs. All estimated were conducted by DIR staff and reviewed by BEAR researchers. Tables C.1-C.3 show assumptions used throughout the analysis for calculating direct costs and savings.

Table C.1: Existing Elevator Installation Assumptions

Data from PSSIMS (Public Safety State Inspection Management System) and LADBS (City of Los Angeles Department of Building and Safety)		
Installations permitted in calendar year 2015 (Note: This number of permitted installations represents a typical robust year for construction, and will be used for projecting future years.) **It is estimated that 75% of the traction elevator installations were machine room-less (MRL) installations**	**Existing Group II installations that will be subject to one-year and five-year periodic testing if the proposed draft regulations are adopted.** Full implementation of this testing will occur in the fourth year (2020) of the new regulations. **This testing is already a requirement in the City of Los Angeles**	**Projected number of elevator installations subject to Firefighters' Emergency Operation testing.** Full implementation of this testing will occur in the fourth year (2020) of the new regulations.
Machine Room Traction – 260 Machine Room-Less (MRL) Traction - 830 Machine Room Hydraulic - 1050 Escalators – 158 Other Conveyances - 537	Traction – 17,163 Hydraulic – 41,551 Escalator – 2,299	121,500

Table C.2: Labor Cost Assumptions

Projected Labor Costs for 2020 **(first year of fully implemented proposed regulations)** **See DIR Prevailing Wage Determination for current hourly rates. The labor rate below is an average of the Northern California and Southern California rates.**		**Multiplier to Obtain Estimated Competitive Sell Rate (per industry representatives) for testing existing Group II conveyances.**	**Estimated Average Competitive Sell Rate**
Mechanic	$104	300%	$312
Helper	$82	300%	$246
Team	$186	300%	$558

The proposed Group V Elevator Safety Orders contain provisions that will affect the number of permitted installations for each type of elevator shown in Table C.3.

If adopted, the Group V Elevator Safety Orders will have an immediate effect on machine room-less (MRL) elevator designs. In the first year the number of machine room-less (MRL) traction elevator installations will be reduced by 750. Approximately 70% of those installations will become machine room traction elevators (mid-rise installations), and 30% will become machine room hydraulic elevators (low-rise installations). After the first year, new machine room-less (MRL) traction elevator designs will begin to re-capture some of the machine room traction and hydraulic elevator market. Equilibrium should be reached by the third year.

Table C.3: New Elevator Installation Assumptions

	Group IV	Projections Subsequent to Adoption of Proposed Group V ESOs			
Type	2015	Year 1	Year 2	Year 3	Future Years
Machine Room Traction Elevators	260	790	730	680	680
Machine Room-Less (MRL) Traction Elevators	830	80	160	240	240
Machine Room Hydraulic Elevators	1,050	1,270	1,250	1,220	1,220

Note: Year 3 will be used for calculating many of the "fully implemented" economic impacts that follow.

7.1 Periodic Testing of Existing Group II Conveyances

The proposed Group V Elevator Safety Orders will require one-year and five-year testing of existing Group II elevators and escalators as is required by the model

consensus standard ASME A17.1 – 2013. Previous regulations only required a five-year load test for hydraulic elevators.

The Division reached out to BOMA representatives to get an estimate of the actual economic impact created by this new requirement. Many BOMA representatives stated that this testing is already included in their contracts with the elevator companies. Other BOMA representatives indicated that money was budgeted for this testing (was not spent if testing not required).

For this economic impact estimate, the Division has assumed that elevator companies will successfully solicit additional money for testing of **50%** of the existing Group II elevators and escalators. Our estimate will use a **competitive sell rate (300% markup)** for labor, not "cost."

Tables C.4-C.6 show the calculations for the cost (negative impacts) and cost savings (positive impacts) of the periodic testing requirements. The total average negative economic impact for a "fully implemented" year is **$34,272,167** ($32,759,241 x 4 years = $131,036,964 (1-year tests) + $40,323,870 (5-year test) = $171,360,834/5 years). The total average positive impact for a "fully implemented" year (Table C.6) is **$13,911,163** ($69,555,816/5 years).

Table C.4: Negative Impact of One-Year Periodic Testing

Type of Conveyance	Formula for Estimate	Negative Economic Impact
Traction Elevators	4 team hours @ $558/hr. x 17,163 units x 50%	$19,153,908
Hydraulic Elevators	2 mechanic hours @ $312/hr. x 41,551 units x 50%	$12,963,912
Escalators (adds step/skirt performance index test)	1 team hour @ $558/hr. x 2,299 units x 50%	$641,421
Total		$32,759,241

Table C.5: Negative Impact of Five-Year Periodic Testing

Type of Conveyance	Formula for Estimate	Negative Economic Impact
Traction Elevators	6 team hours @ $558/hr. x 17,163 units x 50%	$28,730,862
Hydraulic Elevators (only required when an overspeed valve is installed – estimate 25% of total Group II hydraulic elevators)	4 team hours @ $558/hr. x 10,388 units x 50%	$11,593,008
Total		$40,323,870

Table C.6: Positive Impact of Periodic Testing

Type of Conveyance	Formula for Estimate	Positive Economic Impact
Hydraulic Elevators (75% will no longer require a five-year full load test)	4 team hours @ $558/hr. x 31,163 units	$69,555,816

7.2 Installed Elevator Cost

7.2.1 Economic Impact for Machine Room Traction Elevators

Assumptions:

- Motor and motion controllers will be installed in the machine room.
- 90% of the installations will go to NEII companies
- 10% of the installations will go to small business elevator companies

Negative Economic Impact Estimate:

420 (680-260) machine room-less traction elevators will be converted to machine room traction elevators. NEII companies will install 90% of these elevators. NEII companies have standardized machine room installations that utilize all of the equipment used in their machine room-less elevators. In some cases, the elevator design is slightly modified. The cost for these modifications is estimated at $10,000 per installation.

420 x 90% = 378 x $10,000 = $3,780,000

420 machine rooms must be constructed at an additional cost (extending the vertical construction of the hoistway approximately 5 vertical feet) of $200,000 per machine room (US Army Corps of Engineers estimate).

420 x $20,000 = $8,400,000

The total negative economic impact per year for converting machine room-less (MRL) traction elevators to machine room traction elevators is **$12,180,000** ($3,780,000 + $8,400,000).

Positive Economic Impact Estimate:

Small business elevator companies will install 10% of the elevators that are converting from machine room-less (MRL) traction elevators to machine room traction elevators. Small business elevator companies have reported that the cost of material and the installation time is reduced when the equipment is installed in a machine room configuration. Estimate a cost savings of $20,000 per installation.

The total positive economic impact per year for converting machine room-less (MRL) traction elevators to machine room traction elevators is **$840,000** (420 x 10% = 42 x $20,000).

7.2.2 Economic Impact for Machine Room-Less (MRL) Traction Elevators

By the third year after adoption, equilibrium in product mix is reached. The projection shows that an estimated 240 installations will remain machine room-less (MRL) traction elevators for future years. There is no economic impact for these installations.

7.2.3 Economic Impact for Machine Room Hydraulic Elevators

Assumptions:

- Average machine room-less (MRL) traction elevator installation price = $180,000
- Average machine room hydraulic elevator installation price = $90,000
- Additional cost to construct a machine room, in lieu of a control room = $15,000

Negative Economic Impact Estimate:

170 (1,220 – 1,050) machine room-less (MRL) traction elevators will be converted to machine room hydraulic elevators.

170 machine rooms must be constructed at an additional cost (hydraulic machine room cost offset by elimination of the control space) of $15,000 per machine room.

The total negative economic impact per year for constructing a hydraulic machine room when converting machine room-less (MRL) traction elevators to machine room hydraulic elevators is **$2,550,000** (170 x $15,000).

Positive Economic Impact Estimate:

170 (1,220 – 1,050) machine room-less (MRL) traction elevators will be converted to machine room hydraulic elevators.

The total positive economic impact per year for converting machine room-less (MRL) traction elevators to machine room hydraulic elevators is **$15,300,000** (170 x $90,000 ($180,000 - $90,000)).

7.3 Converting control spaces to control rooms

The proposed Group V Elevator Safety Orders prohibit the installation of motor and motion controller equipment in public spaces and require that this equipment be installed in a control room. The 240 projected machine room-less (MRL) elevator installations will require an additional construction cost of $5,000 per room.

The total negative economic impact per year for converting control spaces to control rooms is **$1,200,000** (240 x $5,000).

7.4 Rentable space in the building

Assumptions:

- The average cost of rentable space is $35 per sq. ft. per month.
- The average hydraulic machine room requires 35 sq. ft.
- The average control room requires 33 sq. ft.
- The average control space requires 17 sq. ft.

Negative Economic Impact Estimate:

240 (830 – 590) machine room-less (MRL) traction elevator control spaces will be converted to control rooms.

240 x 16 sq. ft. (33 – 17) x $35 per sq. ft. x 12 months = $1,612,800

170 (1220 - 1050) machine room-less (MRL) traction elevator control spaces will be converted to hydraulic elevator machine rooms.

170 x 18 sq. ft. (35 – 17) x $35 per sq. ft. x 12 months = $1,285,000

The total negative economic impact per year on rentable space in a building for converting machine room-less (MRL) traction elevator control spaces to control rooms and hydraulic elevator machine rooms is **$2,897,800** ($1,612,800 + 1,285,000).

Positive Economic Impact Estimate:

420 (680 - 260) machine room-less (MRL) traction elevators will be converted to machine room traction elevators. These elevators will no longer require a control space in the building because the motor and motion controllers will be installed in the machine room.

The total positive economic impact per year on rentable space in a building for converting machine room-less (MRL) traction elevators to machine room traction elevators is **$2,998,800** (420 x 17 sq. ft. x $35 per sq. ft. x 12 months).

7.5 Maintenance Costs

Assumptions:

- For the purposes of this estimate we will consider the costs of maintaining a machine room-less (MRL) traction elevator to be equal to the cost of maintaining a machine room traction elevator.
- Average monthly cost to maintain a machine room-less (MRL) or machine room traction elevator = $700
- Average monthly cost to maintain a machine room hydraulic elevator = $225
- The one-year and five-year periodic testing costs are included in the monthly maintenance price.

Positive Economic Impact Estimate:

170 (1,220 – 1,050) machine room-less (MRL) traction elevators will be converted to machine room hydraulic elevators.

The total positive economic impact per year for maintenance costs associated with converting machine room-less (MRL) traction elevators to machine room hydraulic elevators is **$969,000** (170 x $475 per month x 12 months).

7.6 Firefighters' Emergency Operation Testing

The current Elevator Safety Order regulations require 12 monthly tests of firefighters' emergency operation. The proposed Group V Elevator Safety Orders have changed the frequency of this testing to quarterly (note: The more extensive one-year periodic test of firefighters' emergency operation is already included in maintenance contracts). Therefore, the number of routine tests per year has been reduced from 12 to 3.

Assumptions:

- 95% of the projected (after full implementation) 121,500 elevators are equipped with firefighters' emergency operation.
- Firefighters' Emergency Operation testing will be done during the course of routine maintenance.
- Additional time required to conduct the testing = 15 minutes
- Average **cost** (not a competitive sell rate as used to estimate periodic testing of Group II elevators) for a 15-minute test = $26.00
- Elevator companies are conducting quarterly routine maintenance.

Positive Economic Impact Estimate:

9 tests of firefighters' emergency operation will be eliminated for 115,425 (95% of 121,500) existing elevators.

The total positive economic impact for the reduction in the frequency of firefighters' emergency operation testing is **$27,009,450** (121,500 x 95% = 115,425 x 9 x $26 per test).

Note: The labor time and cost associated with this duty will be transferred to Item No. 1–Periodic Testing of Group II Conveyances. The same Certified Competent Conveyance Mechanics that were previously employed to do this task will now be conducting periodic testing (transfer of duties).

7.7 Variances

The proposed Group V Elevator Safety Orders adopt by reference the most current version of the model consensus standard. The proposed Group V Elevator Safety Orders include provisions for alternate suspension and machine room-less installations which were the major reasons for seeking permanent variances.

Assumptions:

- Permanent variances will be reduced by approximately 590 per year after full implementation of the proposed Group V Elevator Safety Orders.
- Very few applications for permanent variances will be required in subsequent years.
- NEII estimates that the cost per variance = $6,000.

Positive Economic Impact Estimate:

590 applications for a permanent variance will be eliminated in the first year of adoption of the proposed Group V Elevator Safety Orders.

The total positive economic impact for the reduction in applications for a permanent variance is **$3,540,000** (590 x $6,000).

7.8 Plan Check Fees

Plan Check is required by Labor Code §7301.1. The Plan Check fee is based on a series of unique installation factors (see Title 8 §344.30 for Conveyance Inspection Program Fees).

Negative Economic Impact Estimate:

- Traction Elevator $976,500
- Hydraulic Elevator $457,500
- Escalator $67,500
- Other $96,500

The total negative economic impact for plan check fees is **$1,598,000**.

Note: If looked at in greater detail, plan check may be a positive economic impact because non-code compliant installations would be discovered during the planning process. Currently non-code compliant installations are discovered after the installation has been completed (e.g., the re-design costs for Levi's Stadium probably exceeded the figure shown above). This analysis takes a conservative approach by assuming that plan check fees are an additional cost.

7.9 Additional sources of economic impact:

Negligible Economic Impacts:

- **Elevator Industry Engineering Costs related to Plan Check**

  ASME A17.1 already requires layout drawings that would be acceptable for most installations. Additional installation information would only be required for machine room-less elevators.

- **Elevator Industry Engineering Costs for Converting Machine Room-less Elevators to Machine Room Elevators**

  Most major manufacturers already have standardized designs that place MRL components within a machine room.

Positive Economic Impacts:

- **Building Developer Architectural and Structural Engineering Costs**

  The reduced number of proprietary machine room-less (MRL) traction elevator designs will allow architects to utilize standardized dimensions when sizing the core of the building. This will lead to an increase in the number of competitive bids. This will also eliminate the need to revise building plans after an elevator company has been selected for the project.

- **Building Owner Elevator Replacement Costs**

  The useful life of a typical machine room traction elevator (40 years) and hydraulic elevator (30 years) exceeds the useful life of a typical machine room-less (MRL) elevator (15-20 years). The long-term costs (modernization and

replacement costs) to building owners and managers will be reduced by requiring a more sustainable elevator product.

- **Building Owner Permit-Required Confined Space Costs**

  The proposed Group V Title 8 Elevator Safety Orders require installations that eliminate most permit-required confined spaces for machine room-less (MRL) traction elevators. These proposed requirements follow the prevention through design (PtD) methodology contained in NFPA 350 (Guide for Safe Confined Space Entry and Work) and ANSI Z590.3 (Prevention through Design - Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes). This eliminates the cost of providing additional personnel when doing work in a confined space (on top of the elevator car at the top of the hoistway where the machine room-less (MRL) elevator machine, brakes, encoder and governor resides). It also eliminates the need for the building owner or manager to manage a confined space program.

- **Small Elevator Conveyance Businesses**

  Small California-based Certified Qualified Conveyance Companies have been adversely affected by the machine room-less (MRL) traction elevator designs. Major manufacturers hold patented hoistway configurations that block the small business' ability to compete.

  The economic impact analysis for the proposed ESOs projects a significant increase in the number of machine room traction and machine room hydraulic elevator installations. There are no patent issues for machine room installations. This will benefit small CQCCs.

  Small business CQCCs will purchase the required elevator components from industry suppliers (some with major manufacturing facilities in California) and sell machine room traction elevators at an average installed cost of $190,000 to $230,000 per elevator. NEII has estimated that the cost to convert a machine room-less (MRL) traction elevator (estimated cost of $200,000 per elevator) to a machine room traction elevator is $150,000 to $300,000 per elevator.[15] That puts the installed cost of a NEII supplied machine room traction elevator at $350,000 to $500,000. If NEII's estimate is to be believed, it would be a massive stimulus for small CQCC elevator businesses.

  We believe NEII has over-inflated its estimate of a machine room traction elevator. Ultimately, it will compete with small businesses and take back

[15] See NEII document: http://www.neii.org/pdf/CA%20Cost%20Calculations%201.pdf.

approximately 90% of machine room traction installations. That leaves 10% for small businesses.

7.10 Summary of Economic Impact

Tables C.7 and C.8 show a summary of the economic impact before and after transfer of labor duties.

C.7: Total Economic Impact after Transfer of Labor Duties

Negative Economic Impact per Year	Positive Economic Impact per Year
-$20,953,550	$30,296,246

C.8: Total Economic Impact before Transfer of Labor Duties

Negative Economic Impact per Year	Positive Economic Impact per Year
-$55,225,717	$64,568,413